



Two new genera and twelve new species of Graphidaceae from Puerto Rico: a case for higher endemism of lichenized fungi in islands of the Caribbean?

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Abstract

Two new genera and twelve new species of Graphidaceae are described from Puerto Rico. The two new genera, *Borinquenotrema* and *Paratopeliopsis*, are based on a combination of molecular sequence data and phenotype characters. *Borinquenotrema*, with the single new species *B. soredicarpum*, features rounded ascomata developing beneath and persistently covered with soralia and with an internal anatomy reminiscent of *Carbacanthographis*; it is close to the tribe Ocellulariae. *Paratopeliopsis*, including the single new species *P. caraibica*, resembles a miniature *Topeliopsis* but differs in the distinctly farinose thallus and the small, brown ascospores; it is not closely related to the latter genus but belongs in tribe Thelotremaeae. The other ten new species belong in the genera *Acanthotrema*, *Clandestinotrema*, *Compositrema*, *Fissurina*, *Ocellularia*, and *Thalloloma*. *Acanthotrema alboisidiatum* is closely related to *A. brasiliianum* but differs in the short, white isidia resembling insect eggs. *Clandestinotrema portoricense* has a unique ascospore type with a longitudinal septum only in the proximal cell. *Compositrema borinquense* resembles a species of *Stegobolus* but belongs in *Compositrema* based on sequence data, and is characterized by ascomata with a unique columella composed of thick, irregularly radiating strands. The second new species in this genus, *C. isidiofarinosum*, differs by its ecorticate, farinose thallus with scattered, corticate isidia and by its small ascospores with inconspicuous columella. The three new species of *Fissurina* all have 3-septate ascospores and are otherwise characterized by an isidiate thallus and stellate, orange-yellow lirellae (*F. aurantiacostellata*), a verrucose thallus strongly encrusted with calcium oxalate crystals and white, irregularly branched lirellae (*F. crystallifera*), and myriotremoid ascomata arranged in short lines (*F. monilifera*). *Ocellularia portoricensis* belongs in the core group of *Ocellularia* and differs from *O. cavata* in the white medulla and the larger ascospores becoming brown, whereas *O. vulcanisorediata* produces prominent soralia and immersed ascomata with apically carbonized excipulum and columella and small, transversely septate, hyaline ascospores; it is closely related to *O. conformalis*. Finally, *Thalloloma rubromarginatum* resembles *T. haemographum* in the brownish lirellae with bright red margin but differs from that and other species in the corticate thallus and the norstictic acid chemistry. The new combination *Ampliotrema rimosum* (Hale) Mercado-Díaz, Lücking & Parnmen is also proposed. Considering the current biodiversity knowledge on this family, the high level of endemism observed in other groups of organisms in the island, and the relatively high number of Graphidaceae described, it is highly likely that at least some of these new taxa are endemic to the island. This view is further supported by the unique features of several of the new species, representing novel characters in the corresponding genera.

Keywords: Caribbean, conservation

Introduction

Considering its relatively small size (8,900 km²), the Caribbean island of Puerto Rico is among the biologically richest islands of the world. For instance, Puerto Rico harbors about 2,255 native species of vascular plants, compared to 1,300 species in the Hawaiian Islands (Santiago-Valentín 2008; Imada 2012). Amphibian diversity per

unit area in Puerto Rico is not only greater than the rest of the Greater Antillean islands, but greater than most other islands in the world (Joglar 2005). Puerto Rico's rich biological heritage is also astonishing considering the fact that more than 90% of the island was deforested by 1940 (Grau *et al.* 2003). Although forest cover showed signs of recovery in the past (Birdsey & Weaver 1987; Pasarella *et al.* 2000), recent work indicate that forest expansion may be slowing down (Brandeis & Turner 2013; Kennaway & Helmer 2007). Puerto Rico is also the most densely populated territory in all of the Americas [<http://data.worldbank.org/indicator/EN.POP.DNST>], with 3.7 million persons within 9,000 km², suggesting a high pressure on the island's natural resources.

Although at least half of the global lichen diversity is expected to occur in the tropics, these organisms remain poorly characterized in that region (Lücking *et al.* 2009). Compared to other areas in the neotropics, the knowledge of lichen diversity in the Caribbean is particularly rudimentary. Even when Puerto Rico is considered to be among the most well-known islands in this respect (Mercado-Díaz & Santiago-Valentín 2010; Lücking *et al.* 2009), more work is still needed to get a comprehensive picture of the island's lichen biodiversity. For instance, only one preliminary key exists based on a workshop in 1989, with many taxa left unidentified (Harris 1989). This situation is of concern, particularly because of the possible existence of undiscovered species that may be in risk of extinction. Thorough conservation initiatives accompanied by comprehensive biological inventories are therefore essential for the protection of poorly known organisms such as lichens, and biodiversity overall. The preliminary checklist of lichens and lichenicolous fungi for Puerto Rico represents a first step in this direction (Mercado-Díaz 2009; Mercado-Díaz & Santiago-Valentín 2010). However, while these works list a total of 1,181 names for the island, recent estimates suggest that there may be at least 1,600 species in Puerto Rico (Lücking *et al.* 2009).

Graphidaceae is the dominant family of lichenized fungi in the tropics and, with recent global efforts to catalogue and classify its diversity, has increased to nearly 2,500 currently recognized species (Rivas Plata *et al.* 2012a, 2013; Lücking *et al.* 2014). With 175 species described as new in this volume, a global model predicts that at least further 1,800 species await discovery and formal description. Many of these species are expected to be found in understudied tropical regions (Lücking *et al.* 2014). One of the most important findings in global revisions of these and other families, such as Lobariaceae and Hygrophoraceae, is the fact that there are few widespread species and instead, endemism is much more frequent than previously assumed. Thus, of 22 species of *Fissurina* documented for the Hawaiian islands, 19 are inferred endemic, and similar trends are observed for the genera *Lobariella*, *Pseudocyphellaria*, and *Sticta* (Lobariaceae), as well as the basidiolichens *Acantholichen*, *Cora*, *Corella*, *Cyphelostereum*, and *Dictyonema* in the family Hygrophoraceae (Dal-Forno *et al.* 2013; Lücking *et al.* 2013; Moncada *et al.* 2013a, b). Therefore, one would also expect a certain level of endemism in lichenized fungi for islands in the Caribbean, although perhaps not as marked as for the Hawaiian archipelago.

In this paper, we report the results from work on a set of specimens of Graphidaceae collected in El Yunque National Forest in Puerto Rico. This collection resulted from a project characterizing lichen communities along an elevational gradient in the northeastern portion of the island (Mercado-Díaz *et al.*, in prep). Using molecular sequence data in combination with phenotype characters, we identified 12 species new to science, including two new genera. Based on our current understanding of regional biodiversity trends within this family, the results of this study, and comprehensive collection efforts throughout the island, we consider that El Yunque is perhaps a biodiversity hotspot for this family in the island, and possibly the Caribbean. Moreover, the remarkably high number of Graphidaceae species discovered together with the fact that high endemism in other groups of organisms of the island is not an uncommon phenomenon (e.g. 91% in reptiles; Joglar 2005), suggest that at least some of the newly discovered taxa are potentially endemic to the island. These observations are further supported by the unique and novel characteristics found in several of the new species. In this sense, we consider that these discoveries represent additional support for the hypothesis that the degree of endemism in lichenized fungi in Puerto Rico, and consequently the Caribbean islands, is potentially much higher than hitherto assumed (Mercado-Díaz *et al.* 2013). Nevertheless, since many areas of the Caribbean remain undercollected (Lücking *et al.* 2009), more studies and exhaustive inventories of similar habitats throughout the region are sorely needed, not just to confirm the endemic status of these taxa, but to keep unraveling the unparalleled biodiversity that thrive in the forests of the Caribbean islands, underlining the needs for their continued protection (Myers *et al.* 2000).

Material and Methods

The studied material was collected in the vicinity of research plots which are part of an ongoing study describing different ecological parameters in eight forest ecosystems present in the northeastern portion of the island (González *et al.* 2013; Gould *et al.* 2006). Specifically, the examined material came from forest patches representing the following forest types present in El Yunque National Forest: Tabonuco forest, Palo Colorado forest and Sierra Palm forest. Forest type names are derived from tree species that are dominant in each of these ecosystems [Tabonuco = *Dacryodes excelsa* Vahl (1810: 116); Palo Colorado = *Cyrilla racemiflora* Linnaeus (1767: 162); Sierra Palm = *Prestoea acuminata* var. *montana* (Graham) Henderson & Galeano (1996: 53)]. Environmental conditions vary among these forests and particular vegetation composition and structure characterizes each forest type (Lugo 2005).

The specimens were processed at the International Institute of Tropical Forestry and studied at The Field Museum. Thallus morphology was examined using a LEICA MS5 dissecting microscope. Sections of thalli and ascocarps were cut by hand with a razor blade and examined with squash preparations in water, KOH and Lugol's solution, using a ZEISS Axioskop 2 compound microscope. All measurements are given in water. TLC was done using standard techniques with solvent C following Orange *et al.* (2010). Molecular sequence data of the mitochondrial small subunit (mtSSU) and the nuclear large subunit (nuLSU) of the rDNA cistron were obtained for most specimens following previously published protocols (Rivas Plata *et al.* 2012b, 2013) and are published separately (Kraichak *et al.* 2014; Lumbsch *et al.* 2014).

Taxonomic Treatment

Acanthotrema alboisidiatum Mercado-Díaz, Lücking & Parnmen, sp. nov. (Fig. 1A–B)

Mycobank #808423

Sequence accessions: KJ667049 (mtSSU, holotype), KJ667050 (mtSSU, paratype).

Differing from *Acanthotrema brasiliandum* in the white, short isidia that resemble insect eggs.

Type:— PUERTO RICO. Río Grande: Barrio Guzmán Arriba, road PR-186; 18°17'36"N, 65°50'23"W, 518 m; on trunk of *Dacryodes excelsa*; Mercado-Díaz 625 (holotype UPR!; isotype F!).

Thallus corticolous, epiperidermal, up to 5 cm diam., continuous; surface smooth to uneven, light olive-green, shiny, isidiate; prothallus present, white-grey, shiny. Isidia scattered to numerous, at first egg-shaped but eventually becoming short cylindrical to sausage-shaped (allantoid), with slightly constricted base, white, 0.2–0.5(–1.0) mm long and 0.1–0.15 mm broad. Thallus in section 20–30 µm thick, with dense, prosoplectenchymatous cortex, 4–7 µm thick, and photobiont layer 20–25 µm thick, lacking crystal clusters. Photobiont *Trentepohlia*; cells rounded to irregular in outline, in irregular groups, yellowish green, 7–11 × 6–10 µm. Ascocarps not observed.

Secondary chemistry:—No substances detected by TLC.

Etymology:—The epithet refers to the white isidia contrasting strongly with the olive-green thallus.

Distribution and ecology:— This species was found growing in the shaded understory of Tabonuco forests in El Yunque National Forest, particularly toward the base of *Dacryodes excelsa* trees.

Remarks:—This new species is here formally described even in the absence of ascocarps and ascospores, based on the very characteristic, white isidia resembling insect eggs especially when not fully grown. Sequence data from the mitochondrial small subunit rDNA (Fig. 2) show that both available collections are conspecific and are strongly supported within the genus *Acanthotrema* Frisch in Frisch *et al.* (2006: 77), but as a species distinct from the hitherto known three species, *A. brasiliandum* (Hale) Frisch in Frisch *et al.* (2006: 77), *A. frischii* Lücking in Rivas Plata *et al.* (2010: 181), and *A. kalbii* Lücking in Sipman *et al.* (2012: 20).

Additional specimen examined:—PUERTO RICO. Luquillo: Barrio Sabana, road PR-988; 18°19'02"N, 65°44'31"W, 300 m; on trunk of *Dacryodes excelsa*; Mercado-Díaz 624 (F, UPR).

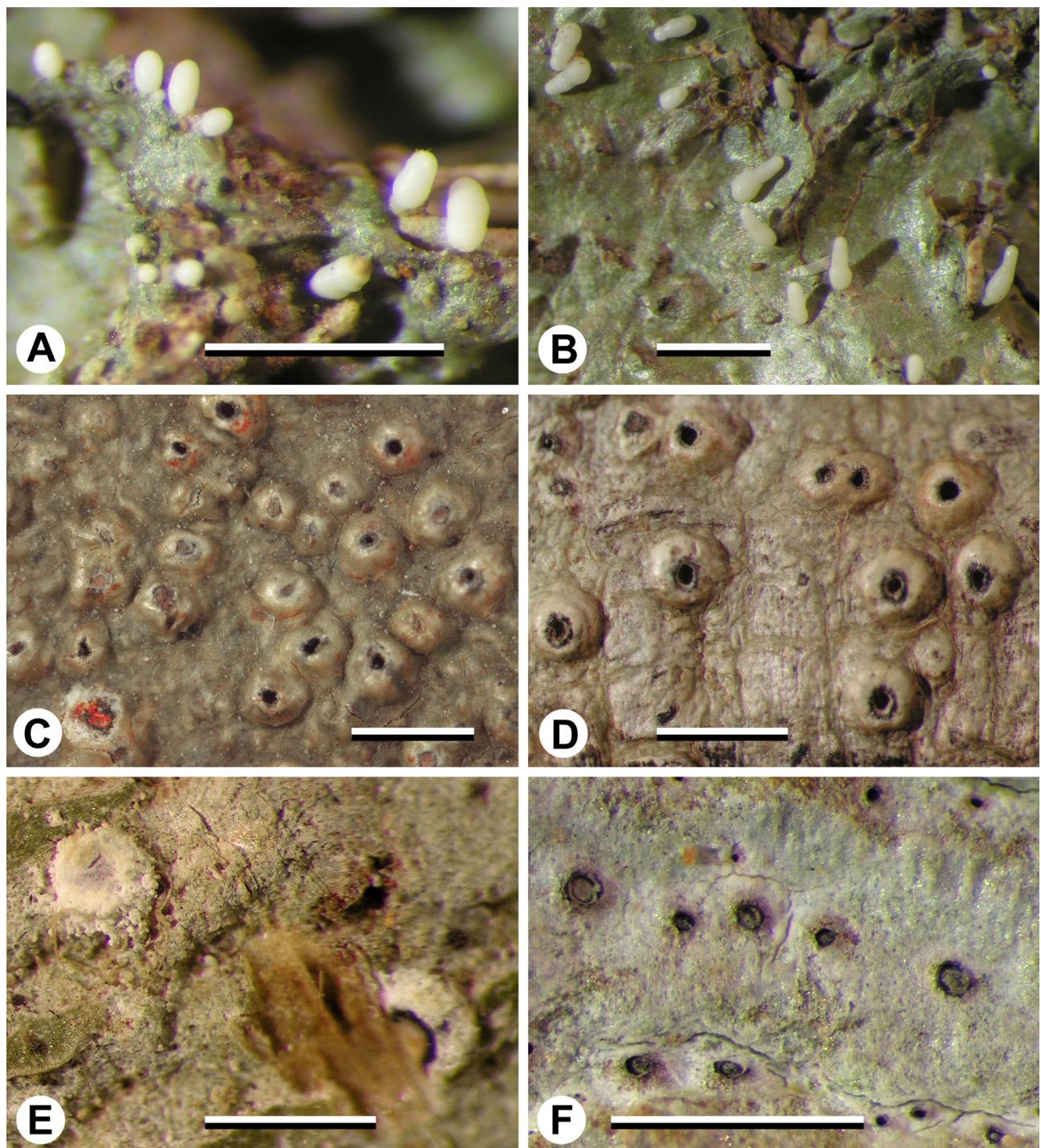


FIGURE 1. A–B. *Acanthotrema alboisidiatum*, thallus with isidia (isotype). C–D. *Ampliotrema rimosum*, thallus with ascomata (C, holotype in US; D, Mercado-Díaz 627). E. *Boringuenotrema soredicarpum*, thallus with ascocarp (isotype). F. *Clandestinotrema portoricense*, thallus with ascomata (isotype). Scale = 1 mm.

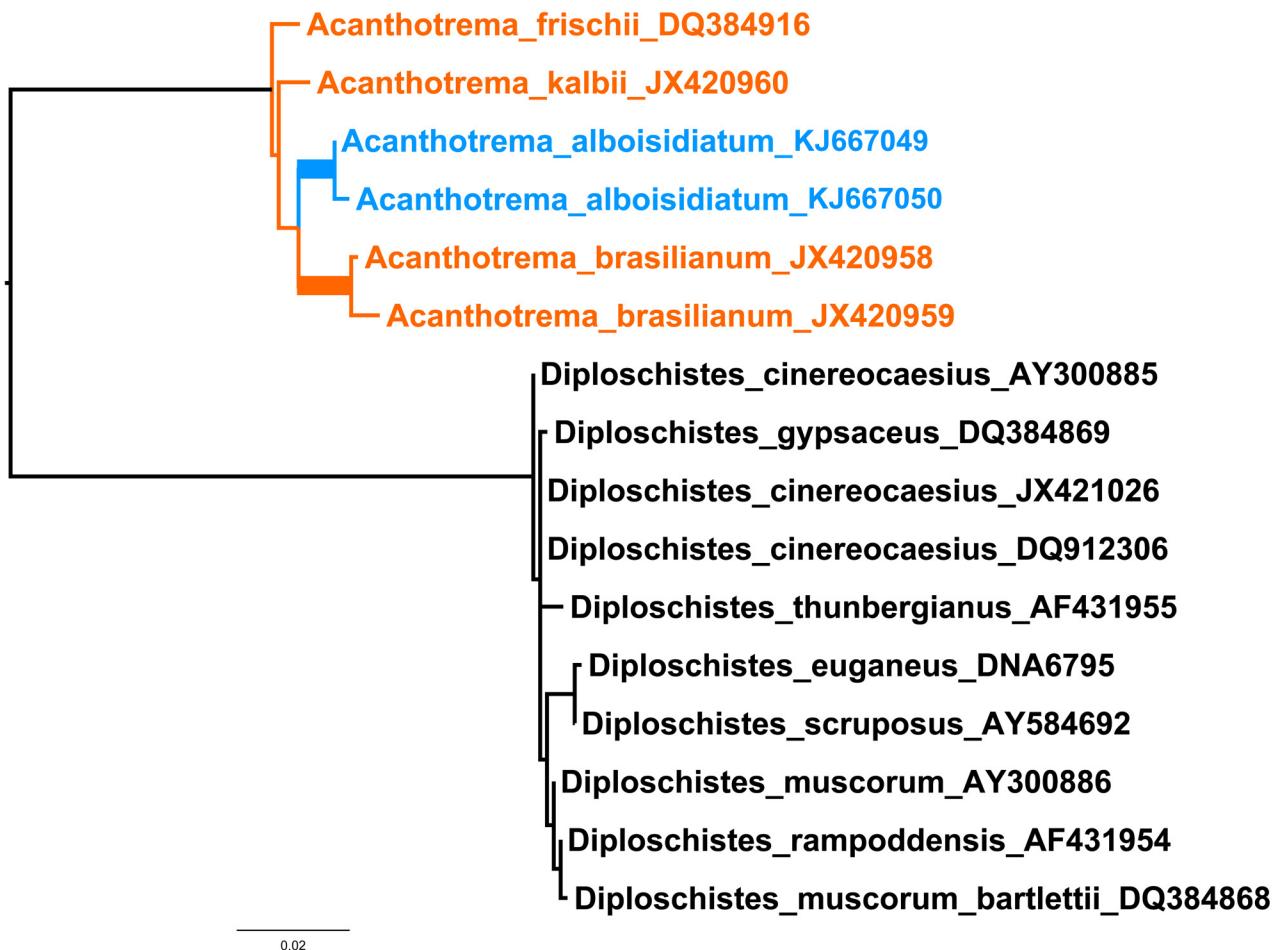


FIGURE 2. Phylogeny of *Acanthotrema* based on mtSSU sequence data showing placement of *A. alboisidiatum*. Thick lines indicate 100% bootstrap support.

***Ampliotrema rimosum* (Hale) Mercado-Díaz, Lücking & Parnmen, comb. nov. (Fig. 1C–D)**
Mycobank #808431

Ocellularia rimosa Hale, Smithson. Contr. Bot. 16: 27 (1974). Holotype: DOMINICA, Hale 37978 (US!).

Remarks:—This taxon has been greatly misunderstood in the literature. The name *Ocellularia rimosa* is usually applied to species of *Ocellularia* s.str. with inspersed hymenium and was even synonymized with *O. fumosa* (Ach.) Müller (1887a: 7; Mangold *et al.* 2009), covering a mixture of taxa actually unrelated to this species. Restudy of the type material from Dominica (Hale 1974) revealed that the disc of the ascocarps features a bright red pigment, not mentioned in the original description. Also, the overall morphology of the ascocarps, with the excipulum carbonized mostly in the upper parts, the broad pore, and the lack of a columella, point to a close relationship with the species currently recognized in the genus *Ampliotrema* Kalb ex Kalb in Frisch *et al.* (2006: 81). Molecular sequence data of a specimen from Puerto Rico identical to the type material confirmed this view (Kraichak *et al.* 2014), and hence the combination into *Ampliotrema* is proposed here. *Ampliotrema rimosum* is known with certainty only from the Caribbean (Puerto Rico and Dominica); all other reports must be critically revised and most likely represent unrelated species in *Ocellularia* s.str.

Specimen examined:—PUERTO RICO. Naguabo: Barrio Río Blanco, road PR-930; 18°17'39"N, 65°47'11"W, 759 m; on trunk of *Clusia rosea*; Mercado-Díaz 627 (F, UPR).

***Borinquenotrema soredicarpum* Mercado-Díaz, Lücking & Parnmen, gen. et sp. nov.** (Fig. 1E)

Mycobank #808439 (genus), #808483 (type species)

Sequence accessions: KJ440980 (mtSSU, holotype), KJ440940 (nuLSU, holotype).

A new genus and species close to the tribe Ocellulariae, characterized by carbonized ascomata with internal anatomy resembling *Carbacanthographis* and developing from within soralia, as well as distoseptate, I+ blue-violet ascospores.

Type:—PUERTO RICO. Luquillo: Barrio Sabana, road PR-988; 18°19'02"N, 65°44'31"W, 300 m; on trunk of *Dacryodes excelsa*; Mercado-Díaz 883 (holotype UPR!; isotype F!).

Thallus corticolous, epiperidermal, up to 2 cm diam., continuous; surface smooth to uneven, light greyish green, sorediate; prothallus absent. Soralia maculiform to capitate, white, granular, 0.2–0.6 mm diam. Thallus in section 50–70 µm thick, ecorporate, with irregular, photobiont layer 40–60 µm thick and indistinct medulla, lacking clusters of calcium oxalate crystals. Photobiont *Trentepohlia*; cells rounded to irregular in outline, densely packed, olive green, 7–12 × 6–10 µm. Ascomata developing exclusively under the soralia, rounded, becoming prominent and hemispherical but remaining covered by a layer of granular soredia, 0.5–0.6 mm diam., 0.25–0.35 mm high; disc concealed; proper margin distinct only after removing the soredia, black; thalline margin thin, forming a grey layer up to the pore and covered by a thick layer of white soredia. Excipulum carbonized down to the base but absent below the hymenium, 70–120 µm wide, fused with thin thalline margin and externally covered by a layer of granular soredia, distinctly overarching the hymenium with a deep slit; hypothecium prosoplectenchymatous, 20–30 µm high, yellowish to olive-brown; hymenium 200–250 µm high, hyaline, clear; epithecium indistinct, 10–15 µm high, hyaline. Paraphyses mostly unbranched but anastomosing in lateral portions of the hymenium close to the excipulum, smooth; periphysoids not observed; ascii oblong to clavate, 180–230 × 30–40 µm. Ascospores 8 per ascus, irregularly arranged, oblong-oval, muriform with 9–13 transverse and 1–3 longitudinal septa per segment, 40–50 × 12–15 µm, 3–4 times as long as wide, hyaline, distoseptate with lens-shaped to rounded lumina, I+ violet-blue.

Secondary chemistry:—Stictic acid and satellite substances.

Etymology:—The genus name refers to the indigenous name Borinquen for the island of Puerto Rico, and the epithet to the unusual development of ascomata beneath soralia.

Distribution and ecology:—This taxon was found growing in the shaded understory of Tabonuco forests in El Yunque National Forest, on the living trunk of an unidentified tree.

Remarks:—This new taxon was at first mistaken for a species of *Carbacanthographis* Staiger & Kalb in Staiger (2002: 98), due to the thin, ecorporate thallus and the anatomy of the excipulum overarching the hymenium with a deep slit. However, molecular sequence data of the small subunit of the mitochondrial rDNA place it close to tribe Ocellulariae (Lumbsch *et al.* 2014), which is consistent with the I+ strongly blue-violet ascospores. Hence the new genus *Borinquenotrema* is described for it. The most remarkable feature of the new taxon are the ascomata developing under soralia and maintaining a cover of granular soredia even in the mature condition, hiding the ascoma completely. Such a morphology is otherwise known from certain species of *Pertusaria* DC. in Lamarck & de Candolle (1805: 319). This strategy might aid in dispersing soredia together with ascospores to ensure the availability of photobiont cells upon resymbiosis. The stictic acid chemistry is also unusual for tribe Ocellulariae but for example known from *Ocellularia pyrenuloides* Zahlbr. ex H. Magn. in Magnusson & Zahlbruckner (1944: 46).

***Clandestinotrema portoricense* Mercado-Díaz, Lücking & Parnmen, sp. nov.** (Fig. 1F)

Mycobank #808424

Differing from *Clandestinotrema analorenae* in the peculiar, submuriform ascospores, with the uppermost cell featuring a longitudinal septum.

Type:—PUERTO RICO. Canóvanas: Barrio Cubuy, road PR-186, to the right side of trail leading to Pico del Toro; 18°16'40"N, 65°50'53"W, 815 m; on trunk of an unidentified tree; Mercado-Díaz 701 (holotype UPR!; isotype F!).

Thallus corticolous, thinly epiperidermal or partially endoperidermal, up to 5 cm diam., continuous; surface smooth to uneven, white, slightly shiny; prothallus absent. Thallus in section 20–30 µm thick, with irregular, thin, prosoplectenchymatous cortex, 4–7 µm thick, and irregular photobiont layer 15–25 µm thick, lacking crystal

clusters. Photobiont *Trentepohlia*; cells rounded to irregular in outline, in irregular groups, yellowish green, 7–12 × 6–10 µm. Ascomata rounded, immersed, with lateral thalline margin, 0.1–0.2 mm diam., 0.05–0.07 mm high; disc covered by 0.05–0.1 mm wide pore almost completely filled by black columella; proper margin thin but distinct, entire, forming a black rim around the pore; thalline margin entire, light to dark grey. Excipulum entire, carbonized in upper half, in lower portion orange-brown, 20–40 µm wide, prosoplectenchymatous in thin sections; laterally covered by algiferous thallus; columella finger-like to plug-shaped, carbonized except for the basal, yellowish brown portion, 50–100 µm wide; hypothecium prosoplectenchymatous, 5–10 µm high, colorless; hymenium 80–90 µm high, colorless, clear; epithecium indistinct, 3–5 µm high, colorless. Paraphyses unbranched, apically smooth; periphysoids absent; ascii fusiform to clavate, 80–90 × 15–20 µm. Ascospores 8 per ascus, ellipsoid with the distal end slightly tapering and acute, 3-septate to often submuriform with the upper segment featuring an additional, longitudinal septum, 12–15 × 4–5 µm, 2.5–3.5 times as long as wide, hyaline, distoseptate with diamond-shaped lumina, I₊.

Secondary chemistry:—No substances detected by TLC.

Etymology:—The epithet refers to the island of Puerto Rico.

Distribution and ecology:—This species was found in the shaded understory of a Palo Colorado forest in El Yunque National Forest, on the living trunk of an unidentified tree.

Remarks:—The genus *Clandestinotrema* Rivas Plata *et al.* (2012a: 116) includes species with *Ocellularia*-type, often carbonized and columellate ascomata but closely related to *Fissurina* Fée (1825: xxxv, cx) in subfamily Fissurinoideae (Rivas Plata *et al.* 2012a). Thus far, 13 species are known in this genus, usually found at higher elevations in montane rain and cloud forests (Rivas Plata *et al.* 2012a; Sipman *et al.* 2012). Most have regularly (sub-)muriform ascospores, except for *C. analorense* Lücking in Sipman *et al.* (2012: 56), *C. maculatum* (Hale) Rivas Plata *et al.* (2012a: 118), and *C. protoalbum* (Hale) Rivas Plata *et al.* (2012a: 118), with regularly 3-septate ascospores. The new species differs in its seemingly 3-septate ascospores in which the thicker proximal segment may form an additional, longitudinal septum. It is otherwise most similar to *C. analorense* from Costa Rica (Sipman *et al.* 2012) in overall morphology but differs, apart from the peculiar ascospore septation, in the carbonization of excipulum and columella (complete in *C. analorense*).

***Compositrema borinquense* Mercado-Díaz, Lücking & Parnmen, sp. nov.** (Fig. 3A–B)

Mycobank #808462

Sequence accessions: KJ435180 (mtSSU, holotype).

Differing from *Compositrema thailandicum* in the distinct, irregularly radiating columella.

Type:—PUERTO RICO. Canóvanas: Barrio Cubuy, road PR-186, to the right side of trail leading to Pico del Toro; 18°16'40"N, 65°50'53"W, 815 m; on trunk of an unidentified tree Mercado-Díaz 953 (holotype UPR!; isotype F!).

Thallus corticolous, epiperidermal, up to 10 cm diam., continuous; surface smooth to uneven, light grey-green, shiny; prothallus absent or white-grey, shiny. Thallus in section 80–100 µm thick, with dense, prosoplectenchymatous cortex, 10–15 µm thick, and photobiont layer 70–90 µm thick, lacking crystal clusters. Photobiont *Trentepohlia*; cells rounded to irregular in outline, in irregular groups, yellowish green, 7–12 × 5–10 µm. Ascomata rounded to irregular in outline, prominent to broadly sessile, with lateral thalline margin, 0.7–1.5 mm diam., 0.2–0.3 mm high; disc more or less exposed but completely filled by irregular columella with numerous radiating to irregularly arranged, cream-white strands; proper margin distinct, entire, visible as cream-white rim around the pore; thalline margin entire, light greyish green. Excipulum entire, orange-brown, 20–30 µm wide, prosoplectenchymatous in thin sections; laterally covered by corticate algiferous thallus filled with numerous small, grey crystals; columella in section divided into numerous strands, orange-brown, each strand 20–30 µm wide, apically covered with small, grey crystals; hypothecium prosoplectenchymatous, 10–20 µm high, colorless; hymenium 100–120 µm high, colorless, clear; epithecium indistinct, 5–10 µm high, colorless. Paraphyses unbranched, apically smooth; periphysoids absent; ascii fusiform to clavate, 90–110 × 10–12 µm. Ascospores 8 per ascus, ellipsoid, 3-septate, 10–15 × 4–5 µm, 2.5–3 times as long as wide, hyaline, distoseptate with lens-shaped lumina, I₊ violet-blue.

Secondary chemistry:—Psoromic, subpsoromic, and 2'-*O*-demethylpsoromic acids.

Etymology:—The epithet refers to the indigenous name Borinquen for the island of Puerto Rico.

Distribution and ecology:— This species was found in the shaded understory of a Palo Colorado forest in El Yunque National Forest, on the living trunk of an unidentified tree.

Remarks:—The type species of the genus *Compositrema*, *C. cerebriforme* J.E. Hern. & Lücking in Rivas Plata *et al.* (2012b: 1174), forms compound ascomata with brain-like appearance. A second species described simultaneously, *C. thailandicum* Rivas Plata *et al.* (2012: 1174), resembles the genus *Stegobolus* Montagne (1845: 4) in having ascocarps with a complex columella, although the two genera are not closely related (Rivas Plata *et al.* 2013; Kraichak *et al.* 2014). The new species introduced here, *C. borinquense*, further supports the notion of close morphological resemblance between the two genera, as without molecular data, it would have been identified as a species of *Stegobolus*. It differs from all known species in the two genera in the morphology of the columella, with conspicuous, irregularly arranged to radiating strands. Most similar is *Stegobolus radians* (Müll. Arg.) Frisch in Frisch *et al.* (2006: 479), in which, however, the columella strands are much thinner, white, and regularly radiate.

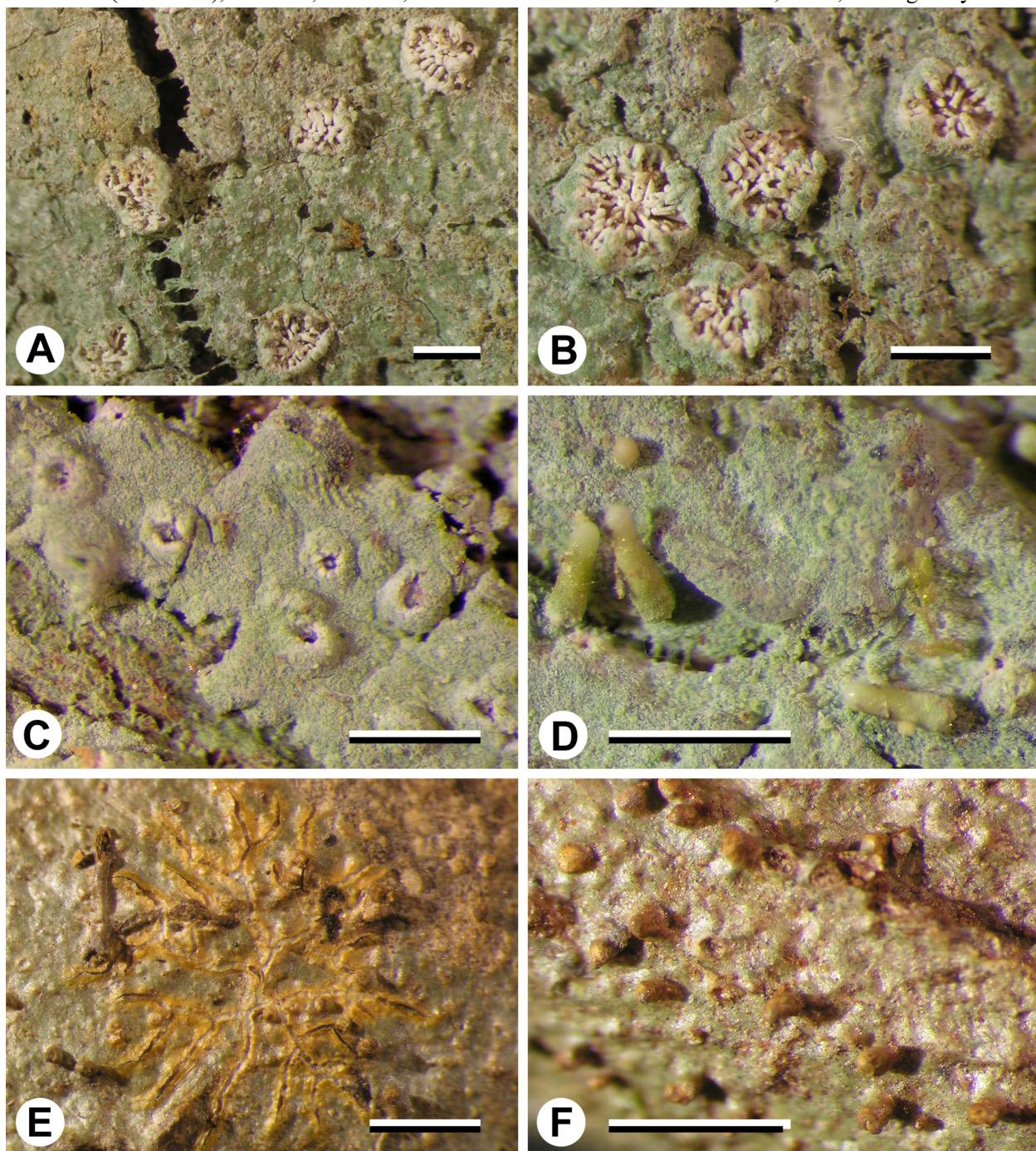


FIGURE 3. A–B. *Compositrema borinquense*, thallus with ascocarps (isotype). C–D. *C. isidiofarinosum*, thallus with ascocarps and isidia (isotype). E–F. *Fissurina aurantiacostellata*, thallus with ascocarps and isidioid outgrowths (E, isotype; F, paratype). Scale = 1 mm

***Compositrema isidiofarinosum* Mercado-Díaz, Lücking & Parnmen, sp. nov.** (Fig. 3C–D)

Mycobank #808463

Sequence accessions: KJ435175 (mtSSU, holotype), JX421018 (mtSSU, paratype).

Differing from other species of *Compositrema* in the ecorticate, farinose thallus furnished with scattered, corticate isidia, and the small ascomata with inconspicuous columella.

Type:—PUERTO RICO. Canóvanas: Barrio Cubuy, road PR-186, to the right side of trail leading to Pico del Toro; 18°16'40"N, 65°51'01"W, 796 m; on trunk of an unidentified tree; *Mercado-Díaz* 880 (holotype UPR!; isotype F!).

Thallus corticolous, epiperidermal, up to 10 cm diam., continuous; surface minutely farinose-arachnoid, light greenish white, isidiate; prothallus absent. Isidia sparse, scattered, at first globose but soon becoming short cylindrical, light yellowish green, corticate and shiny, 0.3–0.7 mm long and 0.1–0.15 mm broad, often with pinkish base when breaking off. Thallus in section 50–70 µm thick, ecorticate but surface with vertically projecting, short, arbuscular hyphae causing the farinose-arachnoid appearance, with photobiont layer 20–30 µm thick and medulla 30–40 µm thick, bordering the ascomata up to 100 µm thick, both layers densely encrusted with small, grey crystals. Photobiont *Trentepohlia*; cells rounded to irregular in outline, in irregular groups, yellowish green, 8–12 × 6–10 µm. Ascomata rounded to angular, erumpent, with complete thalline margin, 0.3–0.5 mm diam., 0.15–0.2 mm high; disc covered by 0.1–0.2 mm wide pore partially filled with irregular, white-tipped columella; proper margin indistinct; thalline margin entire to fissured, light greenish-white. Excipulum entire, yellow-brown, 15–30 µm wide, prosoplectenchymatous in thin sections; laterally covered by several layers of dead periderm cells covered by algiferous thallus with thick medulla; columella present but inconspicuous, becoming irregular in outline with radial slits, yellow-brown, 50–100 µm wide; hypothecium prosoplectenchymatous, 10–15 µm high, colorless; hymenium 90–100 µm high, colorless, clear; epithecium indistinct, 5–10 µm high, colorless. Paraphyses unbranched, apically smooth; periphysoids absent; ascii fusiform to clavate, 90–100 × 10–12 µm. Ascospores 8 per ascus, ellipsoid, 3-septate, 12–15 × 5–6 µm, 2–3 times as long as wide, hyaline, distoseptate with lens-shaped lumina, I+ violet-blue.

Secondary chemistry:—Psoromic, subpsoromic, and 2'-*O*-demethylpsoromic acids.

Etymology:—The epithet refers to the farinose, isidiate thallus.

Distribution and ecology:—This species was found in the shaded understory of a Palo Colorado forest in El Yunque National Forest. It was found on the living trunk of an unidentified tree.

Remarks:—This new taxon at first glance resembles a species of *Melanotrema* Frisch in Frisch *et al.* (2006: 382) or *Redingeria* Frisch in Frisch *et al.* (2006: 402), with the ecorticate thallus and ascomata featuring an irregular columella. However, molecular sequence data of the mitochondrial small subunit rDNA place it within the recently described genus *Compositrema*, with strong support (Kraichak *et al.* 2014), together with another new species described above, *C. boringense*. *Compositrema isidiofarinosum* differs from all other species in that genus by the minutely farinose-arachnoid thallus furnished with scattered, corticate isidia, and the comparatively small, erumpent ascomata with inconspicuous columella. The holotype clusters with a specimen from Venezuela thus far identified as *Compositrema* sp. (Rivas Plata *et al.* 2013). For some time, we believed that this was an artifact, since that specimen superficially resembled *Myriotrema ecorticatum* J.E. Hern. & Kalb in Lücking *et al.* (2012: 4), a species related to *Ocellularia terebrata* (Ach.) Müller (1887b: 398) and relatives (Rivas Plata *et al.* 2012b, 2013). However, the material from Puerto Rico confirms this as a distinct species unrelated to *M. ecorticatum*, with a remarkable degree of morphological convergence.

Additional specimen examined:—VENEZUELA. Aragua: Henri Pittier National Park, Dr. Alberto Fernández Yépez Biological Station, km 12 on road from Maracay to Ocumare, "Andrew Field" trail; 10°21'N, 67°40'W, 1100–1200 m; tropical cloud forest; August 2010, Kalb s.n. (F!, hb. Kalb).

***Fissurina aurantiacostellata* Mercado-Díaz, Lücking & Parnmen, sp. nov.** (Fig. 3E–F)

Mycobank #808425

Differing from *Fissurina astroisidiata* in the orange-yellow lirellae with concealed disc and the irregular isidioid outgrowths.

Type:—PUERTO RICO. Naguabo: Barrio Río Blanco, road PR-930, 18°17'39"N, 65°47'11"W, 759 m; on trunk

of *Clusia rosea*; Mercado-Díaz 739 (holotype UPR!; isotype F!).

Thallus corticolous, epiperidermal, up to 10 cm diam., continuous; surface smooth to uneven, olive-green, shiny, isidiate; prothallus absent. Thallus in section 40–60 µm thick, with prosoplectenchymatous cortex, 10–15 µm thick, and photobiont layer 30–50 µm thick, lacking clusters of calcium oxalate crystals. Isidia scattered to numerous, at first verruciform but eventually becoming short cylindrical with irregular tips (tuberculiform), olive-green with the tips darkened or orange-yellow, 0.3–0.5 mm long and 0.1–0.2 mm broad. Photobiont *Trentepohlia*; cells rounded to irregular in outline, densely packed, olive green, 7–11 × 5–9 µm. Ascomata lirellate, irregularly to stellately branched, erumpent to prominent, more or less roof-like to hemithecoid with thin to distinct labia and concealed disc, 1–3 mm long, 0.15–0.25 mm broad, 0.07–0.1 mm high; disc concealed; proper margin thin but distinct, forming a thin, dark brown line along the slit; thalline margin orange-yellow. Excipulum yellowish below, dark brown in upper parts, 10–20 µm wide, prosoplectenchymatous, fused with thalline margin; thalline margin 30–50 µm thick, with the cortex tinted yellow; hypothecium prosoplectenchymatous, 10–15 µm high, hyaline; hymenium 50–60 µm high, hyaline, clear; epithecium indistinct, 3–5 µm high, hyaline. Paraphyses unbranched, smooth; periphysoids not observed; ascii cylindrical to clavate, 50–60 × 8–12 µm. Ascospores 8 per ascus, irregularly arranged, ellipsoid, 3-septate, 8–12 × 3–4 µm, 2.5–3 times as long as wide, hyaline, subdistoseptate with more or less angular lumina, I—.

Secondary chemistry:—No substances detected by TLC.

Etymology:—The epithet refers to the orange-yellow, stellately branched lirellae.

Distribution and ecology:—This species was found in a Palo Colorado forest in El Yunque National Forest, growing on *Clusia rosea* trees in shaded to partly illuminated conditions.

Remarks:—*Fissurina aurantiacostellata* is characterized by the usually stellately branched lirellae with orange-yellow thalline margin and the isidioid outgrowths with orange-yellow or darkened, irregular, tuberculiform tips. A similar thallus structure with isidioid outgrowths is found in *F. aurantiacolirellata* Papong, Lücking & Kraichak in Papong *et al.* (2014), described from New Caledonia. In that species, the lirellae are also orange-yellow, but the color is caused by an anthraquinone pigment, whereas pigments are absent in *F. aurantiacostellata*. Also, the lirellae in *F. aurantiacolirellata* are prominent to sessile and shorter, and the ascospores are persistently 1-septate. Another similar species is *F. astroisidiata* Herrera-Camp. & Lücking in Lumbsch *et al.* (2011: 56), described from Mexico. That species also has stellately branched lirellae, but the thallus features true isidia and lacks any orange-yellow tinge; in addition, the ascospores are submuriform.

Additional specimen examined:—PUERTO RICO. Naguabo: Barrio Río Blanco, road PR-930, 18°17'39"N, 65°47'11"W, 759 m; on trunk of *Clusia rosea*; Mercado-Díaz 737 (F, UPR).

***Fissurina crystallifera* Mercado-Díaz, Lücking & Parnmen, sp. nov.** (Fig. 4A)

Mycobank #808426

Sequence accessions: KJ440941 (nuLSU, holotype).

Differing from *Fissurina dumastii* and similar species in the coarsely verrucose thallus strongly encrusted with clusters of calcium oxalate crystals and in the white lirellae.

Type:—PUERTO RICO. Canóvanas: Barrio Cubuy, road PR-186, to the right side of trail leading to Pico del Toro; 18°16'40"N, 65°51'01"W, 796 m; on trunk of *Cecropia peltata*; Mercado-Díaz 740 (holotype UPR!; isotype F!).

Thallus corticolous, epiperidermal, up to 5 cm diam., continuous; surface coarsely but shallowly verrucose, partially cracked, white-grey with slight greenish tinge, strongly shiny; prothallus absent or white-grey, shiny. Thallus in section 100–150 µm thick, with thin, prosoplectenchymatous cortex, 5–10 µm thick, irregular photobiont layer 15–25 µm thick immediately below the cortex and in additional layers within and below the medulla, and massive medulla, 80–120 µm thick, completely encrusted with large clusters of calcium oxalate crystals. Photobiont *Trentepohlia*; cells rounded to irregular in outline, in irregular groups, olive green, 6–12 × 5–9 µm. Ascomata lirellate, irregularly branched, fissurine, erumpent, roof-like with closed slit, 1–3 mm long, 0.2–0.25 mm broad, 0.15–0.2 mm high; disc concealed; proper margin indistinct; thalline margin white. Excipulum colorless to pale yellowish, 10–15 µm wide, prosoplectenchymatous, fused with thalline margin; thalline margin 70–150 µm thick, completely encrusted with large clusters of calcium oxalate crystals and with internal and external photobiont layer; hypothecium prosoplectenchymatous, 10–15 µm high, hyaline; hymenium 80–100 µm high,

hyaline, clear; epithecium indistinct, 5–10 µm high, hyaline. Paraphyses unbranched, apically spinulose; periphysoids not observed; asci cylindrical, 80–100 × 12–15 µm. Ascospores 4–8 per ascus, uniseriate to irregularly arranged, ellipsoid to oblong, 3-septate, 20–25 × 6–7 µm, 3–4 times as long as wide, hyaline, distoseptate with more or less lens-shaped to angular lumina, I–.

Secondary chemistry:—No substances detected by TLC.

Etymology:—The epithet refers to the thallus being strongly encrusted with calcium oxalate crystals.

Distribution and ecology:—This species was found in the shaded understory of a Palo Colorado forest in El Yunque National Forest. It was found growing on the living trunk of *Cecropia peltata*.

Remarks:—*Fissurina crystallifera* is characterized by a shallowly verrucose, cracked thallus massively encrusted with large clusters of calcium oxalate crystals. Thus far, no other species of *Fissurina* is known to produce such a thallus. The only other species with 3-septate ascospores larger than 20 µm, fissurinoid lirellae, and lacking secondary substances is *F. furfuracea* (Leight.) Archer (2007: 14), which differs in the non-crystalline thallus with smooth to uneven surface and the distinct labia bordering the slightly gaping disc. The saxicolous *F. howeana* (A. W. Archer) Archer (2005: 71) has a superficially similar thallus but completely immersed lirellae and much smaller ascospores. *Fissurina dumastii* Fée (1825: xc) differs in thallus structure, the apically spinulose paraphyses, and smaller, weakly amyloid ascospores (Staiger 2002).

***Fissurina monilifera* Mercado-Díaz, Lücking & Parnmen, sp. nov.** (Fig. 4B)

Mycobank #808427

Sequence accessions: KJ435167 (mtSSU, holotype), KJ440941 (nuLSU, holotype).

Differing from all other species of *Fissurina* in the initially myriotremoid ascomata arranged in short lines.

Type:—PUERTO RICO. Río Grande: Barrio Guzmán Arriba, road PR-186; 18°17'36"N, 65°50'23"W, 518 m; on the bark of woody vine; *Mercado-Díaz* 838 (holotype UPR!; isotype F!).

Thallus corticolous, epiperidermal, up to 7 cm diam., continuous; surface smooth, olive-green, shiny; prothallus absent. Thallus in section 70–100 µm thick, with thick, prosoplectenchymatous cortex with internal splitting, 20–30 µm thick, and photobiont layer 50–70 µm thick, lacking clusters of calcium oxalate crystals. Photobiont *Trentepohlia*; cells rounded to irregular in outline, in irregular groups, olive green to bright green, 6–11 × 5–7 µm. Ascomata rounded (myriotremoid) to lirellate, unbranched but arranged in short lines (moniliform), immersed, slightly gaping, 0.1–0.5 mm long, 0.1–0.15 mm broad, 0.1 mm high; disc covered by 0.05 mm wide pore or slit; proper margin distinct, forming a yellowish white rim around the pore or slit. Excipulum pale yellowish, 10–15 µm wide, prosoplectenchymatous, fused with thalline margin; thalline margin 70–120 µm thick, with bright green photobiont cells; hypothecium prosoplectenchymatous, 10–15 µm high, hyaline; hymenium 70–80 µm high, hyaline, clear; epithecium indistinct, 5–10 µm high, hyaline. Paraphyses unbranched, smooth; periphysoids not observed; asci cylindrical, 70–80 × 10–12 µm. Ascospores 4–8 per ascus, uniseriate, ellipsoid, 3-septate, 15–20 × 6–7 µm, 2–3 times as long as wide, hyaline, subdistoseptate with more or less angular lumina and thick outer walls, I– to weakly I+ violet.

Secondary chemistry:—No substances detected by TLC.

Etymology:—The epithet refers to the myriotremoid to elongate ascomata arranged in short, moniliform lines.

Distribution and ecology:—This species was found growing in the shaded understory of Tabonuco forests in El Yunque National Forest, on a woody vine.

Remarks:—This new taxon was at first identified as a species of *Myriotrema* Fée (1825: 34), but molecular sequence data place it within the genus *Fissurina* (Lumbsch *et al.* 2014). The morphology of the ascomata is unusual, starting out as myriotremoid pores and becoming elongate, but never fissurine; instead, the ascoma margin always remains entire and flat. The arrangement of the ascomata in short lines gives them the appearance of cortical feeding traces of insect larvae. Within subfamily Fissurinoideae (Rivas Plata *et al.* 2012a, 2013), morphologically most similar is *Pycnotrema pycnoporellum* (Nyl.) Rivas Plata & Lücking in Rivas Plata *et al.* (2012a: 120), which also has myriotremoid ascomata. However, in that species they never become lirelliform and feature a dark margin contrasting with the more or less grey thallus; in addition, the ascospores are submuriform.

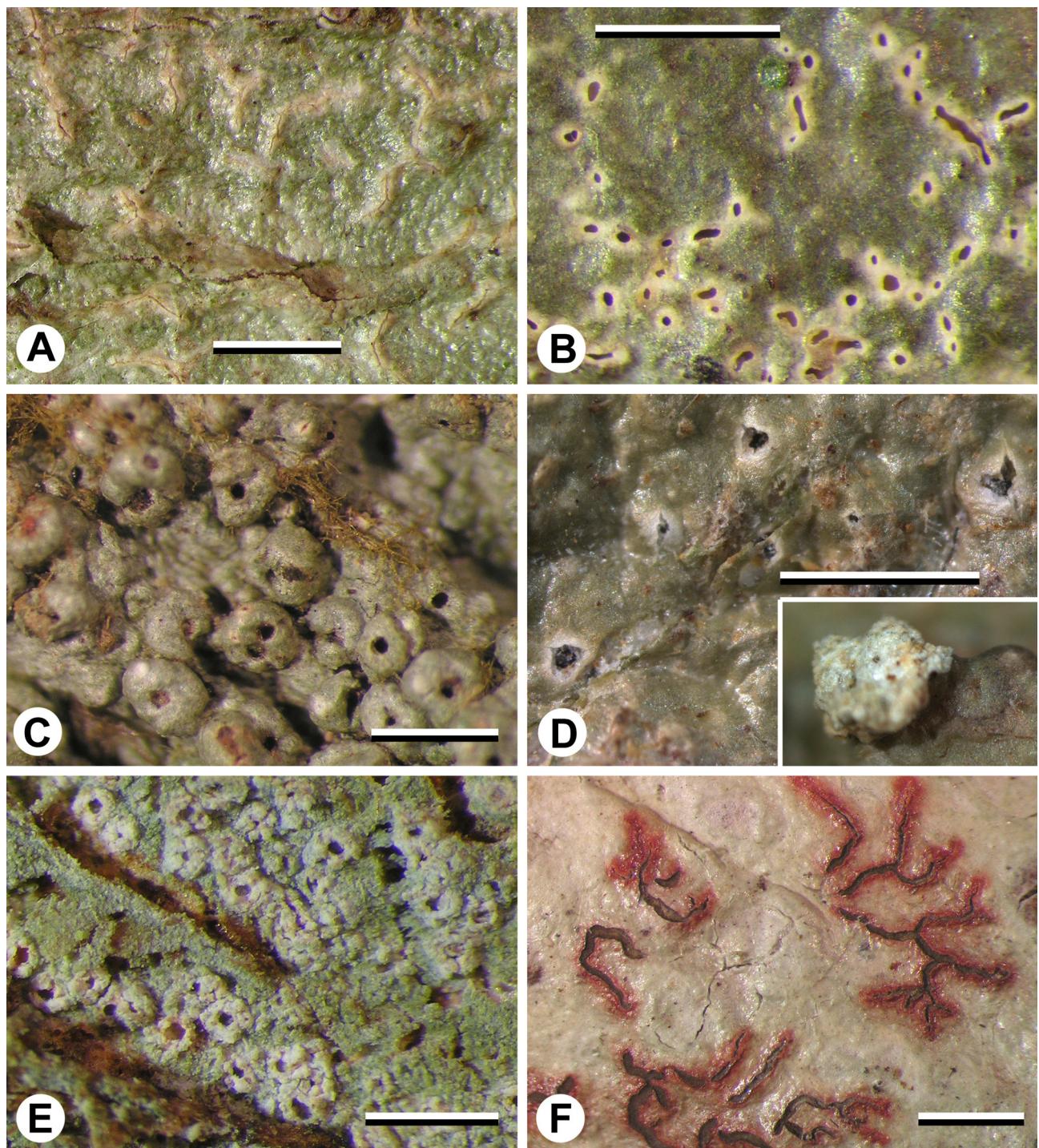


FIGURE 4. A. *Fissurina crystallifera*, thallus with ascomata (isotype). B. *F. monilifera*, thallus with ascomata (isotype). C. *Ocellularia portoricensis*, thallus with ascomata (isotype). D. *O. vulcanisorediata*, thallus with ascomata and soralium enlarged (large, paratype; small inset, isotype). E. *Paratopeliopsis caribica*, thallus with ascomata (isotype). F. *Thalloloma rubromarginatum*, thallus with ascomata (isotype). Scale = 1 mm.

Ocellularia aff. mordenii Hale

Remarks:—This material clusters with *Ocellularia mordenii* Hale (1974: 22) in molecular phylogenetic analysis (Kraichak *et al.* 2014), but is specifically distinct and characterized by the sole presence of large soralia on an otherwise sterile, verrucose thallus. Sterile sorediate specimens of *Ocellularia* sequenced so far are widely

dispersed among *Ocellularia* s.lat., representing either unique, undescribed species or, in rare cases, sorediate counterparts of known species (Rivas Plata *et al.* 2012b, 2013). Such thalli are usually neglected in biotic inventories, except for a single study (Emmerer & Hafellner 2004), but apparently are a significant component of biodiversity in this clade.

Specimen examined:—PUERTO RICO. Río Grande: Barrio Jiménez, road PR-186, east of El Verde Field Station; 18°19'10"N, 65°48'58"W, 433 m; on trunk of *Dacryodes excelsa*; Mercado-Díaz 888 (F, UPR).

***Ocellularia portoricensis* Mercado-Díaz, Lücking & Parnmen, sp. nov.** (Fig. 4C)

Mycobank #808428

Sequence accessions: KJ435179 (mtSSU, holotype), KJ435178 (mtSSU, paratype).

Differing from *Ocellularia cavata* in the white medulla and larger ascospores becoming brown.

Type:—PUERTO RICO. Canóvanas: Barrio Cubuy, road PR-186, to the right side of trail ending in Pico del Toro; 18°16'40"N, 65°51'01"W, 796 m; on trunk of an unidentified tree; Mercado-Díaz 881 (holotype UPR!; isotype F!).

Thallus corticolous, epiperidermal, up to 10 cm diam., continuous; surface coarsely and densely verrucose, olive-green to yellowish green; prothallus absent. Verrucae irregular, more or less hemispherical, 0.1–0.2 mm diam. Thallus in section 150–250 µm thick, with thin, paraplectenchymatous cortex, 5–10 µm thick, photobiont layer 30–50 µm thick, strongly encrusted with small, grey crystals, and rather thick medulla, up to 200 µm thick under the verrucae, completely filled with large clusters of calcium oxalate crystals. Photobiont *Trentepohlia*; cells rounded to irregular in outline, in irregular groups, yellowish green, 8–12 × 6–10 µm. Ascomata rounded to irregular in outline, prominent, with complete thalline margin, 0.5–0.8 mm diam., 0.2–0.3 mm high; disc covered by 0.1–0.2 mm wide pore filled with black columella; proper margin indistinct, entire, visible as thin, whitish rim around the pore; thalline margin entire, light olive-green, bumpy. Excipulum entire, carbonized in upper half, yellow to orange brown below, 30–50 µm wide, prosoplectenchymatous in thin sections; laterally covered by corticate algiferous thallus including clusters of calcium oxalate crystals; columella present, finger-like to plug-shaped, carbonized in upper half, 70–150 µm wide; hypothecium prosoplectenchymatous, 10–20 µm high, colorless to pale yellowish; hymenium 200–250 µm high, colorless, clear; epithecium indistinct, 5–10 µm high, colorless. Paraphyses unbranched, apically smooth; periphysoids absent; asci fusiform, 180–220 × 15–20 µm. Ascospores 8 per ascus, irregularly arranged, oblong, 11–15-septate, 60–80 × 8–10 µm, 7–9 times as long as wide, becoming brown, subdistoseptate with lens-shaped to angular lumina, young I+ violet-blue.

Secondary chemistry:—Cinchonarum unknown and accessory substances.

Etymology:—The epithet refers to the island of Puerto Rico.

Distribution and ecology:—This species was found in the shaded understory of a Palo Colorado forest in El Yunque National Forest, on the living trunk of an unidentified tree.

Remarks:—This new species belongs in *Ocellularia* s.str. and its general morphology and secondary chemistry agrees well with that of the type species, *O. cavata* (Ach.) Müller (1882: 499), and its relatives. It differs from *O. cavata* by the absence of a medullary pigment and by the larger and pigmented ascospores. Several species in this group with cinchonarum unknown chemistry and lacking medullary pigments are known to produce rather large ascospores, such as *O. rhabdospora* (Nyl.) Redinger (1936: 26); however, the ascospores in these species always remain hyaline. Brown ascospores are rare in *Ocellularia* and for example found in the distantly related *O. allospora* (Nyl.) Zahlbruckner (1923: 582), which has a smooth thallus with erumpent ascomata and lacks secondary substances. Molecular sequence data suggest the new species to be most closely related to *O. polydiscus* Redinger (1933: 61) and *O. xanthostromiza* (Nyl.) Zahlbruckner (1923: 604), both with pale yellow medullary pigments.

Additional specimen examined:—PUERTO RICO. Canóvanas: Barrio Cubuy, road PR-186, to the right side of trail ending in Pico del Toro; 18°16'40"N, 65°51'01"W, 796 m; on trunk of an unidentified tree; Mercado-Díaz 882 (F, UPR).

***Ocellularia vulcanisorediata* Mercado-Díaz, Lücking & Parnmen, sp. nov.** (Fig. 4D)

Mycobank #808429

Sequence accessions: KJ435174 (mtSSU, holotype), KJ435165 (mtSSU, paratype).

Differing from *Ocellularia conformalis* in the transversely septate ascospores and the large, protruding soralia.

Type:—PUERTO RICO. Naguabo: Barrio Río Blanco, road PR-930, 18°17'39"N, 65°47'11"W, 759 m; on trunk of a young, unidentified tree; *Mercado-Díaz* 884 (holotype UPR!; isotype F!).

Thallus corticolous, epiperidermal, up to 5 cm diam., continuous; surface smooth to uneven, light greyish green, sorediate; prothallus absent. Soralia regularly dispersed over the thallus of the holotype, absent from the paratype, crateriform to capitate, formed on slightly to strongly protruding structures resembling miniature volcanoes, 0.4–0.7 mm diam and 0.3–1.0 mm high, laterally corticate, internally with irregular layers of photobiont cells and irregular to amorphous layers of orange-brown periderm. Thallus in section 80–100 µm thick, with thick, prosoplectenchymatous cortex, 40–50 µm thick, and photobiont layer 40–50 µm thick, strongly encrusted with small, grey crystals, and indistinct medulla, lacking clusters of calcium oxalate crystals except when bordering the ascomata. Photobiont *Trentepohlia*; cells rounded to irregular in outline, in irregular groups, yellowish green, 8–12 × 7–10 µm. Ascomata only found on the paratype, absent from the holotype, rounded, immersed-erumpent, with complete thalline margin, 0.3–0.4 mm diam., 0.1–0.15 mm high; disc covered by 0.1–0.2 mm wide pore filled with black columella; proper margin indistinct, entire to slightly fissured, visible as whitish rim around the pore; thalline margin entire to slightly fissured, light greyish green. Excipulum entire, carbonized only apically, yellowish below, 20–30 µm wide, prosoplectenchymatous; laterally covered by corticate algiferous thallus including large clusters of calcium oxalate crystals; columella present, finger-like to plug-shaped, carbonized in upper half, 50–70 µm wide; hypothecium prosoplectenchymatous, 5–10 µm high, colorless; hymenium 80–100 µm high, colorless, clear; epithecium indistinct, 3–6 µm high, colorless. Paraphyses unbranched, apically smooth; periphysoids absent; ascii fusiform to clavate, 80–90 × 10–12 µm. Ascospores 8 per ascus, irregularly arranged, oblong-ellipsoid, 3–5-septate, 15–20 × 5–6 µm, 3–3.5 times as long as wide, hyaline, distoseptate with lens-shaped lumina, I+ violet-blue.

Secondary chemistry:—No substances detected by TLC.

Etymology:—The epithet refers to the large, protruding soralia resembling small volcanoes.

Distribution and ecology:—This species was found in a Palo Colorado forest in El Yunque National Forest, growing on a young, unidentified tree in shaded to partly illuminated conditions.

Remarks:—*Ocellularia vulcanisorediata* is an excellent example how molecular sequence data can reveal hitherto unrecognized taxa. The species is known from two collections, one bearing soralia only and the other ascomata only. Except for the generally similar thallus structure, nothing would have suggested that both represent the same species. The fertile material would have been identified as *O. papillata* (Leight.) Zahlbrückner (1923: 597) or a close relative. In reality, the new species is not a genuine *Ocellularia* but is closely related to *O. conformalis* (Kremp.) M. Cáceres & Lücking in Cáceres *et al.* (2012: 809), which belongs in a yet undescribed genus in the vicinity of *O. pyrenuloides* and *Melanotrema* (Rivas Plata *et al.* 2012b, 2013). More molecular data are needed to delimit this genus.

Additional specimen examined:—PUERTO RICO. Canóvanas: Barrio Cubuy, road PR-186, to the right side of trail ending in Pico del Toro; 18°16'40"N, 65°50'53"W, 815 m; on trunk of an unidentified tree; *Mercado-Díaz* 701 (F, UPR).

Paratopeliopsis caraibica Mercado-Díaz, Lücking & Parnmen, gen. et sp. nov. (Fig. 4E)

Mycobank #808440 (genus), #808484 (type species)

Sequence accessions: KJ440983 (mtSSU, holotype).

A new genus and species in tribe Thelotremaeae, differing from species of *Topeliopsis* in the farinose thallus and small, brown ascospores.

Type:—PUERTO RICO. Naguabo: Barrio Río Blanco, road PR-930, 18°17'39"N, 65°47'11"W, 759 m; on the trunk of *Cyrilla racemiflora*; *Mercado-Díaz* 836 (holotype UPR!; isotype F!).

Thallus corticolous and overgrowing adjacent bryophytes, epiperidermal, up to 5 cm diam., continuous;

surface farinose, light greyish green with bluish tinge; prothallus absent. Thallus in section 30–50 µm thick, ecarticate, with irregular photobiont layer 20–40 µm thick and indistinct medulla, partially encrusted with small grey crystals. Photobiont *Trentepohlia*; cells rounded to irregular in outline, densely packed, olive green, 7–11 × 6–9 µm. Ascomata rounded to irregular in outline, crowded, prominent, 0.2–0.3 mm diam., 0.1–0.15 mm high; disc covered by 0.1–0.2 mm wide pore, flesh-colored to grey-brown, thinly white-pruinose; proper margin distinct, thick, entire to fissured or appearing bumpy, white, becoming layered; thalline margin indistinct. Excipulum yellow-brown, 15–25 µm wide, fused with thalline margin, externally covered by thin thalline margin lacking photobiont cells; hypothecium prosoplectenchymatous, 5–10 µm high, pale yellowish; hymenium 55–65 µm high, hyaline, clear; epithecium 3–5 µm high, grey-brown. Paraphyses unbranched, smooth; periphysoids not observed; asci clavate, 50–60 × 8–10 µm. Ascospores 8 per ascus, uniseriate to irregularly arranged, ellipsoid, 3-septate, 10–12 × 4–5 µm, 2–3 times as long as wide, grey-brown, distoseptate with lens-shaped, I+ violet-blue when young.

Secondary chemistry:—No substances detected by TLC.

Etymology:—The genus name refers to the superficial similarity of the ascomata with those of the distantly related genus *Topeliopsis*, whereas the epithet indicates a presumed Caribbean distribution.

Distribution and ecology:—This species was found in the shaded understory of a Palo Colorado forest in El Yunque National Forest, growing among mosses on the trunk of *Cyrilla racemiflora*.

Remarks:—This new taxon was at first identified with *Thelotrema byssoidaeum* (Kremp.) Salisbury (1966: 195), a species described from Borneo and known from tropical Southeast Asia and Australia. Both share the leprose thallus and small, crowded ascomata, as well as the grey-brown, 3-septate ascospores. However, *T. byssoidaeum* differs in the felty rather than farinose thallus, the larger, ornamented ascospores, and psoromic acid as secondary compound, and is apparently not closely related to the Puerto Rican material and also not a genuine *Thelotrema* but appears to belong in tribe Ocellulariae. Molecular sequence data place *Paratopeliopsis caribica* in tribe Thelotrematae, where it does not cluster with any of the currently accepted genera (Lumbsch *et al.* 2014). The genus name refers to the superficial similarity of the ascomata with those of *Topeliopsis* Kantvilas & Vězda (2000: 347), a genus not closely related to the new taxon (Rivas Plata *et al.* 2013).

***Thalloloma rubromarginatum* Mercado-Díaz, Lücking & Parnmen, sp. nov.** (Fig. 4F)

Mycobank #808430

Differing from *Thalloloma haemographum* in the corticate thallus containing norstictic acid.

Type:—PUERTO RICO. Río Grande: Barrio Jiménez, left side of the road leading to Pico El Yunque, 18°18'16"N, 65°47'43"W, 917 m; on the trunk of *Cecropia peltata*; Mercado-Díaz 962 (holotype UPR!; isotype F!).

Thallus corticolous, epidermal, up to 5 cm diam., continuous; surface smooth, white, shiny; prothallus absent. Thallus in section 100–130 µm thick, with thin, prosoplectenchymatous cortex, 10–15 µm thick, photobiont layer 20–30 µm thick, and thick medulla, 70–90 µm thick, strongly encrusted with clusters of calcium oxalate crystals. Photobiont *Trentepohlia*; cells rounded to irregular in outline, in irregular groups, olive green, 7–11 × 5–8 µm. Ascomata lirellate, irregularly to stellately branched, immersed, 1–3 mm long, 0.15–0.25 mm broad, 0.1 mm high; disc narrow, slightly immersed, purplish-brown, non-pruinose; proper margin indistinct, forming a very thin, greyish rim along the disc; thalline margin distinct, not prominent, bright red. Excipulum dark brown in upper half, yellow-brown below, 5–10 µm wide, prosoplectenchymatous; thalline margin 70–120 µm thick, with bright green photobiont cells; hypothecium prosoplectenchymatous, 10–15 µm high, hyaline; hymenium 90–100 µm high, hyaline, clear; epithecium red-brown granular, 3–6 µm high, hyaline. Paraphyses unbranched, smooth; periphysoids not observed; asci clavate, 80–90 × 12–15 µm. Ascospores 8 per ascus, irregularly arranged, ellipsoid, submuriform with 3–5 transverse and 0–1 longitudinal septa per segment, 15–20 × 6–8 µm, 2–3 times as long as wide, hyaline, distoseptate with lens-shaped to rounded lumina, I+ blue-violet.

Secondary chemistry:—Norstictic acid (thallus in section with K+ yellow efflux forming red, needle-shaped crystals); dark red pigment isohypocreline along the lirellae (K+ dark green).

Etymology:—The epithet refers to the bright red margin of the lirellae.

Distribution and ecology:—This species was found in a Sierra Palm forest in El Yunque National Forest, growing on the upper branches of a fallen *Cecropia peltata* tree.

Remarks:—*Thalloloma rubromarginatum* is unusual in the genus in producing norstictic acid as secondary substance and having a distinct cortex. In other characters, the new species resembles *T. haemographum* (Nyl.) Staiger (2002: 435), which also has brownish discs with bright red margins and muriform ascospores but, apart from the lack of other secondary substances and the ecorticate thallus, also has larger ascospores (20–30 µm long).

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