

## Forty-six new species of *Trypetheliaceae* from the tropics

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**ABSTRACT:** The following 46 new species of *Trypetheliaceae* are described: *Astrothelium aenascens* Aptroot from Papua New Guinea, which is similar to *A. aenoides* but differs by the hamathecium which is not inspersed; *A. alboverrucoides* Aptroot from Indonesia with globose ascomata with constricted base, internally similar to *A. megaspermum*; *A. clypeatum* Aptroot & Gueidan from Vietnam with black conical ascomata in which the pseudostroma is reminiscent of a clypeus, a rimose thallus, and 3-septate ascospores, 85–95 × 22–25 µm; *A. colombiense* Aptroot from Colombia with 1 muriform ascospore of 240–300 × 45–50 µm per ascus, and an inspersed hamathecium; *A. condoricum* Aptroot from Ecuador with a bright orange thallus and contrasting bright scarlet internal pigment, and muriform ascospores, 38–42 × 18–21 µm; *A. corallinum* Aptroot from Guyana, which is most similar to *A. ochroleucoides* but the thallus is without lichexanthone; *A. dicoloratum* Aptroot from Venezuela with an orange thallus and more yellowish pseudostromata with usually only 1 ascoma, and 9–11-septate ascospores; *A. ecuadoriense* Aptroot from Ecuador with ascospores 2 per ascus, muriform, 80–175 × 25–50 µm, and an inspersed hamathecium; *A. flavomaculatum* Aptroot from Ecuador, Guyana and Venezuela which is similar to *A. graphicum*, but with ascospores 50–75 × 12–25 µm; *A. flavomeristosporum* Aptroot from the Philippines and Ecuador with mostly simple ascomata with an orange to yellow, inspersed hamathecium and muriform ascospores 140–200 × 25–30 µm; *A. flavostiolatum* Aptroot from Ecuador with bright yellow ostioles and a very irregular thallus, and muriform ascospores, 175–230 × 35–45 µm; *A. guianense* Aptroot from Guyana with a very irregular thallus, eccentric, fused ostioles and ascospores 4 per ascus, muriform, 70–80 × 20–25 µm; *A. inspersogalbineum* Aptroot & Weerakoon from Singapore which is similar to *A. macrocarpum* but with the hamathecium inspersed; *A. komposchii* Aptroot from Venezuela with chimney-like ostioles and a very irregular, almost squamulose thallus and muriform ascospores, 130–180 × 35–45 µm; *A. laurosphaerioides* Aptroot from Guyana with aggregated ascomata with internally and partly (when abraded) also superficially orange anthraquinone pigment, ascospores 2 per ascus, muriform, 110–130 × 30–35 µm; *A. lucidomedullatum* Aptroot from Ecuador with lichexanthone in the medulla of the thallus, ascospores 4 per ascus, muriform, 80–115 × 25–35 µm; *A. lucidostromum* Aptroot from Guyana which is similar to *A. eustomuralis* but lichexanthone is present in the whole pseudostroma; *A. lucidothallinum* Aptroot from Guyana with the thallus containing lichexanthone, ascomata in pseudostromata without lichexanthone, ostioles apical, hamathecium not inspersed, ascospores muriform, 70–90 × 18–20 µm; *A. mediocrassum* Aptroot from Guyana which resembles *A. octosporum* but without lichexanthone in the thallus or pseudostromata, muriform ascospores, 70–80 × 22–25 µm, with median septum strongly thickened; *A. megatropicum* Aptroot from Guyana with 3-septate ascospores 100–120 × 33–35 µm, and hemispherical dark brown pseudostromata; *A. megochroleucum* Aptroot from El Salvador with 3-septate ascospores 60–70 × 16–18 µm and lichexanthone in the thallus and pseudostromata; *A. neoinspersum* Aptroot from El Salvador which is similar to *A. aenascens* but with bright yellow pseudostromata; *A. perspersum* Aptroot & Ertz from Gabon which is similar to *A. scoria* but with ascospores 26–38 × 7–9 µm; *A. philippinense* Aptroot & Schumm from the Philippines without pseudostromata, ostiole apical, hamathecium inspersed, ascospores muriform, 125–170 × 30–35 µm, 4 per ascus; *A. pseudannulare* Aptroot & Etayo from Ecuador with the appearance

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of the *A. puiggarii*-group, but differing from all other species of it by the 3-septate ascospores  $80\text{--}88 \times 32\text{--}36 \mu\text{m}$ , which are 2–4 per ascus; *A. pseudodissimulatum* Aptroot from Papua New Guinea with K+ red crystals in the ascoma wall and 5-septate ascospores of  $25\text{--}33 \times 9\text{--}11 \mu\text{m}$ ; *A. pseudoferrugineum* Aptroot from Indonesia, of the *A. conicum*-group with an orange thallus and pseudostroma pruina, differing from *A. ferrugineum* by the ascospores  $28\text{--}31 \times 9\text{--}11 \mu\text{m}$  and the more glossy thallus; *A. pseudomegalophthalmum* Aptroot from Colombia, similar to *A. megaspermum* but differing by the 7-septate ascospores  $152\text{--}166 \times 32\text{--}37 \mu\text{m}$ ; *A. rimosum* Aptroot from Guyana and Colombia with 7–11-septate ascospores  $110\text{--}150 \times 30\text{--}37 \mu\text{m}$  and a rimose thallus with yellow medulla; *A. sanguineoxanthum* Aptroot from Brazil with the thallus containing lichexanthone and pseudostromata with numerous immersed round ascomata, the whole inside of which is full of red, K+ green pigment; *A. septemseptatum* Aptroot from Guyana and Venezuela with the thallus and pseudostromata UV+ yellow and 7–9-septate ascospores  $50\text{--}55 \times 12\text{--}17 \mu\text{m}$ ; *A. sexloculatum* Aptroot from Guyana and Papua New Guinea with 5-septate ascospores  $25\text{--}27 \times 7\text{--}11 \mu\text{m}$  and lichexanthone in the thallus and pseudostromata; *A. sipmanii* Aptroot from Guyana with simple ascomata with 5-septate ascospores  $100\text{--}150 \times 35\text{--}40 \mu\text{m}$  and an inspersed hamathecium; *A. trypethelioides* Aptroot from Venezuela with fused ostioles, an inspersed hamathecium and 7–9-septate ascospores  $49\text{--}52 \times 13\text{--}16 \mu\text{m}$ ; *A. ultralucentis* Aptroot from Venezuela with lichexanthone in the thallus and pseudostromata, fused ostioles and 3-septate ascospores over  $105\text{--}130 \times 35\text{--}42 \mu\text{m}$ ; *A. vulcanum* from Guyana, of the *A. nitidiusculum*-group with simple ascomata, an inspersed hamathecium and lichexanthone; *A. zebrinum* Aptroot from Guyana with fused ostioles and 7-septate ascospores  $60\text{--}70 \mu\text{m}$  long, without lichexanthone, anthraquinones and inspersed; *Polymeridium rhodopruinosum* Aptroot from Puerto Rico with red pruina on the ascomata and 3-septate ascospores  $17\text{--}19 \times 3.5\text{--}5.0 \mu\text{m}$ ; *Pseudopyrenula americana* Aptroot from Guyana with 3-septate ascospores  $26\text{--}32 \times 7\text{--}10 \mu\text{m}$ , without inspersed and without lichexanthone; *P. guianensis* Aptroot from French Guiana and Surinam with a hyaline hamathecium with inspersed, a thallus with lichexanthone and 3-septate ascospores  $21\text{--}25 \times 6\text{--}9 \mu\text{m}$ ; *P. hexamera* Aptroot from Venezuela with 5-septate ascospores  $16\text{--}21 \times 6\text{--}7 \mu\text{m}$ , lumina clearly diamond-shaped; *P. thallina* Lücking & Aptroot from Costa Rica with a greenish corticate thallus and 3-septate ascospores,  $21\text{--}25 \times 6\text{--}9 \mu\text{m}$ ; *Trypethelium infracluteriae* Aptroot & Gueidan from Vietnam which is similar to *T. subcluteriae* but with lower pseudostromata and ascospores 7–9-septate,  $37\text{--}42 \times 9\text{--}11 \mu\text{m}$ ; *Viridothelium inspersum* Aptroot from Papua New Guinea with solitary, immersed ascomata, an inspersed hamathecium, and 12–14-septate ascospores,  $60\text{--}75 \times 12\text{--}17 \mu\text{m}$ ; *V. kinabaluense* Aptroot from Sabah which is similar to *V. indutum* with emergent black ascomata, but with 17–25-septate ascospores  $100\text{--}150 \times 18\text{--}23 \mu\text{m}$ ; and *V. solomonense* Aptroot from the Solomon Islands having ascomata with lateral, partly fused ostioles and black clypeus, and ascospores 15–19-septate,  $75\text{--}98 \times 17\text{--}20 \mu\text{m}$ . The new species are known from Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Gabon, Guyana, Indonesia, Papua New Guinea, the Philippines, Puerto Rico, Sabah, Singapore, Solomon Islands, Surinam, Venezuela and/or Vietnam.

**Key words:** *Astrothelium*, Gabon, lichens, Malesia, Neotropics, *Polymeridium*, *Pseudopyrenula*, *Trypethelium*, *Viridothelium*

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## Introduction

The family *Trypetheliaceae* is an almost exclusively tropical corticolous lichen family. The first members were encountered at the end of the 18th century on pieces of medicinal bark (mainly *Cinchona* for quinine) that were collected in South American forests (Zenker 1829). The conspicuous, often brightly coloured ascomata with complex structures intrigued the lichenologists of the time. Soon afterwards, more species became known from places such as Australia, Brazil and Borneo, which were described in many

separate papers, for example by Krempelhuber, Montagne and Müller Argoviensis.

Relatively few species were known for a long time, and little more than the type specimen was known from most described species. In 1986, Harris started publishing on the family, defining it in a restricted sense, and taking up a generic division that has been in use since then, although it was clear that it was largely untenable because, for example, a single specimen could partly belong to one genus and partly to another. Aptroot & Cáceres (2014), in a revision of the genus *Polymeridium*, showed that many species

in this family still await description or recognition.

This paper describes new species of *Trypetheliaceae* from various parts of the world, largely collected by the authors and/or by Harrie Sipman. They originate from many different countries, but many are from Ecuador, Guyana and/or Venezuela. The generic concept applied here follows the phylogenetic studies by Nelsen *et al.* (2014) and Lücking *et al.* (2016). All species are keyed out in Aptroot & Lücking (2016).

### Material and Methods

Identification and descriptive work was mostly carried out in Soest using an Olympus SZX7 stereomicroscope and an Olympus BX50 compound microscope with interference contrast, connected to a Nikon Coolpix digital camera. Sections were mounted in tap water, in which all measurements were also taken.

The chemistry of all specimens was investigated under UV light, and often a test with 10% KOH was made, generally on sections. The chemistry of many specimens, including types of all newly described species, was investigated by thin-layer chromatography (TLC) using solvent A (Orange *et al.* 2001).

### The Species

#### *Astrothelium aenascens* Aptroot sp. nov.

Mycobank No.: MB 815206

*Astrothelium* similar to *A. aenoides* Aptroot, but differing by the non-inspersed hamathecium.

Type: Papua New Guinea, Central Prov., Varirata National Park, 1981, *H. Streimann* & *N. Naoni* 15083 (CANB—holotype; ABL—isotype).

(Fig. 1A)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas  $\leq 5$  cm diam., *c.* 0.2 mm thick, olive-green to olive-grey, not surrounded by a prothallus, not inducing gall formation of the host bark.

*Ascomata* globose, 0.8–1.2 mm diam., immersed in groups of 2–5 in pseudostromata with a surface different from the thallus, which are distinctly raised above the thallus, irregular to often linear in outline, sides sloping, whitish mottled with orangish colour, inside with a cream layer containing

bark tissue. *Wall* dark brown all around,  $\leq c.$  70  $\mu\text{m}$  thick. *Ostioles* apical, not fused, flat to concave, brown. *Hamathecium* inspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, 3-septate, fusiform, 20–25  $\times$  6–9  $\mu\text{m}$ , ends rounded, lumina diamond-shaped, not surrounded by a gelatinous layer.

*Chemistry.* Thallus surface UV–, thallus medulla K–; pseudostroma surface UV+ pink to orange, medulla of pseudostromata K+ blood red. TLC: an anthraquinone, probably parietin.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Papua New Guinea.

*Discussion.* This species is similar to *A. aenoides*, which differs by the inspersed hamathecium. Both are named after the somewhat reminiscent species *A. aeneum* (Eschw.) Aptroot & Lücking, which mainly differs by the orange pigment on the thallus.

#### *Astrothelium alboverrucoides* Aptroot sp. nov.

Mycobank No.: MB 815207

*Astrothelium* with globose ascomata with constricted base; internally similar to *A. megaspermum* (Mont.) Aptroot & Lücking.

Type: Indonesia, Sumatra, Aceh, 35 km NNW of Kutacane, alt. 800 m, 1988, *R. Hensen* (ABL—holotype).

(Fig. 1B)

*Thallus* corticate, smooth, somewhat shiny, continuous, greyish green, covering areas  $\leq 4$  cm diam., *c.* 0.2 mm thick, surrounded by a black prothallus line *c.* 0.4 mm wide, not inducing gall formation of the host bark.

*Ascomata* globose, 0.8–1.4 mm diam., mostly single, occasionally 2 aggregated, in almost globose pseudostromata of thallus colour or more greyish, with often constricted base. *Wall* carbonized,  $\leq c.$  120  $\mu\text{m}$  thick. *Ostioles* apical, not fused, pointed, ochraceous to brown. *Hamathecium* inspersed with oil globules. *Asci* with 4 ascospores. *Ascospores* hyaline, muriform, ellipsoid, 140–190  $\times$  20–30  $\mu\text{m}$ , with

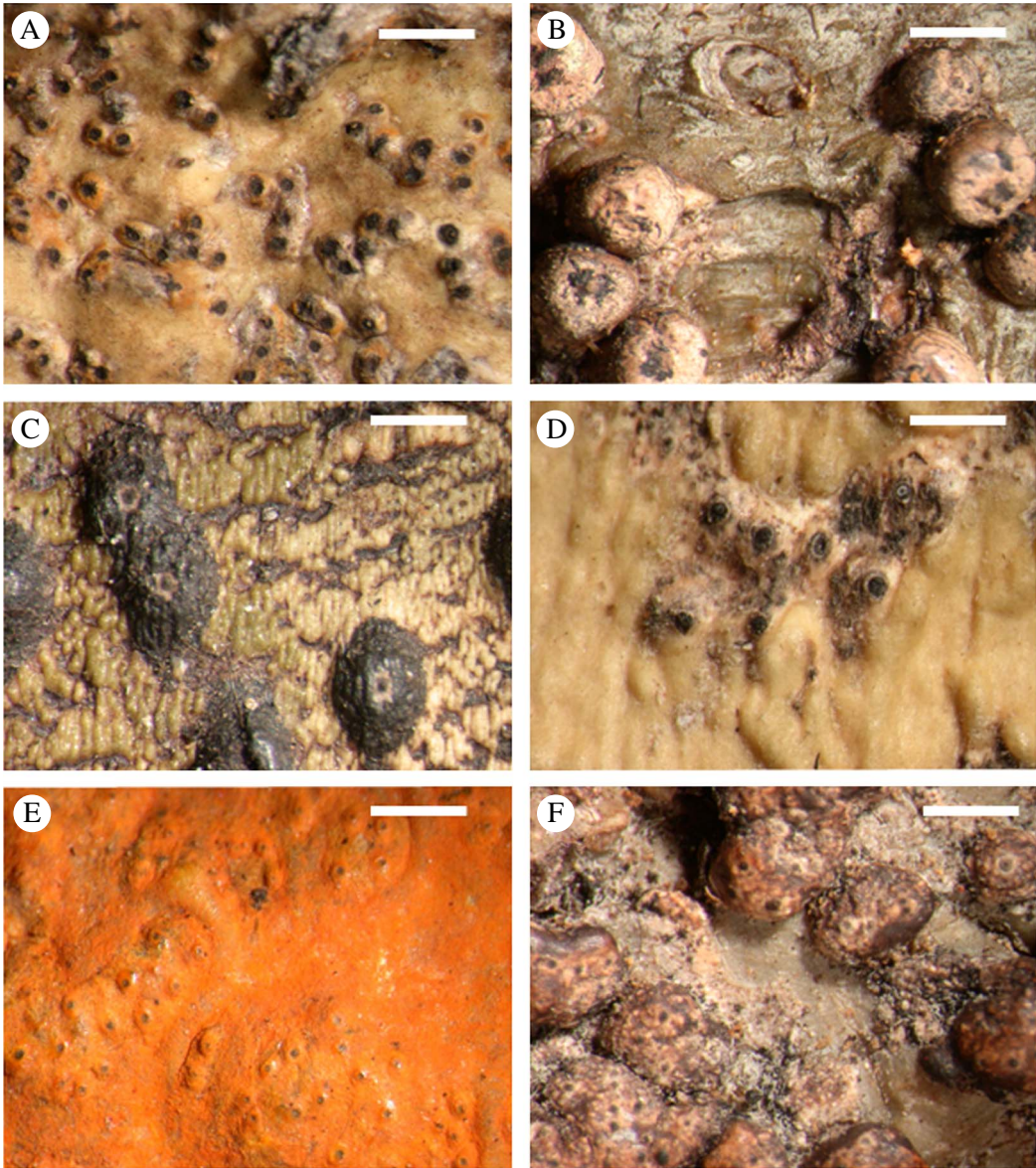


FIG. 1. Habitus of new species of Trypetheliaceae (holotypes). A, *Astrothelium aenascens*; B, *A. alboverrucoides*; C, *A. clypeatum*; D, *A. colombiense*; E, *A. condoricum*; F, *A. corallinum*. Scales: A–F = 1 mm. In colour online.

a distinctly thickened median septum, ends rounded, not surrounded by a gelatinous layer.

*Pycnidia* not observed.

*Chemistry.* Thallus and pseudostromata K–, UV–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Indonesia.

*Discussion.* This species is characterized by the globose ascomata with constricted base; internally it is similar to *A. megaspermum*, the

ascospores of which are, however, usually wider than 30 µm.

***Astrothelium clypeatum* Aptroot & Gueidan sp. nov.**

Mycobank No.: MB 815208

*Astrothelium* with black conical ascomata, pseudostromata reminiscent of a clypeus, with a rimose thallus and 3-septate ascospores, 85–95 × 22–25 µm.

Type: Vietnam, Dong Nai Prov., Cát Tiên National Park, along the road towards the Forest Ecologde, 12 February 2012, C. Gueidan 3005 (BM—holotype).

(Fig. 1C)

*Thallus* olive-green, somewhat minutely rimose-bullate and interspersed with branched lines of black prothallus.

*Ascomata* conical in section, black, thin-walled, single, fully immersed in pseudostromata. *Pseudostromata* 0.8–1.3 mm diam., superficial, carbonized, conical with flattened top, resembling a clypeus, without pigment, but a zone with bark colour and tissue is present between the ascoma and the clypeus. *Wall* carbonized, ≤ 220 µm at the sides, carbonized all around. *Ostioles* apical, rusty brown, surrounded by an ochraceous ring. *Hamathecium* interspersed with hyaline oil droplets, filaments profusely anastomosing. *Ascospores* 8 per ascus, 3-septate, 85–95 × 22–25 µm, lumina diamond-shaped.

*Chemistry.* Thallus and pseudostromata UV–, K–. TLC: no secondary substances detected.

*Ecology and distribution.* On bark of trees along a road. Known only from Vietnam.

*Discussion.* This species is anomalous owing to the black conical ascomata in which the pseudostroma is a clypeus. It is described here in the genus *Astrothelium* because of the well-developed, corticate, rimose thallus, but it could also turn out to belong to *Pseudopyrenula*.

***Astrothelium colombiense* Aptroot sp. nov.**

Mycobank No.: MB 815209

*Astrothelium* with 1 muriform ascospore of 240–300 × 45–50 µm per ascus, and an inspersed hamathecium.

Type: Colombia, Nariño, Tumaco, Estacion Forestal La Espriella, alt. 35 m, 4–6 June 1986, H. J. M. Sipman & F. Velosa 33018 (B—holotype).

(Fig. 1D)

*Thallus* corticate, smooth to somewhat rugose, shiny, covering areas ≤ 10 cm diam., c. 0.2 mm thick, pale ochraceous green, not surrounded by a prothallus, not inducing gall formation of the host bark.

*Ascomata* pyriform, 0.6–0.9 mm diam., solitary, completely immersed in the bark, below decorticated flat areas that are flush with the thallus but can be seen as ochraceous white pseudostromata. *Wall* carbonized all around, ≤ c. 80 µm thick. *Ostioles* apical, simple, flat to convex, black, often surrounded by an ochraceous ring, presenting the only part of the ascoma that is visible from above. *Hamathecium* interspersed with oil globules. *Asci* with 1 ascospore. *Ascospores* hyaline, muriform, 240–300 × 45–50 µm, ellipsoid, without distinctly thickened median septum.

*Pycnidia* not observed with certainty, although some of the many black dots around the ostioles may represent young pycnidia.

*Chemistry.* Thallus and pseudostromata UV–, K–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Colombia.

*Discussion.* This is one of the very few *Astrothelium* species with only 1 ascospore in the ascus, and the only one with ascospores usually over 250 µm and with an inspersed hamathecium.

*Additional material examined.* **Colombia:** same data as the type, 33022 (B, topotype).

***Astrothelium condoricum* Aptroot  
sp. nov.**

Mycobank No.: MB 815210

*Astrothelium* with a bright orange thallus and contrasting bright scarlet internal pigment, and muriform ascospores,  $38\text{--}42 \times 18\text{--}21 \mu\text{m}$ .

Type: Ecuador, Morona-Santiago Prov., Cordillera del Condor, 12 km E of Los Encuentros, alt. 1200 m, 26 July 1982, *A. Aptroot* 10452 (ABL—holotype).

(Fig. 1E)

*Thallus* dull, completely covered with bright orange pigment, not surrounded by a prothallus, not inducing gall formation of the host bark.

*Ascomata* globose, immersed in low pseudostroma warts, in groups of 3–11. *Pseudostromata* orange-pigmented on the surface, internally with a thick layer of bright scarlet pigment. *Ostioles* apical, mostly orange. *Hamathecium* not interspersed, IKI–. *Ascospores* 8 per ascus, hyaline, muriform,  $38\text{--}42 \times 18\text{--}21 \mu\text{m}$ , ellipsoid, without distinctly thickened median septum.

*Chemistry*. Orange pigment K+ purple, UV+ red; bright scarlet internal pigment K+ purple (almost black). TLC: two anthraquinones.

*Ecology and distribution*. On smooth bark of trees in mountain forest. Known only from Ecuador.

*Discussion*. Unmistakable by the bright orange thallus and the contrasting bright scarlet internal pigment.

*Additional material examined*. **Ecuador**: same data as the type, 10451 (ABL, topotype).

***Astrothelium corallinum* Aptroot  
sp. nov.**

Mycobank No.: MB 815211

*Astrothelium* which is most similar to *A. ochroleucoides* Aptroot & M. Cáceres, but without lichexanthone in the thallus.

Type: Guyana, Upper Mazaruni Distr., Paruima Mission, Rain Mountain SE of the village, alt. 500 m, 30 April 1997, *H. J. M. Sipman* 39574 (B—holotype).

(Fig. 1F)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas  $\leq 8$  cm diam., *c.* 0.1 mm thick, olive-green, surrounded by a black prothallus line *c.* 0.3 mm wide, not inducing gall formation of the host bark.

*Ascomata* globose, 0.4–0.6 mm diam., immersed in groups of *c.* 2–40 in pseudostromata. *Pseudostromata* with a surface different from the thallus, *c.* 0.5–1.0 mm raised above the thallus, oval to irregular or reticulate in outline,  $\leq c.$  3 mm wide, brownish black, usually partly with whitish cover, partly brownish, partly whitish inside. *Wall* dark brown all around,  $\leq c.$  40  $\mu\text{m}$  thick. *Ostioles* apical, not fused, flat to convex, brown. *Hamathecium* not interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, muriform, fusiform,  $60\text{--}150 \times 15\text{--}30 \mu\text{m}$ , ends rounded, not surrounded by a gelatinous layer, central septum not strongly thickened.

*Pycnidia* not observed.

*Chemistry*. Thallus surface UV–, thallus medulla K–; whitish parts of pseudostroma surface UV+ yellow, K–, pseudostroma medulla K–. TLC: lichexanthone.

*Ecology and distribution*. On smooth bark of trees in rainforest. Known only from Guyana.

*Discussion*. This species is most similar to *A. ochroleucoides*, which differs by the UV+ yellow thallus. These two species grow together in close contact in Guyana.

*Additional material seen*. **Guyana**: East Demarara Distr.: Timehri, Dakara Creek, Thompson's farm, 1985, *Sipman & Aptroot* 18040 & 18052 (B). *Potaro-Siparuni Region*: surroundings of Paramakatoi village, alt. 800 m, 1996, *Sipman* 41275 p.p. (B).

***Astrothelium dicoloratum* Aptroot  
sp. nov.**

Mycobank No.: MB 815212

*Astrothelium* with an orange thallus and more yellowish pseudostromata with usually only 1 ascoma, and 9–11-septate ascospores.

Type: Venezuela, Amazonas, Alto Orinoco, *c.* 15 km SW of La Esmeralda, W bank of Surumoni, on *Goupia*

*glabra*, alt. 110 m, 15 February 1997, *J. Hafellner* & *H. Komposch* 209-6-50 (GZU—holotype).

(Fig. 2A)

*Thallus* dull, completely covered with bright orange pigment, not surrounded by a prothallus, not inducing gall formation of the host bark.

*Ascomata* pyriform, 0.6–0.9 mm diam., solitary or occasionally 2–5 fused, completely immersed to emergent from the bark, in yellow-orange to ochraceous pseudostromata. *Wall* carbonized all around,  $\leq c.$  80  $\mu\text{m}$  thick. *Ostioles* apical, simple, flat to convex, black, often surrounded by an ochraceous ring, again surrounded by a black ring in the case of emergent ascomata. *Hamathecium* interspersed with oil globules. *Asci* with 1 ascospore. *Ascospores* hyaline, 9–11-septate, 50–75  $\times$  11–15  $\mu\text{m}$ , ellipsoid, without distinctly thickened median septum.

*Pycnidia* not observed with certainty, although some of the many black dots around the ostioles may represent young pycnidia.

*Chemistry.* Thallus and pseudostromata UV+ red, K+ purple. TLC: an anthraquinone.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Venezuela.

*Discussion.* Characterized by the orange thallus and more yellowish pseudostromata with usually only 1 ascoma, and the 9–11-septate ascospores; it is the only species with 9–11-septate ascospores that has an orange thallus.

*Additional material examined.* **Venezuela:** same locality as the type, 1997, *J. Hafellner* & *H. Komposch* 318-5-48, 178-5-44, 178-5-23; 1996, *J. Hafellner* 37440; 1 km N of Estación A. de Humboldt, 15 iii 1996, *K. Jetzsch* (all GZU).

### ***Astrothelium ecuadoriense* Aptroot sp. nov.**

Mycobank No.: MB 815213

*Astrothelium* with ascospores 2 per ascus, muriform, 80–175  $\times$  25–50  $\mu\text{m}$ , and an interspersed hamathecium.

Type: Ecuador, Zamora-Chinchipec, Estacion Cientifico San Francisco, 40 km S of Loja, 16 May 2004, *H. J. M. Sipman* 52318 (B—holotype).

(Fig. 2B)

*Thallus* corticate, very smooth, shiny, covering areas  $\leq 10$  cm diam., *c.* 0.3 mm thick, pale ochraceous green, not surrounded by a prothallus, not inducing gall formation of the host bark.

*Ascomata* pyriform, 0.6–1.2 mm diam., solitary, completely immersed to emergent from the bark and then the black wall partly exposed, without pseudostromata. *Wall* carbonized all around,  $\leq c.$  100  $\mu\text{m}$  thick. *Ostioles* mostly eccentric, simple, concave, brown, surrounded by an ochraceous ring, presenting the only part of the ascoma that is visible from above. *Hamathecium* interspersed with oil globules. *Asci* with 2 ascospores. *Ascospores* hyaline, muriform, 80–175  $\times$  25–50  $\mu\text{m}$ , ellipsoid, without distinctly thickened median septum.

*Chemistry.* Thallus UV–, K–. No substances detected.

*Ecology and distribution.* On smooth bark of trees in mountain forest. Known only from Ecuador.

*Discussion.* This is one of the few *Astrothelium* species with only 2 ascospores in the ascus, and the only one with large ascospores and an interspersed hamathecium, except for *A. pyrenuliforme* Flakus & Aptroot, which has pseudocyphephae.

### ***Astrothelium flavomaculatum* Aptroot sp. nov.**

Mycobank No.: MB 815214

*Astrothelium* similar to *A. graphicum* Aptroot & S. M. A. Martins, but with ascospores 50–75  $\times$  12–25  $\mu\text{m}$ .

Type: Ecuador, Morona-Santiago Prov., Cordillera del Condor, 12 km E of Los Encuentros, alt. 1200 m, 26 July 1982, *A. Aptroot* 10441 (ABL—holotype).

(Fig. 2C)

*Thallus* corticate, smooth to somewhat bullate, somewhat shiny, continuous, covering

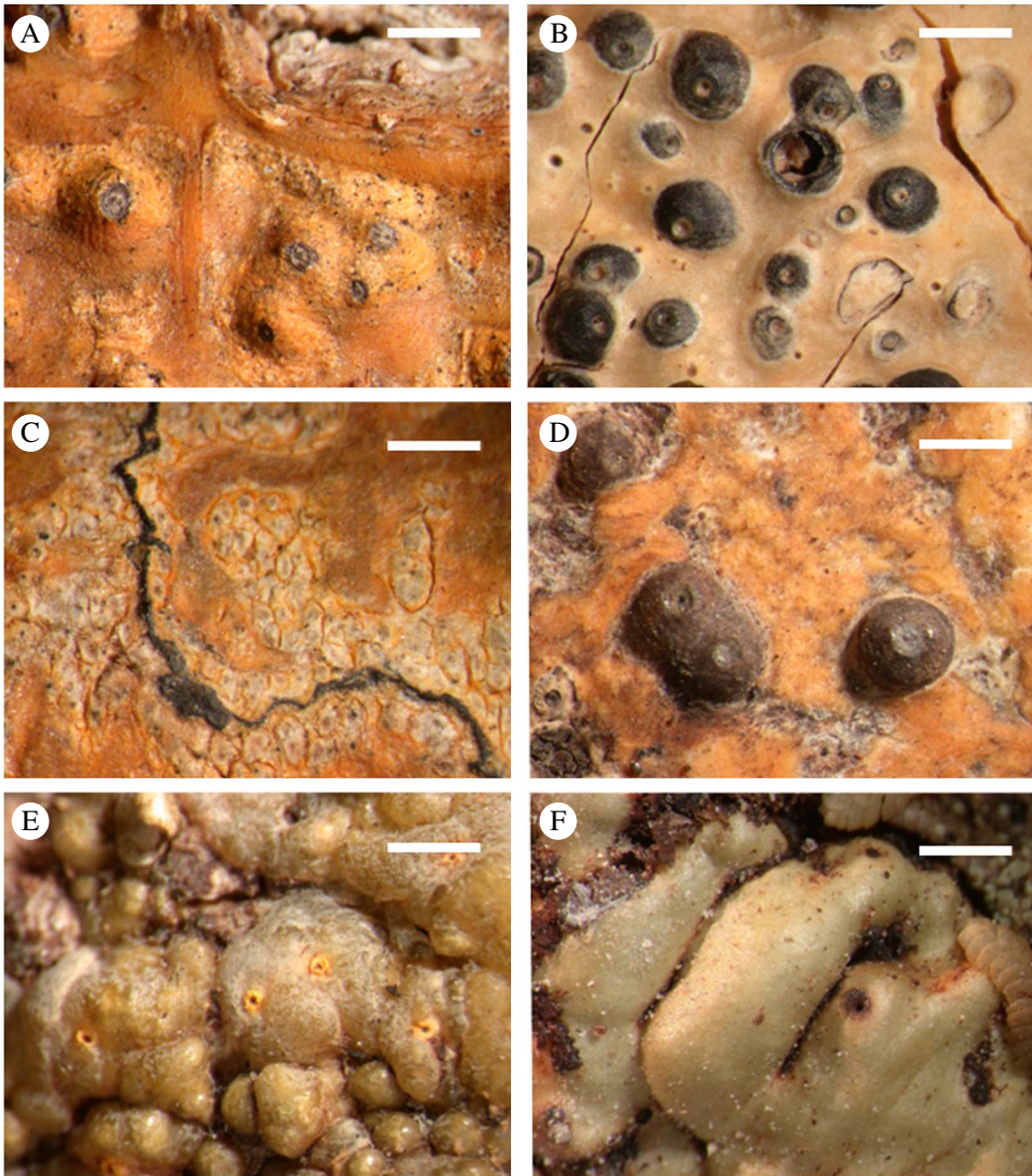


FIG. 2. Habitus of new species of *Trypetheliaceae* (holotypes). A, *Astrothelium dicoloratum*; B, *A. ecuadoriense*; C, *A. flavomaculatum*; D, *A. flavomeristosporum*; E, *A. flavostiolatum*; F, *A. guianense*. Scales: A–F = 1 mm. In colour online.

areas  $\leq 4$  cm diam., *c.* 0.1 mm thick, green with thin orange pruina, not surrounded by prothallus, not inducing gall formation of the host bark.

*Ascomata* globose, 0.3–0.4 mm diam., mostly aggregated 20–80, immersed in or

even below pseudostromata with a surface different from the thallus, which are not or not much higher than the thallus, irregular in outline, anastomosing to meandering in a reticulate pattern,  $\leq c.$  5 mm diam. (but total network covering *c.* 50% of the whole



thallus), ochraceous with thin orange pruina, inside ochraceous, not containing bark tissue, but ascomata often immersed in the bark. *Wall* carbonized,  $\leq c.$  80  $\mu\text{m}$  thick. *Ostioles* apical, not fused, flat, ochraceous to brown. *Hamathecium* not interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, muriform, ellipsoid,  $50\text{--}75 \times 12\text{--}25 \mu\text{m}$ , without distinctly thickened median septum, ends rather pointed, not surrounded by a gelatinous layer.

*Chemistry.* Thallus and pseudostromata UV–; orange pigment K+ purple, UV+ red. TLC: an anthraquinone.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known from Guyana, Venezuela, and Ecuador.

*Discussion.* This species is similar to *A. graphicum*, which generally has smaller ascospores, reaching  $\leq 66 \mu\text{m}$ .

*Additional specimens seen.* **Guyana:** Upper Takutu Distr.: Kuyuwini Landing, 1992, *H. J. M. Sipman* 58044 (B); Marudi Mts., NorMan Mines camp, alt. 300 m, 1982, *F. Stoffers et al.* 251 (B).—**Venezuela:** Bolivar: Cerro Guaiquinima, along Rio Carapo, alt. 800 m, 1990, *H. J. M. Sipman* 26961 (B).

### ***Astrothelium flavomeristosporum* Aptroot sp. nov.**

Mycobank No.: MB 815215

*Astrothelium* with mostly simple ascomata with an orange to yellow, interspersed hamathecium and muriform ascospores of  $140\text{--}200 \times 25\text{--}30 \mu\text{m}$ .

Type: Philippines, Luzon, Sorsogon, Irosin, June 1916, *E. Elmer* 15788b (B—holotype).

(Fig. 2D)

*Thallus* corticate, smooth, somewhat shiny, continuous, greyish green, covering areas  $\leq 9 \text{ cm}$  diam.,  $c.$  0.2 mm thick, surrounded by a black prothallus line  $c.$  0.1 mm wide, not inducing gall formation of the host bark.

*Ascomata* globose, 0.8–1.2 mm diam., mostly single, occasionally 2 aggregated,

in hemispherical brown pseudostromata without thallus cover. *Wall* carbonized,  $\leq c.$  120  $\mu\text{m}$  thick. *Ostioles* apical, concave, ochraceous to brown. *Hamathecium* yellow to orange (at least partly), interspersed with oil globules. *Asci* with 4–8 ascospores. *Ascospores* hyaline, muriform, ellipsoid,  $140\text{--}200 \times 25\text{--}30 \mu\text{m}$ , with distinctly thickened median septum, ends rounded, not surrounded by a gelatinous layer.

*Chemistry.* Thallus and pseudostromata K–, UV–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known from Ecuador and the Philippines.

*Discussion.* Unmistakable among *Astrothelium* species with simple ascomata and muriform ascospores because of the orange to yellow, interspersed hamathecium.

*Additional material seen.* **Ecuador:** Prov. Zamora-Chinchi: Cordillera Numbala, reserva Biologica San Francisco, 2003, *H. J. M. Sipman & E. Mandl* 51363 (B).

### ***Astrothelium flavostiolatum* Aptroot sp. nov.**

Mycobank No.: MB 815216

*Astrothelium* with bright yellow ostioles, a very irregular thallus and muriform ascospores,  $175\text{--}230 \times 35\text{--}45 \mu\text{m}$ .

Type: Ecuador, Zamora-Chinchi, Cordillera Numbala, reserva Biologica San Francisco, alt. 2020 m, 24 June 2004, *H. J. M. Sipman* 52934 (B—holotype).

(Fig. 2E)

*Thallus* corticate, discontinuous, consisting of hemispherical warts or irregularly sinuose to moniliform rows of globose to slightly flattened bullate areas that fuse together to form a continuous thallus, with a hyaline cortex, covering areas  $\leq 10 \text{ cm}$  diam., olive-green, not surrounded by a prothallus, not inducing gall formation of the bark.

*Ascomata* almost globose, 0.8–1.3 mm diam., single, immersed in the bark below

raised parts of the thallus. *Wall* carbonized,  $\leq c.$  90  $\mu\text{m}$  thick. *Ostioles* apical to rarely eccentric, not fused, erumpent, bright yellow, chimney-like. *Hamathecium* interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, muriform, fusiform, 175–230  $\times$  35–45  $\mu\text{m}$ , bent, ends rounded, without markedly thickened median septum, without gelatinous sheath.

*Chemistry.* Thallus surface UV–, thallus medulla K–; ostiole K+ red. TLC: a yellow anthraquinone.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Ecuador.

*Discussion.* This species is characterized within *Astrothelium* by its muriform ascospores, bright yellow ostioles and a very irregular thallus.

***Astrothelium guianense* Aptroot  
sp. nov.**

Mycobank No.: MB 815217

*Astrothelium* with a very irregular thallus, eccentric, fused ostioles and ascospores 4 per ascus, muriform, 70–80  $\times$  20–25  $\mu\text{m}$ .

Type: Guyana, Upper Mazaruni distr., Pakaraima Mountains, 2 km NW of Kamarang, 4 February 1985, H. J. M. Sipman & A. Aptroot 18261 (B—holotype; ABL—isotype).

(Fig. 2F)

*Thallus* corticate, discontinuous, consisting of irregularly sinuose to moniliform rows of globose to slightly flattened bullate areas that fuse together to form a continuous thallus, with a thick hyaline cortex, covering areas  $\leq$  at least 6 cm diam., olive-green, prothallus not observed, inducing irregular gall formation of the bark which splits and deforms below the thallus.

*Ascomata* almost globose, 0.8–1.3 mm diam., single, immersed in the bark below raised parts of the thallus. *Wall* carbonized,  $\leq c.$  100  $\mu\text{m}$  thick. *Ostioles* eccentric, often fused, inconspicuous. *Hamathecium* not interspersed with oil globules. *Asci* with

4 ascospores. *Ascospores* hyaline, muriform, fusiform, 70–80  $\times$  20–25  $\mu\text{m}$ , ends pointed, outer wall thick, without markedly thickened median septum, without gelatinous sheath.

*Chemistry.* Thallus and pseudostromata UV–, K–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Guyana.

*Discussion.* This species is characterized by a very irregular thallus and small muriform ascospores 70–80  $\times$  20–25  $\mu\text{m}$ . It is the only *Astrothelium* species with 4 muriform ascospores per ascus, eccentric fused ostioles and without hamathecium interspersed.

***Astrothelium intersogalbineum*  
Aptroot & Weerakoon sp. nov.**

Mycobank No.: MB 815218

*Astrothelium* similar to *A. macrocarpum* (Fée) Aptroot & Lücking, but hamathecium interspersed.

Type: Singapore, 20 April 2012, G. Weerakoon 118 (ABL—holotype).

(Fig. 3A)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas  $\leq$  3 cm diam., *c.* 0.2 mm thick, pale greenish grey, with a black prothallus line *c.* 0.2 mm wide, not inducing galls of the host bark.

*Ascomata* pyriform, *c.* 0.4–0.7 mm diam., mostly aggregated 4–10, mostly immersed in the bark tissue below pseudostromata with orange surface different from the thallus, which are distinctly raised above the thallus, mostly roundish in outline and  $\leq$  2 mm wide. *Wall* carbonized,  $\leq c.$  40  $\mu\text{m}$  thick. *Ostioles* eccentric, fused, flat, black, surrounded by a whitish zone. *Hamathecium* interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, 3-septate, 22–25  $\times$  9–11  $\mu\text{m}$ , fusiform, ends pointed, lumina diamond-shaped, not surrounded by a gelatinous layer.

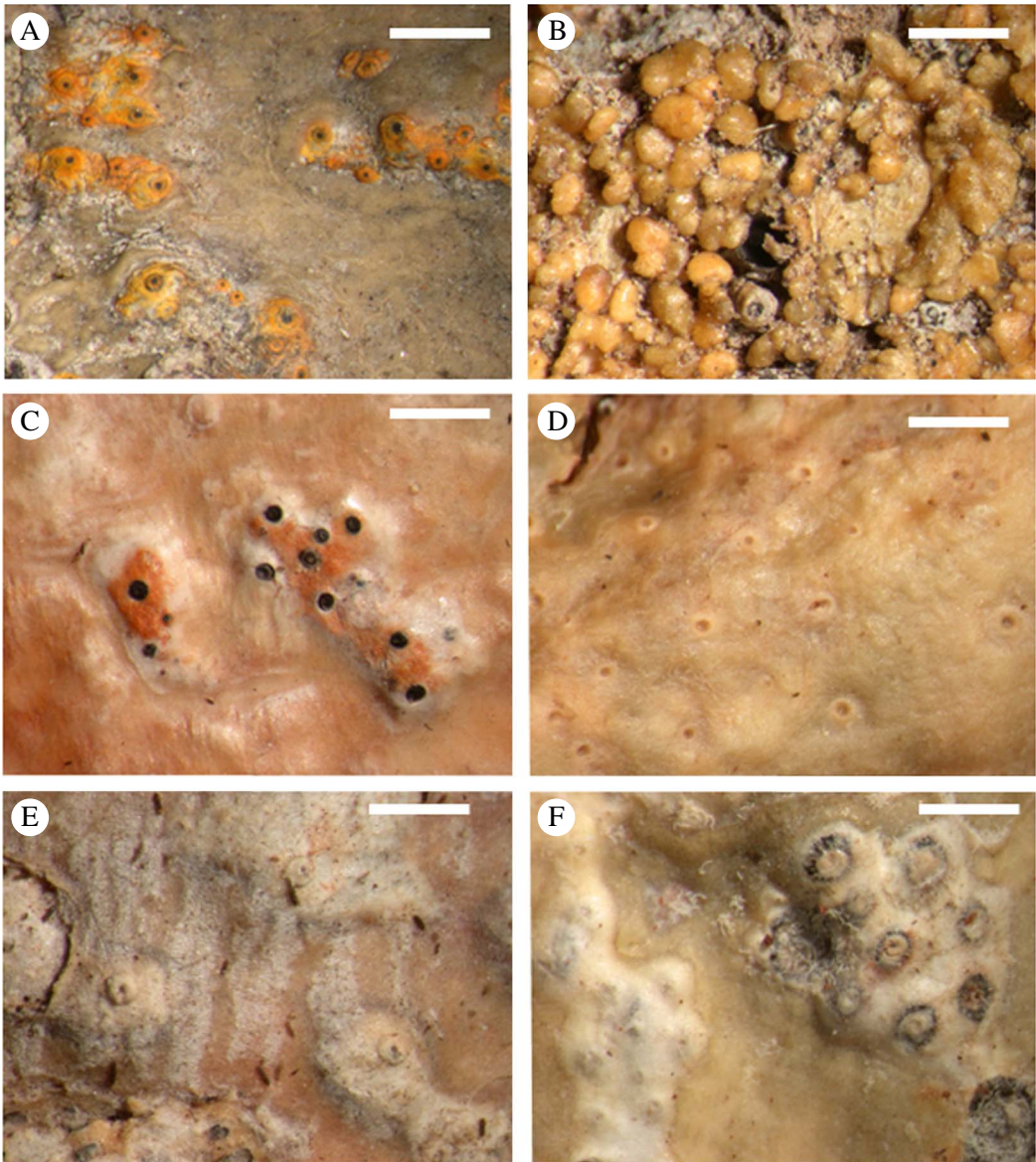


FIG. 3. Habitus of new species of *Trypetheliaceae* (holotypes). A, *Astrothelium intersogalbineum*; B, *A. komposchii*; C, *A. laurerosphaerioides*; D, *A. lucidomedullatum*; E, *A. lucidostromum*; F, *A. lucidothallinum*. Scales: A–F = 1 mm. In colour online.

**Chemistry.** Thallus UV+ yellow, K–, with lichexanthone; pseudostromata K+ purple, UV+ red. TLC: a yellow to orange anthraquinone.

**Ecology and distribution.** On smooth bark of trees in rainforest. Known only from Singapore.

**Discussion.** This is the only member of the the core group of the genus, the *Astrothelium conicum*-group, with an inspersed hamathecium. Other species of the group are very numerous and often abundant, and they are never inspersed. The new species is similar to

*A. macrocarpum*, which was for a long time known as *A. galbineum* Krempelh.

***Astrothelium komposchii* Aptroot  
sp. nov.**

Mycobank No.: MB 815219

*Astrothelium* with chimney-like ostioles, a very irregular, almost squamulose thallus and muriform ascospores, 130–180 × 35–45 µm.

Type: Venezuela, Amazonas, Alto Orinoco, c. 15 km SW of La Esmeralda, W bank of Surumoni, on *Goupia glabra*, alt. 110 m, 1997, J. Hafellner & H. Komposch 539-2-20 (GZU—holotype).

(Fig. 3B)

*Thallus* green, discontinuous, consisting of irregularly sinuose to moniliform rows of flattened, almost squamulose thallus lobes which mostly consist of a hyaline cortex ≤150 µm, not surrounded by a prothallus, not inducing gall formation of the bark.

*Ascomata* almost globose, 0.8–1.3 mm diam., single, immersed in the bark below raised parts of the thallus. *Wall* carbonized, ≤c. 90 µm thick. *Ostioles* apical to rarely eccentric, not fused, erumpent, chimney-like, glossy olive-brown outside, black inside. *Hamathecium* interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, muriform, fusiform, 130–180 × 35–45 µm, bent, ends rounded, with a markedly thickened median septum, without gelatinous sheath.

*Chemistry.* Thallus and pseudostromata UV–, K–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Venezuela.

*Discussion.* This species is characterized by chimney-like ostioles, very irregular almost squamulose thallus, and 8 muriform ascospores per ascus.

*Additional material seen.* **Venezuela:** same data as type material, all 1997, 539-2-20, 313-3-16, 539-4-12,

991-5-15, 313-4-14, 170-5-30, 170-6-6, 170-6-19, 313-5-64, 539-6-11, 539-5-50 (all GZU).

***Astrothelium laurerospaerioides*  
Aptroot sp. nov.**

Mycobank No.: MB 815220

*Astrothelium* with aggregated ascomata with internally and partly (when abraded) also superficially orange anthraquinone, ascospores 2 per ascus, muriform, 110–130 × 30–35 µm.

Type: Guyana, Upper Takutu Distr., Rupununi Savannah, Kusad Mountain, alt. 450 m, 29 September 1992, H. J. M. Sipman 57835 (B—holotype).

(Fig. 3C)

*Thallus* corticate, smooth, shiny, covering areas ≤15 cm diam., c. 0.1 mm thick, pale ochraceous green, not surrounded by a prothallus, not inducing gall formation of the host bark.

*Ascomata* pyriform, 0.6–0.9 mm diam., mostly aggregated 3–7, completely immersed to erumpent from the bark (and then often partly exposing the black wall), below decorticated flat, internally and partly (when abraded) also superficially orange pseudostromata that are slightly raised above the thallus. *Wall* carbonized all around, ≤c. 80 µm thick. *Ostioles* apical, simple, flat to concave, black. *Hamathecium* not interspersed with oil globules. *Asci* with 2 ascospores. *Ascospores* hyaline, muriform, 110–130 × 30–35 µm, ellipsoid, without distinctly thickened median septum.

*Chemistry.* Thallus UV–, K–; medulla and sometimes surface of pseudostromata K+ purple. TLC: an anthraquinone.

*Ecology and distribution.* On smooth bark of trees in savannah forest. Known only from Guyana.

*Discussion.* This is the only *Astrothelium* with an orange anthraquinone in the pseudostroma medulla and ascospores which are 2 per ascus and muriform.

***Astrothelium lucidomedullatum*****Aptroot sp. nov.**

Mycobank No.: MB 815221

*Astrothelium* with lichexanthone in the medulla of the thallus, ascospores 4 per ascus, muriform, 80–115 × 25–35 µm.

Type: Ecuador, Zamora-Chinchi, Cordillera Numbala, reserva Biologica San Francisco, alt. 2025 m, 16 June 2004, *H. J. M. Sipman* 52318a (B—holotype).

(Fig. 3D)

*Thallus* corticate, very smooth, shiny, covering areas ≤ 5 cm diam., *c.* 0.3 mm thick, pale ochraceous green, not surrounded by a prothallus, not inducing gall formation of the host bark.

*Ascomata* pyriform, 0.6–1.2 mm diam., solitary, completely immersed in the bark, without pseudostromata. *Wall* pale to partly dark brown, ≤ *c.* 70 µm thick. *Ostioles* eccentric, simple, concave, pale brown, surrounded by an ochraceous ring, presenting the only part of the ascoma that is visible from above. *Hamathecium* interspersed with oil globules. *Asci* with 4 ascospores. *Ascospores* hyaline, muriform, 80–115 × 25–35 µm, ellipsoid, without a distinctly thickened median septum.

*Chemistry.* Thallus UV–, K–, thallus medulla UV+ yellow, visible through the hyaline cortex. TLC: lichexanthone in the medulla (not in the cortex as usual).

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Ecuador.

*Discussion.* The presence of lichexanthone in the medulla rather than in the cortex is probably unique in the family. It is rare in other lichen families too, otherwise known only from *Megalotremis infernalis* (Mont.) Aptroot and a few macrolichens.

*Additional material seen.* **Ecuador:** same locality as the type, 2004, *H. J. M. Sipman* 52318b (B); 2004, *Sipman* 52452 (B).

***Astrothelium lucidostromum*****Aptroot sp. nov.**

Mycobank No.: MB 815222

*Astrothelium* similar to *A. eustomuralis* Aptroot & M. Cáceres, but with lichexanthone present in the whole pseudostroma.

Type: Guyana, Upper Takutu Distr., *c.* 45 km S of Aishalton, 3 km S of Kuyuwini Landing, alt. 230 m, 29 October 1992, *H. J. M. Sipman* 57013 (B—holotype).

(Fig. 3E)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas ≤ 7 cm diam., under 0.1 mm thick, pale yellowish grey, not surrounded by prothallus, not inducing gall formation of the host bark.

*Ascomata* pyriform, *c.* 0.6–1.0 mm diam., mostly aggregated 2–5, mostly immersed in the bark tissue below pseudostromata with a whitish surface different from the thallus, which are distinctly raised above the thallus and mostly linear to irregular in outline and ≤ 4 mm long and 1 mm wide, not forming a network. *Wall* carbonized, ≤ *c.* 80 µm thick. *Ostioles* eccentric, fused, strongly convex, pale brownish, surrounded by a whitish pruinose ring. *Hamathecium* not interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, submuriform, fusiform, 35–40 × 13–15 µm, ends rounded, without thickened median septum, not surrounded by a gelatinous layer.

*Chemistry.* Thallus UV–, K–; pseudostromata UV+ yellow. TLC: lichexanthone.

*Ecology and distribution.* On smooth bark of trees in savannah forest. Known only from Guyana.

*Discussion.* Similar to *A. eustomuralis*, but lichexanthone is present in the whole pseudostroma, not only on the ostiole.

***Astrothelium lucidothallinum*****Aptroot sp. nov.**

Mycobank No.: MB 815223

*Astrothelium* with the thallus containing lichexanthone; ascomata in pseudostromata without lichexanthone,

ostioles apical, hamathecium not interspersed, ascospores muriform,  $70\text{--}90 \times 18\text{--}20 \mu\text{m}$ .

Type: Guyana, Upper Takutu Distr., c. 30 km S of Aishalton, N border of Parabara savannah, alt. 300 m, 7 October 1992, *H. J. M. Sipman* 58038 (B—holotype).

(Fig. 3F)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas  $\leq 9$  cm diam.,  $\leq 0.1$  mm thick, pale yellowish grey, surrounded by a black prothallus line c. 0.1 mm wide, inducing gall formation of the host bark in the form of bark galls underneath the thallus.

*Ascomata* almost globose, c. 0.8–1.2 mm diam., immersed in pseudostromata, but also in the bark, mostly in groups of 2–8, usually clustered in lines. *Pseudostromata* whitish, slightly raised and linear. *Wall* carbonized,  $\leq c. 150 \mu\text{m}$  thick. *Ostioles* apical, ochraceous, surrounded by a whitish ring and around this often a thin black ring with exposed ascoma walls. *Hamathecium* not interspersed. *Ascospores* 8 per ascus, hyaline, IKI–, densely muriform,  $70\text{--}90 \times 18\text{--}20 \mu\text{m}$ , fusiform, without thickened median septum.

*Chemistry.* Thallus UV+ yellow; pseudostromata in contrast UV–. TLC: lichexanthone.

*Ecology and distribution.* On smooth bark of trees in savannah forest. Known only from Guyana.

*Discussion.* Characterized by the thallus containing lichexanthone, contrasting with the pseudostromata which are without lichexanthone; ascospores muriform,  $70\text{--}90 \times 18\text{--}20 \mu\text{m}$ .

***Astrothelium mediocrassum* Aptroot  
sp. nov.**

Mycobank No.: MB 815224

*Astrothelium* resembling *A. octosporum* (Vain.) Aptroot & Lücking, but without lichexanthone in the thallus or pseudostromata, ascospores muriform,  $70\text{--}80 \times 22\text{--}25 \mu\text{m}$ , and median septum strongly thickened.

Type: Guyana, Upper Takutu Distr., c. 45 km S of Aishalton, 3 km S of Kuyuwini Landing, alt. 230 m, 29 October 1992, *H. J. M. Sipman* 56971 (B—holotype).

(Fig. 4A)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas  $\leq 12$  cm diam.,  $\leq 0.3$  mm thick, pale green, not surrounded by prothallus, not inducing gall formation of the host bark.

*Ascomata* pyriform, c. 0.6–1.0 mm diam., mostly aggregated 2–5, immersed in pseudostromata with a smooth cream surface different from the thallus, which are distinctly raised c. 1 mm above the thallus and almost constricted at the base. *Wall* carbonized,  $\leq c. 80 \mu\text{m}$  thick. *Ostioles* eccentric, fused, strongly convex, brown. *Hamathecium* not interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, muriform, fusiform,  $70\text{--}80 \times 22\text{--}25 \mu\text{m}$ , median septum strongly thickened, ends pointed, not surrounded by a gelatinous layer.

*Chemistry.* Thallus and pseudostromata UV–, K–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in savannah forest. Known only from Guyana.

*Discussion.* This species resembles *A. octosporum*, but has no lichexanthone in the thallus or pseudostromata. It has the smallest ascospores of the *Astrothelium* species, with 8 muriform ascospores per ascus, eccentric and fused ostioles, and a hamathecium without interspersed and without secondary substances.

***Astrothelium megatropicum* Aptroot  
sp. nov.**

Mycobank No.: MB 815225

*Astrothelium* with 3-septate ascospores  $100\text{--}120 \times 33\text{--}35 \mu\text{m}$ , and hemispherical dark brown pseudostromata.

Type: Guyana, Potaro-Siparuni Region, surroundings of Paramakatoi village, alt. 800 m, 23 February 1996, *H. J. M. Sipman* 41281 (B—holotype).

(Fig. 4B)

*Thallus* corticate, smooth, somewhat shiny, continuous, pale ochraceous green, covering areas  $\leq 7$  cm diam., c. 0.2 mm thick,

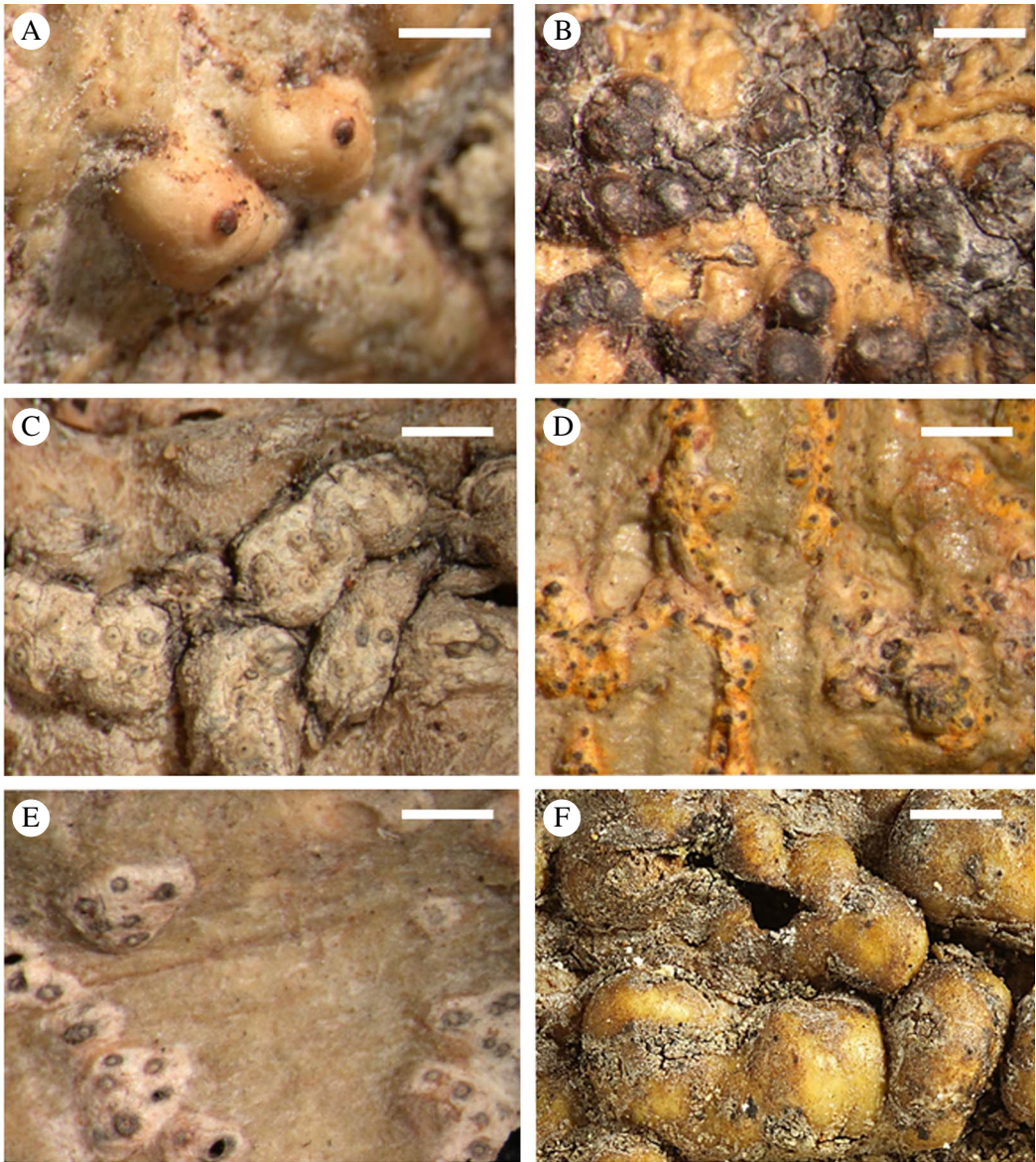


FIG. 4. Habitus of new species of *Trypetheliaceae* (holotypes). A, *Astrothelium mediocrassum*; B, *A. megatropicum*; C, *A. megochroleucum*; D, *A. neoinspersum*; E, *A. perspersum*; F, *A. philippinense*. Scales: A–F = 1 mm. In colour online.

surrounded by a black prothallus line *c.* 0.1 mm wide, not inducing gall formation of the host bark.

*Ascomata* globose, 0.6–1.0 mm diam., mostly single, occasionally 2 aggregated, in hemispherical dark brown pseudostromata without thallus cover. *Wall* carbonized,

*≤c.* 100  $\mu$ m thick. *Ostioles* apical, concave, ochraceous, white pruinose. *Hamathecium* interspersed with oil globules. *Asci* with 4–8 ascospores. *Ascospores* hyaline, 3-septate, ellipsoid, 100–120  $\times$  33–35  $\mu$ m, lumina diamond-shaped, ends rounded, not surrounded by a gelatinous layer.

**Chemistry.** Thallus and pseudostromata UV<sup>-</sup>, K<sup>-</sup>. TLC: no secondary substances detected.

**Ecology and distribution.** On smooth bark of trees in savannah forest. Known only from Guyana.

**Discussion.** This species has by far the longest 3-septate ascospores in the family. The dark brown pseudostromata contrast strongly with the ochraceous thallus and this gives the impression of a species without pseudostromata, such as *Nigrovothelium tropicum* (Ach.) Lücking *et al.*, hence the name.

### ***Astrothelium megochroleucum***

#### **Aptroot sp. nov.**

Mycobank No.: MB 815226

*Astrothelium* with 3-septate ascospores 60–70 × 16–18 µm and lichexanthone in the thallus and pseudostromata.

Type: El Salvador, Depto. Ahuachapán, Parque Nacional El Imposible, sector L Campana, Cafetal Las Piedrones, on *Leucaena trichandra* in coffee plantation, alt. 1300 m, 10 November 1998, H. J. M. Sipman, S. Sandoval & J. Welz 44823 (B—holotype).

(Fig. 4C)

**Thallus** corticate, smooth, somewhat shiny, continuous, covering areas ≤ 4 cm diam., under 0.1 mm thick, ochraceous with whitish pruina, surrounded by a black prothallus line c. 0.1 mm wide, inducing gall formation of the host bark, which splits open and forms a callus under the thallus.

**Ascomata** globose, 0.6–0.9 mm diam., immersed in groups of c. 2–10 in pseudostromata. **Pseudostromata** with a surface hardly different from the thallus, c. 0.5–1.0 mm raised above the thallus, mostly oval in outline, ≤ c. 3 mm diam., with whitish cover, partly brownish inside. **Wall** black, ≤ 80 µm thick. **Ostioles** apical, not fused, convex, ochraceous to grey. **Hamathecium** not interspersed with oil globules. **Asci** with 8 ascospores. **Ascospores** hyaline, 3-septate, fusiform, 60–70 × 16–18 µm, not surrounded by a gelatinous layer.

**Chemistry.** Thallus and pseudostromata UV<sup>+</sup> yellow, K<sup>-</sup>. TLC: lichexanthone.

**Ecology and distribution.** On smooth bark of trees in coffee plantation. Known only from El Salvador.

**Discussion.** This species has the appearance of *Astrothelium ochroleucoides* Aptroot & M. Cáceres, from which it differs, for example, by the long 3-septate ascospores. It has the longest ascospores among *Astrothelium* species with 3-septate ascospores and lichexanthone in the thallus and pseudostromata.

### ***Astrothelium neoinspersum***

#### **Aptroot sp. nov.**

Mycobank No.: MB 815227

*Astrothelium* similar to *A. aenascens* Aptroot, but with bright yellow pseudostromata.

Type: El Salvador, Santa Ana, Metapan, Parque Nacional Montecristo, 1993, H. J. M. Sipman, F. Berendsohn & L. Ladino 37365 (B—holotype).

(Fig. 4D)

**Thallus** corticate, smooth, somewhat shiny, continuous, covering areas ≤ 5 cm diam., c. 0.2 mm thick, olive-green, not surrounded by a prothallus, not inducing gall formation of the host bark.

**Ascomata** globose, 0.4–0.7 mm diam., immersed in groups of 2–10 in pseudostromata with a surface different from the thallus, and which are distinctly raised above the thallus, irregular to often linear in outline, sides sloping, bright yellow, inside with a cream layer containing bark tissue. **Wall** dark brown all around, ≤ c. 70 µm thick. **Ostioles** apical, not fused, flat to convex, black. **Hamathecium** interspersed with oil globules. **Asci** with 8 ascospores. **Ascospores** hyaline, 3-septate, fusiform, 18–23 × 7–8 µm, ends rounded, lumina diamond-shaped, surrounded by a 3 µm thick gelatinous layer.

**Chemistry.** Thallus UV<sup>-</sup>, pseudostromata UV<sup>+</sup> red, K<sup>+</sup> purple. TLC: an anthraquinone.

**Ecology and distribution.** On smooth bark of trees in rainforest. Known only from El Salvador.

**Discussion.** Similar to *A. aenascens*, but with bright yellow pseudostromata. Also similar to



*A. inspersaeneum* E. L. Lima *et al.*, which has at least some orange pigmentation on the thallus.

***Astrothelium perspersum* Aptroot & Ertz sp. nov.**

Mycobank No.: MB 815228

*Astrothelium* similar to *A. scoria* (Fée) Aptroot & Lücking, but with ascospores of 26–38 × 7–9 µm.

Type: Gabon, Nzé, au nord-est de Makokou, entre Massaha et Batouala, 12 April 2006, D. Ertz 9716 (BR—holotype).

(Fig. 4E)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas ≤4 cm diam., ≤0.1 mm thick, pale greenish grey, surrounded by a black prothallus line *c.* 0.1 mm wide, not inducing gall formation of the host bark.

*Ascomata* almost globose, *c.* 0.5–0.7 mm diam., immersed in pseudostromata, but also in the bark, mostly in groups of 2–8, usually clustered in lines. *Pseudostromata* whitish, slightly raised and linear. *Wall* carbonized, ≤*c.* 90 µm thick. *Ostioles* apical, whitish, surrounded by a thin black ring with exposed ascoma walls. *Hamathecium* interspersed with oil globules. *Ascospores* 8 per ascus, hyaline, 3-septate, 26–38 × 7–9 µm, lumina diamond-shaped.

*Chemistry.* Thallus and pseudostromata UV–, K–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Gabon.

*Discussion.* Similar to *A. scoria*, but with larger ascospores. This is one of the few *Trypetheliaceae* species described (and known only) from Africa.

***Astrothelium philippinense* Aptroot & Schumm sp. nov.**

Mycobank No.: MB 815229

*Astrothelium* without pseudostromata, ostiole apical, hamathecium interspersed, ascospores muriform, 125–170 × 30–35 µm, 4 per ascus.

Type: Philippines, Negros, Negros Oriental, Mt. Talinis, 1100–1600 m, 19 August 2000, F. Schumm & S. Schwarz 7532 (B—holotype; hb. Schumm, ABL—iso-types).

(Fig. 4F)

*Thallus* corticate, smooth, shiny, covering areas ≤7 cm diam., *c.* 0.2 mm thick, pale ochraceous green, surrounded by a brown to black prothallus line *c.* 0.4 mm wide, inducing gall formation of the host bark in the form of numerous *c.* 1–2 mm wide hemispherical warts.

*Ascomata* pyriform, 0.6–0.9 mm diam., solitary, completely immersed in the bark, below the thallus cortex which, however, can be raised in warts by the bark galls, not in pseudostromata. *Wall* carbonized all around, ≤*c.* 80 µm thick. *Ostioles* apical, simple, flat, black, presenting the only part of the ascoma that is visible from above. *Hamathecium* interspersed with oil globules. *Asci* with 4 ascospores. *Ascospores* hyaline, muriform, 125–170 × 30–35 µm, ellipsoid, with a distinctly thickened median septum.

*Pycnidia* not observed with certainty, although some of the many black dots around the ostioles may represent young pycnidia.

*Chemistry.* Thallus and pseudostromata UV–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from the Philippines.

*Discussion.* Characterized by the combination of the following characters: muriform ascospores, 4 per ascus, without pseudostromata, ostiole apical, hamathecium interspersed.

*Additional specimen seen.* **Philippines:** Mindanao: Prov. Cotabato, Mt. Apo, 1250 m, 1999, F. Schumm & S. Schwarz 5993 (hb. Schumm).

***Astrothelium pseudannulare* Aptroot & Etayo sp. nov.**

Mycobank No.: MB 815230

*Astrothelium* with the appearance of the *A. puiggarii* (Müll. Arg.) Aptroot & Lücking-group, but

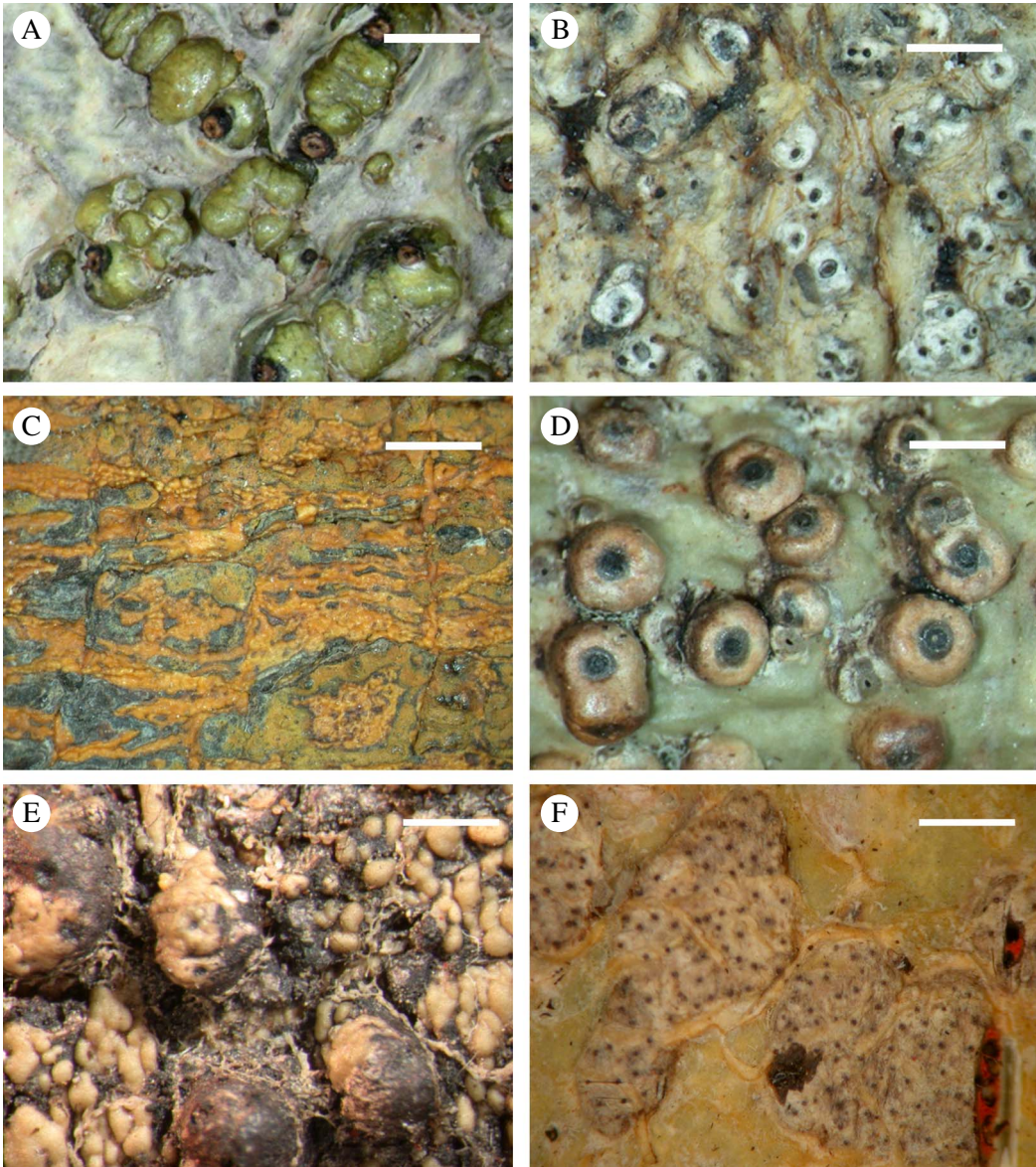


FIG. 5. Habitus of new species of Trypetheliaceae (holotypes). A, *Astrothelium pseudannulare*; B, *A. pseudodissimulatum*; C, *A. pseudoferrugineum*; D, *A. pseudomegalophthalmum*; E, *A. rimosum*; F, *A. sanguineoxanthum*. Scales: A–F = 1 mm. In colour online.

differing from all other species of it by the 3-septate ascospores  $80\text{--}88 \times 32\text{--}36 \mu\text{m}$ , which are 2–4 per ascus.

Type: Ecuador, Loja, Cajanuma, Parque Nacional Podocarpus, nudo de Sabanilla, 3000 m, 4 August 1999, *J. Etayo & Z. Palice* 20154 (hb. Etayo—holotype; ABL—isotype).

(Fig. 5A)

*Thallus* consisting of raised, corticate patches, smooth, shiny, covering areas of c. 1.0–3.5 mm diam., c. 0.2 mm thick, olive-green, breaking through the host bark.

*Ascomata* globose, 0.7–1.3 mm diam., single or more often in lines of 2–5, not in pseudostromata. *Wall* black all around,  $\leq c.$  60  $\mu\text{m}$  thick. *Ostioles* apical to often somewhat eccentric, not fused, convex to pointed, brown, surrounded by a black ring  $c.$  0.1 mm wide. *Hamathecium* not interspersed with oil globules. *Asci* with 2–4 ascospores. *Ascospores* hyaline, 3-septate, fusiform, 62–80  $\times$  20–25  $\mu\text{m}$ , ends rounded, lumina diamond-shaped, surrounded by an  $\leq 12 \mu\text{m}$  thick gelatinous layer.

*Pycnidia* not observed.

*Chemistry.* Thallus and medulla UV–, K–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in mountain forest. Known only from Ecuador.

*Discussion.* This is a species with the appearance of the *A. puiggarii*-group, characterized for example by the solitary ascomata with partly eccentric ostioles that are immersed in isolated superficial thallus patches. It would otherwise key out as *A. annulare* (Mont.) Aptroot & Lücking because of the large 3-septate ascospores.

### ***Astrothelium pseudodissimulatum* Aptroot sp. nov.**

Mycobank No.: MB 815231

*Astrothelium* with K+ red crystals in the ascoma wall and 5-septate ascospores of 25–33  $\times$  9–11  $\mu\text{m}$ .

Type: Papua New Guinea, Madang Prov., Brahman Mission, alt. 100 m, 29 October 1995, H. J. M. Sipman 38789 (B—holotype).

(Fig. 5B)

*Thallus* corticate, rather smooth, continuous, covering areas  $\leq 15 \text{ cm}$  diam.,  $c.$  0.2 mm thick, pale yellowish green, not surrounded by a prothallus, partly bullate, apparently inducing irregular gall formation of the host bark.

*Ascomata* globose, 0.4–0.7 mm diam., immersed in the thallus, single or in loose groups of 2–9, not in clear pseudostromata.

*Wall* black all around,  $\leq c.$  80  $\mu\text{m}$  thick, with K+ red crystals. *Ostioles* apical, not fused, concave, brown. *Hamathecium* densely interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, 5-septate, fusiform, 25–33  $\times$  9–11  $\mu\text{m}$ , ends rounded, lumina diamond-shaped, not surrounded by a gelatinous layer.

*Pycnidia* not observed.

*Chemistry.* Thallus and medulla UV–, K–; ascomata wall K+ red. TLC: an anthraquinone.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Papua New Guinea.

*Discussion.* This is probably a species of the *A. annulare* (Mont.) Aptroot & Lücking-group, characterized for example by the K+ red crystals in the ascoma wall. It keys out near *A. dissimulatum* (Makhija & Patw.) Aptroot & Lücking because of the 5-septate ascospores.

### ***Astrothelium pseudoferrugineum* Aptroot sp. nov.**

Mycobank No.: MB 815232

*Astrothelium* of the *A. conicum* Eschw.-group with an orange thallus and pseudostroma pruina, differing from *A. ferrugineum* (Müll. Arg.) Aptroot & Lücking by the 28–31  $\times$  9–11  $\mu\text{m}$  ascospores and the glossier thallus.

Type: Indonesia, Java, Djombang, October 1937, P. Groenhart 5739 (L—holotype; ABL—istotype).

(Fig. 5C)

*Thallus* corticate, smooth, somewhat shiny to glossy, continuous, covering areas  $\leq 3 \text{ cm}$  diam.,  $c.$  0.1 mm thick, bright orange, not surrounded by a prothallus.

*Ascomata* pyriform, 0.2–0.3 mm wide, 0.3–0.5 mm high, immersed in pseudostromata. *Pseudostromata* conical, raised above the thallus, with orange pruina. *Wall* black all around,  $\leq c.$  90  $\mu\text{m}$  thick. *Ostioles* eccentric, 2–5 fused, convex to pointed, black. *Hamathecium* not interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline,

3-septate, fusiform,  $28\text{--}31 \times 9\text{--}11 \mu\text{m}$ , ends somewhat pointed, lumina diamond-shaped, not surrounded by a gelatinous layer.

*Pycnidia* not observed.

*Chemistry.* Thallus UV<sup>-</sup>, K<sup>-</sup>; pseudostromata UV<sup>+</sup> red, K<sup>+</sup> purple. TLC: an orange anthraquinone, possibly parietin.

*Ecology and distribution.* On smooth bark of trees in disturbed rainforest. Known only from Indonesia.

*Discussion.* This is a species of the *A. conicum*-group, characterized for example by the conical pseudostromata with anthraquinone. It differs from all species except *A. ferrugineum* (Müll. Arg.) Aptroot & Lücking by the orange thallus, and from this species by the larger ascospores and glossier thallus.

***Astrothelium pseudomegalophthalmum* Aptroot sp. nov.**

Mycobank No.: MB 815233

*Astrothelium* similar to *A. megaspermum* (Mont.) Aptroot & Lücking, but differing by the 7-septate ascospores of  $152\text{--}166 \times 32\text{--}37 \mu\text{m}$ .

Type: Colombia, Amazonas, Aracuara, opposite Isla Morrocoy, alt. 300 m, 3 November 1988, *H. J. M. Sipman* & *J. van Duivenvoorden* 28501 (B—holotype).

(Fig. 5D)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas  $\leq 7$  cm diam., *c.* 0.1 mm thick, pale olive-green, surrounded by a thin brown prothallus, not inducing irregular gall formation of the host bark.

*Ascomata* globose, 0.7–1.1 mm diam., superficial, completely covered by thallus, not in pseudostromata; warts hemispherical, *c.* 0.9–1.4 mm diam. and 0.6–1.1 mm high. *Wall* black all around,  $\leq c.$  70  $\mu\text{m}$  thick. *Ostioles* apical, not fused, concave, black, surrounded by a brown ring *c.* 0.2 mm wide. *Hamathecium* densely interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, 7-septate, fusiform,  $152\text{--}166 \times 32\text{--}37 \mu\text{m}$ , ends rounded, lumina diamond-shaped, not surrounded by a gelatinous layer.

*Pycnidia* not observed.

*Chemistry.* Thallus and medulla UV<sup>-</sup>, K<sup>-</sup>. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in savannah forest. Known only from Colombia.

*Discussion.* This species has the appearance of *A. megaspermum*, characterized for example by the superficial single ascomata in hemispherical warts, but it differs by the only transversely septate ascospores. It keyed out near *A. megalophthalmum* (Müll. Arg.) Aptroot & Lücking because of the large 7-septate ascospores.

***Astrothelium rimosum* Aptroot sp. nov.**

Mycobank No.: MB 815234

*Astrothelium* with 7–11-septate ascospores,  $110\text{--}150 \times 30\text{--}37 \mu\text{m}$ , and a rimose thallus with yellow medulla.

Type: Guyana, Potaro-Siparuni Region, Kaieteur Falls National Park, around airstrip, sclerophyllous forest, alt. 400 m, 13–20 February 1996, *H. J. M. Sipman* 40391 (B—holotype).

(Fig. 5E)

*Thallus* olive-green to yellowish green, strongly rimose, partly with almost globose lobules, with a thick hyaline cortex, medulla pale citrine yellow, not surrounded by a prothallus, not inducing gall formation of the bark.

*Ascomata* globose, 0.7–1.1 mm diam., superficial, solitary or a few fused sideways, brown, often with constricted base, at the sides partly covered by thallus, not in pseudostromata. *Wall* carbonized,  $\leq c.$  90  $\mu\text{m}$  thick. *Ostioles* apical to eccentric, black, convex. *Hamathecium* interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, 7–11-septate,  $110\text{--}150 \times 30\text{--}37 \mu\text{m}$ , lumina diamond-shaped.

*Chemistry.* Thallus UV<sup>-</sup>, K<sup>+</sup> red, especially the medulla; with anthraquinone.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known from Colombia and Guyana.

**Discussion.** Characterized by the 7–11-septate ascospores of  $110\text{--}150 \times 30\text{--}37 \mu\text{m}$  and the rimose thallus with yellow medulla. It is similar to *A. luridum* (Zahlbr.) Aptroot & Lücking, which also has a yellow medulla and 7–11-septate ascospores, but which has much shorter ascospores of, at most,  $88 \mu\text{m}$ .

**Additional material seen.** **Colombia:** Depto. Valle del Cauca: Buenaventura, alt. 230 m, *M. van Rooden*, *B. J. H. ter Welle* & *B. Topper* 571 (B).

***Astrothelium sanguineoxanthum*  
Aptroot sp. nov.**

Mycobank No.: MB 815235

*Astrothelium* with the thallus containing lichexanthone and pseudostromata with numerous immersed round ascomata, the whole inside of which is full of red, K+ green pigment.

Type: Brazil, Matto Grosso, Santa Anna da Chapada, 21 March 1894, *G. O. A. Malme* 2484C (S—holotype).

(Fig. 5F)

**Thallus** green to greyish, smooth.

**Pseudostromata** whitish, rather flat, rounded to irregular in shape or elongated, with rather steep sides, generally with numerous immersed round ascomata with complete black wall,  $\leq 5 \text{ mm}$  long and  $2 \text{ mm}$  wide, the whole inside full of red, K+ green pigment. **Ostioles** apical, black, flush. **Hamathecium** not interspersed, filaments profusely anastomosing. **Ascospores** 8 per ascus, muriform,  $59\text{--}86 \times 15\text{--}20 \mu\text{m}$ , IKI+ violet, without strongly thickened median septum.

**Chemistry.** Thallus UV+ yellow, K–, pseudostroma exterior UV+ yellow, inside pink, reacting K+ green; with lichexanthone and isohypocrellin.

**Ecology and distribution.** On smooth bark of trees in rainforest. Known only from Brazil.

**Discussion.** The only *Astrothelium* with the thallus containing lichexanthone and pseudostromata with numerous immersed round ascomata, the whole inside of which is full of the red, K+ green pigment isohypocrellin.

**Additional specimen seen.** **Brazil:** same locality, 1894, *G. O. A. Malme* 2530D p.p. (S).

***Astrothelium septemseptatum*  
Aptroot sp. nov.**

Mycobank No.: MB 815236

*Astrothelium* with the thallus and pseudostromata UV+ yellow and 7–9-septate ascospores of  $50\text{--}55 \times 12\text{--}17 \mu\text{m}$ .

Type: Guyana, Upper Takutu Distr., c. 45 km S of Aishalton, 3 km S of Kuyuwini Landing, alt. 230 m, 29 October 1992, *H. J. M. Sipman* 56970 (B—holotype).

(Fig. 6A)

**Thallus** corticate, smooth, somewhat shiny, continuous, covering areas  $\leq 9 \text{ cm}$  diam., under  $0.1 \text{ mm}$  thick, pale yellowish grey, surrounded by a  $\leq 0.5 \text{ mm}$  wide black prothallus, not inducing gall formation of the host bark.

**Ascomata** pyriform, c.  $0.6\text{--}1.0 \text{ mm}$  diam., mostly aggregated 2–5, mostly immersed in the bark tissue below pseudostromata with a whitish surface different from the thallus, which are distinctly raised above the thallus and mostly linear to irregular in outline, and  $\leq 4 \text{ mm}$  long and  $1 \text{ mm}$  wide. **Wall** carbonized,  $\leq c. 80 \mu\text{m}$  thick. **Ostioles** eccentric, fused, strongly convex, pale brownish, surrounded by a whitish pruinose ring. **Hamathecium** not interspersed with oil globules. **Asci** with 8 ascospores. **Ascospores** hyaline, fusiform, 7–9-septate,  $50\text{--}55 \times 12\text{--}17 \mu\text{m}$ , ends rounded, not surrounded by a gelatinous layer.

**Chemistry.** Thallus (mostly) and pseudostromata (everywhere) UV+ yellow, K–. TLC: lichexanthone.

**Ecology and distribution.** On smooth bark of trees in savannah and rainforest. Known from Guyana and Venezuela.

**Discussion.** The only *Astrothelium* with a UV+ yellow thallus and pseudostromata, and 7–9-septate ascospores.

**Additional specimens seen.** **Venezuela:** Amazonas: Alto Orinoco, Surumoni, 1998, *J. Hafellner* & *H. Komposch* 3264, 3290 & 3342 (GZU).

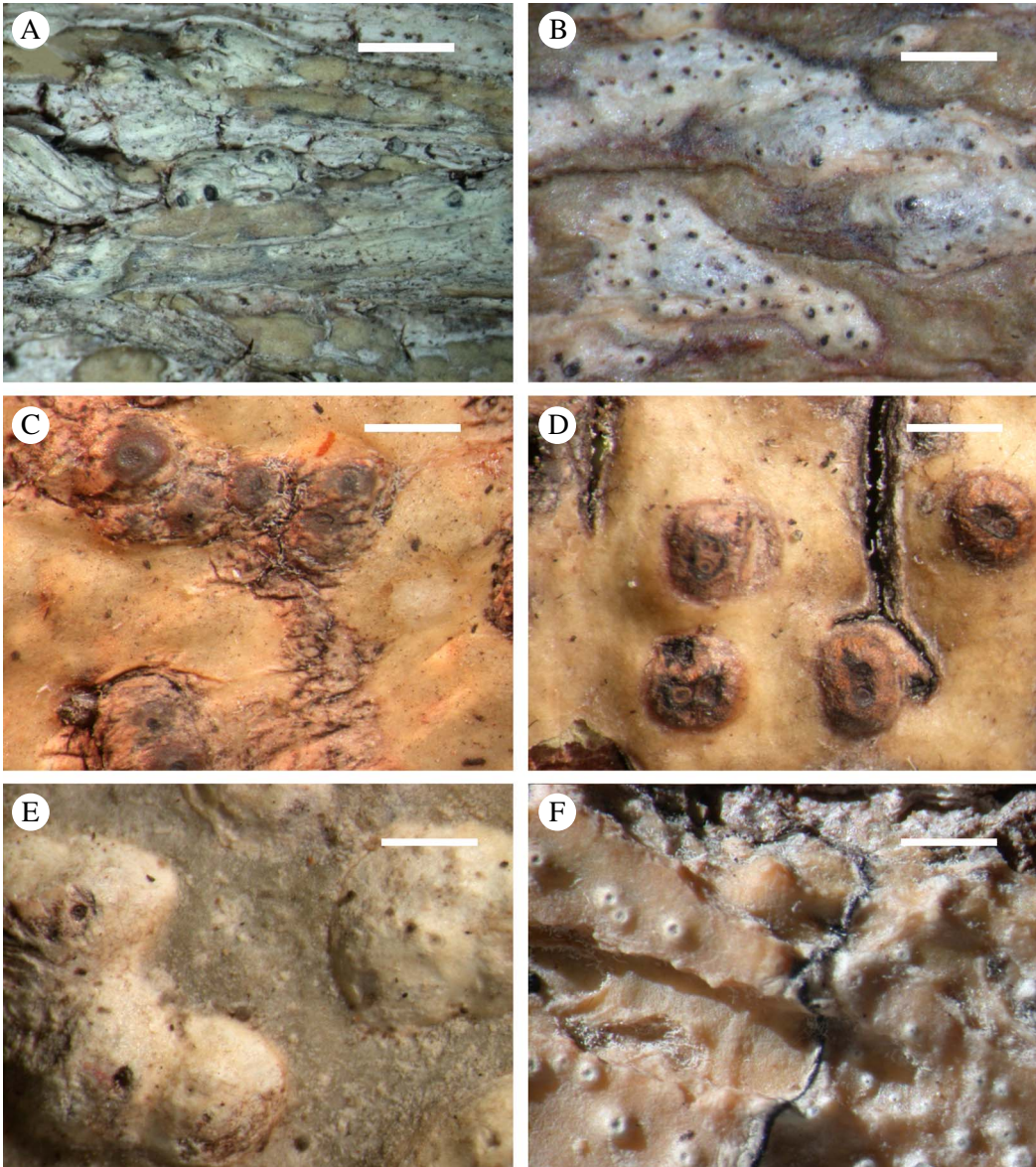


FIG. 6. Habitus of new species of Trypetheliaceae (holotypes). A, *Astrothelium septemseptatum*; B, *A. sexloculatum*; C, *A. sipmanii*; D, *A. trypethelioides*; E, *A. ultralucens*; F, *A. vulcanum*. Scales: A–F = 1 mm. In colour online.

***Astrothelium sexloculatum* Aptroot  
sp. nov.**

MycoBank No.: MB 815237

*Astrothelium* with 5-septate ascospores of  $25\text{--}27 \times 7\text{--}11\ \mu\text{m}$  and lichexanthone in the thallus and pseudostromata.

Type: Guyana, Upper Takutu Distr., Rupununi Savannah, Dadadanawa ranch, near headquarters,

alt. 120 m, 20 September–16 November 1992, H. J. M. Sipman 57381 (B—holotype).

(Fig. 6B)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas  $\leq 9\ \text{cm}$  diam., under 0.1 mm thick, pale yellowish

grey, surrounded by a  $\leq 1$  mm wide black prothallus, not inducing gall formation of the host bark.

*Ascomata* pyriform, *c.* 0.6–1.0 mm diam., mostly aggregated 2–5, mostly immersed in the bark tissue below pseudostromata with a whitish surface different from the thallus, which are distinctly raised above the thallus and mostly linear to irregular in outline,  $\leq 4$  mm long and 1 mm wide, often forming a network. *Wall* carbonized,  $\leq c.$  80  $\mu$ m thick. *Ostioles* eccentric, fused, strongly convex, pale brownish, surrounded by a whitish pruinose ring. *Hamathecium* not interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, fusiform, (3–)5-septate, 25–27  $\times$  7–11  $\mu$ m, ends rounded, not surrounded by a gelatinous layer.

*Chemistry.* Thallus and pseudostromata UV+ yellow (pseudostromata stronger than thallus), K–. TLC: lichexanthone.

*Ecology and distribution.* On smooth bark of trees in savannah forest. Known from Guyana and Papua New Guinea.

*Discussion.* *Astrothelium diplocarpoides* Müll. Arg. is the only other species with 5-septate ascospores and lichexanthone in the thallus and pseudostromata; however, it has much larger ascospores of at least 80  $\mu$ m.

*Additional material seen.* **Guyana:** Upper Takutu Distr.: Rupununi Savannah, Kusad Mountain, alt. 450 m, 1992, *H. J. M. Sipman* 57820 (B).—**Papua New Guinea:** Central Prov.: Varirata National Park, 1995, *H. J. M. Sipman* 38638 (B).

### *Astrothelium sipmanii* Aptroot sp. nov.

Mycobank No.: MB 815238

*Astrothelium* with simple ascomata with 5-septate ascospores 100–150  $\times$  35–40  $\mu$ m and an interspersed hamathecium.

Type: Guyana, Upper Takutu Distr., *c.* 35 km S of Aishalton. 4 km N of Kuyuwini Landing, along track to Karaudanawa, alt. 250 m, 31 October 1992, *H. J. M. Sipman* 57080 (B—holotype).

(Fig. 6C)

*Thallus* corticate, smooth to somewhat bullate, shiny, covering areas  $\leq 4$  cm diam.,

*c.* 0.2 mm thick, pale ochraceous green, surrounded by a  $\leq 1$  mm wide black prothallus, inducing dispersed hemispherical galls of the host bark.

*Ascomata* pyriform, 0.7–1.2 mm diam., solitary or 2–4 together, emergent from decorticated flat areas that are almost flush with the thallus but that can be seen as ochraceous white pseudostromata, emergent parts brown. *Wall* carbonized all around,  $\leq c.$  80  $\mu$ m thick. *Ostioles* apical, simple, concave, black. *Hamathecium* interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, 5-septate, 100–150  $\times$  35–40  $\mu$ m, ellipsoid.

*Pycnidia* not observed with certainty, although some of the many black dots around the ostioles may represent young pycnidia.

*Chemistry.* Thallus and pseudostromata UV–, K–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in savannah forest. Known only from Guyana.

*Discussion.* Characterized by the simple ascomata with 5-septate ascospores of more than 100  $\mu$ m and the interspersed hamathecium. *Astrothelium curvisporum* Aptroot & M. Cáceres shares these characters but has distinctly curved ascospores; *A. pustulatum* (Vain.) Aptroot & Lücking has generally more septa and longer ascospores of at least 180  $\mu$ m.

### *Astrothelium trypethelioides* Aptroot sp. nov.

Mycobank No.: MB 815239

*Astrothelium* with fused ostioles, an interspersed hamathecium and 7–9-septate ascospores of 49–52  $\times$  13–16  $\mu$ m.

Type: Venezuela, Bolivar, Cerro Guaiquinima, along Rio Carapo, alt. 800 m, 11 February 1990, *H. J. M. Sipman* 26976 (B—holotype).

(Fig. 6D)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas  $\leq$  at least 9 cm diam., under 0.1 mm thick, pale

yellowish grey, prothallus not observed, not inducing gall formation of the host bark.

*Ascomata* pyriform, *c.* 0.4–0.6 mm diam., mostly aggregated 2–9, mostly immersed in the bark tissue below pseudostromata with pale brownish surfaces different from the thallus, which are distinctly raised above the thallus and mostly ellipsoid in outline,  $\leq 2$  mm long and 1 mm wide. *Wall* brown,  $\leq c.$  60  $\mu\text{m}$  thick. *Ostioles* eccentric, fused, convex, black. *Hamathecium* interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, fusiform, 7–9-septate,  $49\text{--}52 \times 13\text{--}16 \mu\text{m}$ , ends pointed, not surrounded by a gelatinous layer.

*Chemistry.* Thallus and pseudostromata K–, UV–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Venezuela.

*Discussion.* This species is characterized by the combination of fused ostioles, an interspersed hamathecium and 7–9-septate ascospores.

### ***Astrothelium ultralucens* Aptroot sp. nov.**

Mycobank No.: MB 815240

*Astrothelium* with the thallus and pseudostromata containing lichexanthone, fused ostioles and 3-septate ascospores over  $105\text{--}130 \times 35\text{--}42 \mu\text{m}$ .

Type: Venezuela, Bolivar, Cerro Guaiquinima, along Rio Carapo, alt. 800 m, 12 February 1990, *H. J. M. Sipman* 27057 (B—holotype).

(Fig. 6E)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas  $\leq$  at least 7 cm diam., under 0.1 mm thick, pale greenish grey, without prothallus, not inducing gall formation of the host bark.

*Ascomata* pyriform, *c.* 0.7–1.2 mm diam., mostly aggregated 2–7, mostly immersed in the bark tissue below pseudostromata with a whitish surface different from the thallus,

which are distinctly raised above the thallus and mostly ellipsoid to irregular in outline,  $\leq 4$  mm long and 3 mm wide. *Wall* carbonized,  $\leq c.$  180  $\mu\text{m}$  thick. *Ostioles* eccentric, fused, flat, ochraceous. *Hamathecium* not interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, fusiform, 3-septate,  $105\text{--}130 \times 35\text{--}42 \mu\text{m}$ , ends rounded, surrounded by a gelatinous layer *c.* 3  $\mu\text{m}$  thick.

*Chemistry.* Thallus UV+ yellow (but much duller than the pseudostromata and therefore easily overlooked), K–; pseudostromata UV+ yellow, K–. TLC: lichexanthone.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Venezuela.

*Discussion.* This species is characterized by the combination of fused ostioles, lichexanthone in the thallus and pseudostromata, and 3-septate ascospores of over 100  $\mu\text{m}$ .

### ***Astrothelium vulcanum* Aptroot sp. nov.**

Mycobank No.: MB 815241

*Astrothelium* of the *A. nitidiusculum* (Nyl.) Aptroot & Lücking-group, with simple ascomata, an interspersed hamathecium and containing lichexanthone.

Type: Guyana, Rupununi District, Kuyuwini Landing, alt. 200 m, 5 February 1991, *M. J. Jansen-Jacobs*, *B. J. ter Welle*, *D. Gopaul* & *V. James* 2400 (L—holotype; ABL—isotype).

(Fig. 6F)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas  $\leq 25$  cm diam., *c.* 0.1 mm thick, pale ochraceous, surrounded by a thin black prothallus line, not inducing gall formation of the host bark.

*Ascomata* globose, 0.3–0.6 mm diam., single, immersed in the thallus and partly in the bark, tops slightly protruding. *Wall* black or dark brown all around,  $\leq c.$  50  $\mu\text{m}$  thick. *Ostioles* apical, not fused, concave, whitish, surrounded by a cream-coloured ring *c.* 0.1 mm wide. *Hamathecium* densely interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, 3-septate,



fusiform, 20–25 × 6.5–7.5 µm, ends rounded, lumina diamond-shaped, not surrounded by a gelatinous layer.

*Pycnidia* not observed.

**Chemistry.** Thallus UV+ yellow, K–. TLC: lichexanthone.

**Ecology and distribution.** On smooth bark of trees in savannah forest. Known only from Guyana.

**Discussion.** This is a species of the *A. nitidiusculum*-group, which is split up again. It differs from *A. nitidiusculum* s. str. by the interspersed hamathecium and the presence of lichexanthone.

***Astrothelium zebrinum* Aptroot sp. nov.**

Mycobank No.: MB 815242

*Astrothelium* with fused ostioles and 7-septate ascospores 60–70 µm long, without lichexanthone, anthraquinones or inspersion.

Type: Guyana, Potaro-Siparuni Region, Kaieteur Falls National Park, around airstrip, sclerophyllous forest, 20 February 1996, H. J. M. Sipman 40580 (B—holotype).

(Fig. 7A)

**Thallus** corticate, smooth, somewhat shiny, continuous, covering areas ≤9 cm diam., under 0.1 mm thick, pale yellowish grey, not surrounded by prothallus, not inducing gall formation of the host bark.

**Ascomata** pyriform, c. 0.6–1.2 mm diam., mostly aggregated 2–5, mostly immersed in the bark tissue below pseudostromata with a whitish surface different from the thallus, which are slightly raised above the thallus and mostly linear to irregular in outline, and ≤1 cm long and 4 mm wide, not forming a network. **Wall** carbonized, ≤c. 80 µm thick. **Ostioles** eccentric, fused, strongly convex, pale brownish, surrounded by a thick whitish pruinose ring. **Hamathecium** not interspersed with oil globules. **Asci** with 8 ascospores. **Ascospores** hyaline, fusiform, 7-septate, 60–70 × 14–28 µm, ends pointed, not surrounded by a gelatinous layer.

**Chemistry.** Thallus and pseudostromata UV–, K–. TLC: no secondary substances detected.

**Ecology and distribution.** On smooth bark of trees in rainforest. Known only from Guyana.

**Discussion.** Characterized by the combination of fused ostioles, absence of inspersion and secondary substances, and 7-septate ascospores 60–70 µm long.

***Polymeridium rhodopruinosum* Aptroot & Mercado Diaz sp. nov.**

Mycobank No.: MB 815243

*Polymeridium* with red pruina on the ascomata and 3-septate ascospores 17–19 × 3.5–5.0 µm.

Type: Puerto Rico, Maricao, Bosque estatal de Maricao, Vereda Los Viveros, alt. c. 850 m, on tree bark in disturbed primary sclerophyllous forest, 18 February 2014, A. Aptroot 72208 (UPR—holotype; ABL, F—iso-types).

(Fig. 7B)

**Thallus** ecorticate, white.

**Ascomata** 0.1–0.3 mm diam., solitary, erumpent, black, glossy, partly with dark red pruina. **Ostioles** apical, white. **Hamathecium** not interspersed with oil droplets. **Ascospores** 8 per ascus, IKI–, 3-septate, 17–19 × 3.5–5.0 µm, not ornamented, wall not thickened, surrounded by a 1 µm thick gelatinous sheath.

**Chemistry.** Thallus UV–, ascoma pruina UV+ dark blood red (almost black). TLC: an anthraquinone.

**Ecology and distribution.** On smooth bark of trees in disturbed primary sclerophyllous forest. Known only from Puerto Rico.

**Discussion.** This is the only *Polymeridium* with red pruina and the only species in the family with a white thallus and black ascomata with red pruina.

***Pseudopyrenula americana* Aptroot sp. nov.**

Mycobank No.: MB 815244

*Pseudopyrenula* with 3-septate ascospores of 26–32 × 7–10 µm, without inspersion and without lichexanthone.

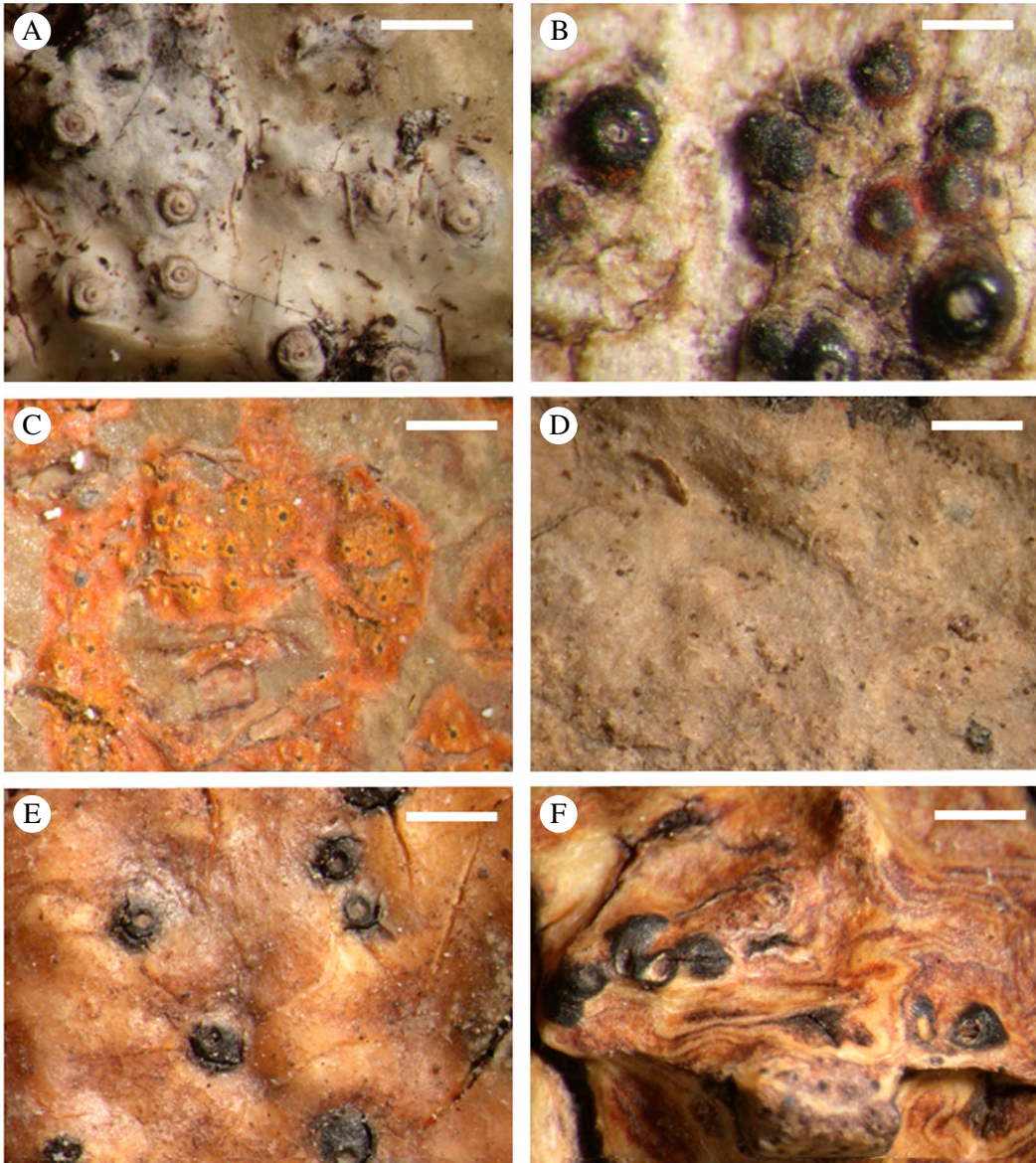


FIG. 7. Habitus of new species of Trypetheliaceae (holotypes). A, *Astrothelium zebrinum*; B, *Polymeridium rhodopruinosum*; C, *Trypethelium infracluteriae*; D, *Viridothelium inspersum*; E, *V. kinabaluense*; F, *V. solomonense*. Scales: A, C–F = 1 mm; B = 0.2 mm. In colour online.

Type: Guyana, Upper Mazaruni Distr., N slope of Mount Roraima, alt. *c.* 700 m, in *c.* 25 m tall virgin mossy forest, 25 m high in canopy, 12–19 February 1985, *H. J. M. Sipman* & *A. Aptroot* 18699 (B—holotype).

*Thallus* ecorticate, whitish.

*Ascomata* solitary or occasionally a few fused sideways, hemispherical, black, 0.3–0.5 mm diam. *Ostioles* apical, whitish to

black. *Hamathecium* not inspersed, hyaline. *Ascospores* 8 per ascus, IKI–, 3-septate, 26–32 × 7–10 µm, not ornamented, lumina diamond-shaped.

*Chemistry.* Thallus UV–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Guyana.

*Discussion.* This is a mostly negatively characterized species of the *Pseudopyrenula diluta* (Fée) Müll. Arg.-group (the medium sized 3-septate *Pseudopyrenula* species), without inspersion and without lichexanthone.

*Additional specimen seen. Guyana:* Upper Mazaruni Distr.: Mount Latipu, c. 8 km N of Kamarang, alt. c. 1000 m, in scrub on summit plateau, 1985, H. J. M. Sipman & A. Aptroot 19117 (B).

***Pseudopyrenula guianensis* Aptroot  
sp. nov.**

MycoBank No.: MB 815245

*Pseudopyrenula* with a hyaline hamathecium with inspersion, a thallus with lichexanthone and 3-septate ascospores 21–25 × 6–9 µm.

Type: French Guiana, Saül, 1986, D. Montfoort & R. Ek 385 (B—holotype; L—isotype).

*Thallus* ecorticate, whitish.

*Ascomata* solitary, hemispherical, black, 0.3–0.5 mm diam. *Ostioles* apical. *Hamathecium* hyaline, inspersed with oil droplets. *Ascospores* 3-septate, 21–25 × 6–9 µm, not ornamented, lumina diamond-shaped.

*Chemistry.* Thallus UV+ yellow. TLC: lichexanthone.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known from Surinam and French Guiana.

*Discussion.* This is a species of the *Pseudopyrenula subgregaria* Müll. Arg.-group (the smaller-spored 3-septate *Pseudopyrenula* species) characterized by a hyaline

hamathecium with inspersion and a thallus with lichexanthone.

*Additional specimen seen. Surinam:* Brokopondo area, R. Zielman 1307 (ABL, L).

***Pseudopyrenula hexamera* Aptroot  
sp. nov.**

MycoBank No.: MB 815246

*Pseudopyrenula* with 5-septate ascospores 16–21 × 6–7 µm, lumina clearly diamond-shaped.

Type: Venezuela, Est. Amazonas, Alto Orinoco, 15 km W of Esmeralda, W bank of Surumoni, on *Qualea* sp., alt. 110 m, 10 February 1997, J. Hafellner & H. Komposch 178-5-48 (GZU—holotype).

*Thallus* ecorticate, whitish.

*Ascomata* solitary or occasionally a few sideways, hemispherical, black, c. 0.2 mm diam. *Ostioles* apical, black. *Hamathecium* not inspersed, hyaline. *Ascospores* 5-septate, 16–21 × 6–7 µm, not ornamented, with a 1 µm thick gelatinous sheath, lumina diamond-shaped.

*Chemistry.* Thallus UV–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Venezuela.

*Discussion.* This is the only *Pseudopyrenula* with 5-septate ascospores. It resembles *Polymeridium quinqueseptatum* (Nyl.) R. C. Harris except for the thickened ascospore walls leaving diamond-shaped lumina. The specimen was already named in the herbarium and in an accompanying unpublished manuscript which was kindly made available to me by Harald Komposch.

***Pseudopyrenula thallina* Lücking &  
Aptroot sp. nov.**

MycoBank No.: MB 815247

*Pseudopyrenula* with a greenish corticate thallus and 3-septate ascospores, 21–25 × 6–9 µm.

Type: Costa Rica, Guanacaste, Hacienda Granadilla, 500–600 m, 10 February 1930, C. W. Dodge & E. Thomas 6787 (FH-DODGE—holotype).

*Thallus* yellow-green, corticate, somewhat shiny, without pseudocyphellae, without prothallus.

*Ascomata* solitary. *Ostioles* apical. *Hamathecium* hyaline, interspersed with oil droplets. *Ascospores* 3-septate,  $21\text{--}25 \times 6\text{--}9 \mu\text{m}$ .

*Chemistry.* Thallus UV-. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Costa Rica.

*Discussion.* This is the only *Pseudopyrenula* with a distinct thallus. It is similar to *P. subnudata* Müll. Arg. These specimens have already been commented upon in Aptroot *et al.* (2008: 86), but not formally described before.

*Additional specimen seen. Costa Rica:* San José, Guayabillos, C. W. Dodge & E. Thomas 5319 (FH-DODGE).

### ***Trypethelium infraeluteriae* Aptroot & Gueidan sp. nov.**

Mycobank No.: MB 815248

*Trypethelium* similar to *T. subeluteriae* Makhija & Patw., but with lower pseudostromata and ascospores 7–9-septate,  $37\text{--}42 \times 9\text{--}11 \mu\text{m}$ .

Type: Vietnam, Western Highlands, Dong Nai Province, Cát Tiên National Park, 10 km south-west of the accommodation area, in a tree plantation near a gate leading to the minority village, 16 February 2012, C. Gueidan 3052 (BM—holotype; ABL, VNMN—iso-types).

(Fig. 7C)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas  $\leq$  at least 5 cm diam., c. 0.1 mm thick, olive-greenish grey, prothallus not observed, not inducing gall formation of the host bark.

*Ascomata* globose, 0.3–0.5 mm diam., immersed in groups of 6–15 in pseudostromata with surfaces different from the thallus, which are slightly raised above the thallus, irregular to often linear in outline,  $\leq 8$  mm long and 2 mm wide, occasionally

forming a net, orange. *Wall* dark brown all around,  $\leq c. 50 \mu\text{m}$  thick. *Ostioles* apical, not fused, flat to concave, grey. *Hamathecium* not interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, fusiform, 7–9-septate,  $37\text{--}42 \times 9\text{--}11 \mu\text{m}$ , ends pointed, lumina ellipsoid, not surrounded by a gelatinous layer.

*Chemistry.* Thallus UV-, K-; pseudostroma exterior K+ red, inside K+ red. TLC: parietin, emodin and two derivatives.

*Ecology and distribution.* On bark of trees in plantations or along the road. Known only from Vietnam.

*Molecular data.* The ITS barcode is provided for the holotype CG3052 (GenBank no. KU179797) as well as the additional material: CG3042 (KU179795), CG3043 (KU179796) and CG3054 (KU179798).

*Discussion.* This species resembles *T. subeluteriae* in organization and colour, but differs by the generally lower pseudostromata and the smaller ascospores with fewer septa.

*Other specimens examined. Vietnam:* Western Highlands: Dong Nai Province, Cát Tiên National Park, 6 km south-west of the accommodation area, near a ranger house, 2012, C. Gueidan 3042, 3043 (BM, VNMN); 10 km south-west of the accommodation area, near the minority village, 2012, C. Gueidan 3054 (BM, VNMN).

### ***Viridothelium inspersum* Aptroot sp. nov.**

Mycobank No.: MB 815249

*Viridothelium* with solitary, immersed ascomata and an interspersed hamathecium, ascospores 12–14-septate,  $60\text{--}75 \times 12\text{--}17 \mu\text{m}$ .

Type: Papua New Guinea, Central Prov., along Hiritano Highway, 50 km NW of Port Moresby, 5 km NW of Brown River, alt. 25 m, February 1987, A. Aptroot 17317 (ABL—holotype).

(Fig. 7D)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas  $\leq$  at least

7 cm diam., *c.* 0.1 mm thick, olive-green, prothallus not observed, not inducing gall formation of the host bark.

*Ascomata* globose, 0.5–0.8 mm diam., single, deeply immersed in the bark below the thallus, without discernible pseudostromata. *Wall* brown, not always all around,  $\leq c.$  50  $\mu\text{m}$  thick. *Ostioles* apical, convex, brownish grey. *Hamathecium* interspersed with oil globules. *Asci* with 8 ascospores. *Ascospores* hyaline, fusiform, 12–14-septate, 60–75  $\times$  12–17  $\mu\text{m}$ , ends pointed, lumina ellipsoid, not surrounded by a gelatinous layer.

*Chemistry.* Thallus and pseudostromata UV–, K–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in rainforest. Known only from Papua New Guinea.

*Discussion.* This is the only *Viridothelium* with solitary, immersed ascomata and an interspersed hamathecium.

### ***Viridothelium kinabaluense* Aptroot sp. nov.**

Mycobank No.: MB 815250

*Viridothelium* similar to *V. indutum* (Stirt.) Aptroot & Lücking with emergent black ascomata, but with 17–25-septate ascospores of 100–150  $\times$  18–23  $\mu\text{m}$ .

Type: Sabah, Mount Kinabalu, along summit trail, alt. 2800 m, 12 May 1998, *H. J. M. Sipman & B. Tan* 31226 (B—holotype).

(Fig. 7E)

*Thallus* corticate, smooth, somewhat shiny, continuous, covering areas  $\leq$  at least 7 cm diam., *c.* 0.1 mm thick, olive-brown, surrounded by a 0.3 mm wide black prothallus line, not inducing gall formation of the host bark.

*Ascomata* globose, 0.6–1.0 mm diam., single, emergent from the bark and from the thallus, often largely exposed, black, without discernible pseudostromata. *Wall* black,  $\leq c.$  100  $\mu\text{m}$  thick. *Ostioles* apical, concave, brown. *Hamathecium* not interspersed with oil

globules. *Asci* with 4 ascospores. *Ascospores* hyaline, fusiform, 17–25-septate, occasionally with a longitudinal septum, 100–150  $\times$  18–23  $\mu\text{m}$ , ends pointed, lumina ellipsoid, not surrounded by a gelatinous layer.

*Chemistry.* Thallus and pseudostromata UV–, K–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in mountain forest. Known only from Sabah.

*Discussion.* This species is similar to *V. indutum*, but that species has smaller ascospores 90–105  $\times$  12–16  $\mu\text{m}$ .

*Additional specimens seen.* **Sabah:** same as type, *H. J. M. Sipman & B. Tan* 31255 (B); Mount Kinabalu, along summit trail, alt. 2800 m, 1989, *H. J. M. Sipman & B. Tan* 31292 (B).

### ***Viridothelium solomonense* Aptroot sp. nov.**

Mycobank No.: MB 815251

*Viridothelium* with ascomata with lateral, partly fused ostioles and black clypeus, ascospores 15–19-septate, 75–98  $\times$  17–20  $\mu\text{m}$ .

Type: Solomon Islands, Santa Isabel Island, Tanabuli Island, near Tatamba, 1965, *D. J. Hill* 11040 (BM—holotype; ABL—isotype).

(Fig. 7F)

*Thallus* yellowish brown, smooth, thin, absent (probably abraded by the harsh sea winds) over large stretches.

*Ascomata* mostly simple, a few aggregated with fused ostioles, emergent from the bark and the thallus, becoming fully exposed. *Pseudostromata* in the normal sense absent, but a carbonized clypeus is present. *Wall* black,  $\leq 80$   $\mu\text{m}$  thick. *Ostioles* lateral. *Hamathecium* not interspersed with oil droplets. *Ascospores* hyaline, fusiform, 15–19-septate, 75–98  $\times$  17–20  $\mu\text{m}$ , ends pointed, with ellipsoid lumina.

*Chemistry.* Thallus UV–, K–. TLC: no secondary substances detected.

*Ecology and distribution.* On smooth bark of trees in coastal rainforest. Known only from the Solomon Islands.

*Discussion.* Unique in the family owing to the partly fused ascomata with lateral ostioles and black clypeus. This species looks like, and has an ascoma structure similar to, a *Pyrenula* sp. with lateral ostioles. The hamathecium filaments are, however, thin and anastomosing, and the ascospores remain hyaline.

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