



## New species of Graphidaceae from the Neotropics and Southeast Asia

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### Abstract

Descriptions and illustrations are provided for 20 new species in the family Graphidaceae (lichenized fungi) originating from El Salvador, the Guianas, Venezuela, Colombia, and Malaysia: *Acanthothecis adjuncta* Welz & Sipman, differing from all other *Acanthothecis* species by the rounded ascocarps with covered discs; *Astrochapsa albella* Sipman, differing from *A. meridensis* in the white apothecium rim, the corticolous growth habit, the more or less clear hymenium, and the protocetraric acid chemistry; *A. columnaris* Sipman, differing from other *Astrochapsa* species by the columnar marginal slips; *Chapsa francisci* Sipman, differing from other *Chapsa* species by the numerous marginal lacinae; *C. nubila* Sipman, differing from other *Chapsa* species by the combination of a guttulate hymenium and 4- to 8-spored asci; *Diorygma extensum* Sipman, differing from *D. minisporum* in producing norstictic acid instead of stictic acid; *Fissurina chapsoides* Sipman, a *Fissurina* species with large, muriform ascospores and short ascocarps opening mostly by branched slits; *F. gigas* Sipman, differing from *F. rufula* in the larger ascomata and muriform ascospores; *F. vorax* Sipman, differing from other *Fissurina* species by the aggregated ascocarps in combination with papillose paraphysis tips; *Graphis murali-elegans* Sipman, differing from *G. elegans* and *G. lumbricina* in the muriform ascospores; *G. nigroglobosa* Sipman, differing from *G. mexicana* in the absence of a complete thalline margin; *Melanotrema comosum* Sipman, a species of *Melanotrema* with extruding, clavate, brown hyphae on columella and excipulum; *Myriochapsa annulata* Sipman, differing from *M. psoromica* by the conspicuous, free excipulum; *M. chocoensis* Sipman, differing from *M. psoromica* in the smaller ascospores; *Ocellularia pitalensis* Sipman, differing from *O. maxima* by producing hypoprotocetraric acid; *O. rugosa* Sipman, similar to *O. zamorana* but with wider ostioles and 1-septate, pigmented ascospores with thick-walled juvenile stage; *Thelotrema berendsohnii* Sipman, similar to *T. alboolivaceum*, from which it differs by submuriform ascospores; *T. kinabaluense* Sipman, differing from other *Thelotrema* species by small, brown ascospores and protocetraric acid; *T. paludosum* Sipman, differing from other *Thelotrema* species by an inspersed hymenium, hypoprotocetraric acid and colorless, transversely septate ascospores of c.  $30 \times 7 \mu\text{m}$ ; and *T. parvisporum* Sipman, differing from *T. adjectum* in the small, grey-brown ascospores.

**Key words:** taxonomy, Thelotremataceae, ascospore development.

### Introduction

During fieldwork in Central America, northern South America, and East Asia, over the years unidentifiable specimens of Graphidaceae accumulated in the herbarium of the Botanical Garden and Botanical Museum Berlin-Dahlem (B). The recent progress in the classification of tropical Graphidaceae, and in particular the publication of new identification keys (Lücking *et al.* 2008, 2009; Rivas Plata *et al.* 2010; Sipman *et al.* 2012) allowed a new attempt to classify this material. As a result, many could be identified and it became clear that some others represent undescribed species, sometimes even difficult to accommodate in the current generic system. These new taxa are here formally introduced, along with a discussion of their key diagnostic characters and taxonomic affinities, paying particular attention to ascospore development.

## Material and Methods

The investigated specimens were collected in little-disturbed primary vegetation and air-dried. Vouchers are kept in B and duplicates of most of the material in ARA, COL, GUY, LAGU, LOJA or VEN, as indicated below. External morphology was examined with a WILD M7 dissecting microscope. Anatomical details were studied with a ZEISS Axioskop compound microscope, using sections made by hand with razor blades, embedded in tap water or Lugol's solution. Occasionally, lactophenol-cottonblue (LPCB) staining was used to clarify hyphal and cellular structures. Secondary chemistry was studied by TLC following Orange *et al.* (2010), using solvents A, B' and C.

## Taxonomic Treatment

*Acanthothecis adjuncta* Welz & Sipman, *sp. nov.* (Fig. 1A–E)

Mycobank #807349

Differing from all other *Acanthothecis* species by the rounded ascocarps with covered discs.

**Type:**—EL SALVADOR. **Ahuachapán:** Mpio. San Francisco Menéndez, Cantón San Benito, P.N. El Imposible, sector San Benito; c. 500 m; forest in deep valley, along Río Guayapa, on Naranjillo (*Swartzia simplex*) 15 cm diam. tree trunk; 26 Nov 1993, *H. Sipman, W. Berendsohn & E. Sandoval 37989* (holotype B!; isotype LAGU!).

Thallus greenish grey, in the herbarium turning more yellowish, large and sometimes over 10 cm diam., epiphloeodal, about 50 µm thick, continuous or slightly fissured, more or less warty, with very thin cortex; medulla whitish, filled with continuous calcium oxalate crystals, which may show as tiny greenish spots on the thallus surface. Ascocarps immersed in the thallus or slightly raised in poorly delimited warts, round, c. 0.5–1.0 mm wide, with thin thalline margin split in few incurved slips, often in several whorls, the innermost on the inner side covered by swollen, somewhat papillose cells, with covered disc and without columella. Hymenium 130–150 µm, clear; paraphyses c. 1.5 µm thick, apically swollen to about 2 µm, papillose. Ascospores (2–)4(–8) per ascus, muriform, c. 45–60 × 20–30 µm, c. 25 × 10–12 loculate in optical section, colorless, I–, with thin wall and septa.

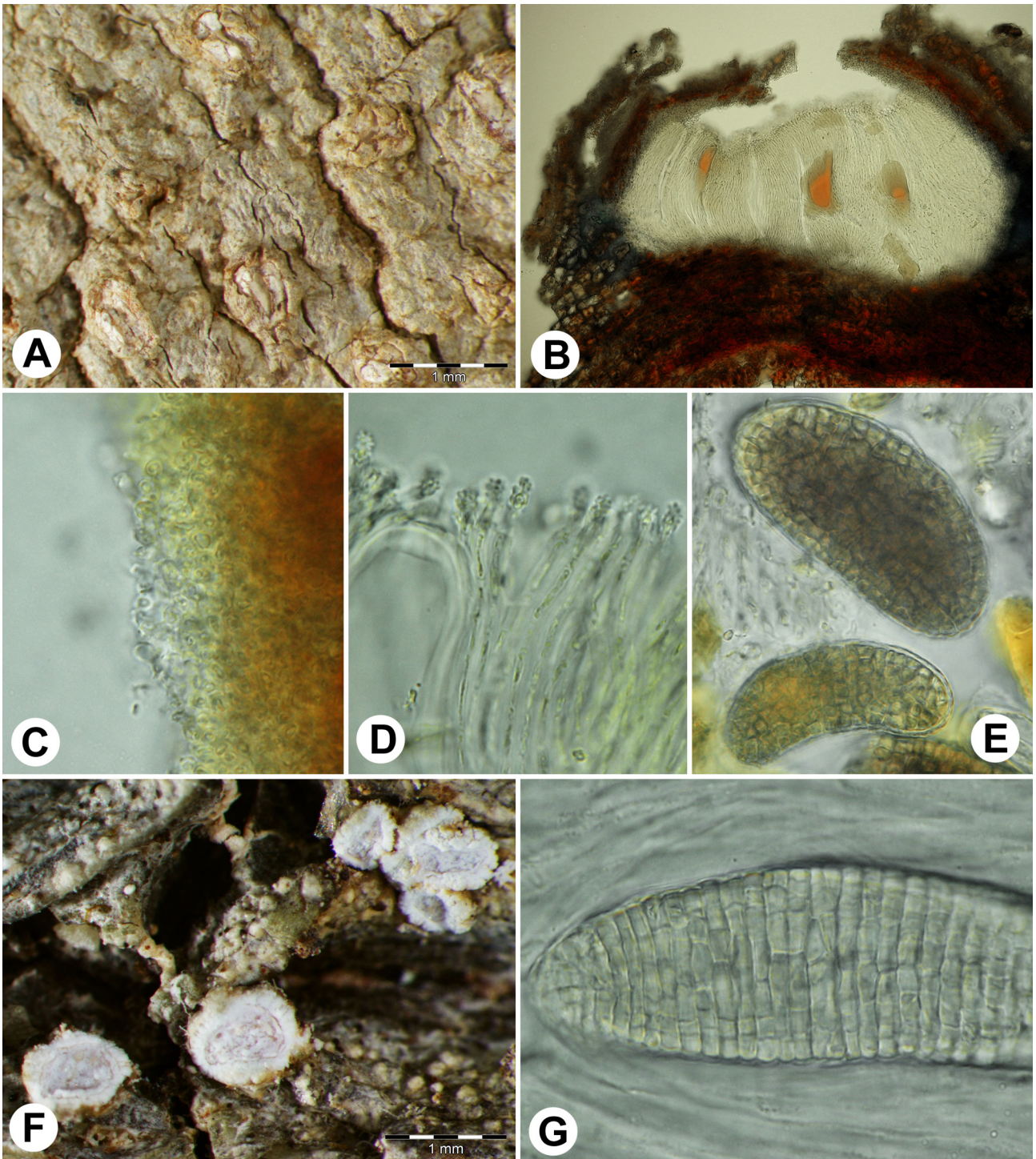
**Secondary chemistry:**—No substances detected by TLC.

**Etymology:**—The epithet is a modification of that of *Thelotrema adjectum* Nylander (1866: 290), with which the species was initially confused.

**Distribution and Ecology:**—Known so far only from PN El Imposible in El Salvador where it was collected in seasonal, disturbed forest around 600 m.

**Remarks:**—The classification of this species is particularly puzzling. It shows a considerable similarity to *Schizotrema guadeloupense* (Hale) Mangold & Lumbsch in Mangold *et al.* (2009: 657), with which it co-occurs, basing on the concentric arrangement of excipular slips and the non-amyloid, muriform ascospores of similar size. However, that species differs clearly by slips that are more numerous and radially arranged, and the thallus contains stictic acid or cinchonarum unknown. But the papillose paraphyse tips plead in particular against this generic affinity (Mangold *et al.* 2009). Also the other *Schizotrema* species occurring in the Neotropics, *S. cryptotrema* (Nyl.) Rivas Plata & Mangold in Rivas Plata *et al.* (2010: 184), looks rather different because its ascocarps are immersed in thallus warts and open by small pores. The lack of periphysoids precludes affinity with *Topeliopsis* Kantvilas & Vězda (2000: 247) and *Pseudotopeliopsis* Parmen *et al.* (2012: e51392). Therefore the species is placed here in the genus *Acanthothecis* Clements (1909: 59), which shares the papillose paraphyse tips and the I-negative ascospores with thin walls and septa. Within the genus its position seems unique because of its purely round apothecia with covered discs and the excipulum slips in more than one whorl. However, while most species currently accepted in *Acanthothecis* have lirelliform ascomata, in the type species, *A. hololeucooides* (Nyl.) Staiger & Kalb (1999: 100), they are also rounded. The somewhat papillose cells on the inner side of the inner excipulum slips above the hymenium are difficult to observe; they may represent very short periphysoids. In Lugol the hymenium remains unstained, but a blue reaction occurs at the base of the lateral excipulum.

**Additional specimens examined:**—EL SALVADOR. Ahuachapán: P.N. El Imposible, Hda. San Benito, al E del pie de la Pres.; c. 610 m; on Mulo (*Licania retifolia*) 21 Dec. 1992, *E. & M. Sandoval 934* (B, LAGU); *ibid.*, sector La Fincona, Montaña de la Cueva de Cal; 500 m; 11 Nov 1999, *J. Bohnke & H. Sipman 1029* (B).



**FIGURE 1.** A–E. *Acanthothecis adjuncta* (holotype). A. Habitus. B. Ascocarp transverse section, in Lugol. C. Inner side of excipulum above hymenium. D. Warty paraphyse tips. E. Ascospores, in Lugol. F–G. *Astrochapsa albella* (holotype). F. Habitus. G. ascospore.

*Astrochapsa albella* Sipman, *sp. nov.* (Fig. 1F–G)

Mycobank #807514

Differing from *Astrochapsa meridensis* in the white apothecium rim, the corticolous growth habit, the more or less clear hymenium, and the protocetraric acid chemistry.

**Type:**—VENEZUELA. Bolivar: Cerro Guaiquinima, central part of upper plateau (near camp 4); 5°40'N, 63°34'W, 950 m; low, mossy forest on rocky sandstone slope towards stream; 6 Feb 1990, *H. Sipman* 26633 (holotype VEN!; isotype B!).

Thallus light grey, uneven to evanescent, thinly corticate; photobiont layer and medulla with clusters of calcium oxalate crystals. Apothecia sessile with constricted base, rounded, c. 1.0–1.5 mm diam.; disc exposed, pale brown, thickly white-pruinose; thalline margin crenulate, somewhat granular, inside with felty white-pruinose, adnate excipulum. Columella absent. Excipulum colorless; periphysoids not seen, probably absent. Hymenium 75–130 µm high, clear or slightly fine-inspersed; paraphyses unbranched, 2 µm thick, apically not swollen. Ascospores 1 per ascus, densely muriform (ca. 50 × 10 locules), c. 110–140 × 30–35 µm, ovoid, with thin septa and angular lumina, colorless, I–.

**Secondary chemistry:**—Protocetraric acid.

**Etymology:**—The epithet reflects the whitish color of the ascocarps, which resemble *Lecanora albella* (Pers.) Acharius (1810: 369).

**Distribution and Ecology:**—The species is known thus far from two collections from one site on Cerro Guaiquinima in the Guayana Highlands, eastern Venezuela, where it was found on trunks in stunted mossy forest at c. 950 m elevation.

**Remarks:**—By its basally constricted ascocarps with almost entire margins, this is a very unusual species in Graphidaceae, resembling at first glance a member of the Lecanorales. However, the anatomical details of the hymenium and ascospores and the inner excipulum fits well the genus *Chapsa* Massalongo (1860: 257) and its relatives, and the crenulations on the thalline margin remind the usual marginal slips of this genus. *Chapsa eitenii* (Hale) Frisch in Frisch *et al.* (2006: 87) shares the thin-septate, muriform, ascospores, single in the asci and the chemistry, but differs by the ecorticate thallus, the erumpent ascocarps with recurved margins, and the somewhat smaller ascospores (80–100 µm long; Hale 1975: 176: as *Thelotrema eitenii* Hale). *Astrochapsa meridensis* (Kalb & Frisch) Parnmen *et al.* (2012: 9) shares the basally constricted ascocarps, but deviates by the strongly inspersed hymenium, the incurved ascocarp margins, the lack of secondary substances (based on material from Costa Rica; see Sipman *et al.* 2012), and the muscicolous habitat. However, in view of the external morphological resemblance the new species is considered congeneric with it.

**Additional specimen examined:**—VENEZUELA. Bolivar: Cerro Guaiquinima, central part of upper plateau (near camp 4); c. 5°40'N, 63°34'W, 950 m; low, mossy forest on rocky slope towards stream, epiphytic; 5 Feb 1990, *H. Sipman* 26624 (B, VEN).

*Astrochapsa columnaris* Sipman, *sp. nov.* (Fig. 2A–C)

Mycobank #807515

Differing from other *Astrochapsa* species by the columnar marginal slips.

**Type:**—VENEZUELA. Bolivar: Cerro Guaiquinima, central part of upper plateau (near camp 4); c. 5°40'N, 63°34'W, 950 m; low, mossy forest on rocky sandstone slope towards stream; 6 Feb 1990, *H. Sipman* 26635 (holotype VEN!; isotype B!).

Thallus light grey, smooth to uneven or evanescent, thinly corticate, cortex up to 5 µm thick, prosoplectenchymatic; photobiont layer and medulla with clusters of calcium oxalate crystals. Apothecia sessile with constricted base, rounded, 1–3 mm diam.; disc exposed, pale brown, white-pruinose; margin divided in more than ten, columnar, incompletely separated, recurved slips which become easily damaged and granular, white. Columella absent. Excipulum colorless; periphysoids not found, probably absent. Hymenium 140–150 µm high, clear; paraphyses unbranched, 2 µm thick, apically not swollen. Ascospores 1 per ascus, densely muriform, c. 140–170 × 40 µm, elongate, with thin septa and angular lumina, colorless, I–.

**Secondary chemistry:**—Norstictic acid.

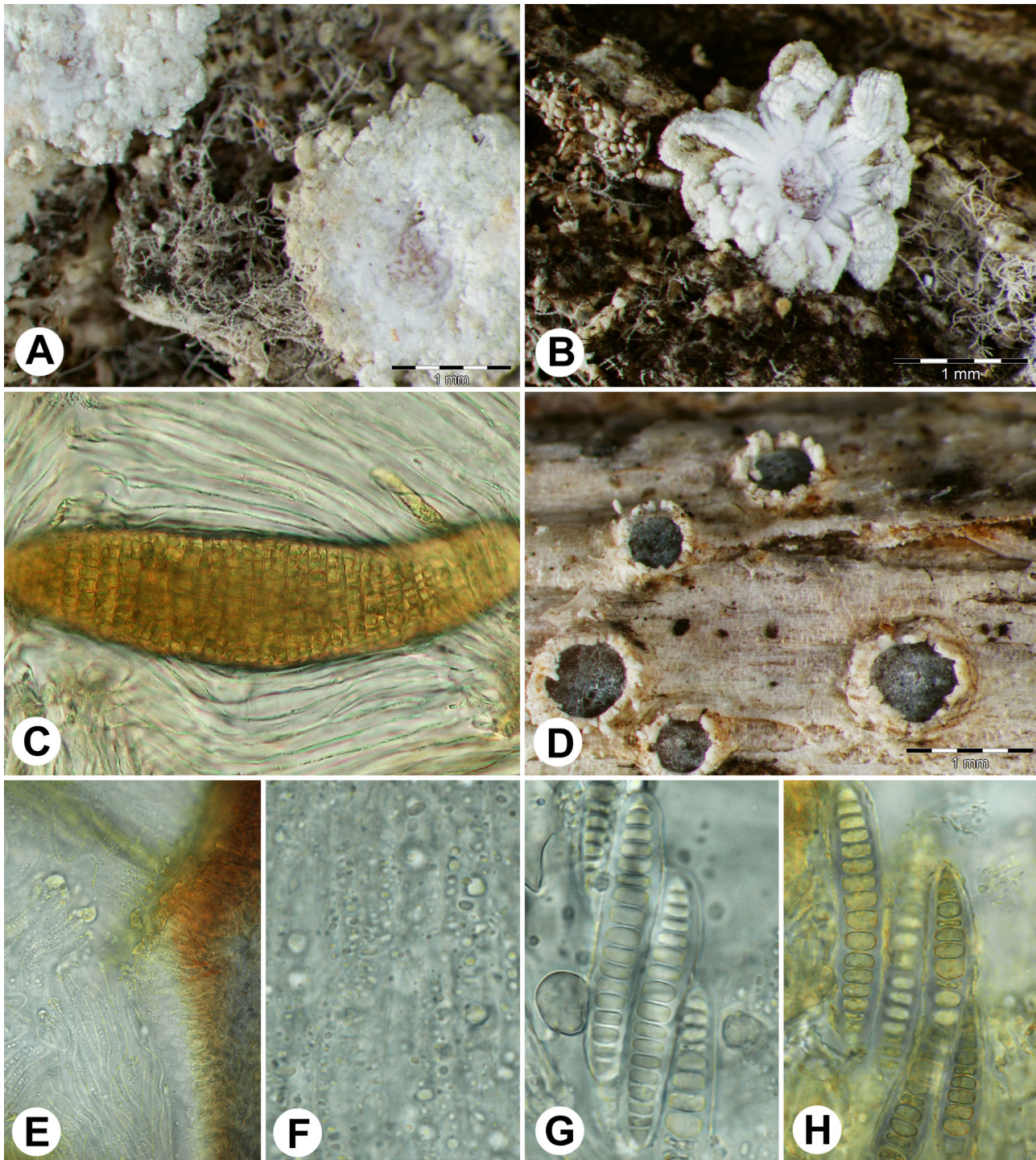
**Etymology:**—The specific epithet reflects the columnar structure of the ascocarp margin slips.

**Distribution and Ecology:**—Known only from Cerro Guaiquinima in the Guayana Highlands, eastern Venezuela, where it grows on stunted trees in light, humid forest on poor soil at 950–1200 m.

**Remarks:**—The most striking character of this species, which distinguishes it from all other similar and related taxa, is the intense splitting of the margin into columnar, fragile slips bearing some resemblance to the

much-split *Welwitschia* leaves. Otherwise, this species fits well in the genus *Chapsa* sensu Rivas Plata *et al.* (2010) and, in the subdivision of *Chapsa* by Parnmen *et al.* (2012), as *Astrochapsa*. The species is probably best accommodated in the genus *Astrochapsa* in view of its similarity to *A. meridensis*. The constricted base of the ascocarps is unusual in the genus, although it is shared by *A. meridensis* and *A. albella* (see above). From both species, *A. columnaris* differs by the presence of norstictic acid, the larger ascocarps, and the columnar marginal slips. The poor development of the excipulum, without visible periphysoids, is also deviating in the genus.

**Additional specimen examined:**—VENEZUELA. Bolivar: Cerro Guaiquinima, near NE edge of upper plateau (near camp 2); c. 5°54'N, 63°27'W, 1250 m; rocky sandstone area with scrub on exposed ridge; 8 Feb 1990, H. Sipman 26755 (VEN; B).



**FIGURE 2.** A–C. *Astrochapsa columnaris* (holotype). A. Habitus. B. Young ascocarp with undamaged margin. C. Ascospore, in Lugol. D–H. *Chapsa francisci* (holotype). D. Habitus. E. Inner side of excipulum with periphysoids. F. hymenium guttules. G. mature ascospores. H. mature ascospores, in Lugol

***Chapsa francisci* Sipman, sp. nov.** (Fig. 2D–H)

Mycobank #807353

Differing from other *Chapsa* species by the numerous marginal lacinae.

**Type:**—ECUADOR. Zamora-Chinchipec: Cordillera Numbala, Reserva Biologica San Francisco, S of road Loja-Zamora, Transecto 2; 3°58'S, 79°04'W, 2300 m; on sheltered twig in scrubby forest, within reach from the soil; 18 Aug 2003, *H. Sipman & N. Mandl* 51330 (holotype B!; isotype LOJA!).

Thallus pale grey, smooth to uneven, not corticate, endophloeoidic; photobiont layer and medulla without clusters of calcium oxalate crystals. Apothecia erumpent, rounded, 0.5–1.0 mm diam.; disc exposed, dark flesh-colored, thinly white-pruinose; thalline margin erect, divided in 10–20 small, to 0.2 mm long slips, inside whitish. Columella absent. Excipulum colorless; periphysoids present, c. 10 µm long, next to the hymenium indistinct, above the hymenium c. 2 µm thick and apically swollen to 3 µm. Hymenium c. 90 µm high, interspersed with c. 1–4 µm diam. guttules; paraphyses unbranched, c. 1.5 µm thick, apically slightly swollen, to 2 µm thick. Ascospores 8 per ascus, c. 20-septate, c. 40 × 7 µm, elongate-fusiform, with slightly thickened septa and angular lumina and thick outer wall, colorless, I+ pale blue (weakly amyloid).

**Secondary chemistry:**—No substances detected by TLC.

**Etymology:**—Named after Franciscus Assisiensis, after whom also the region and the nature reserve where the type specimen was found are named.

**Distribution and Ecology:**—Known from a single collection from the eastern slopes of the Andes in Ecuador, prov. Zamora-Chinchipec, found on a sheltered twig near the ground in scrubby forest on a steep mountain slope at 2300 m elevation.

**Remarks:**—This species fits well in the genus *Chapsa* (Rivas Plata *et al.* 2010; Parmen *et al.* 2012) by its thin-septate ascospores with weak I–reaction and the erect margin divided into slips. The very numerous slips, and the thick outer wall of the ascospores are uncommon in the genus and suggest that the species is not closely related to other *Chapsa* species. The numerous marginal slips and the guttulate hymenium distinguish it from all other known *Chapsa* species with hyaline, transversely septate ascospores.

***Chapsa nubila* Sipman, sp. nov.** (Fig. 3A–C)

Mycobank #807354

Differing from other *Chapsa* species by the combination of a guttulate hymenium and 4- to 8-spored asci.

**Type:**—VENEZUELA. Bolivar: Cerro Guaiquinima, central part of upper plateau, along Rio Carapo (near camp 3-nuevo); c. 5°49'N, 63°32'W, 800 m; rocky slope with low forest in deep clefts and along the river; 11 Feb 1990, *H. Sipman* 26956 (holotype VEN!; isotype B!).

Thallus whitish, smooth to uneven, without cortex, endophloeoidic; photobiont layer and medulla without clusters of calcium oxalate crystals. Apothecia erumpent, angular-rounded or elongate, c. 1 mm diam.; disc exposed, white-pruinose; thalline margin sorediate and reduced to a rim around the disc; excipulum indistinct. Columella absent. Excipulum brownish; periphysoids indistinct. Hymenium c. 110 µm high, interspersed with c. 1–4 µm diam. guttules; paraphyses unbranched (branched and anastomosing in places where probably old asci are being resorbed), c. 1.5 µm thick, apically not swollen but with a few long branchlets, covered by granules. Ascospores 4(–8) per ascus, muriform (ca. 20 × 4 locules), c. 60 × 15 µm, fusiform, with slightly thickened septa and angular lumina, colorless, I–.

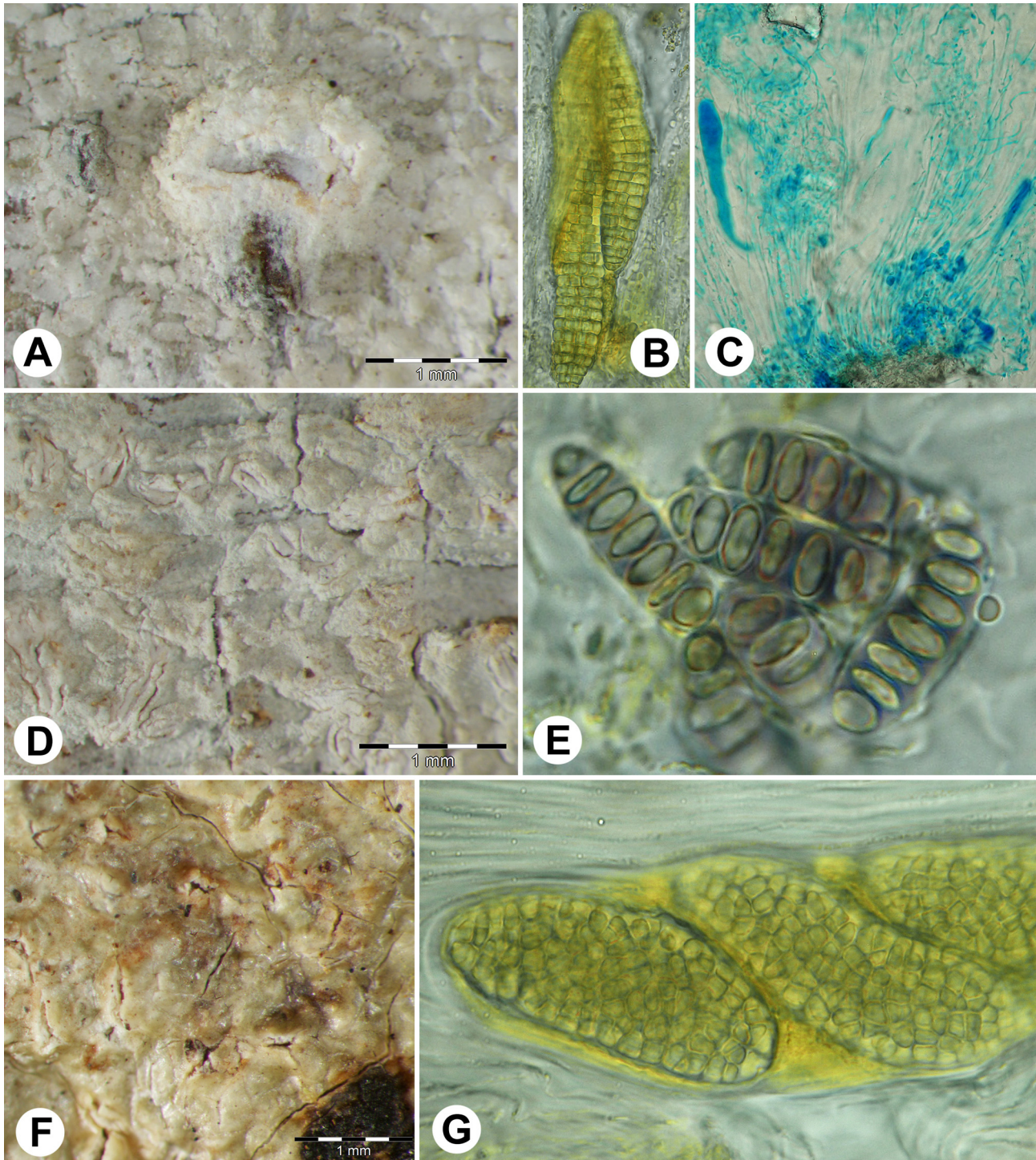
**Secondary chemistry:**—No substances detected by TLC.

**Etymology:**—The epithet reflects the guttulate, cloudy hymenium.

**Distribution and Ecology:**—Known from a single collection from Cerro Guaiquinima in the Guayana Highlands, eastern Venezuela, where it was found on trunks in stunted mossy forest at c. 800 m elevation.

**Remarks:**—This species fits well the genus *Chapsa* by the ascocarp shape and thin-septate ascospores. An

inspersed hymenium is unusual in *Chapsa* and related genera, and besides *Astrochapsa meridensis*, the only other species with colorless, muriform, I-negative ascospores known is *C. niveocarpa* Mangold (2009: 654). The latter differs by its larger ascospores ( $80\text{--}190 \times 20\text{--}50 \mu\text{m}$ ) occurring in numbers of 1 (–2) per ascus. In portions of the hymenium, the paraphyses appear to be densely anastomosing (Fig. 5C); seemingly in these spots old, degenerated asci and ascospores are being resorbed.



**FIGURE 3.** A–C. *Chapsa nubila* (holotype). A. Habit; B. Ascospores, in Lugol. C. Squashed hymenium with spots of denser, anastomosing paraphyses, LPCB-stained. D–E. *Diorygma extensum* (holotype). D. Habit. E. Ascospores, in Lugol. F–G. *Fissurina chapsoides*. F. Habit (holotype). G. Ascospores in Lugol (Sipman 26945).

***Diorygma extensum* Sipman, sp. nov.** (Fig. 3D–E)

Mycobank #807355

Differing from *Diorygma minisporum* in producing norstictic acid instead of stictic acid.

**Type:**—VENEZUELA. Bolivar: Cerro Guaiquinima, at confluence of rivers Carapo and Lima (near camp 7); 350 m; c. 15 m tall, light forest on poor soil on W-bank of Carapo; 1 Feb 1990, *H. Sipman* 26377 (holotype VEN!; isotype B!).

Thallus pale bluish grey, to over 10 cm wide, dull, epiphloeodic, c. 50 µm thick, continuous, without cortex but with smooth surface, with white medulla, without accumulations of calcium oxalate crystals. Apothecia immersed, linear, 0.2–0.3 mm wide, up to c. 1 mm long. Labia slightly swollen and raised above the thallus surface, closed, thalloid, sometimes regenerating with a second pair of white labia in between; no carbonized or brown parts, I–. Hymenium 70–80 µm, clear, I–, with tough gelatine not allowing the paraphyses to spread. Ascospores 8 per ascus, bacillar, 18–20 × 5–6 µm, transversely 4–6-septate, with lenticular lumina, colorless, I+ weakly blue-violet.

**Secondary chemistry:**—Norstictic acid.

**Etymology:**—The epithet expresses the size of the thalli, which form large whitish patches on forest trees.

**Distribution and Ecology:**—A rather common species in eastern Venezuela and Guyana forming large, conspicuous, pale patches on tree trunks in the Guayana Highland area, and probably elsewhere but unrecognized because the thalli are usually sterile. It was found so far in light, humid forests at 300–600 m.

**Remarks:**—*Diorygma extensum* fits well in the genus *Diorygma* Eschweiler (1824: 13, 25) by the ecorticate, bluish thallus, the absence of carbonisation in the ascocarps, and the strongly agglutinated paraphyses. The few species with bacillar ascospores included in *Diorygma* (Kalb *et al.* 2004) so far share clearly thickened septa. Only one species has similarly small ascospores and closed ascocarp labiae, *D. minisporum* Kalb *et al.* (2004: 161), known only from Guatemala. It differs by the presence of hypostictic and stictic acids and the I+ violet reaction of the ascospores. *D. circumfusum* (Stirt.) Kalb *et al.* (2004: 145), from Australia, differs by open discs and much larger (60–100 × 8.5–16 µm), I+ violet ascospores but shares the presence of norstictic acid. Only two fertile specimens with ascospores were found, both from Cerro Guaiquinima. Several additional collections from the Guayana Highland and adjacent Guyana fit well in thallus and ascocarp morphology and chemistry, but lack ascospores. They suggest that the species is rather widespread but easily missed by the absence of ascospores. The genus *Thallolooma* is very similar, by the absence of carbonization in the ascocarps, the absence of a thallus cortex and by the strongly conglutinated hymenium. It differs by the presence of red or brown pigments in the hymenium and the poorly developed excipulum, which does not form thalline labia (Staiger 2002).

**Additional specimens examined (fertile):**—VENEZUELA. Bolivar: Cerro Guaiquinima, at confluence of rivers Carapo and Lima (near camp 7); 320 m; c. 15 m tall, 3 Feb 1990, *H. Sipman* 26453 (B, VEN).

**Additional specimens examined (sterile):**—VENEZUELA. Bolivar: Cerro Guaiquinima, at confluence of rivers Carapo and Lima (near camp 7); 320 m; 2 Feb 1990, *H. Sipman* 26441 (B, VEN). GUYANA. Upper Mazaruni District: Jawalla village, at confluence of Kukui and Mazaruni rivers; 500 m; 6 Feb 1985, *H. Sipman & A. Aptroot* 18401 (B, GUY), 18507 (B, GUY); *ibid.*, E-bank of Waruma river, c. 4 km S of confluence with Kako river (campsite 1); 550 m; 9 Feb 1985, *H. Sipman & A. Aptroot* 18569 (B, GUY); *ibid.*, (campsite 3); 550 m; in c. 25 m tall virgin riverain forest, on 10 cm diam. trunk; 10 Feb 1985, *H. Sipman & A. Aptroot* 18642 (B, GUY); *ibid.*, trail from Kamarang river to Pwipwi mountain at landing site c. 5 km NW of Waramadan; 600 m; 27 Feb. to 1 Mar 1985, *H. Sipman & A. Aptroot* 19203 (B, GUY).

***Fissurina chapsoides* Sipman, sp. nov.** (Fig. 3F–G)

Mycobank #807356

*A Fissurina species with large, muriform ascospores and short ascocarps opening mostly by branched slits.*

**Type:**—VENEZUELA. Bolivar: Cerro Guaiquinima, central part of upper plateau, along Rio Carapo (near camp 3-nuevo); 800 m; rocky slope with low forest in deep clefts and along the river, 11 Feb 1990, *H. Sipman* 26980 (holotype VEN!; isotype B!).

Thallus greyish green, to over 10 cm wide, usually glossy, epiphloeodic, c. 50 µm thick, continuous, with very dense cortex, c. 12 µm thick, showing as pellucid sheet in bursts, with white medulla with dense accumulations of calcium oxalate crystals. Apothecia immersed below the cortex, roundish, invisible and recognizable only by, often



forked, fissures in the upper surface. Labia not differentiated and often more than two thallus slips present, slightly raised above the thallus surface, without carbonized or brown parts. Hymenium 170–200 µm, clear; paraphyses unbranched, not papillose apically. Ascospores 1–4 per ascus, muriform, 75–80 × 20–35 µm, c. 25 × 10 loculate, with thin septa and irregularly arranged locules, colorless, I–.

**Secondary chemistry:**—No substances detected by TLC.

**Etymology:**—The epithet reflects the unusual ascocarps which resemble more those of the genus *Chapsa* than *Fissurina*.

**Distribution and Ecology:**—Known so far from the Guyana Highland in eastern Venezuela, and the Central Cordillera in Colombia, and thus probably more widespread in northern South America. It was found in humid, mossy forest at 800–1950 m.

**Remarks:**—The species looks like many *Fissurina* Fée (1825: XXXV, CX) species with its greenish thallus with well-developed cortex and ascocarps opening by a split. However, in most *Fissurina* species, the ascocarps are clearly lirelline and do not form several marginal slips. In the new species the ascocarps are short and have often a branched split, resulting in three or more slips rather than two labiae, much like in *Chapsa dissuta* (Hale) Mangold in Mangold *et al.* (2009: 653), a species which differs by the much smaller, 4-locular ascospores. *Fissurina chapsoides* differs also from most other species in the genus by the large ascospores, over 70 µm long, with 1–4 in each ascus. However, three other species come close in overall morphology and ascospore size: *F. monospora* C. Knight (1883: 345), *F. submonospora* Sharma *et al.* (2012: 352), and *Phaeographina nitidescens* Fink (1927: 221). All three have more distinctly lirellate ascomata, with thick labia in *F. monospora* from New Zealand and ascospores becoming brown in *P. nitidescens* from Puerto Rico, both with single-spored asci. *F. submonospora* from India agrees with the new species in most characters but apart from the lirellate ascomata has also slightly larger ascospores (70–130 × 20–50 µm).

**Additional specimens examined:**—VENEZUELA. Bolivar: Cerro Guaiquinima, central part of upper plateau, along Rio Carapo (near camp 3-nuevo); 800 m; rocky slope with low forest in deep clefts and along the river; 11 Feb 1990, *H. Sipman* 26945 (B, VEN). COLOMBIA. Risaralda: Mnpio. Sta. Rosa de Cabal, al W de Termales de Sta. Rosa, Hacienda La Gaviota; 1980 m; selva subandina con *Cecropia* sp., *Hieronima alchorneoides* y *Miconia acuminifera*, epífita sobre Lauraceae (*Wolf* 1294); 22 Jul 1986, *J. Wolf* 1159 (B, COL).

***Fissurina gigas* Sipman, sp. nov.** (Fig. 4A–C)

Mycobank #807357

Differing from *Fissurina rufula* in the larger ascomata and muriform ascospores.

**Type:**—VENEZUELA. Bolivar: Cerro Guaiquinima, central part of upper plateau (near camp 4); 1000 m; sandstone flats with boggy *Stegolepis* vegetation and scrub; 6 Feb 1990, *H. Sipman* 26702 (holotype VEN!; isotype B!).

Thallus greyish green, often very large and to over 20 cm wide, usually glossy, epiphloeodic, c. 100 µm thick, continuous, with strong cortex showing as pellucid sheet in bursts, with white medulla with dense accumulations of calcium oxalate crystals. Apothecia immersed below the cortex, visible from above by the strongly swollen, closed labia tips forming over 1 mm wide and often over 1(–2) cm long whitish to greenish lirellae with constricted base. Labia internally brownish with strongly swollen, whitish tips, separated by a split which connects to a cavity above the hymenium, anatomically with a layered structure and coarse crystal aggregates. Hymenium 150–300 µm, clear; paraphyses unbranched, not papillose apically. Ascospores 1–2 per ascus, muriform, 70–140 × 25–35 µm, c. 50 × 15 loculate, with c. 5 primary septa, colorless, I+ weakly blue-violet.

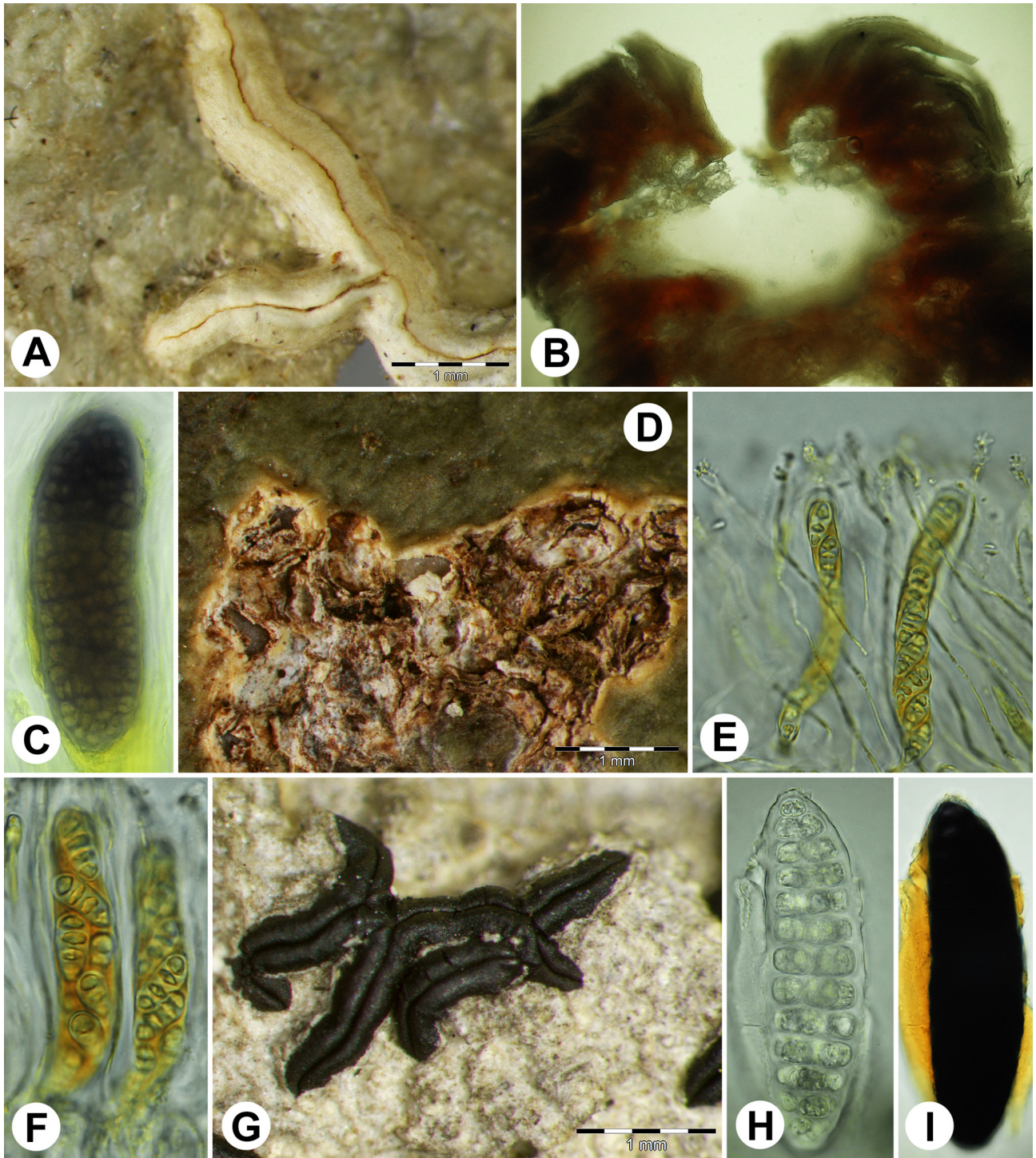
**Secondary chemistry:**—No substances detected by TLC.

**Etymology:**—Both ascospores and ascocarps are unusually large for Graphidaceae.

**Distribution and Ecology:**—This conspicuous species is known so far from the Guiana Shield in northern South America, from French Guiana to eastern Venezuela. The available specimens are from small trunks in humid, light and low forest at 50–1100 m.

**Remarks:**—The non-carbonized labiae and colorless, muriform ascospores of this new species remind at first of the genus *Hemithecium* Trevisan (1853: 11; Staiger 2002), particularly *H. chlorocarpum* (Fée) Trevisan (1853: 12) and *H. multistriatum* (Müll. Arg.) Chitale & Makhija (2009: 86), which have similar ascospores and striate labia. However, in *Hemithecium*, the ascospores show a strong color reaction with iodine, like in *Graphis*, and the

hymenium is not overarched by the labiae, with a deep fissure in between. Such a fissure occurs in *Dyplolabia* Massalongo (1854: 6) and *Carbacanthographis* Staiger & Kalb (Staiger 2002: 98), which both have carbonized labiae, and in *Fissurina* (Staiger 2002). Hence, the new species is attributed to the genus *Fissurina*; its ascocarps are indeed very similar in structure to *F. rufula* (Mont.) Staiger (2002: 160), which differs by its 3-septate ascospores. Only two *Fissurina* species with such large, muriform ascospores are known, *F. monospora* and *F. submonospora* (see above). While the latter has typical fissurine ascomata, the former also resembles a species of *Hemithecium*, but its ascospores are much broader than in the new species (35–60  $\mu\text{m}$  broad) and its labia are entire.



**FIGURE 4.** A–C. *Fissurina gigas* (holotype). A. Habitus. B. Ascocarp, transverse section. C. Ascospore, in Lugol. D–F. *Fissurina vorax* (holotype). D. Habitus. E. papillose paraphyse tips, in Lugol. F. Asci with ascospores, in Lugol. G–I. *Graphis murali-elegans* (holotype). G. Habitus. H. Ascospore. I. Same in Lugol.

**Additional specimens examined:**—VENEZUELA. Bolivar: Cerro Guaiquinima, at confluence of rivers Carapo and Lima (near camp 7); 350 m; 1 Feb 1990, *H. Sipman 26341* (B, VEN); *ibid.*, near NE edge of upper plateau (near camp 2); 1100 m; 9 Feb 1990, *H. Sipman 26899* (B, VEN). GUYANA. Upper Mazaruni District: Paruima Mission, hill along Kamarang river, E of the village; 450 m; 1 May 1997, *H. Sipman 39590* (B, GUY). Pakaraima mountains, c. 2 km N of Kamarang; 500 m; 4 Feb 1985, *H. Sipman & A. Aptroot 18225* (B, GUY); *ibid.*, E-bank of Waruma river, c. 4 km S of confluence with Kako river (campsite 1); 550 m; 9 Feb. 1985, *H. Sipman & A. Aptroot 18614* (B, GUY). Upper Demerara-Berbice District: Mabura Hill, 180 km SSE of Georgetown; 50 m; evergreen forest, Nov to Dec 1988, *B. Bleij & J. C. Biesmeijer s.n.* (B). FRENCH GUYANA. Saül: Saül, 2 km S of the village, Sentier Limonade; 180–210 m; 1986, *D. Montfoort & R.C. Ek s.n.* (B).

***Fissurina vorax* Sipman, sp. nov.** (Fig. 4D–F)

Mycobank #807358

Differing from other *Fissurina* species by the aggregated ascocarps in combination with papillose paraphysis tips.

**Type:**—FRENCH GUIANA. Regina: S-shore of creek Arataye near confluence with river Approuague, surroundings of Camp Aratai; 3°59'N, 52°35'W, 50–150 m; epiphyte in undergrowth of humid, primary lowland forest on low hills; 23 Feb 2003, *H. Sipman 50920* (holotype B!).

Thallus greenish, smooth to uneven, with c. 25 µm thick, waxy cortex of pachydermatic prosoplectenchyma; photobiont layer and medulla with dense clusters of calcium oxalate crystals. Apothecia erumpent, angular-rounded, c. 0.3–0.5 mm diam.; disc exposed, flesh-colored; thalline margin erect, split in c. 5 c. 0.2 mm tall slips which easily fall off; apothecia in 5–10 mm wide aggregates consisting in the centre of old, empty ascocarps, with young ascocarps developing along the margin. Columella absent. Excipulum colorless; periphysoids present, c. 1.2 µm thick and 20–40 µm long, apically not swollen. Hymenium c. 60 µm high, clear; paraphyses unbranched, c. 1.2 µm thick, apically swollen, subglobose, 2 µm thick, densely beset with c. 0.5 µm tall papillae (ca. 6 visible in optical section. Ascospores 8 per ascus, 3-septate, c. 11 × 5 µm, elongate, with slightly thickened septa and angular to lenticular lumina, colorless, I+ pale bluish.

**Secondary chemistry:**—No substances detected by TLC.

**Etymology:**—Named after the ascocarp aggregates which seem to destroy the thallus gradually.

**Distribution and Ecology:**—Known from a single collection from the interior of French Guiana, found in the undergrowth of humid, primary lowland forest at c. 100 m elevation.

**Remarks:**—This species shows considerable similarity to *Chapsa* and its relatives, because of the marginal slips of the ascomata and the periphysoids and in particular to *Astrochapsa* (Parnmen *et al.* 2012) by its thick, waxy cortex. It is deviating, however, by the thickened ascospore septa and the papillose paraphyse tips. These tips remind of the spinulose paraphyse tips found in the genus *Acanthotrema* Frisch in Frisch *et al.* (2006: 77), but here the excrescences on the paraphyse tips are much larger, over 2 µm long. However, paraphyse tips with similar low excrescences are found in *Fissurina* species, where 3-septate, I+ pale blue ascospores with thickened septa are also quite common. Therefore this species is included in this genus, where it differs from all known species by the large aggregations of ascocarps. Nevertheless within *Chapsa* a fairly similar species is known with colorless, transversely septate, non-amyloid ascospores, *C. dissuta*, which shares also the thick cortex, incurved marginal slips and 3-septate ascospores of 10–12 × 4–6 µm with rather thick septa, but its ascocarps are not aggregated and its paraphyse tips not papillose. An affinity with *Cruentotrema* Rivas Plata, Papong, Lumbsch & Lücking in Rivas Plata *et al.* (2012a: 119) is suggested by the colorless, I-negative ascospores with thickened septa, but in that genus the ascocarps have carbonized marginal slips and the paraphyses are apically smooth.

***Graphis murali-elegans* Sipman, sp. nov.** (Fig. 4G–I)

Mycobank #807359

Differing from *Graphis elegans* and *G. lumbricina* in the muriform ascospores.

**Type:**—COLOMBIA. Cauca: Cordillera Central, Mnpio. Puracé, Along road La Plata-Puracé, páramo 2 km W of Laguna de San Rafael; 3300 m; on *Diplostephium* in open, c. 3 m tall scrub in bog; 6 Oct 1984, *J. Aguirre C. & H. J. M. Sipman 5998* (holotype B!; isotype COL!).

Thallus pale grey, a few cm wide (judging from the available thallus fragments), epiphloeodic, thin, continuous, with thin cortex, without distinct medulla, with irregular accumulations of calcium oxalate crystals making the thallus surface irregularly warty. Ascocarps sessile, c. 2(–5) mm long, c. 0.4 mm wide when labiae simple, to 0.6 mm wide when labia striate, straight or irregularly curved, occasionally branched, near the thallus limit sometimes stellate. Labia closed, black, without thalline cover or with low basal thalline ridge, entire or once or a few times regenerating and thus becoming coarsely striate; carbonized parts about 100 µm thick, separate at the base, but a slight carbonization may be present in the top layer of the substrate. Hymenium 120–150 µm, clear. Ascospores about 1–4 per ascus, muriform, c. 70–100 × 20–35 µm, c. 12 × 3 loculate in optical section, colorless, I+ dark-violet, the locules arranged in transverse rows, with rounded lumina, turning pale grey when overmature.

**Secondary chemistry:**—Norstictic acid.

**Etymology:**—The epithet expresses the external resemblance with *Graphis elegans* (Borrer ex Sm.) Ach., from which it differs by the muriform instead of bacillar ascospores.

**Distribution and Ecology:**—The few available specimens suggest that its habitat is humid subalpine forest of the Neotropics.

**Remarks:**—The new species is very similar to *Graphis elegans* (Borrer ex Sm.) Acharius (1814: 85) and *G. lumbricina* Vainio (1899: 256) in its sessile, jet-black lirellae with coarse striation and the presence of norstictic acid. It deviates from both species by its muriform ascospores. All three species are typically found at high elevations in the tropics (Lücking *et al.* 2008).

**Additional specimen examined:**—COSTA RICA. Cartago: La Chonta, in Río Macho Forest reserve, c. 5 km S of El Empalme on road to San Isidro del General; 2300 m; 11 Nov 1988, *H. Sipman, J. Gómez-Laurito & B. Hein 41744* (B, CR).

***Graphis nigroglobosa* Sipman, *sp. nov.*** (Fig. 5A–D)

Mycobank #807360

Differing from *Graphis mexicana* in the absence of a complete thalline margin.

**Type:**—VENEZUELA. Bolivar: Cerro Guaiquinima, central part of upper plateau (near camp 4); 1000 m; open scrub with boggy places on sandstone flats; 5 Feb 1990, *H. Sipman 26564* (holotype VEN!; isotype B!).

Thallus pale grey, to over 10 cm wide, strongly glossy and varnish-like, epiphloeodic, thin, continuous, with thin cortex, without distinct medulla, with scarce, irregular accumulations of calcium oxalate crystals leaving the thallus surface mostly smooth. Ascocarps sessile, subglobose, 0.4–0.6 mm in diam., c. 0.2 mm tall, with constricted base, with a fissure over its whole diameter, the fissure being occasionally branched. Labia closed, black, without thalline cover or partly covered by a thin thallus layer, mainly laterally; carbonized parts about 50 µm thick, continuous at the base. Hymenium over 250 µm, clear. Ascospores 1 per ascus, muriform, 130–200 × 40–45 µm, c. 80 × 10 loculate in optical section, colorless, I+ dark-violet, with rounded lumina, the locules arranged in transverse rows.

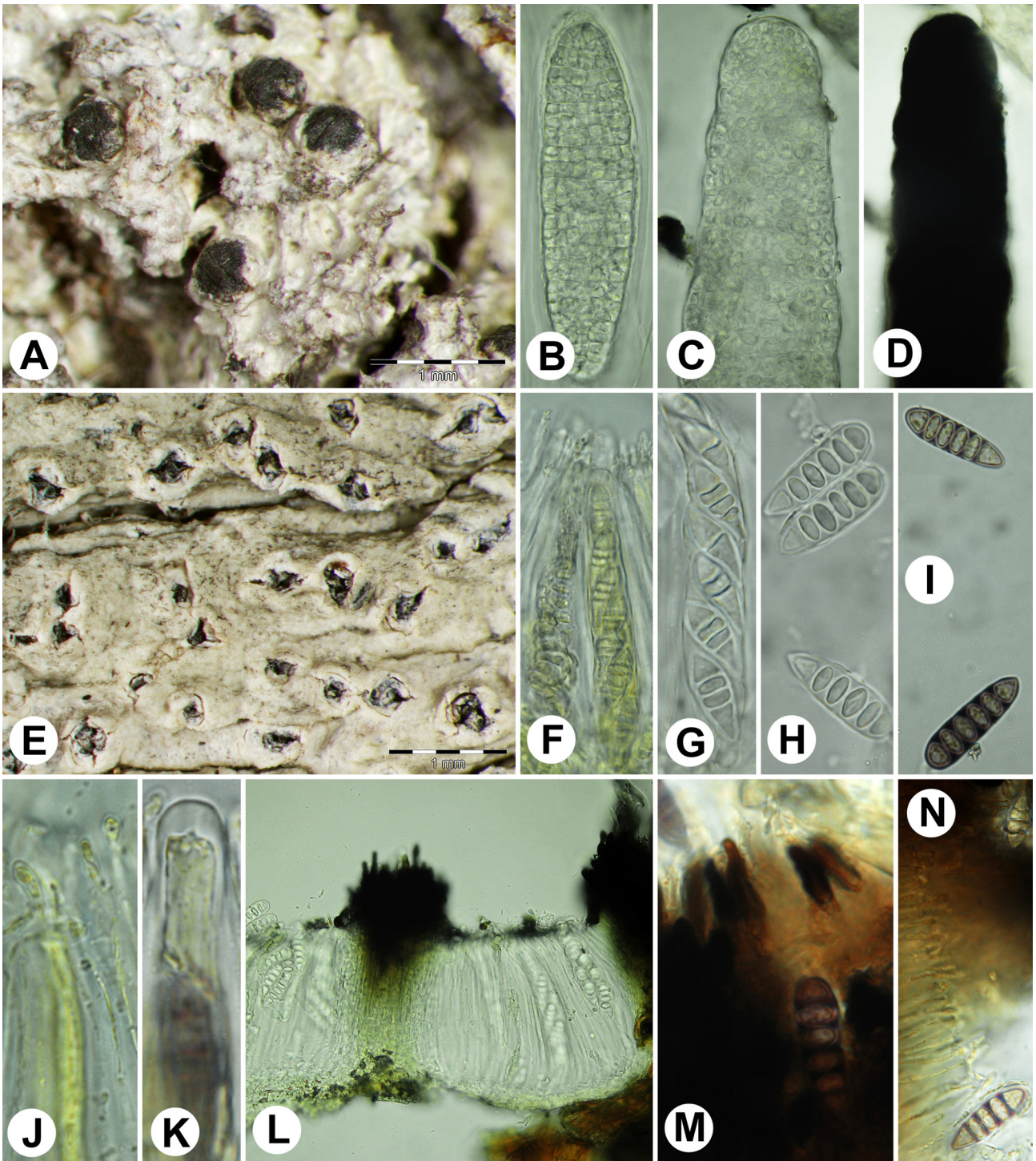
**Secondary chemistry:**—No substances detected by TLC.

**Etymology:**—The epithet expresses the free, black labiae, contrary to other species of *Graphis* with subglobose ascocarps, in which these are completely covered by a white thallus layer.

**Distribution and Ecology:**—The species is so far known only from the Guayana Highland, both from the Venezuelan and the Guyanan part, where it grows on stunted trees in savanna bush at 650–1000 m.

**Remarks:**—This species closely resembles *Graphis mexicana* (Hale) Kalb, Lücking & Lumbsch in Mangold *et al.* (2008: 44) and *G. globosa* (Fée) Sprengel (1827: 249) by the subglobose ascocarps and large, hyaline, muriform ascospores single in the asci. Both species differ by the larger ascocarps, about 1 mm in diam., which are consistently with a complete thallus cover.

**Additional specimens examined:**—VENEZUELA. Bolivar: Cerro Guaiquinima, central part of upper plateau (near camp 4); 1000 m; 5 Feb 1990, *H. Sipman 26559* (B, VEN). GUYANA. Upper Mazaruni District: Trail from Kamarang river to Pwipwi mountain, c. 5 km N of Waramadan; 650 m; 27 Feb to 1 Mar 1985, *H. Sipman & A. Aptroot 19256* (B, GUY).



**FIGURE 5.** A–D. *Graphis nigroglobosa* (holotype). A. Habitus. B. Juvenile ascospore. C. Part of mature ascospore. D. Same in Lugol. E–N. *Melanotrema comosum* (holotype). E. Habitus. F. Asci with young and postmature ascospores with swollen endospore globules. G. Juvenile ascospores. H. Adult ascospores. I. Adult ascospores, in Lugol. J. Paraphyse tips. K. Ascus apex. L. Apothecium section showing the dark brown columella and excipulum. M. Columella tip with protruding, swollen and stained hyphae. N. periphysoides, next to the hymenium (colorless) and above the hymenium (brown).

***Melanotrema comosum* Sipman, sp. nov. (Fig. 5E–N)**

Mycobank #807361

A species of *Melanotrema* with extruding, clavate, brown hyphae on columella and excipulum.

**Type:**—COLOMBIA. Amazonas: Araracuara, tableland on S-side of river Caquetá W of Puerto Santander, opposite airstrip of Araracuara, Ciudad Perdida 1 km W of Chorro; 0°36'S, 72°25'W, 350 m; sandstone plates with low savanna forest, epiphyte on isolated shrubs; 30 Oct 1988, *H. Sipman & J. Duivenvoorden 27859* (holotype B!; isotype ARA!).

Thallus light yellowish grey, smooth to uneven, thinly corticate, largely endophloeoidic; photobiont layer and medulla with scattered clusters of calcium oxalate crystals. Apothecia erumpent, angular-rounded to elongate, 0.5–0.8 mm diam.; disc invisible; thalline margin raised, divided in c. 4 thick, to c. 0.3 mm long, erect slips, well separated from the whitish exciple of the one or two discs inside. Columella sometimes present, with dark-brown tip with extruding 2.5 µm thick dark-brown hyphae. Excipulum brownish with dark-brown tips with extruding swollen hyphae, sometimes regenerated; periphysoids present, c. 15 µm long. Hymenium 75–85 µm high, clear; paraphyses unbranched, c. 1.5 µm thick, apically with clavate, 3 µm thick terminal cell with granular surface. Ascospores 8 per ascus, 5-septate, c. 24–26 × 7 µm, elongate, with thickened septa and lenticular lumina, colorless, I+ dark violet.

**Secondary chemistry:**—Lichexanthone, hypoprotocetraric, 4-*O*-demethylnotatic acids.

**Etymology:**—The specific epithet refers to the extruding, swollen hyphae on the columella.

**Distribution and Ecology:**—Known from a single specimen from the Colombian part of the Amazon Basin, along Río Caquetá, found on an isolated, stunted tree in savanna forest on sandstone tableland at 350 m elevation.

**Remarks:**—The loose-structured columella without crystals relates this species to the genera *Melanotrema* Frisch in Frisch *et al.* (2006: 382) and *Redingeria* Frisch in Frisch *et al.* (2006: 402), but the absence of *Redingeria*-type ascospores excludes the second genus (Frisch *et al.* 2006). Within *Melanotrema*, the new species differs from all known species by the presence of hypoprotocetraric acid. Also the extruding hyphae with swollen, brown-stained apex are unique within the family.

***Myriochapsa annulata* Sipman, sp. nov. (Fig. 6A–D)**

Mycobank #807464

Differing from *Myriochapsa psoromica* by the conspicuous, free excipulum.

**Type:**—VENEZUELA. Bolivar: Cerro Guaiquinima, at confluence of rivers Carapo and Lima (near camp 7); c. 5°35'N, 63°32'W, 320 m; c. 15 m tall, light forest on poor soil on E-bank of Carapo, on fallen branch from canopy; 31 Jan 1990, *H. Sipman 26333* (holotype VEN!; isotype B!).

Thallus light grey, smooth to uneven, corticate; photobiont layer and medulla with scattered clusters of calcium oxalate crystals. Apothecia erumpent, rounded, c. 0.6–1.2 mm diam.; disc invisible; thalline margin thick and low, entire to shallowly lobate, excipulum free and incurved, lacerate, leaving a small pore. Columella absent. Excipulum colorless; periphysoids c. 10–40 µm long, 2 µm thick, apically not swollen, smooth. Hymenium 200–210 µm high, clear; paraphyses unbranched, 2 µm thick, apically not swollen, septate at c. 4 m intervals; epithecium without crystals. Ascospores 8 per ascus, transversely 9–11-septate, c. 40–50 × 10 µm, elongate, with thickened septa and lenticular lumina, colorless, I+ dark violet.

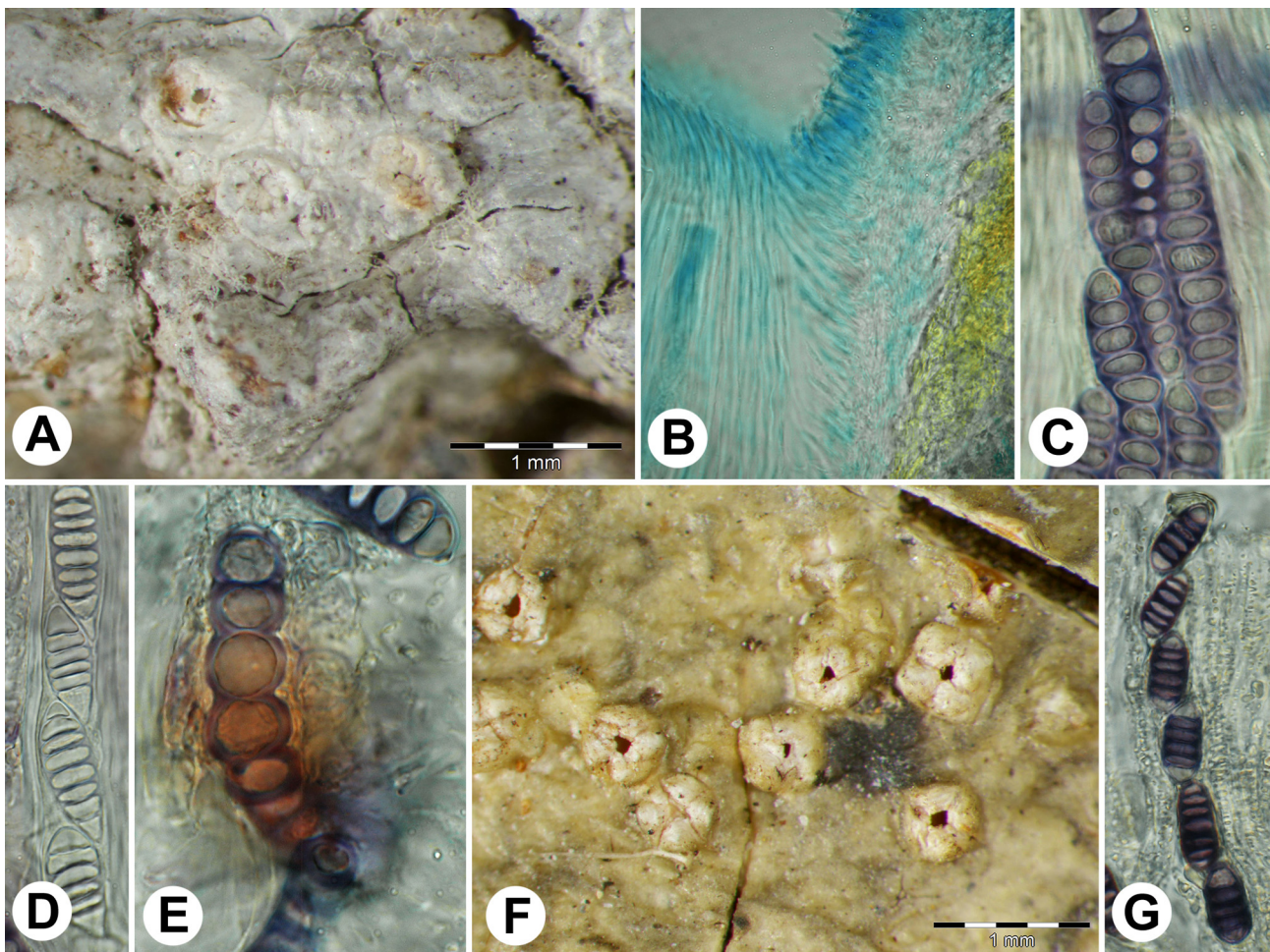
**Secondary chemistry:**—Psoromic acid.

**Etymology:**—Named after the conspicuous free excipulum ring inside the thalline margin of the ascocarps.

**Distribution and Ecology:**—The only specimen known originates from the Guyana Highland, eastern Venezuela. It was collected in light forest on poor soil at c. 320 m elevation.

**Remarks:**—The apothecial structure with free excipulum inside an ascocarp wart reminds of *Thelotrema*. However, the ascospores deviate and agree more with tribe Ocellularieae (Rivas Plata *et al.* 2012b) by their lenticular lumina and dark-violet iodine-staining, the juvenile stage with thin septa and walls, and the overmature stage in which the outer wall and septa disintegrate and the endospore turns into globules. Therefore the species best fits the genus *Myriochapsa* M. Cáceres, Lücking & Lumbsch in Parnmen *et al.* (2013: 128). It agrees with *M. psoromica* (M. Cáceres, Santos de Jesus & Santos Vieira) M. Cáceres, Lücking & Lumbsch in Parnmen *et al.*

(2013: 128) by its ascospores and psoromic acid, but it deviates considerably in the conspicuous, free excipulum and the absence of hymenium guttules.



**FIGURE 6.** A–E. *Myriochapsa annulata* (holotype). A. Habitus. B. Hymenium margin and periphysoids, stained with LPCB. C. Mature ascospores, in Lugol. D. Juvenile ascospores. E. Overmature ascospore with swollen endospore globules, in Lugol. F–G. *Myriochapsa chocoensis* (holotype). F. Habitus. G. Mature ascospores and guttulate hymenium, in Lugol.

***Myriochapsa chocoensis* Sipman, sp. nov.** (Fig. 6E–F)

Mycobank #807465

Differing from *Myriochapsa psoromica* in the smaller ascospores, c.  $16 \times 8 \mu\text{m}$ .

**Type:**—COLOMBIA. Valle del Cauca: Mnpio. Buenaventura, forest exploitation in the concession of Cartón de Colombia;  $3^{\circ}56'N$ ,  $77^{\circ}10'W$ , 230 m; primary tropical rainforest with annual rainfall 7400 mm, rich in epiphytes and lianas and with a dense understory, on very brittle bark of tree; 15 Nov to 6 Dec 1979, *J. van Rooden*, *B. J. H. ter Welle* & *S. M. C. Topper* RWT 428 (holotype B!; isotypes COL!, L!).

Thallus grey-green, smooth to uneven, strongly corticate, cortex flaky, prosoplectenchymatic, c.  $25 \mu\text{m}$  thick; photobiont layer and medulla without clusters of calcium oxalate crystals. Apothecia erumpent, rounded, almost urceolate, 0.4–0.6 mm diam.; disc invisible, pale flesh-colored; thalline margin incurved and entire with c. 4 short apical incisions, concolorous with the thallus, with a white rim, without visible excipulum. Columella absent. Excipulum yellowish; periphysoids c.  $10 \mu\text{m}$  long and  $2 \mu\text{m}$  wide, apically not swollen and smooth. Hymenium c.  $125 \mu\text{m}$  high, guttulate; paraphyses unbranched,  $2 \mu\text{m}$  thick, apically slightly swollen to  $3 \mu\text{m}$ ; epithecium without crystals. Ascospores c. 5(–8) per ascus, 7-septate, c.  $16 \times 8 \mu\text{m}$ , elongate, with thickened septa and lenticular lumina, colorless, I+ dark violet.

**Secondary chemistry:**—Psoromic acid.

**Etymology:**—Named after the region where it was discovered, a high-rainfall area with a very special flora.

Unfortunately its natural forest is much exploited and disturbed in recent decades and the species may be already threatened with extinction.

**Distribution and Ecology:**—Known only from a single specimen from the Choco area along the Pacific coast of Colombia. It was found on tree bark in virgin tropical rainforest in high rainfall area at c. 230 m.

**Remarks:**—The species is very similar to *Myriocephala psoromica* in chemistry, hymenium inspersion and ascoma shape, but differs in the considerably smaller ascospores,  $16 \times 8 \mu\text{m}$  instead of  $35\text{--}45 \times 9\text{--}12 \mu\text{m}$ , and the less open ascocarps. Its ascospores are very similar to the most frequent type in tribe Ocellularieae (Rivas Plata *et al.* 2012b) by the iodine staining and lenticular lumina, confirming the molecular phylogenetic relationships of this genus (Parnmen *et al.* 2012, 2013).

***Ocellularia pitalensis* Sipman, sp. nov.** (Fig. 7A–E)

Mycobank #807362

Differing from *Ocellularia maxima* by producing hypoprotocetraric acid.

**Type:**—EL SALVADOR. Chalatenango: Mpio. San Ignacio, Cantón Rio Chiquito, Cerro Pital, Finca El Pital, La Punta; 2600 m; mossy *Quercus* forest on mountain top; 22 Nov 1993, H. Sipman, W. Berendsohn & D. Vásquez 37822 (holotype B!; isotype LAGU!).

Thallus pale greenish grey, several cm diam., epiphloeodal, thin, c.  $50\text{--}100 \mu\text{m}$  thick, continuous, with smooth surface, with distinct, thin cortex; medulla indistinct, with scattered accumulations of calcium oxalate crystals making the thallus somewhat warty. Ascocarps immersed in raised,  $0.7\text{--}1.0\text{--}1.5$  mm wide and to c.  $500 \mu\text{m}$  high, well delimited thallus warts, often somewhat lobed due to crystal accumulations, with  $0.1$  mm wide, round, depressed pore, pore area mostly concolorous with thallus; columella absent; excipulum uncarbonized, brown, without externally visible inner excipulum. Hymenium  $300\text{--}400 \mu\text{m}$ , clear. Ascospores 1 per ascus, muriform, c.  $220\text{--}230 \times 40\text{--}45 \mu\text{m}$ , c.  $60 \times 10$  loculate in optical section, colorless, I+ dark violet.

**Secondary chemistry:**—Hypoprotocetraric and 4-*O*-demethylnotatic acids.

**Etymology:**—Named after the mountain on which it was found.

**Distribution and Ecology:**—Known so far only from Cerro Pital in El Salvador, in mountain forest at 2500–2600 m.

**Remarks:**—The new species is most similar to *Ocellularia maxima* (Hale) Lumbsch & Mangold (Sipman *et al.* 2012: 135) and deviates by the somewhat smaller ascocarp warts, the larger ascospores ( $100\text{--}170 \times 30\text{--}40 \mu\text{m}$  in *O. maxima*), and the presence of hypoprotocetraric instead of psoromic acid. Similar, large, muriform, hyaline ascospores are characteristic of *O. conformis* (Fée) Hale (1980: 136) and *O. interposita* (Nyl.) Hale (1980: 137), both differing by the presence of psoromic acid and distinct columellae. Among species which share the large, muriform ascospores and hypoprotocetraric acid, *O. eumorpha* (Stirt.) Hale (1980: 136) deviates by its carbonized excipulum (Hale 1981), and *O. chiriquiensis* (Hale) Hale (1980: 136) by its pigmented ascospores (Hale 1978, sub *Leptotrema*). Free ascospores can be seen by stereomicroscope laying on the thallus outside the ascocarps; they are black, contrary to their hyaline appearance in sections, similar to what is commonly observed in Trypetheliaceae. The pigmented excipulum seems to develop by the accumulation of brown pigment in hyphae similar to and parallel to the paraphyses but shorter, somewhat resembling periphysoids.

**Additional specimen examined:**—EL SALVADOR. Chalatenango: Mpio. San Ignacio, Cantón Rio Chiquito, Cerro Pital, Finca de los Sres. Portillo; 2500 m; 21 Nov 1993, H. Sipman, W. Berendsohn & D. Vásquez 37624 (B, LAGU).

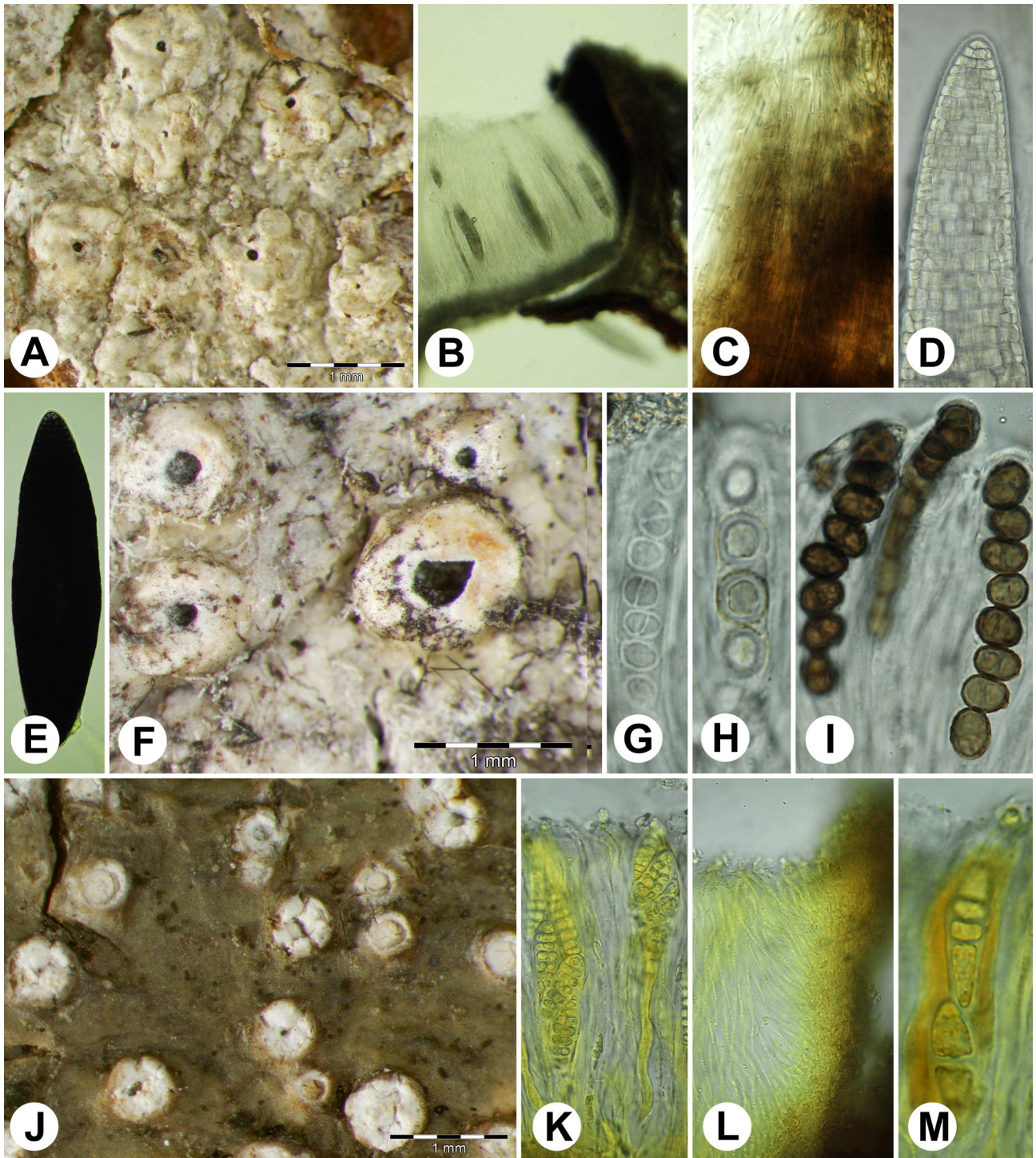
***Ocellularia rugosa* Sipman, sp. nov.** (Fig. 7F–I)

Mycobank #807363

Similar to *Ocellularia zamorana* but with wider ostioles and 1-septate, pigmented ascospores with thick-walled juvenile stage.

**Type:**—VENEZUELA. Bolívar: Cerro Guaiquinima. Near NE edge of upper plateau (near camp 2); c.  $5^{\circ}54'N$ ,  $63^{\circ}27'W$ , 1200 m; rocky sandstone area with scattered scrub; 9 Feb 1990, H. Sipman 26819 (holotype VEN!; isotype B!).





**FIGURE 7.** A–E. *Ocellularia pitalensis* (holotype). A. Habitus. B. Ascocarp transverse section. C. Transition hymenium-carbonized excipulum. D. Part of ascospore. E. Ascospore, in Lugol. F–I. *Ocellularia rugosa* (holotype). F. Habitus. G. Juvenile ascospores. H. Late juvenile ascospores, in Lugol. I. (Post-)mature ascospores. J–M. *Thelotrema berendsohnii* (holotype). J. Habitus. K. Ascospores, in Lugol. L.Periphysoids. M. Juvenile ascospores, in Lugol.

Thallus light grey, smooth to uneven, thinly corticate with 5–10  $\mu\text{m}$  thick, prosoplectenchymatic cortex; photobiont layer and medulla with scattered clusters of calcium oxalate crystals. Apothecia erumpent, rounded-urceolate, c. 0.6–1.2 mm diam.; disc scarcely exposed, dark grey, thinly white-pruinose; margin entire, incurved, black near the rim, probably due to spore masses. Columella absent. Excipulum yellowish; periphysoids absent. Hymenium c. 70  $\mu\text{m}$  high, clear; paraphyses unbranched, 2  $\mu\text{m}$  thick, apically gradually slightly swollen to 3  $\mu\text{m}$ . Ascospores 8 per ascus, 1-septate, c. 10  $\times$  7  $\mu\text{m}$ , subglobose, with thickened septa and rounded lumina, dark grey-brown, I–, with reticulately ridged surface at post-mature (?) stage.

**Secondary chemistry:**—Psoromic acid.

**Etymology:**—The epithet expresses the sculptured outer side of the over-mature ascospores.

**Distribution and Ecology:**—Known only from a single specimen from the Guyana Highlands, eastern Venezuela. It was collected in stunted, humid forest on poor soil at 1200 m elevation.

**Remarks:**—The wart-like ascocarps without carbonization and without marginal lobes remind of the genus *Thelotrema*, but the spore development is unusual for this genus and periphysoids were not found. The thick-walled, pale grey, late-juvenile stage (Fig. 16C) is particularly uncommon among thelotremoid Graphidaceae with small ascospores and known only from the genera *Leucodecton* Massalongo (1860: 325), *Leptotrema* Mont. & Bosch in Miquel (1855: 483) and *Reimnitzia* Kalb (2001: 325) (Frisch *et al.* 2006). The post-mature, ridged stage (Fig. 16D) may be unique. Ridged ascospores are mentioned by Frisch (2006) for *Stegobolus metaphoricus* (Nyl.) Frisch in Frisch *et al.* (2006: 470), but specimens in B do not show a similar structure as on photo 4 and the ridges of *S. metaphoricus* apparently are poorly visible with a standard microscope. Other *Stegobolus* species have sculpturing of the outer spore wall, but this does not consist of reticulate ridges and is equally inconspicuous under the standard microscope. Frisch (2006) indicates ridged ascospores also for *Leucodecton* but without illustration or species. Wart-like, uncarbonized ascocarps occur also in the genus *Ocellularia*, like psoromic acid and stained ascospores. Concluding, the affinity of the species is unclear, and as interim solution the species is placed here in *Ocellularia*, awaiting a new classification for the species left in this genus at present. In this genus it differs from all species by the stained, coarsely ridged, bicellular ascospores with thick-walled juvenile stage.

***Thelotrema berendsohnii* Sipman, sp. nov.** (Fig. 7J–M)

Mycobank #807364

Similar to *Thelotrema alboolivaceum*, from which it differs by the submuriform ascospores.

**Type:**—EL SALVADOR. Ahuachapán: P.N. El Imposible, sector La Fincona, along trail through Bosque del Tanque, near La Fincona; 800 m; primary forest remnant, low forest on top of cliff, on half-shady Pergamino (*Erythroxylum areolatum*) tree-trunk; 6 Nov 1998, H. Sipman, E. Sandoval & R. Welz 44607 (holotype B!; isotype LAGU!).

*Thallus* dark olive greenish, usually a few cm diam., epiphloeodal, thin, c. 50 µm thick, continuous, with smooth surface, with thick cortex showing as hyaline sheet at bursts; medulla indistinct, without crystals, leaving the thallus thin and smooth. Apothecia immersed in the thallus, rounded, 0.4–0.7 mm diam., scattered or sometimes two fused, sometimes arranged in lines, with continuous, erect thalline rim about 0.2 mm tall and 0.1 mm thick, greenish outside, volcano-like, with entire, white rim; disc hardly visible while deeply immersed, white-pruinose but often hymenium absent or degenerated and leaving a white, shrunken layer; periphysoids present, paraphyse-like and gradually shorter towards the excipulum tip. Hymenium c. 75 µm, clear. Ascospores 8 per ascus, muriform, c. 22 × 8 µm, 6–8 × 2 loculate in optical section, with rounded locules, colorless, I+ very pale violet.

**Secondary chemistry:**—Stictic, cryptostictic, and constictic acids.

**Etymology:**—The epithet is in honor of Dr. Walter G. Berendsohn (Berlin) who greatly enabled and stimulated lichenological (and further botanical) research in El Salvador.

**Distribution and Ecology:**—Known so far only from two collections from PN El Imposible, El Salvador, in seasonal forest remnant at 800 m elevation.

**Remarks:**—This species belongs to a group of species centered around *Thelotrema leucophthalmum* Nylander (1868: 39), sharing the thick, corticate, "waxy" thallus containing stictic acid and the rough outer margin of the ascomata. Within the world key (Rivas Plata *et al.* 2010) it would key out as *Thelotrema alboolivaceum* Vainio (1929: 38), described from Puerto Rico. However, the key contains an error, since *T. alboolivaceum* does not produce submuriform but only transversely septate ascospores. *Thelotrema berendsohnii* is almost a sporomorph of *T. alboolivaceum*, agreeing in most other characters with that species but differing by submuriform, I-negative ascospores. The ascospores of the new species, with early thickened primary septum, are very similar to those of *Fissurina nitidescens* (Nyl.) Nylander (1890: 108), from which it differs by the rounded rather than elongate ascocarps with a thicker, not recurved thalline margin, and the presence of stictic acid.

**Additional specimen examined:**—EL SALVADOR. Ahuachapán: P.N. El Imposible, sector La Fincona, Bosque del Tanque, near La Fincona; 800 m; 6 Nov 1998, H. Sipman, E. Sandoval & R. Welz 44579 (B, LAGU).

***Thelotrema kinabaluense* Sipman, sp. nov. (Fig. 8A–B)**

Mycobank #807365

Differing from other *Thelotrema* species by its small, brown ascospores of c.  $16 \times 6 \mu\text{m}$  and protocetraric acid.

**Type:**—MALAYSIA. Sabah: Distr. Kota Belud, Kinabalu Park, S-slope of Mount Kinabalu, along Summit Trail; c.  $6^{\circ}05'N$ ,  $116^{\circ}35'E$ , 2800 m; stunted mossy forest on mountain ridge  $\pm$  halfway between Villosa shelter and Carson's Camp; 12 May 1989, *H. Sipman & B. Tan 31291* (holotype B!; isotype KIN!).

Thallus whitish, endophloeoidic, not corticate; photobiont layer and medulla without clusters of calcium oxalate crystals. Apothecia erumpent, angular-rounded, c. 0.6–1.2 mm diam.; disc grey, hardly visible; thalline margin formed by bark vessels, slightly raised, well separated from the whitish, lacerate exciples of the c. 1–3 discs inside, more or less aggregated into several mm long clusters with dozens of exciples. Columella absent. Excipulum colorless; periphysoids short, c.  $5 \mu\text{m}$  long, not thickened. Hymenium c.  $85 \mu\text{m}$  high, clear; paraphyses unbranched,  $2 \mu\text{m}$  thick, apically slightly and gradually swollen to  $3 \mu\text{m}$ . Ascospores 8 per ascus, 3–5-septate, c.  $16 \times 6 \mu\text{m}$ , elongate, with thickened septa and rather angular lumina, with thicker outer wall, dark grey-brown, I–, when young slightly I+ violet, when overmature wrinkled and finally shriveled, long persistent.

**Secondary chemistry:**—Protocetraric acid.

**Etymology:**—The epithet reflects the endophloeoidic position of the species, with the ascocarps developing in holes in the bark surface.

**Distribution and Ecology:**—This species is only known from Mt. Kinabalu in Malaysia, where it grew on a trunk in stunted mossy forest at c. 2800 m in the perhumid mossy forest zone.

**Remarks:**—In the available specimen the thallus of the lichen is completely immersed in very fibrous bark. Consequently the "thalline margin" is clearly shaped by bark vessels which are put upwards by the developing ascocarps. These regenerate from a layer under the old hymenium, causing the remains of the earlier hymenium to stand up as incurved marginal excipulum slips. Sometimes more than one hymenium develops and the ascocarps are grouped. The affinity of the species is unclear and it is placed provisionally in *Thelotrema*. Alternative placement in *Chapsa* is unlikely because the ascospores are fairly thick-walled and the ascocarps do not have clearly split margins. Within *Thelotrema*, it deviates from all known species by the combination of small, brown, transversely septate ascospores and protocetraric acid. The thallus and ascocarps are fairly similar to those of *Crutarndina petractoides* (P.M. Jørg. & Brodo) Parmen *et al.* (2012: e51392), but that species has hyaline ascospores and lacks secondary substances. The compound ascocarps are fairly similar to *Chapsa referta* (Hale) Lücking, but the thallus is completely endophloeoidic, without cortex, and the thalline margin deformed by the bark vessels. Also *C. referta* has larger and colorless ascospores,  $20\text{--}25 \times 6\text{--}8 \mu\text{m}$ , and hypoprotocetraric acid. The spores remind somewhat the 3-septate type of *Fissurina* by their rather thick walls and septa but they have regularly more than 3 septa.

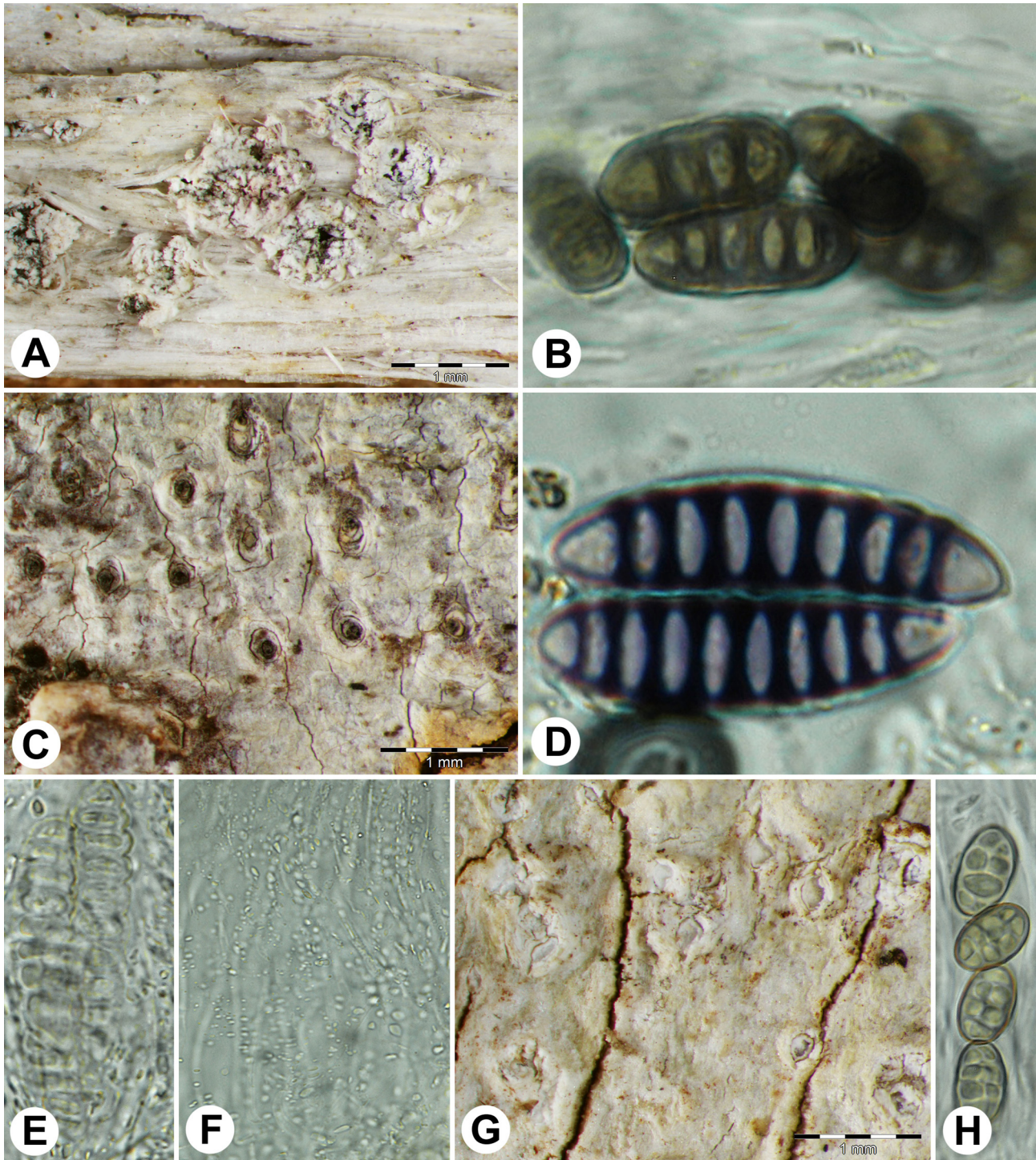
***Thelotrema paludosum* Sipman, sp. nov. (Fig. 8C–F)**

Mycobank #807366

Differing from other *Thelotrema* species by the inspersed hymenium, hypoprotocetraric acid and colorless, transversely septate ascospores of c.  $30 \times 7 \mu\text{m}$ .

**Type:**—COLOMBIA. Amazonas: Comunidad de Villazul, E of Araracuara. N-bank of river Caquetá, opposite E-end of Isla Morrocroy;  $0^{\circ}36'S$ ,  $72^{\circ}10'W$ , 300 m; c. 10 m tall, light savannaforest on podsolized soil with peaty top layer on tertiary sediments 2 km N of the river, epiphyte; 3 Nov 1988, *H. Sipman & J. Duivenvoorden 28446* (holotype B!; isotype ARA!).

Thallus light grey, smooth to uneven, thinly or not corticate; photobiont layer and medulla without clusters of calcium oxalate crystals. Apothecia immersed, rounded, 0.3–0.4 mm diam.; disc invisible; thalline margin not raised, round, separated by a split from the grey exciple ring which leaves only a tiny pore open. Columella absent. Excipulum pale brown, apically dark brown; periphysoids similar to paraphyses but gradually shorter towards the margin. Hymenium c.  $110\text{--}120 \mu\text{m}$  high, guttulate (guttules  $1\text{--}2 \mu\text{m}$  diam.); paraphyses unbranched, c.  $1.2 \mu\text{m}$  thick, apically not swollen. Ascospores 8 per ascus, 11–13-septate, c.  $30 \times 7 \mu\text{m}$ , elongate, with thickened septa and rather lenticular lumina, colorless, turning pale grey when degenerating, I+ dark violet.



**FIGURE 8.** A–B. *Thelotrema excavatum* (holotype). A. Habitus. B. Ascospores. C–F. *Thelotrema paludosum* (holotype). C. Habitus. D. Ascospores, in Lugol. E. Postmature ascospores with swollen endospore globules. F. Hymenium guttules. G–H. *Thelotrema parvisporum* (holotype). G. Habitus. H. Ascospores.

**Secondary chemistry:**—Hypoprotocetraric acid.

**Etymology:**—The epithet reflects the habitat of the species, peat bog at low elevation in the tropics.

**Distribution and Ecology:**—Once found in the Colombian part of the Amazon Basin, in dept. Caqueta, where it occurred in light savanna forest on peat at 300 m elevation.

**Remarks:**—This species resembles externally somewhat the saxicolous *Diploschistes actinostomus* (Ach.) Zahlbruckner (1892: 34) by the ascocarps being visible as wide excipulum rings inside thallus pores. Among the corticolous thelotremoid taxa, the genera *Crutarndina* Parmen *et al.* (2012: e51392), *Schizotrema* and *Thelotrema*

have the most similar ascocarp structure. Of these, *Crutarndina* has similar ascospores with lenticular lumina and a strong I+ dark-violet reaction, but the dense paraphyses with grey epithecium and I+ blue-staining sections in the excipulum suggest a more distant affinity. In *Schizotrema* the ascospores have thin septa and are I-negative. In *Thelotrema* the ascospores are rather variable but the periphysoids are clearly differentiated. Thus none of these fits properly. Therefore the species is provisionally placed in the genus *Thelotrema*. It differs from all described species in this genus, as well as from *Schizotrema* and *Crutarndina*, by the combination of a guttulate hymenium, hypoprotocetraric acid and colorless, transversely septate ascospores of c.  $30 \times 7 \mu\text{m}$ .

***Thelotrema parvisporum* Sipman, sp. nov.** (Fig. 8G–H)

Mycobank #807367

Differing from *Thelotrema adjectum* in the small, grey-brown ascospores of c.  $13 \times 7 \mu\text{m}$ .

**Type:**—VENEZUELA. Bolivar: Cerro Guaiquinima, at confluence of rivers Carapo and Lima (near camp 7); c.  $5^{\circ}35'N$ ,  $63^{\circ}32'W$ , 320 m; c. 15 m tall, light forest on poor soil along Carapo; 2 Feb 1990, H. Sipman 26416 (holotype VEN!; isotype B!).

Thallus whitish, smooth to uneven, not corticate, endophloeiodic; photobiont layer and medulla without clusters of calcium oxalate crystals. Apothecia erumpent, angular-rounded, 0.3–1.0 mm diam.; disc not or slightly exposed, white-pruinose; thalline margin slightly raised to c. 0.2 mm, divided in a few low or hardly distinct, inclined to erect slips, felty white-pruinose inside; excipulum separated by a fissure, forming a separate ring inside the thalline margin, somewhat lacerate. Columella absent. Excipulum colorless; periphysoids present, 5–10  $\mu\text{m}$  long, c. 1  $\mu\text{m}$  thick, not swollen. Hymenium c. 60  $\mu\text{m}$  high, clear; paraphyses unbranched, c. 1.2  $\mu\text{m}$  thick, apically hardly swollen. Ascospores 8 per ascus, submuriform,  $3(-6) \times 0-1$ -septate,  $11-14 \times 6-8 \mu\text{m}$ , ovoid, with thin outer wall and moderately thickened septa, with rounded lumina, grey-brown, I–.

**Secondary chemistry:**—Stictic acid.

**Etymology:**—The epithet reflects the unusually small ascospores.

**Distribution and Ecology:**—Known from a single collection from the Guayana Highlands in eastern Venezuela, where it was found in light forest on poor soil at c. 230 m elevation.

**Remarks:**—This species has a *Thelotrema* morphology with its proper excipulum well separated from the thalline margin and visible as a second, whitish ring inside it, and shares the periphysoids. It is superficially very similar to *Thelotrema adjectum*, which differs by the much ascospores ( $40-80 \times 12-25 \mu\text{m}$ ) remaining colorless and with thick outer wall, and psoromic acid. It differs from all known species (Rivas Plata *et al.* 2010) with brown, muriform ascospores and clear hymenium by the presence of stictic acid and tiny ascospores. It is also fairly similar to the genus *Crutarndina*, which deviates by the dense paraphyses with grey epithecium and I+ blue-staining sections in the excipulum, which suggest a more distant affinity.

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