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SOME ASCOMYCETES (FUNGI) OCCURRING ON TROPICAL FERNS

GARY J. SAMUELS[1] AND CLARK T. ROGERSON

Samuels, Gary J. and Clark T. Rogerson (New York Botanical Garden, Bronx, NY 10458-5126). Some ascomycetes (fungi) occurring on tropical ferns. Brittonia 42: 105–115. 1990.—The new combination **Eudimeriolum cyathearum** is proposed for *Dimeriella cyathearum*; the fungus is found on pinnae of *Cyathea caudata* in the Philippine Islands. **Dimeriella polypodii** is described from scales on pinnae of *Polypodium montigenum* and *P. madrense* in Mexico. *Bioscypha cyatheae*, on pinnae of *Cyathea* sp. in Costa Rica, is redescribed. **Bioscypha pteridicola** is described from pinnae of *Cnemidaria uleana* var. *abitaguensis* in Colombia. **Crocicreas sessilis** is described from pinnae of *Cyathea divergens* var. *tuerckheimii* in Mexico.

We have found the following loculoascomycetes and discomycetes on specimens of ferns preserved in the herbarium of the New York Botanical Garden. The fungi are now deposited in the cryptogamic herbarium of the New York Botanical Garden.

Eudimeriolum cyathearum (H. & P. Sydow) Samuels & Rogerson, comb. nov. (Figs. 1–5)

Dimeriella cyathearum H. & P. Sydow, Philipp. J. Sci. 8: 478. 1913. *Lasiostemma cyathearum* (H. & P. Sydow) H. & P. Sydow, Ann. Mycol. 15: 218. 1917. TYPE: PHILLIPPINE ISLANDS. LUZON: Prov. Laguna, Mt. Maquiling, on *Cyathea caudata*, Mar 1913, [*Merrill*] *8638* (ISOTYPES: BPI, NY!).

Anamorph: None known.

Mycelium dark brown, appearing black, effused, hyphae cylindrical, 3–3.5 μm wide, smooth, nonhyphopodiate, branched, septate; individual hyphae erect, 70–160 μm long, 2.5–3 μm wide, septate, unbranched, smooth. Ascomata globose, 165–228 μm diam, nonpapillate, solitary, seated in mycelium, cupulate and black when dry, globose and green in 3% KOH, with hyphal appendages to 125 μm long, 2.5–3 μm wide, septate, unbranched arising from the wall surface and often attached to the surrounding mycelium; aggregate of hyphae and ascomata easily removed; cells at surface of ascomatal wall angular, 5–7 μm in greatest dimension, wall <1 μm thick; ascomatal wall ca 12 μm wide laterally, 3 or 4 cells wide, cells angular, 5–7 μm in greatest dimension, walls ca 1 μm thick. Ascomatal opening a pore, lined with periphyses. Asci narrowly clavate, 60–75 × 12.5–14 μm, bitunicate, 8-spored; ascospores completely filling each ascus. Ascospores ellipsoidal, (17.5) 19–20 (21) × (6.3) 7.0–7.7 (8.4) μm, smooth, colorless, septum median or slightly supramedian. Hamathecium of 3–3.5 μm wide, branching, anastomosing, septate filaments between asci and attached at apex and base.

Habitat: On adaxial and abaxial surface of pinnae of the tree fern *Cyathea caudata* Hook.

Known distribution: Philippine Islands, known only from the type specimen.

This species cannot be accommodated in *Dimeriella* Speg. [Dothideales, Parodiopsidaceae (Arnaud) ex Toro *sensu* Barr 1987; Eriksson & Hawksworth, 1988], as interpreted by Farr (1979), because of the presence of a hamathecium of pseu-

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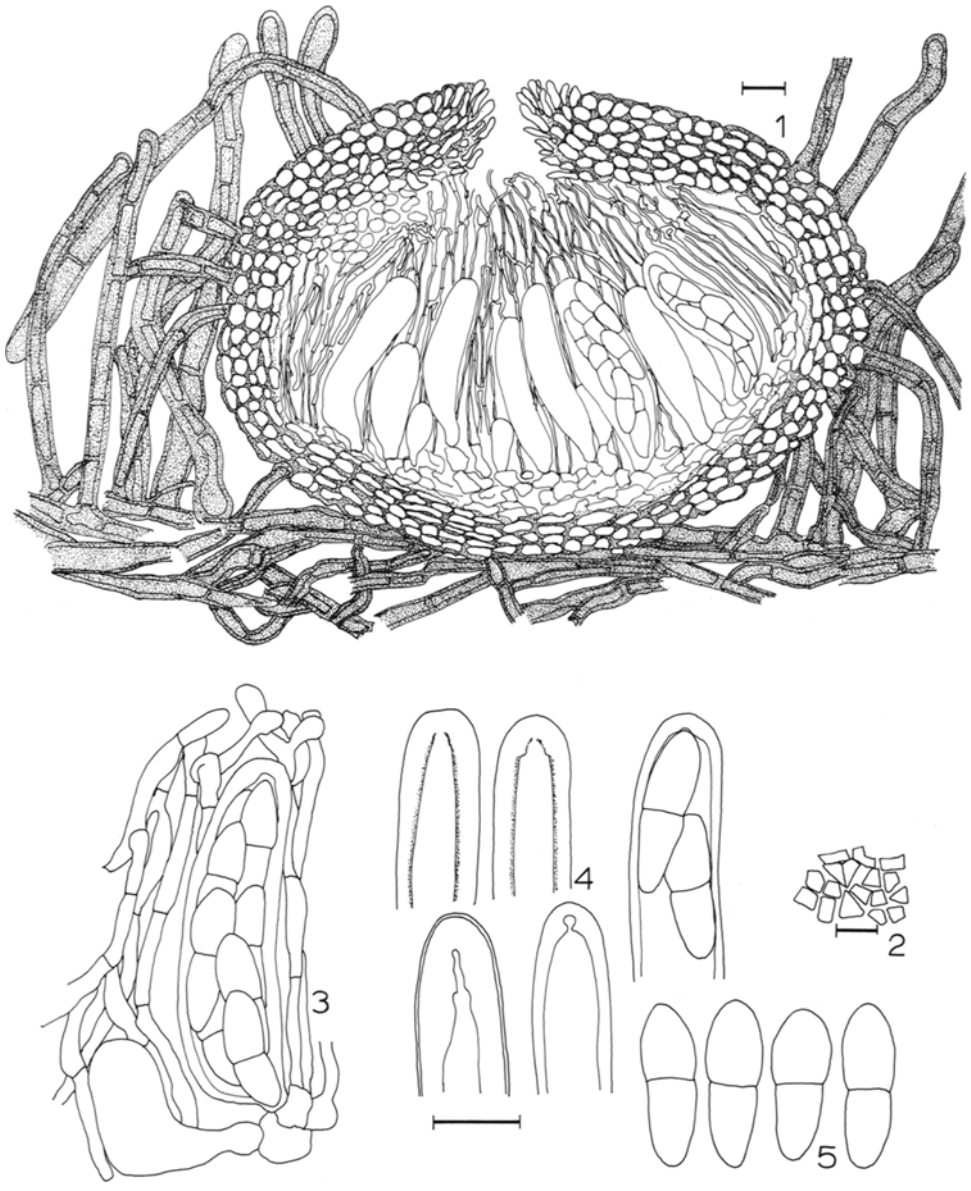
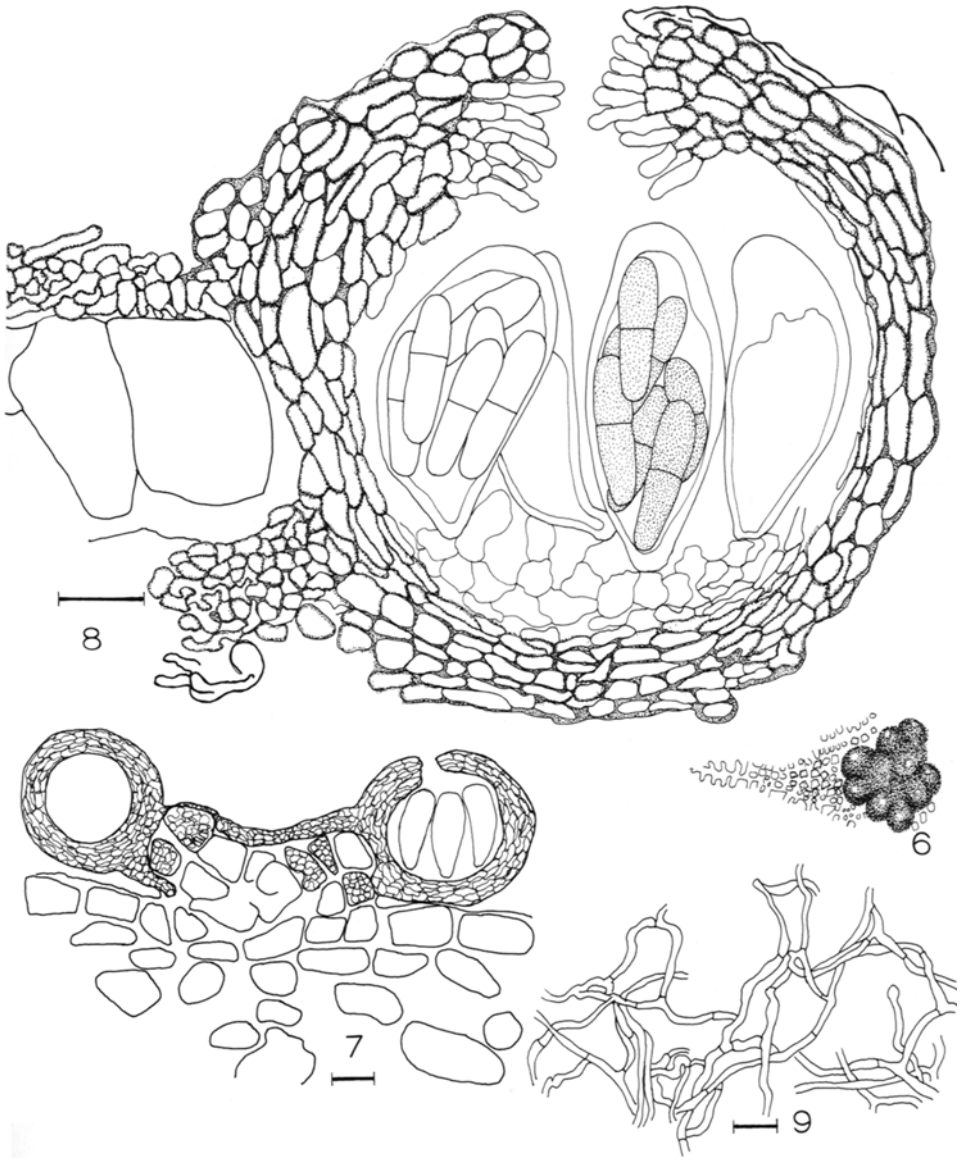


FIGS. 1–5. *Eudimeriolum cyathearum.* 1. Median-longitudinal section of a mature ascoma. 2. Cells at surface of ascomatal wall. 3. Ascus with ascospores and paraphyses. 4. Tips of five asci stained in Congo red, the stippled regions of the endotunica of the two asci at the upper left have stained red with time. 5. Ascospores. (All from the type, NY. Scale bars = 10 μm.)

doparaphyses. Rather it is a member of the Pleosporales, Dimeriaceae Müller & Arx (*sensu* Barr, 1987). According to Farr (1979), followed by Barr (1987), the only distinction between *Lasiostemma* Theissen & H. & P. Sydow and *Eudimeriolum* Speg. is the presence or absence of a distinct subcuticular hyphal layer in the host. We did not observe such a layer in the type collection and accordingly place the species in *Eudimeriolum.*



FIGS. 6–9. *Dimeriella polypodii*. 6. Sketch of a cluster of several ascomata at the base of a scale. 7. Diagrammatic illustration of two ascomata in relation to cells of the scale and of the pinna. 8. Median-longitudinal section of a mature ascoma. 9. Brown hyphae at surface of scale. (Figs. 6–9 from *Mickel 1157*, NY. Scale bars = 10 μm.)

Dimeriella polypodii Samuels & Rogerson, sp. nov. (Figs. 6–13)

Ascomata globosa, 65–90 μm diam, non papillata, nigra; murus perithecialis 8–15 μm latus, e cellulis pseudoparenchymaticis 7 × 2.5 μm constans. Porus ascomaticus periphysatus. Asci clavati, 35–50 × 15–20 μm, bitunicati. Ascosporae naviculatae vel cylindricae, laeves, hyalinae vel brunneae, (12.6) 14.9–20.5 (23.1) × (4.2) 4.7–5.1 (6.3) μm; septum supramediale, cellula superiore quam inferiore breviori ac latiori. Hamathecium nullum. Status anamorphicus ignotus.

Anamorph: None known.

Mycelium restricted to scales on abaxial surfaces of pinnae, hyphae 2–2.5 μm

wide, septate, branched, dark brown and appearing black, growing within cells of scales. Ascomata globose, 65–90 μm diam, nonpapillate, not collapsing when dry, black, not changing color in 3% KOH, forming in groups of 2–6 around the periphery of a superficial, black crust at the base of scales formed of a thin layer of compacted hyphae; aggregate of hyphae and ascomata easily removed intact; cells at surface of ascomatal wall angular, wall <1 μm thick; ascomatal wall 8–15 μm wide, 4 or 5 cells wide, cells angular, ca 7 × 2.5 μm, walls <1 μm thick. Ascomatal opening a pore, lined with periphyses. Asci broadly clavate, 35–50 × 15–20 μm, bitunicate, 8-spored; ascospores completely filling each ascus. Ascospores naviculate to nearly cylindrical, (12.6) 14.9–20.5 (23.1) × (4.2) 4.7–5.1 (6.3) μm, septum supramedian and upper cell somewehat shorter and broader than lower cell, smooth, slowly becoming brown. Hamathecium lacking.

TYPE: MEXICO. OAXACA: Dist. of Ixtlan, along road from Ixtlan toward Tuxtepec, cloud forest on S slope of Cerro Pelon, elev. 8600 ft, on scales of *Polypodium montigenum* (*Mickel 1157*), 7 Aug 1962, *Mickel s.n.* (HOLOTYPE: NY).

PARATYPE: MEXICO. OAXACA: Dist. of Ixtlan, road from Oaxaca to Tuxtepec, km 122, 40 mi beyond Ixtlan, on scales on *Polypodium madrense* (*Hellwig 240*), 26–30 Jun 1967, *R. L. Hellwig s.n.* (NY).

Habitat: On scales on abaxial surface of pinnae of *Polypodium montigenum* Maxon and *P. madrense* J. Sm.

Known distribution: Mexico, known only from the type and paratype collections.

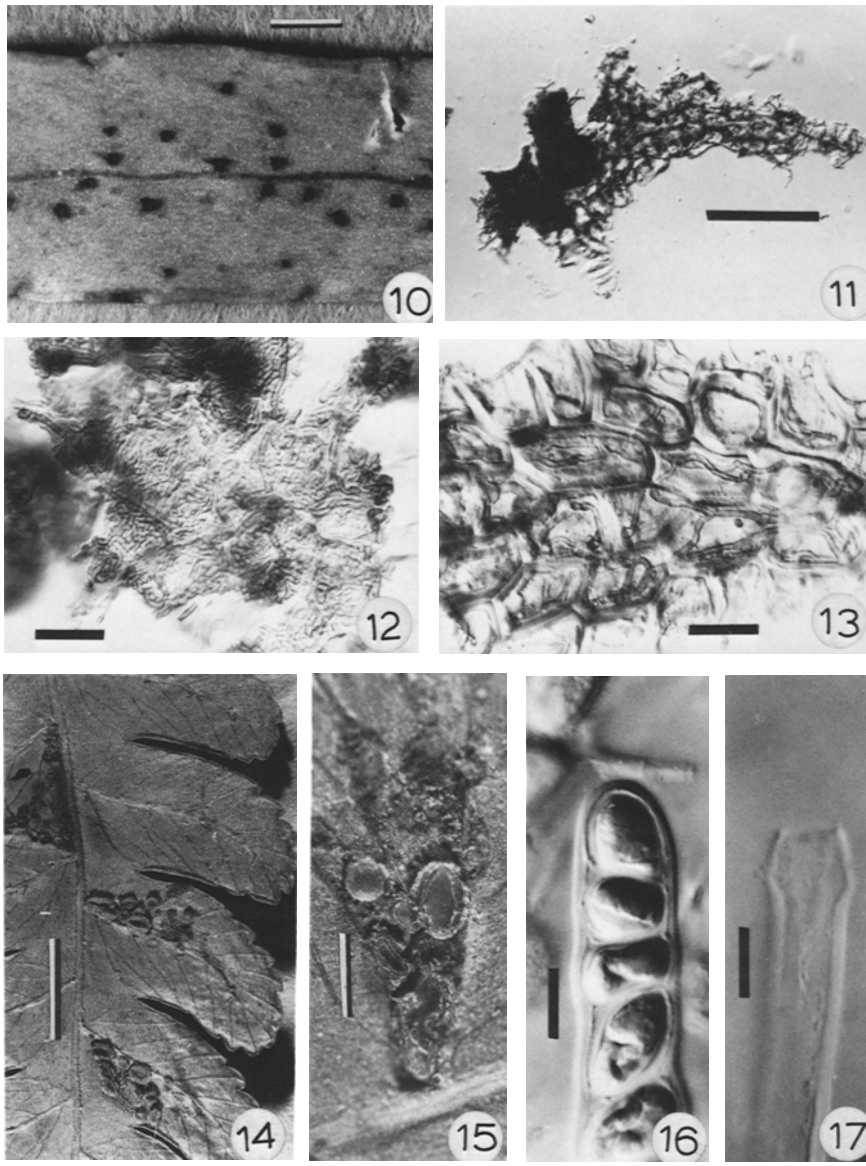
Dimeriella polypodii is assigned to *Dimeriella* Speg. with some doubt. Farr (1979) restricted the genus to the type, *D. hirtula* Speg., a species that has brown, didymosporous ascospores, setose ascomata that lack a hamathecium and that open by lysis of an ostiolar pore, and has partially moniliform hyphae. The ostiolar pore remains aperiphysate. Ascomata of *D. polypodii* lack a hamathecium but are glabrous and open by a schizogenously-formed pore that is lined with periphyses; sterile tissue was not found even among the youngest of asci. Hyphae of *D. polypodii* are cylindrical. We accord brown, didymosporous ascospores and the absence of a hamathecium great significance in placing *D. polypodii,* and know of no genus other than *Dimeriella* that can accommodate these characters. Müller and Arx (1962) and Arx and Müller (1975) synonymized *Dimeriella* under *Wentiomyces* Koorders but the wall of ascomata of the type species of that genus is only a single layer of cells wide, and highly modified hyphal appendages arise from the wall surface. We follow Farr (1979) and Barr (1987) in rejecting the synonymy. *Dimeriella polypodii* is suggestive of the Herpotrichiellaceae Munk (Arx & Müller, 1975; Müller et al., 1987; Barr, 1987) but the asci of this species are not thickened apically and the ascospores and ascomatal wall are too dark, not pallid grayish or olivaceous brown. Barr (1987) included *Dimeriella* in the Capnodiales, Antennulariellaceae Woronichin.

BIOSCYPHA CYATHEAE H. Sydow (Figs. 14–17)

Bioscypha cyatheae H. Sydow, Ann. Mycol. 25: 103. 1927. TYPE. COSTA RICA. Piedades de San Ramon, in fol. *Cyatheae* spec., 7 Feb 1925, *H. Sydow 63* (ISOTYPES: BPI, NY!).

Anamorph: *Chalara* sp.

Apothecia circular to elliptic, 0.5–1 mm long, ca 0.5 mm wide, shallowly discoidal, sessile, broadly attached, when dry light to dark brown, waxy, with the flanks appearing spinose from *Chalara* conidiophores; solitary or gregarious, associated with dense *Chalara* conidiophores arising from the host surface. Asci cylindrical, 130–150 × 12–18 μm, lateral wall thick, apex thinner, J−, 8-spored,



FIGS. 10–17. 10–13. *Dimeriella polypodii.* 10. Ascomata on scales. 11. Two crushed ascomata at the base of a scale. 12. Compacted hyphae at ascomatal base. 13. Hyphae growing within cells of scale. (All from *Mickel 1157.*) 14–17. *Bioscypha cyatheae.* 14, 15. Apothecia. 16. Ascal tip in Melzer's reagent. 17. Dehisced ascus in Melzer's reagent. (All from the type, NY. Scale bars: Fig. 10 = 10 mm; Figs. 11, 15 = 1 mm; Figs. 12, 13 = 20 μm; Fig. 14 = 4 mm; Figs. 16, 17 = 10 μm.)

tapering toward base where swollen or pedicellate. Ascospores broadly ellipsoidal to broadly ovoidal, 15.5–17.5 × 9–10.5 μm, widest at distal end, unicellular, slowly becoming light brown and spinulose. Paraphyses exceeding asci by ca 20 μm, branching dichotomously toward the tip, septate; tip clavate to lanceolate, 3.5–5 μm wide, filled with yellow material, bluing in cotton blue, embedded in J− gel. Ectal excipulum well developed, divided into 2, separable parts. Inner

part of densely compacted, straight, smooth, colorless, 3.5–4.5 μm wide, septate, unbranched or infrequently branched hyphae. Outer part of densely compacted, intertwined, smooth, colorless, 3.5–4.5 μm wide, septate, branched hyphae.

Habitat: On abaxial surface in dead tissue of living pinnae of *Cyathea* sp.

Known distribution: Costa Rica, known only from the type collection.

We did not make microtome sections of the type and only known collection of *B. cyatheae.* We have inferred anatomical details from microtome sections of the following species, *B. pteridicola,* but Sydow (1927) provided a detailed description of apothecia of the type collection. The two species apparently differ only in the size of their ascospores, and in host preference.

Bioscypha H. Sydow is a poorly known genus of two species, *B. cyatheae* and *B. pteridicola,* both of which occur on pinnae of ferns in the American tropics. Carpenter (1981) discussed the genus and its relationship to *Crocicreas* Fr. and *Bisporella* Sacc. *Chalara* conidiophores also arise from apothecia of species of the closely related genus *Crocicreas* (Carpenter, 1981).

The *Chalara* found associated with *B. cyatheae* is undoubtedly the anamorph of this discomycete because the condiophores arise directly from hyphae of the outer excipulum, and because apothecia of the second species, *B. pteridicola,* are associated with a similar *Chalara.* Conidiophores are 50 to 55 μm long and brown; conidia are minute, rectangular, about 3.5 by 1.5 μm, colorless. Conidiophores also form in abundance on the surface of the pinna in crustose areas formed of densely intertwined hyphae. The impression given by mature apothecia is that they develop within and emerge from the crustose tissue, the fragments of that tissue remaining adherent to the apothecium.

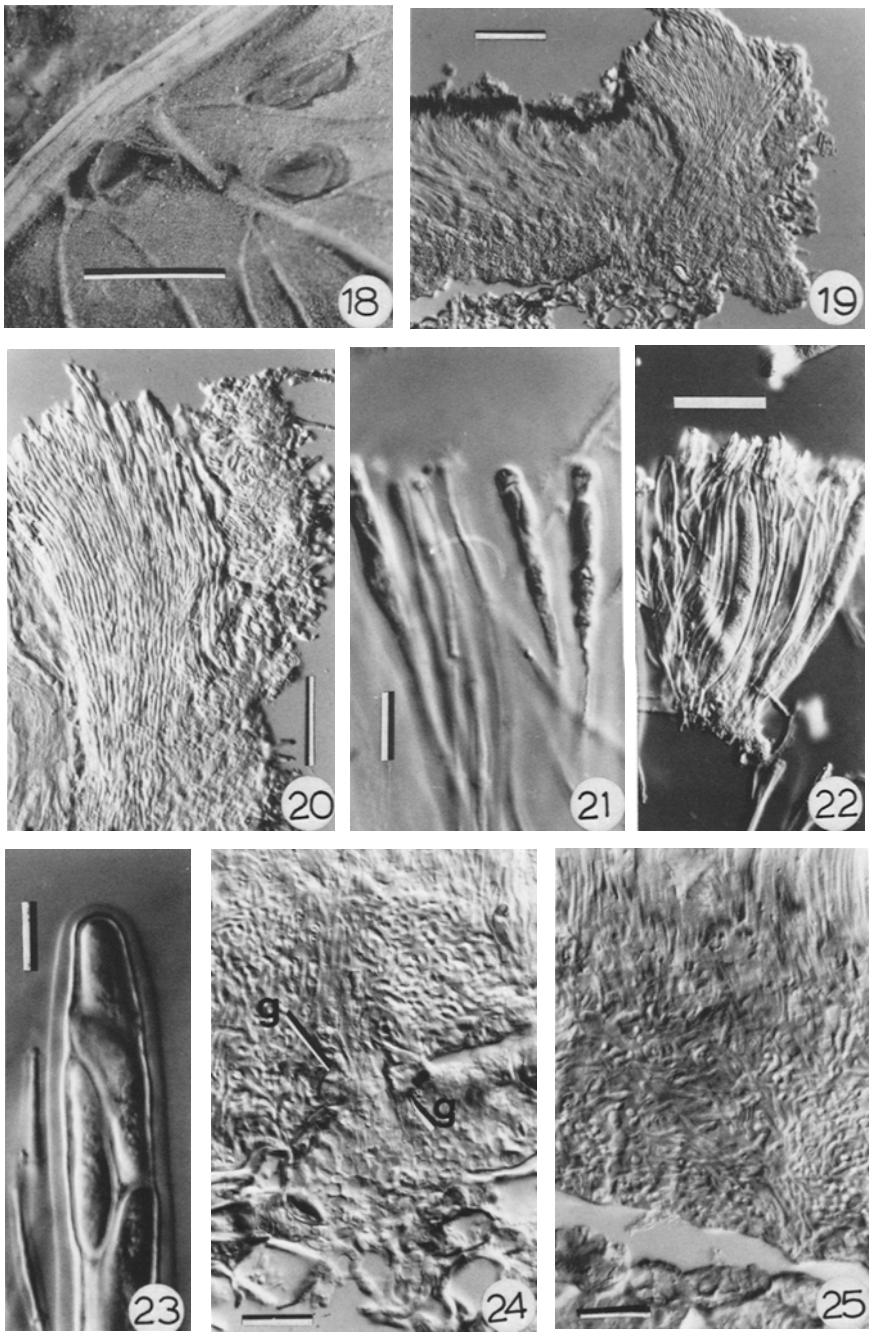
Bioscypha pteridicola Samuels & Rogerson, sp. nov. (Figs. 18–25)

Biosyphae cyatheae H. Sydow similis sed ascosporis cylindricis vel ellipsoideis, 25–30 × 8.8–10.5 μm. Status anamorphicus *Chalara* sp.

Anamorph: *Chalara* sp.

Apothecia circular to elliptic, 1–3 mm long, 0.5–1 mm wide, shallowly discoidal, sessile, broadly attached, when dry light to dark brown, waxy, with the flanks appearing spinose from *Chalara* conidiophores; solitary or gregarious, associated with dense *Chalara* conidiophores arising from the host surface. Asci cylindrical, 150–175 × 15–20 μm, lateral wall thick, apex thinner, J−, 8-spored, tapering toward base and there swollen or pedicellate. Ascospores cylindrical to ellipsoidal, 25–30 × 8.8–10.5 μm, unicellular, slowly becoming light brown and spinulose. Paraphyses exceeding asci by 25–30 μm, branching dichotomously toward the tip, septate; tip clavate to lanceolate, 5–6 μm wide, filled with yellow material, bluing in cotton blue, embedded in J− gel. Subhymenium not well developed, not distinguished from the medullary excipulum. Medullary excipulum ca 40 μm wide, well developed, of densely intertwined, ca 3.5 μm hyphae, extending from flank to flank and broadly attached to the substrate with hyphae growing into stomatal cavities, extending beyond the apothecium as densely interwoven hyphae, continuous with the inner and outer regions of the ectal excipulum. Ectal excipulum well developed, divided into 2, separable parts. Inner part a wedge, ca 150 μm wide at the margin apex, ca 300 μm long, of densely compacted, straight, smooth, colorless, 3.5–5 μm wide, septate, unbranched or infrequently branched hyphae with walls ca 1.5 μm thick, joining with the medullary excipulum below the hymenium. Outer part ca 40 μm wide, of densely compacted, intertwined, smooth, colorless, 3.5–4.5 μm wide, septate, branched hyphae, joining with the medullary excipulum below, with *Chalara* conidiophores arising from the surface.

TYPE: COLOMBIA. INTENDENCIA CAQUETA: ca 57 mi from Florencia on the



FIGS. 18–25. *Bioscypha pteridicola*. 18. Three apothecia. 19. Median longitudinal section of half of an apothecium. 20. Section of the ectal excipulum showing the inner and outer portions. 21. Tips of paraphyses in Melzer's reagent. 22. Asci and paraphyses. 23. Ascal tip with ascospores in Melzer's reagent. 24. Penetration into the fern pinna through a stomatal opening (g = guard cells). 25. Subhymenium of intertwined hyphae. (All from the type, NY. Scale bars: Fig 18 = 5 mm; Fig. 19 = 100 μm; Figs. 20, 22 = 50 μm; Figs. 21, 23 = 10 μm; Figs. 24, 25 = 20 μm.)

Florencia–Altamira Rd, elev. ca 7400 ft, on living leaves of fern, 20 Jan 1976, *K. P. Dumont, P. Buriticá, J. L. Luteyn & L. A. Molina CO 3109* (HOLOTYPE: NY).

Habitat: In dead spots on living pinnae of the fern *Cnemidaria uleana* (Samp.) Tryon var. *abitaguensis* (Domin.) Stolze.

Known distribution: Colombia, known only from the type collection.

Bioscypha pteridicola differs from *B. cyatheae* in having larger ascospores and in the host fern. Asci of both species have a simple apex that is thinner than the lateral ascal wall, dehiscence being effected by bursting of the apex. Hyphae of the fungus grow directly from the medullary excipulum through stomatal openings into the stomatal chamber. Hyphae were seen in epidermal and medullary cells of the host, indicating that the fungus is a parasite. Each apothecium was attached at two or more points.

Chalara conidiophores arise from hyphae of the outer ectal excipulum and are identical to those formed by *B. cyatheae.* The conidia are rectangular, (3.5) 7–8.8 × 1.7–2.5 (3.5) μm.

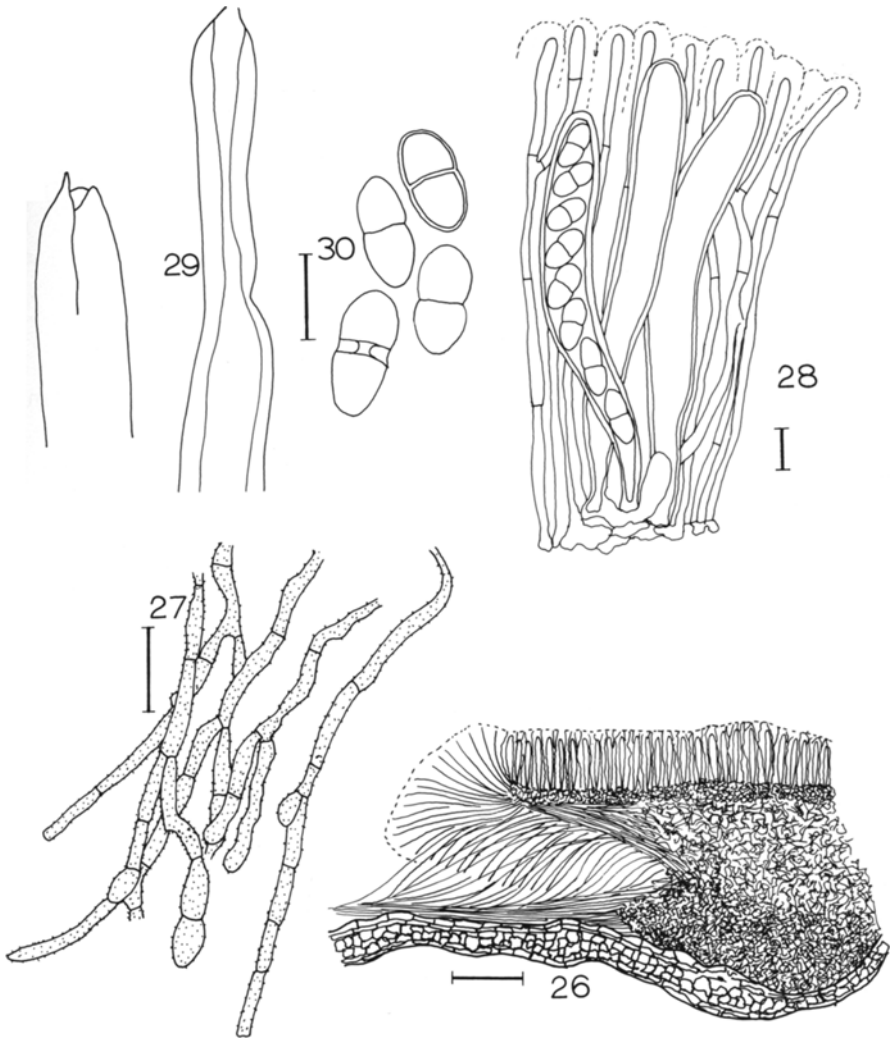
Crocicreas sessilis Samuels & Rogerson, sp. nov. (Figs. 26–38)

Apothecia sessilia, pallide brunnea; textura interior gelatinosa, hyphalis; stipes in folii textura innatus. Asci 95–105 × 12.5–14 μm, apice simplices, iodo non caerulescentes. Ascosporae ellipsoideae vel fusiformes, 12.5–16.7 × 5.2–7 μm, 1-septatae, hyalinae. Status anamorphicus ignotus.

Anamorph: None known.

Apothecia sessile, plane, indefinite in outline, to 2 mm diam, ca 250 μm high, dark brown to near black when dry, surrounded by a gelatinous margin, easily removed from the substrate. Asci cylindrical, 95–105 × 12.5–14 μm, apex simple, J−, 8-spored, tapering to truncate base. Ascospores ellipsoidal to fusiform, 12.5–16.7 × 5.2–7 μm, slowly 1-septate, colorless, smooth, uniseriate in the ascus. Paraphyses infrequently branched, septate, 1.5 μm wide, ends slightly swollen or plane, ca 3.5 μm wide, overreaching asci by ca 35 μm, embedded in gel. Subhymenium well developed and well differentiated from the medullary excipulum, forming a layer ca 175 μm wide at the widest point and diminishing toward the flanks, a compact region of interwoven hyphae with orientation ± perpendicular to the asci, nonpigmented; hyphae growing downward 80–100 μm, widely spaced, embedded in gel, septate, cells variously swollen, pale brown, spinulose; hyphae growing outward to form the ectal excipulum. Medullary excipulum well developed and differentiated from the ectal excipulum, obconical, not extending into the margin, a compact region of interwoven ca 3.5 μm wide nonoriented hyphae with scattered, amorphous, brown intercellular pigment deposits, continuous with the stipe below and with the subhymenium above and ectal excipulum externally. Stipe subepidermal, compressed, of densely interwoven, ca 3.5 μm wide, nonoriented hyphae with abundant, amorphous, brown intercellular pigment deposits. Hyphae arising from stipe and medullary excipulum growing along surface of host beyond margin of apothecium, embedded in gel. Ectal excipulum well developed and well differentiated from the medullary excipulum, ca 175 μm wide at the flanks and below the hymenium and there broadly attached to the surface of the substrate, of smooth, hyaline, ca 2.5 μm wide, septate, much branched, widely spaced hyphae embedded in gel, merging with the paraphyses.

TYPE: MEXICO. OAXACA: Dto. Mixes, N slope of Cerro Zempoalteptel, trail from Totontepec to La Candelaria, elev. 7200 m, on living pinnae of *Cyathea divergens* var. *tuerckheimii* (*Mickel 4740*), 20 Sep 1970, *J. T. Mickel & J. Beitel s.n.* (HOLOTYPE: NY).

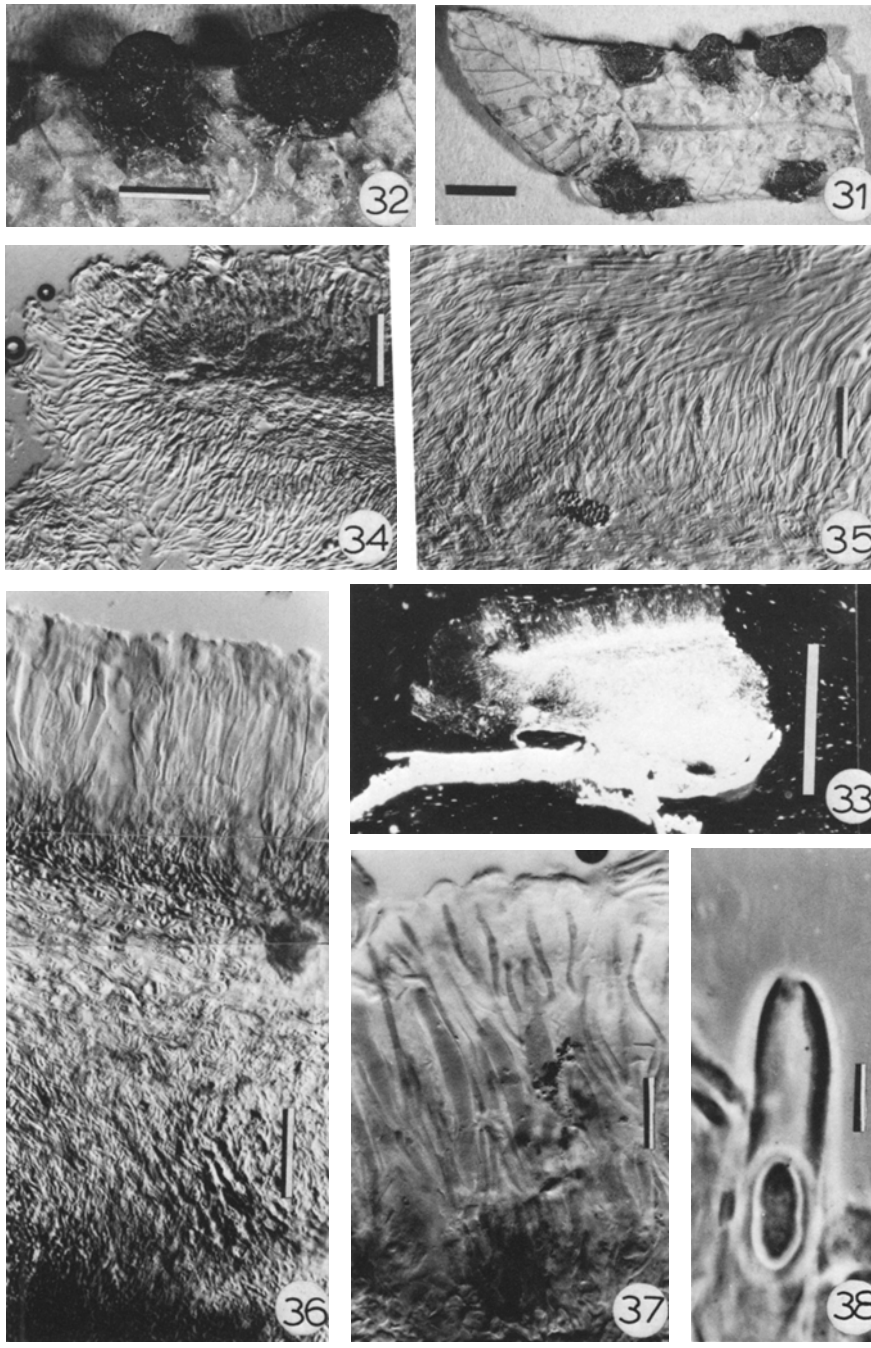


FIGS. 26–30. *Crocicreas sessilis*. 26. Diagram of half of a mature apothecium. 27. Short hyphal elements of the ectal excipulum. 28. Three asci and paraphyses, paraphyses embedded in gel. 29. Two dehisced asci. 30. Ascospores, the ascospore in the lower left developing a septum. (All from the type, NY. Scale bars: Fig. 26 = 50 μm; Figs. 27–30 = 10 μm.)

Habitat: On living pinnae of *Cyathea divergens* Kuntze var. *tuerckheimii* (Maxon) R. Tryon.

Known distribution: Mexico, known only from the type collection.

Crocicreas sessilis was first not taken to be a member of that genus because of its apparently broadly attached, dark apothecia, two-parted ectal excipulum, and asci that lacked any discharge mechanism. Anatomically, however, *C. sessilis* is similar to many of the species illustrated by Carpenter (1981). The densely compacted mass of tissue situated under the middle of the apothecium that is innate within the subcuticular area of the host pinna can be interpreted as the stipe. The excipulum of widely spaced hyphae that are embedded in gel is wholly typical of *Crocicreas*. Asci of most species of *Crocicreas* have a J+ apical discharge mech-



FIGS. 31–38. *Crocicreas sessilis*. 31 and 32. Apothecia. 33. Half of an apothecium, darkfield microscopy. 34. Section of an apothecium showing the hymenium and the hyphal hyphae of the excipulum. 35. Hyphae of the excipulum. 36. Hymenium, subhymenium and medullary excipulum. 37. Asci and paraphyses embedded in gel, in Congo red. 38. A dehisced ascus. (All from the type, NY. Scale bars: Fig. 31 = 2 mm; Fig. 32 = 1 mm; Fig. 33 = 500 μm; Fig. 34 = 100 μm; Figs. 35, 38 = 10 μm; Fig. 36 = 50 μm; Fig. 37 = 20 μm.)

anism but some (e.g., *C. gemmisporum* Carpenter) have undifferentiated ascal apices. The fungus is apparently nonparasitic, entirely superficial except for a slight incursion into the subepidermis, where the fungal tissue is sharply limited to the immediate area of rupture. The whole aggregate, including gelatinous "halo" surrounding the apothecium, is easily removed intact from the substrate.

Acknowledgments

The authors express appreciation to Dr. John L. Mickel for leading us into this work by showing us material of *Dimeriella polypodii* and *Crocicreas sessilis,* and for identifying the fern host of *Bioscypha pteridicola.* Dr. Margaret Barr Bigelow gave us valuable suggestions for our work with *Dimeriella* and *Eudimeriolum.* Dr. Rupert C. Barneby corrected the Latin diagnoses. We were supported in part by National Science Foundation Grant BSR 87-21877.

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BOOK REVIEW

Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. Second Edition. By Jeffrey B. Harborne. Routledge, Chapman & Hall, 29 West 35th St., New York, NY 10001. ISBN 0-412-34330-4. Paper edition 1988. 288 pp. $39.50 (paper).

The second edition of this book has corrected some of the errors in the first edition and contains some new experiments, as well as a whole new section on tannins. While the book may not be quite as modern as the title suggests, it is difficult to imagine a more useful and informative text on plant chemistry than this concise, well-illustrated volume. A course in plant chemistry or biochemical systematics could readily be based on the book. I consult it frequently when I receive enquiries from colleagues, students, and librarians. It is highly recommended to all botanists, especially systematists and ecologists.—P. MICK RICHARDSON, New York Botanical Garden.