HYPOCREACEAE De Not., *in* Sacc., Syll. Fung. 2: 447. 1883

Type: *Hypocrea* Fr.

The *Hypocreaceae* are defined here in a more restricted sense than by Rogerson (1970) who considered the *Hypocreaceae* to be the only family in the *Hypocreales* and thus was equivalent to the order. In this work the *Hypocreaceae* includes 12 genera, with most species placed in the two major genera, *Hypocrea*, having ascospores generally one-septate, non-apiculate, disarticulating, and ascomata generally immersed in a well-developed stroma; and *Hypomyces*, having ascospores generally one-septate, apiculate, not disarticulating, and ascomata immersed in a subiculum. Members of the *Hypocreaceae* generally have discrete or effuse stromata, ranging from less than 1 mm to 5 cm wide or more. The stromata are often light- to bright colored in shades of white, pale yellow, orange or red, rarely black. Stromata of some members appear as disks or clubs up to 6 cm tall, as in *Podostroma*. The genus *Hypocrea* includes about 350 described species. The ascospores are typically hyaline or green, one-septate, and disarticulate at the septum to yield sixteen, non-septate part-ascospores in each ascus instead of the usual eight, one-septate ascospores. The earliest workers considered only gross characteristics of stromal shape and color along with ascospore morphology (Seaver, 1909 a, b; 1910 a, b). Using stromal anatomy and asexual states in his study of species of *Hypocrea* in Japan, Doi (1972) accepted a number of genera segregated from *Hypocrea*, namely *Arachnocrea*, *Podostroma*, and *Protocrea*. He described *Pseudohypocrea* for species that have discrete stromata and fusiform ascospores. One cleistothecial genus, *Aphysiostroma*, is allied with the *Hypocrea* in the *Hypocreaceae* (Rehner & Samuels, 1994; Spatafora & Blackwell, 1993). The other major genus in the *Hypocreaceae* is *Hypomyces*. Species of *Hypomyces* typically have warted, apiculate ascospores and occur on mushrooms (*Agaricales*, *Boletales*), bracket fungi (*Aphyllophorales*), and less frequently on discomycetes (*Helotiales*, *Pezizales*).

Key to the genera of the *Hypocreaceae*

1. Ascospores conspicuously transversely striate, aseptate ..... **Rogersonia**
1. Ascospores smooth, spinulose, longitudinally striate, or ornamented but not transversely striate, one-septate, rarely aseptate or multiseptate 2

2. Ascospores not disarticulating within the ascus 3
2. Ascospores disarticulating while in the ascus 4

3. Ascospores typically fusiform, apiculate, often coarsely warted, less frequently smooth or spinulose; ascomata typically partly or wholly immersed in a densely cottony or highly compacted subiculum; anamorphs *Acremonium*-like (on *Ganodermataceae*), *Cladobotryum* (on *Aphyllophorales*, less frequently on agarics), *Sepedonium* (on boletes), or *Verticillium*-like (on brown-spored agarics); conidia wet or dry ..... **Hypomyces**
3. Ascospores ellipsoid to naviculate, non-apiculate, spinulose; ascomata superficial on a subiculum; anamorphs *Gliocladium*, mononematous, rarely synnematous, conidia wet; fungicolous on *Aphyllophorales* ..... **Sphaerostilbella**

4. Ascomata cleistothecial; stromata less than 1 mm diam, yellow to orange; ascospores one-septate; coprophilous; anamorph *Verticillium*-like ..... **Aphysiostroma**
4. Ascomata perithecial; stromata generally more than 1 mm diam, yellow, orange, brown, or dark olivaceous to nearly black; fungicolous or lignicolous; anamorphs *Acremonium*-, *Gliocladium*-, *Stilbella*-, *Trichoderma*- or *Verticillium*-like 5

5. Stroma a thin, arachnoid to loose, cottony subiculum; white or in shades of yellow; ascospores hyaline; often fungicolous on *Aphyllophorales*, also corticolous or lignicolous, rarely on herbaceous debris; anamorphs, where known, *Acremonium*- or *Verticillium*-like 6
5. Stromata discrete to effused, globose, discoidal to clavate, translucent or yellow to rufous or nearly black; ascospores hyaline or green; usually lignicolous or corticolous, rarely on

persistent *Aphyllophorales* or coprophilous; anamorphs, where known, *Acremonium*-, *Gliocladium*-, *Stilbella*-, *Trichoderma*- or *Verticillium*-like 7

6. Part-ascospores conical or apiculate, septum median, resulting in monomorphic part-ascospores ..... **Arachnocrea**
6. Part-ascospores irregularly globose, septum sub-median, resulting in dimorphic part-ascospores ..... **Protocrea**

7. Stromata prosenchymatous, up to 1.5 mm diam, discrete, pulvinate to discoidal; part-ascospores monomorphic, conical to apiculate, hyaline, smooth; anamorph *Acremonium*-like ..... **Pseudohypocrea**
7. Stromata pseudoparenchymatous, up to several centimeters diam, discrete, pulvinate to discoidal or erect and clavate; part-ascospores generally dimorphic, also monomorphic, globose, subglobose to wedge-shaped, hyaline or green, with broad tubercles or otherwise warted; anamorphs *Acremonium*-, *Gliocladium*-, *Stilbella*-, *Trichoderma*- or *Verticillium*-like 8

8. Stromata small, up to 1 mm diam, each with 3–20 ascomata, yellow-orange; ascospores one-septate, disarticulating, dimorphic, hyaline, spinulose; anamorph unknown ..... **Dialhypocrea**
8. Stromata more than 1 mm diam, pulvinate to discoidal or erect and clavate; ascospores non-septate or one-septate, rarely three-septate, usually disarticulating, monomorphic or dimorphic, hyaline to green, smooth to spinulose or coarsely ornamented; anamorphs present (at least in culture) 9

9. Stroma erect and clavate ..... **Podostroma**
9. Stroma pulvinate to discoidal 10

10. Ascospores one-septate, usually disarticulating, rarely three-septate, and not disarticulating ..... **Hypocrea**
10. Ascospores non-septate ..... **Sarawakus**

THE GENERA OF THE *HYPOCREACEAE*

APHYSIOSTROMA Barrasa, A.T. Martínez & G. Moreno, Canad. J. Bot. 63: 2439. 1985.

Type: *A. stercorarium* Barrasa, A.T. Martínez & G. Moreno.

Ascomata immersed in pulvinate, prosenchymatous stromata, yellow to orange or ochraceous, cleistothecial, subglobose to globose, concolorous with the stroma, KOH–, walls thin, smooth. Asci cylindrical, evanescent, 8-spored, ascospores uniseriate. Ascospores one-septate, separating into monomorphic, globose part-ascospores, coarsely ornamented at maturity. Anamorph *Verticillium*-like. On cow dung.

NOTES.— Barrasa *et al.* (1985) recognized the relationship of the cleistothecial *Aphysiostroma* to species of *Hypocrea* having *Verticillium*-like anamorphs. In their work on the relationships among pyrenomycetous fungi using 18S rDNA sequence data, Spatafora & Blackwell (1993) noted that *Aphysiostroma* grouped with *Hypocrea schweinitzii* in the *Hypocreaceae*.

Aphysiostroma stercorarium Barrasa, A.T. Martínez & G. Moreno, Canad. J. Bot. 63: 2439. 1985.
Anamorph: *Verticillium*-like.

Ascomata immersed in a pulvinate, prosenchymatous stroma, yellow to orange or ochraceous, reminiscent of some *Hypocrea* spp., cleistothecial, subglobose to globose, 140–250 µm diam, bright orange, KOH–; ascomatal wall of thin-walled cells, 9–20 µm diam. Asci cylindrical, 45–55 × 3–4 µm, with obtuse apex, evanescent, 8-spored, ascospores uniseriate. Ascospores equally one-septate, disarticulating into monomorphic, globose part-ascospores, each 3–4 µm diam, hyaline, coarsely ornamented at maturity. Description modified from Barrasa *et al.* (1985).

TYPE.— SPAIN: Puerto de Somosierra, on cow dung, from pure culture JB-GM 3719 = IJFM A-121 (MA–Fungi 8059, holotype). The ex-type culture, ATCC 62321 = CBS 148.85, was used in molecular studies reported by Spatafora & Blackwell (1993).

ARACHNOCREA Z. Moravec, Bull. Trimestriel Soc. Mycol. France 72: 161. 1956.

Type: *A. stipata* (Fuckel) Z. Moravec (≡ *Hypocrea stipata* Fuckel).

Ascomata immersed in a loose subiculum with only papillae visible, individual ascomata remaining discrete within the subiculum, easily separated from it; ascomatal wall of a single, 20–30 µm thick region; papilla of small, rectangular cells that merge with periphyses, cells at the exterior of the papilla circular in outline. Ascomatal surface of *textura epidermoidea*. Asci cylindrical, with more or less thickened apex, sessile or stalked. Ascospores fusiform, equally 1-septate, disarticulating into two conical, monomorphic part-ascospores, hyaline, smooth to slightly spinulose. Anamorph, where known, *Verticillium*-like. On decaying wood, herbaceous substrata or polypores.

Notes.— *Arachnocrea* was established as a segregate of *Hypomyces* and *Hypocrea* for species having fusiform ascospores that disarticulate into part-ascospores at maturity. *Arachnocrea* has characteristics of *Hypomyces*, i.e. ascomata immersed in a subiculum and fusiform ascospores, and *Hypocrea*, i.e. disarticulating ascospores. *Arachnocrea* is distinguished from *Hypomyces* by its disarticulating ascospores. Although ascospores in some species of *Hypomyces* disarticulate at the septum, they do so after being discharged from the asci. Further, ascomata of these species of *Hypomyces* are superficial on a parchment-like subiculum that is easily separated from the host, which is always a basidiomycete and often a member of the *Ganodermataceae*. Although *Arachnocrea* is macroscopically similar to *Protocrea* in having ascomata immersed in a loose subiculum, *Protocrea* has inequally septate ascospores that disarticulate into dimorphic part-ascospores. Two species are included in *Arachnocrea*.

Arachnocrea stipata (Fuckel) Z. Moravec, Bull. Trimestriel Soc. Mycol. France 72: 162. 1956. — Plate 4, e (see page 25); Plate 16, a–c.

≡ *Hypocrea stipata* Fuckel, Jahrb. Nassauischen Vereins Naturk. 25–26: 311. 1871 [as '(Lib.) Fuckel)'].

[≡ *Sphaeria stipata* Lib., Plantae Cryptog. Ardenn. p. 343. 1837, non Schweinitz 1832.]

≡ *Protocrea stipata* (Fuckel) Petch, J. Bot. 75: 219. 1937.

≈ *Hypocrea papyracea* Ellis & Holw., J. Mycol. 2: 66. 1886.

≡ *Hypomyces papyraceus* (Ellis & Holw.) Seaver, Mycologia 2: 80. 1910.

≡ *Arachnocrea papyracea* (Ellis & Holw.) E. Müll., Beitr. Kryptogamenfl. Schweiz, 11(2): 801. 1962.

≈ *Hypomyces arachnoideus* Schroeter, *in* Cohn, Krypt.-Fl. Schlesien 3, Bd. 2: 268. 1908.

Anamorph: *Verticillium*-like.

Ascomata immersed in a loose, cottony subiculum, caespitose, papillae emergent, aggregated ascomata forming in an effused area with sterile white mycelium at the margin; hyphae 5–10 µm wide, constricted at the septa, smooth or warted, branched, anastomosing. Ascomata easily separated from the subiculum, subglobose or globose to pyriform, 190–265 µm high × 145–185 µm diam, white to yellow-orange, KOH–, papillate, with an acute apex about 50 µm high, collapsing vertically. Ascomatal wall 15-20 µm thick, of a single region, cells fusiform to ellipsoid, 15–25 × *ca* 7 µm, thin-walled. Papilla of small, rectangular cells that merge with the periphyses, at the exterior cells circular, 10–15 µm diam, thin-walled. Asci cylindrical, sometimes with a long stalk, 90–110(–125) × 4–6 µm, apex simple, ascospores uniseriate. Ascospores fusiform with acute ends, 1-septate, disarticulating into two conical, monomorphic, distinctly apiculate part-ascospores, (4.5–)5–6(–7) × (1.5–)2–2.5(–3) µm, hyaline, smooth.

Habitat.— On old polypores, also reported on decaying wood with no obvious fruiting bodies.

Distribution.— Europe, reported from Belgium, Czech Republic, Denmark, Estonia (Põldmaa, 1999), France, Germany, Poland, Slovakia, Ukraine, and United Kingdom, and North America.

Type.— GERMANY. Ad *Fagi* folia corticesque putridos, rarissime, in forest below Mappen, Aut., Fuckel, Fungi Rhenani Exs. 2358 (BPI, in bound copy, **lectotype** of *Hypocrea stipata*, designated herein); UNITED STATES. Ohio: A.P. Morgan 920 (NY, holotype of *Hypocrea papyracea*).

Specimens examined.— CANADA. Ontario, Queen's University Biological Station, Lake Opinicon, southwest of Chaffey Locks, on *Fomes* sp., 28 Sep 1958, C.T. Rogerson (NY). FRANCE. vic. Montluçon, Château Begouen, on decorticated, dicotyledonous wood, 12 Oct. 1986, Giles, comm. F. Candossau 4804, det. G.J. Samuels (BPI); GERMANY. Eifel, Gerolstein, on decaying wood, Oct. 1979, J. Daams, det. W. Gams (BPI); UNITED STATES. New York, Tompkins Co., McLean Lloyd Cornell Preserve, on underside of very rotted, decorticated branch, Sep 1995, R.P. Korf & T. Iturriaga (BPI 749248, CUP 63545); Ohio: Warren Co., Fort Ancient State Memorial, on *Phellinus* sp., Oct 1965, W.B. & V.G. Cooke 36373 (NY).

Illustrations.— Ellis & Ellis (1985, Fig. 275); Læssøe (1998); Moravec (1956, Fig. 1, 2); Malençon (1979, Figs. 4A, B, as *A. papyracea*); Seaver (1910a, Pl. 21, Fig. 15, as *Hypomyces papyraceus*).

Notes.— The specimen at BPI issued as Libert, Pl. Crypt. Ardennes, no. 343 (BPI 631843) is not *A. stipata*.

Arachnocrea scabrida Doi, Bull. Natl. Sci. Mus. Tokyo 15: 653. 1972. — Plate 16, d–f.

Anamorph: None known.

Ascomata immersed in white mycelium with the papilla free, individual ascomata not evident, caespitose,

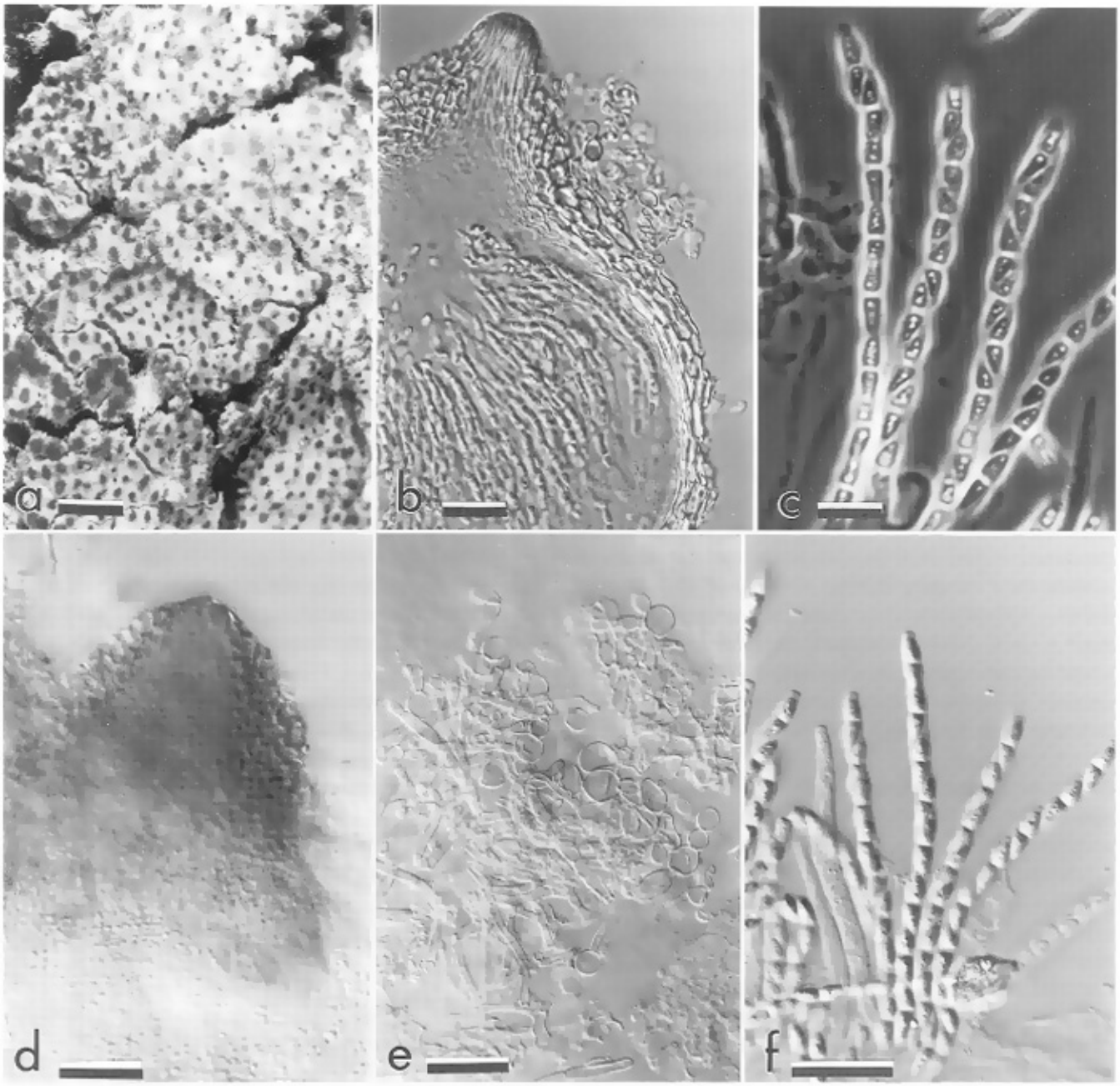


Plate 16. a–c. *Arachnocrea stipata*. a. Surface view of ascomata immersed in stroma. b. Median section of ascoma. c. Asci with disarticulating ascospores in phase contrast. **d–f.** *Arachnocrea scabrida*. d. Ascomatal apex. e. Cells of effused stroma. f. Asci with disarticulating ascospores. a–c. Lectotype Fuckel 2358 – BPI. d–f. Isotype – NY ex TNS–F-223292. Scale bars: a = 500 µm; b, f = 25 µm; c = 10 µm; d, e = 50 µm.

aggregated ascomata forming in an effused area, hyphae uniform in width or somewhat constricted at the septa, smooth-walled. Ascomata easily separated from the subiculum, subglobose to obpyriform, (200–)335–380 µm high × 200–260 µm diam, papillate, white, pale yellow in KOH; papilla of small, rectangular cells that merge with periphyses, cells at the exterior circular, 7–20 µm diam, with 1–2.5 µm thick walls. Ascomatal wall *ca* 20 µm thick, of a single region, cells fusiform to ellipsoid. Asci cylindrical, sessile, (80–)90–105 × (3.5–)5.5–7.2 µm, apex thickened and with a pore, ascospores uniseriate. Ascospores fusiform with ends acute or subacute, one-septate, disarticulating into monomorphic part-ascospores, (5–)5.5–6.5(–7.5) × (2.5–)3–4(–4.5) µm, hyaline, slightly spinulose.

HABITAT.— On wood or herbaceous debris.
DISTRIBUTION.— Japan, New Zealand.

TYPE.— JAPAN. Chiba Pref., Kiyosumi Forestry Experimental Station of Tokyo University, [on bark of *Abies* sp.], 25 Jun. 1966, Y. Doi (TNS–D-106, holotype; NY ex TNS–F-223292, isotype).
ADDITIONAL SPECIMEN EXAMINED.— NEW ZEALAND: Auck-

Key to the species of *Arachnocrea*

1. Part-ascospores mostly 3–4 μm wide, ends acute or subacute, slightly spinulose ..... *A. scabrida*
2. Part-ascospores mostly 2–2.5 μm wide, ends acute, smooth-walled ..... *A. stipata*

land, Waitemata City, Waitakere Ranges, Marguerite Track, on *Rhopalostylis sapida*, 21 Mar. 1977, G. J. Samuels *77-25* (NY ex PDD 35883).

Illustrations.— Doi (1972, Fig. 3).

DIALHYPOCREA Speg., Bol. Acad. Nac. Ci. 23: 475. 1919.

Type: *D. puiggariana* Speg.

Stromata discrete, tuberculate with protruding perithecial apices, pseudoparenchymatous, yellow-orange, KOH–. Ascomata immersed below a narrow layer of pseudoparenchymatous stromal tissue, few to several produced within each stroma, individual ascomata retaining their integrity at least over the upper half; wall KOH–. Apical paraphyses persisting among the nearly mature asci. Asci cylindrical, apex with a ring. Ascospores one-septate, disarticulating early in the development at the septum, hyaline, spinulose. Anamorph unknown. On decaying branches.

Notes.— This unispecific genus was established for a species having *Nectria*-like ascomata and one-septate ascospores that separate into part-ascospores as in *Hypocrea*. Weese (1927) placed *Dialonectria puiggariana* in *Neoskofitzia* Schulzer, a genus for which no type specimen exists. *Dialhypocrea* was considered a synonym of *Hypocrea* by Clements & Shear (1931) and Müller & von Arx (1962). Based on an examination of the type specimen, *Dialhypocrea* is accepted in the *Hypocreaceae*, distinguished from *Hypocrea* on the basis of stromal anatomy and perithecia that are nearly free from each other over a large part of their length. Just as Müller and von Arx (1962) were dubious about placing the species in *Hypocrea*, we are doubtful in retaining *Dialhypocrea*. At the very least, the species would be unusual in *Hypocrea* and there is no doubt about the close affinity of *D. puiggariana* with *Hypocrea*. Characters of asci and ascospores of *D. puiggariana* are typical of *Hypocrea*, and the substratum, i.e. rotten, decorticated wood, is also a feature that sets *Hypocrea* apart in the *Hypocreaceae*. If the anamorph of *D. puiggariana* were a *Trichoderma*, then this species should be placed in *Hypocrea*. However, until the anamorph is discovered or DNA sequences of *D. puiggariana* are analyzed, *Dialhypocrea* is retained as a genus distinct from *Hypocrea*.

Dialhypocrea puiggariana Speg., Bol. Acad. Nac. Ci. 23: 475. 1919. — Plate 17, a–d.

≡ *Neoskofitzia puiggariana* (Speg.) Weese, Mitt. Bot. Lab. TH Wien 4: 86. 1927.

≡ *Hypocrea puiggariana* (Speg.) E. Müll., *in* Müller & von Arx, Beitr. Kryptogamenfl. Schweiz 11(2): 645. 1962.

Anamorph: None known.

Stromata densely gregarious, tuberculate, 1 mm diam × 0.5 mm high, each with 3–20 ascomata. Stromal surface layer *ca* 30 μm thick, of angular cells 5–15 μm diam with walls to 4 μm thick; cells of the stroma below the ascomata pseudoparenchymatous, tending to *textura epidermoidea* with *ca* 4 μm thick walls, not sharply distinguished from the surface region; surface region separated from the ascomata by a narrow layer of small, non-pigmented cells. Ascomata globose to subglobose, 260–310 μm high × 170–200 μm diam, non-papillate, smooth, easily separating from the surrounding stromal tissue at the apex. Asci narrowly cylindrical, 55–87 × 3.5–6.5 μm, 8-spored, apex with a ring; ascospores uniseriate. Part-ascospores dimorphic: distal part conical to subglobose, (3–)3.5–4.5(–5.5) × 2.5–3 μm; proximal part wedge-shaped to oblong, (3.5–)4–5(–6) × 2–2.5(–3) μm, hyaline, spinulose.

Holotype.— BRAZIL. São Paulo, in the forest near Apiahy, on fragments of decaying branches, April, 1890, J. Puiggari 186 (LPS).

HYPOCREA Fr., Syst. Orb. Veg. 1: 104. 1825.

Type: *H. rufa* (Pers. : Fr.) Fr. (≡ *Sphaeria rufa* Pers. : Fr.).

= *Creopus* Link, Handbuch Erk. Gewächse 3: 349. 1833. — Type: *C. gelatinosus* (Tode : Fr.) Link (≡ *Sphaeria gelatinosa* Tode : Fr.), recognized as *Hypocrea gelatinosa* (Tode : Fr.) Fr.

≡ *Chromocrea* Seaver, Mycologia 2: 63. 1910. — Type: *C. gelatinosa* (Tode : Fr.) Seaver (≡ *Sphaeria gelatinosa* Tode : Fr.), recognized as *Hypocrea gelatinosa* (Tode : Fr.) Fr.

Stromata discrete to effused, pseudoparenchyma or highly compacted hyphae, with ascomatal elevations evident or not, stromatal surface variously wrinkled, creased or tuberculate, margins of stromata free from or adherent to the substratum, nearly hyaline, white, yellow, rufous, dark brown to nearly black; ascomata immersed in the stroma, ascomatal wall and stromal tissues KOH+ or KOH–. Asci cylindrical. Ascospores

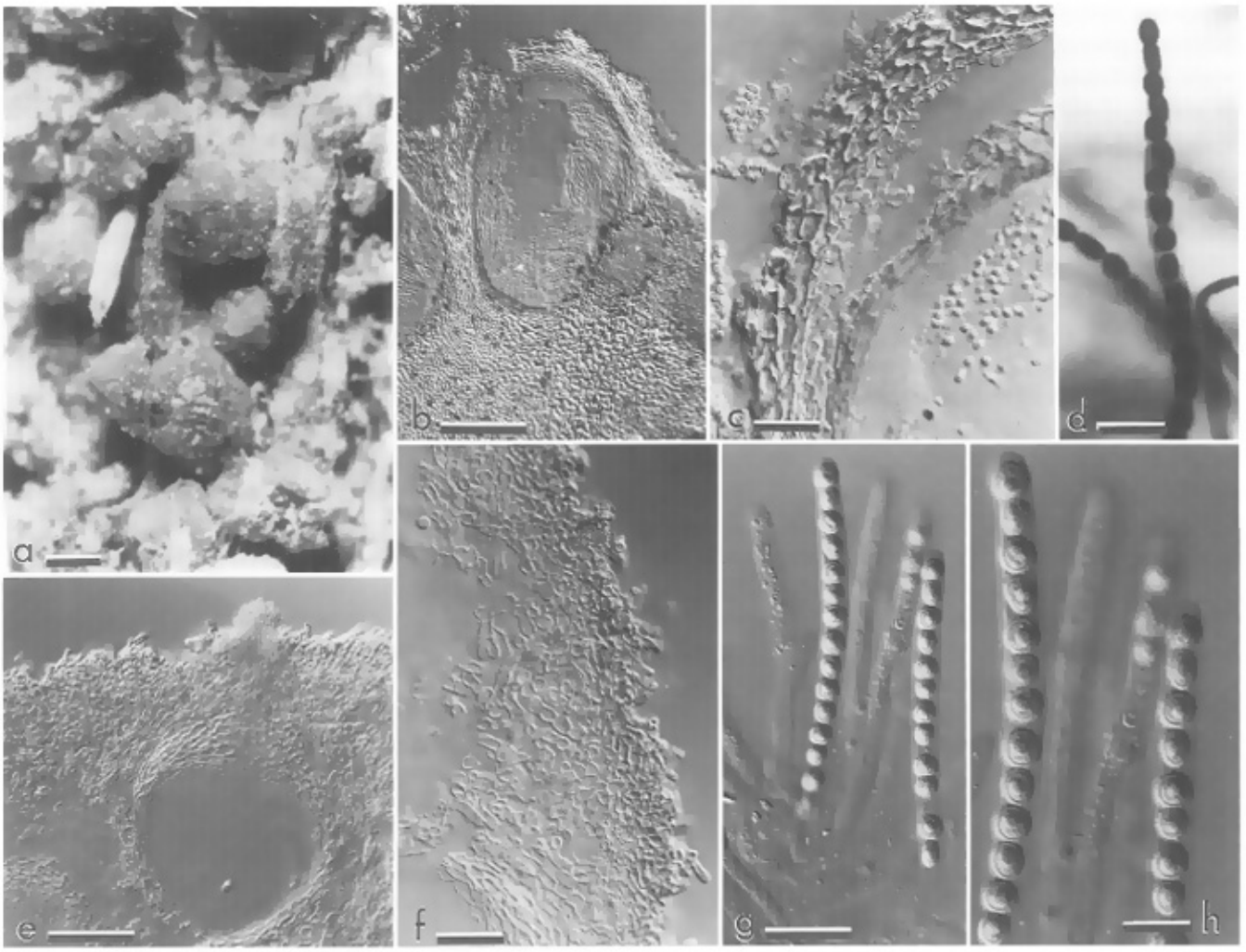


Plate 17. a–d. *Dialhypocrea puiggariana*. a. Stromata with immersed ascomata. b. Median section of ascoma. c. Ascomatal wall. d. Ascus with disarticulating ascospores. **e–h.** *Hypocrea rufa*. e. Median section of stroma with immersed ascoma. f. Close-up of section of stromal surface. g, h. Immature and mature asci with disarticulating ascospores. a–d. Holotype – LPS. e–h. BPI 744478. Scale bars: a = 250 µm; b = 100 µm; c, f = 25 µm; d, h = 10 µm; e = 50 µm; g = 20 µm.

1-septate, disarticulating early in the development into two equal or unequal, globose, subglobose, ovoidal, oblong or wedge-shaped part-ascospores, hyaline or green, typically spinulose or warted, rarely smooth. Anamorphs: *Acremonium*-like, *Gliocladium*-like, *Trichoderma, Stilbella,* and *Verticillium*-like. On decaying woody substrata, also other fungi.

NOTES.— The genus *Hypocrea* is characterized by ascomata that are completely immersed in a stroma and ascospores that are one-septate and disarticulate at the septum so that the ascus appears to contain sixteen ascospores rather than eight. There is considerable variation in color and form of the stroma in *Hypocrea.* The stroma is typically discrete, as in *H. rufa*, but it may be pulvinate with the margins attached to the substratum, or it may be constricted at the base and even appear to be stalked, as in *H. poronioidea* (Samuels & Lodge, 1996a). In some species the stroma is effused over the substratum to a greater or lesser extent. Colors of stromata in *Hypocrea* are typically in shades of rufous to brown or black, also commonly yellow. Ascospores in *Hypocrea* are usually hyaline, but also green. Rifai (1969b) and Samuels & Rossman (1992) segregated species of *Hypocrea* with non-septate ascospores into *Sarawakus* Boedijn.

The genera *Chromocrea* and *Creopus* were segregated from *Hypocrea* on the basis of their green ascospores, but are not recognized here. Three species were included in *Chromocrea*, with *C. gelatinosa* designated as type. This species, currently accepted in the genus *Hypocrea* as *H. gelatinosa*, is also the type of the earlier generic name, *Creopus* Link 1833. Thus *Creopus* and the obligate synonym *Chromocrea* are synonyms of *Hypocrea*.

Most species of *Hypocrea* occur on bark, decorticated wood, or *Aphyllophorales*, although there is no appearent host specialization. A few exceptions include

Hypocrea pulvinata Fuckel, commonly found on the polypore genera, *Tyromyces*, *Fomitopsis* and *Piptoporus* (*Coriolaceae*), and *Hypocrea spinulosa* Fuckel on grasses in alpine and boreal regions.

To characterize species in *Hypocrea*, it is essential to know the anamorph. Apart from the work of a few authors (Doi, 1969, 1972, 1975 a, b; Rifai & Webster, 1966 a, b; Samuels & Lodge, 1996a; Samuels *et al.*, 1998b), anamorphs have not been documented for most of the approximately two-hundred described species of *Hypocrea*. Most proven anamorphs of *Hypocrea* are species of *Trichoderma* and have either green or, less commonly, white (hyaline) conidia. Other anamorphs are *Acremonium*-like, *Gliocladium*-like, *Verticillium*-like or transitional between these genera and *Trichoderma*. Species that have effused stromata, e.g. *H. citrina*, tend to have *Acremonium*-like anamorphs, which were also classified as *Trichoderma* sect. *Hypocreanum* (Bissett, 1991a). Seifert & Samuels (1997) reported a synnematous (*Stilbella*) anamorph for *H. cinereoflava* Samuels & Seifert.

No comprehensive monograph of *Hypocrea* in the modern sense exists for any geographical area. The most complete treatment of the genus is Doi (1972) for Japan. Several common European species have been well illustrated in Breitenbach & Kränzlin (1981) and Schmid & Schmid (1991). Seaver (1910a) included 23 species of *Hypocrea* and related genera in his account of the *Hypocreales* of North America. In defining species, Seaver and other early workers considered only gross characters of stromal shape and color along with ascospore characteristics. In his study of species of *Hypocrea* in Japan, Doi (1972) used stromal anatomy as well as anamorphs to divide *Hypocrea* into the two subgenera *Heterocrea* and *Hypocrea*, and further subdivided subgenus *Hypocrea* into two sections, each with subsections, series, and groups. Doi (1972, 1975b) documented the anamorphs for a number of Japanese and extralimital species of *Hypocrea*. These treatments represent a baseline for monographic accounts of *Hypocrea* but are limited in their regional focus and do not provide keys to either *Hypocrea* or their *Trichoderma* anamorphs. Whether the subdivisions of *Hypocrea* proposed by Doi are applicable to a larger, more diverse group of species has yet to be tested.

The *H. schweinitzii* complex and its anamorphs are the subject of a monographic treatment by Samuels *et al.* (1998b). See Plate 4, g.

Hypocrea rufa (Pers. : Fr.) Fr., Summa Veg. p. 383. 1849. — Plate 17, e–h.

≡ *Sphaeria rufa* Pers. : Fr., Persoon, Observ. Mycol. 1: 20. 1796 : Fries, Syst. Mycol. 3: 335. 1822.

Anamorph: *Trichoderma viride* Pers. : Fr.

Stromata discrete, pulvinate, at most slightly constricted at the base, 1–4 × 1–1.5 mm, sides of stroma nearly perpendicular to the substratum, surface plane, sometimes appearing velvety when young, ostiolar openings not evident or, when moist, appearing as numerous, small viscid dots covering the stromal surface, at first, pale tan with white margin, becoming dark brown or reddish brown. Stromatal surface of several layers of darkly pigmented cells, 4–6 µm wide, some of which extend as cylindrical, septate hairs up to 30 µm long × 3–5 µm wide. Tissue below the stroma surface of loosely packed, *ca* 6 µm wide hyphae. Ascomata *ca* 200 µm high × 140–160 µm diam. Asci cylindrical, 100–124 × 6–7 µm, apex thickened, with a pore, ascospores uniseriate. Ascospores one-septate, disarticulating into two part-ascospores in the asci; part-ascospores dimorphic, with distal part (to the ascal base) subglobose to conical, proximal part oblong to wedge-shaped, hyaline, spinulose. Description modified from Webster (1964).

Habitat.— On rotting wood.
Distribution.— Cosmopolitan, especially in temperate regions.

Type.— No specimen of *Hypocrea rufa* examined by Persoon exists and a neotype has never been designated for this taxon. Thus, the specimen at UPS of Fries: Scleromyceti Sueciae 303 issued as *Sphaeria rufa* is herein designated the **neotype**.
Additional specimen examined.— UNITED STATES. North Carolina: Wayah Bald, on decorticated log, G. J. Samuels 89-142 (BPI 744478).

Illustrations.— Breitenbach & Kränzlin (1981, Fig. 319); Dennis (1978, Pl. 30N); Doi (1975a, Fig. 19); Ellis & Ellis (1985, Fig. 110); Tulasne & Tulasne (1865, Tab. III, Figs. 1–10).

Notes.— The connection between *Hypocrea rufa* and *Trichoderma viride*, type of *Trichoderma*, has been known since the outstanding description of Tulasne & Tulasne (1865). Meyer & Plaskowitz (1989) recognized two entities within the *T. viride*-complex that can be separated based on conidial morphology. Using morphological and molecular techniques, Samuels *et al.* (1999) examined single part-ascospore isolates of *H. rufa* and determined that the segregate of *T. viride* having coarsely warted conidia conformed to the anamorph of *H. rufa* as described by Webster (1964) and agreed with the type specimen of *T. viride*.

Hypocrea spinulosa Fuckel, is related to *H. gelatinosa* (Tode : Fr.) Fr. Mathieson (1952) published an account of the genetics of *H. spinulosa* as *Creopus spinulosus*.

Specimen examined.— FINLAND. Mustiala, Tammela, Tavastia australis, 6 Oct 1867, leg. & det. P.A. Karsten (H 4474, holotype of *H. spinulosa*).

Specimens illustrated:
Hypocrea aureoviridis f. *macrospora* Y. Doi: UNITED STATES. Indiana: Porter Co., Indiana Dunes National Lake shore, in hardwood area, on *Phellinus ferruginosus*, 19 Aug 1996, Jack Murphy 2201, comm. S. Huhndorf, det. G.J. Samuels G.J.S. 96-189 ≡ CBS 101603 (BPI 744524). Plate 4, f (page 25).
Hypocrea pseudokoningii Samuels & O. Petrini: NEW ZEALAND. Westland, Harihari, Lower Pueora Valley, on *Dacrydium cupressinum*, 5 Apr 1963, J. Dingley, det. G. Samuels (PDD 23871). Plate 4, g (page 25).

HYPOCREOPSIS P. Karst., Symb. Mycol. Fenn. 2: 251. 1873.

Type: *H. riccioidea* (Bolton) P. Karst. (≡ *Sphaeria riccioidea* Bolton), a synonym of *Hypocreopsis lichenoides* (Tode) Seaver.
[≡ *Dozya* P. Karst. 1873, non *Dozya* Lacoste 1866].

Ascomata immersed in a well-developed, radiately spreading, indefinite, often lobate, pseudoparenchymatous stroma; stromal surface reddish brown to grey, generally smooth in young lobes, becoming rugose, with minute, black ostioles of perithecia evident, occasionally covered with conidiophores of the anamorph; stromal context soft, light-colored. Ascomata globose, white to pale yellow, KOH–, thin-walled. Asci cylindrical, 8-spored. Ascospores ellipsoid to fusiform, 1-septate, rarely 3-septate, hyaline, minutely to coarsely warted. Anamorph, where known, *Stromatocrea*. On decaying woody substrata, often on *Hymenochaete* spp. and other resupinate basidiomycetes.

Notes.— The original citation of *Hypocreopsis* is in a list of corrections to Karsten's 1873 publication, in which the name *Dozya* P. Karst. is replaced by *Hypocreopsis*, because *Dozya* P. Karst. 1873 was a later homonym of *Dozya* Lacoste 1866; Karsten apparently realized this before the book was published. *Hypocreopsis* is typified by *H. riccioidea*, a species previously placed in *Hypocrea*. With changes in the International Code of Botanical Nomenclature that since 1981 allow priority for pre-Friesian names, the oldest epithet for this species is *H. lichenoides*, neither of the competing names being sanctioned by Fries. Niemelä & Nordin (1985) present a review of the entire genus.

Hypocreopsis lichenoides (Tode) Seaver, Mycologia 2: 82. 1910. — Plate 4, h-i (see page 25).

≡ *Acrospermum lichenoides* Tode, Fungi Mecklenb. sel. 1: 9. 1790.
= *Sphaeria riccioidea* Bolton, Fungi Halifax 4: 182. 1791.
≡ *Hypocrea riccioidea* (Bolton) Berk., Outl. Brit. Fungol. p. 383. 1860.
[≡ *Dozya riccioidea* (Bolton) P. Karst., Symb. Mycol. Fenn. 2: 221. 1873, gen. illeg., Art. 53.]
≡ *Hypocreopsis riccioidea* (Bolton) P. Karst., Symb. Mycol. Fenn. 2: 251. 1873.
= *Sphaeria parmelioides* Mont., Ann. Sci. Nat. Bot., Sér. 2, 6: 333. 1836.
≡ *Hypocrea parmelioides* (Mont.) Mont., Syll. Gen. Sp. Crypt. 210. 1856.
= *Hypocrea digitata* Ellis & Everh., J. Mycol. 1: 42. 1885.
Anamorph: *Stromatocrea cerebriformis* W.B. Cooke, Mycologia 44: 249. 1952.

Stromata developing as radiating ridges, up to 10 cm diam, 1–5 mm thick, divided in marginal areas into separate lobes, forming 2–4 mm wide finger-like projections; on small twigs, minute stromata of only a few separate lobes encircling the wood. Stromata brown, center greyish, margins paler, context pale tan, soft to corky. Surface smooth on young lobes, becoming rugose in central areas, covered by a palisade of fusiform conidiophores budding conidia from their apices, ascomatal ostioles visible as minute black dots. Stroma a uniform reticulum of intermixed hyphae forming a *textura intricata*, hyphae thin-walled, branched, 3–5 µm wide, near the surface with vesicular, intercalary, swollen cells, 10–15 µm diam. Ascomata globose, 180–250 µm diam. Ascomatal wall pseudoparenchymatous. Asci cylindrical, 80–110 × 7–11 µm, 8-spored. Ascospores ellipsoid to short-fusiform, (16–)22–30 × (5–)6–9.5 µm, 1-septate, hyaline, minutely warted.
Anamorph: Conidiophores developing on the surface of the stroma or associated directly with *Hymenochaete tabacina*. Conidia globose, (8–)9–11.5 µm diam, with warted, yellowish, 0.5 µm thick walls. Description modified from Niemelä & Nordin (1985).

Habitat.— On dead wood of dicotyledonous trees and vines and herbaceous stems, often on *Hymenochaete* spp., usually above ground level.
Distribution.— Canada (Labrador, Ontario, Quebec) (Cauchon & Ouellette, 1964; Niemelä & Nordin, 1985), Denmark (Strid, 1967), England, Finland (Niemelä & Nordin, 1985), France (Strid, 1967), Germany, Greenland (Læssøe, 1989), Luxembourg (Marson, 1987), Norway (Eckblad & Torkelsen, 1974), Russia (Niemelä & Nordin, 1985), Spain (Candoussau, 1990), Sweden (Niemelä & Nordin, 1985; Strid, 1967), United States (Idaho – anamorph only, New Hampshire) (Cauchon & Ouellette, 1964).

Type.— The Tode specimen of *A. lichenoides* was destroyed; however, the illustration in Tode (1790) is an inequivocal iconotype. According to Dennis (1975), a portion of the type

Key to the species of *Hypocreopsis*

1. Ascospores 22–30 × 7–9.5 µm, ellipsoid to short-fusiform, 1-septate, minutely warted; primarily from northern Europe including England, northern United States, and Canada ..... *H. lichenoides*
1. Ascospores 12–17 × 12–13.5 µm, globose with one to several spores cemented together, 1–3-septate, thick-walled, irregularly coarsely warted; southern Europe, but also England and southern United States ..... *H. rhododendri*

specimen of *S. riccioidea* at K is in poor condition and was not examined for this study.
Specimen illustrated.— FRANCE. Barèges (65), on *Betula*, 28 Aug 1989, J.-F. Magni A8907.

Illustrations.— Brandt (1992, Fig. 2); Candoussau (1990 Fig. 1D, 2A-B); Dennis (1975, Fig. 8B; 1978, Pl. 31A); Ellis & Ellis (1985, Fig. 1132); Ellis & Everhart (1892, Pl. 11, Figs. 1–3); Laessøe (1989); Marson (1987, Fig. 14-22); Müller & von Arx (1962, Fig. 255, as *H. riccioidea*); Niemelä & Nordin (1985, Figs. 1-3); Nordin (1969, Figs. 1–2); Strid (1967, Figs. 1–5).

Notes.— Cauchon & Ouellette (1964) demonstrated that *Hypocreopsis lichenoides* is fungicolous on *Hymenochaete* spp. Cooke (1952) described a fungus that appears macroscopically identical to *H. lichenoides* as *Stromatocrea cerebriformis* W.B. Cooke, the presumed anamorph of *H. lichenoides*. Cooke's specimen of *S. cerebriformis* from the United States (Idaho) does not contain the teleomorph. Repeated attempts to germinate ascospores or conidia have failed (Candoussau, 1990; W. Gams, pers. comm.), although Candy & Webster (1988) were successful in obtaining cultures from stromatal explants. These cultures produced pigments similar to those of the stroma but failed to sporulate. Niemelä & Nordin (1985) presented a description and illustrations of *H. lichenoides*, and Brandt (1992) discussed the ecology of this species.

A second species of *Hypocreopsis*, *H. rhododendri* Thaxter, is macroscopically similar to *H. lichenoides* and also occurs on *Hymenochaete* spp. but can be differentiated by smaller, globose, warted ascospores (12–17 × 12–13.5 µm) as illustrated by Candoussau (1990) and Marson (1987). *Hypocreopsis rhododendri* was originally described from Tennessee and is reported from England (Dennis, 1975; Henderson & Watling, 1978), southern France (Candoussau, 1990), and the United States (Maryland *fide* Cauchon & Ouellette, 1964; North Carolina, Tennessee and West Virginia, Fayette Co., on *Kalmia latifolia*, alt. 670 m, 24 Aug 1893, L. W. Nuttall 567, BPI 631883). Candy & Webster (1988) and Candoussau (1990) provided good descriptions and illustrations of both *H. lichenoides* and *H. rhododendri*. An unidentified species of *Hypocreopsis* was reported from Australia (May & Eichler, 1993).

HYPOMYCES (Fr.) Tul., Ann. Sci. Nat. Bot., Sér. 4, 13: 11. 1860

(≡ *Hypocrea* subgenus *Hypomyces* Fr., Syst. Orb. Veg. p. 105. 1825).
Lectotype, designated by Seaver (1910a): *H. lactifluorum* (Schwein. : Fr.) Tul. (≡ *Sphaeria lactifluorum* Schwein. : Fr.). — Plate 4, j (page 25); Plate 18, a–d.

= *Bonordenia* Schulzer, Verh. K. Zool. Bot. Ges. Wien 16: 58. 1866. — Type: *B. aurantia* (Pers. : Fr.) Schulzer, recognized as *Hypomyces aurantius* (Pers. : Fr.) Tul. & C. Tul.
= *Peckiella* (Sacc.) Sacc., Syll. Fung. 9: 944. 1891 (≡ *Hypomyces* subgenus *Peckiella* Sacc., Syll. Fung. 2: 472. 1883). — Lectotype, designated by Seaver (1910a): *P. viridis* (Alb. & Schwein. : Fr.) Sacc. (≡ *Sphaeria viridis* Alb. & Schwein. : Fr. ≡ *Hypomyces viridis* (Alb. & Schwein. : Fr.) P. Karst.), a synonym of *Hypomyces luteovirens* (Fr. : Fr.) Tul., as discussed by Rogerson & Samuels (1994).
= *Clintoniella* (Sacc.) Rehm, Hedwigia 39: 223. 1900 ≡ *Hypocrea* subgenus *Clintoniella* Sacc., Syll. Fung. 2: 532. 1883. — Lectotype, designated by Clements & Shear (1931): *C. apiculata* (Cooke & Peck) Sacc. (≡ *Hypocrea apiculata* Cooke & Peck ≡ *Hypomyces apiculatus* (Cooke & Peck) Seaver), a synonym of *Hypomyces armeniacus* Tul., according to Rogerson & Samuels (1994).
= *Apiocrea* Syd. & P. Syd., Ann. Mycol. 18: 186. 1920 [1921]. — Type: *A. chrysosperma* (Tul. & C. Tul.) Syd. & P. Syd., recognized as *Hypomyces chrysospermus* Tul. & C. Tul.
= *Chiajaea* Höhn., Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1, 129: 151. 1920. — Lectotype, designated by Clements & Shear (1931): *C. rhodomela* (Fr.) Höhn. (≡ *Sphaeria rhodomela* Fr.), a synonym of *Hypomyces roselllus* (Alb. & Schwein. : Fr.) Tul.

Subiculum of loosely intertwined or compacted hyphae, sometimes forming thin, separable sheets upon which ascomata are seated, or a firm stroma-like tissue within which ascomata are completely immersed, light- to bright-colored, reacting or not to KOH. Ascomata solitary to densely gregarious or caespitose, superficial on or immersed in the subiculum to a greater or lesser extent, pyriform, papillate, ascomatal wall smooth, thin, generally less than 25 µm, nearly hyaline or in shades of yellow, orange, tan or green, part or all of each ascoma becoming red or purple in KOH or not reacting to KOH. Asci cylindrical, apex thickened to a greater or lesser extent, with a pore, 8-spored. Ascospores ellipsoid, lanceolate with rounded ends, or fusiform with a blunt or acute apiculus at each end, apiculus obscure to conspicuous, non- or 1-septate with

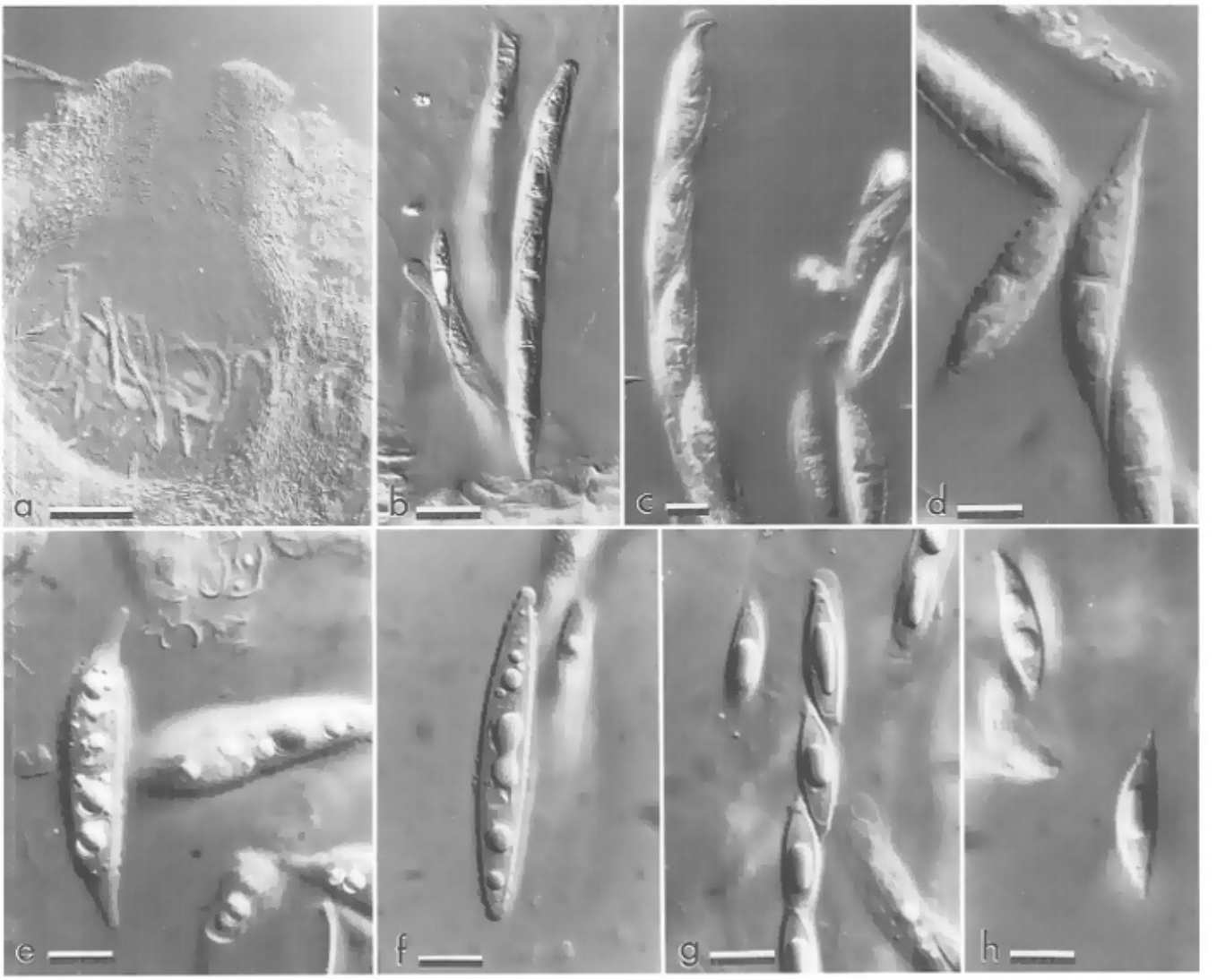


Plate 18. a–d. *Hypomyces lactifluorum*. a. Median section of ascoma. b. Asci with ascospores. c. Apical portion of ascus. d. Ascospores. **e.** *Hypomyces armeniacus*. Ascospores. **f.** *Hypomyces banningiae*. Ascospores. **g–h.** *Hypomyces lateritius*. g. Ascospores in median focus. h. Ascospores focussed on outer wall to show finely spinulose ornamentation. a. C.T. Rogerson, 31 July 1964 – NY. b–d. R.L. Shaffer, 25 July 1964 – NY. e. C.T. Rogerson 90-32 – NY. f. C.T. Rogerson 80-101 – NY. g–h. C.T. Rogerson 84-11 – NY. Scale bars: a = 100 µm; b = 25 µm; c–h = 10 µm.

a median or submedian septum, rarely 3-septate, hyaline, smooth, spinulose to tuberculate.

ANAMORPHS.— *Acremonium*-like, *Cladobotryum*, *Mycogone*, *Papulaspora*-like, *Stephanoma*, *Sepedonium*, or *Verticillium*-like.

HABITAT.— On other fungi, most commonly on mushrooms (*Agaricales*, *Boletales*), bracket fungi (*Poriales*), and discomycetes (*Helotiales*, *Pezizales*).

NOTES.— *Hypomyces* includes about 150 described taxa that typically have warted, apiculate ascospores. Ascomatal ontogeny has been described for a few species of *Hypomyces* and is typical of the *Hypocreales* (Hanlin, 1963b, 1964; Samuels, 1973c). Rogerson & Samuels (1985, 1989, 1993, 1994) described and illustrated the sexual and asexual forms of 48 species of *Hypomyces* contributing to a monographic account of the genus. Host preferences and correlated morphological characteristics of sexual and asexual forms suggest that within *Hypomyces* exist groups of species that may represent distinct genera or infrageneric taxa. Species that occur on boletes, agarics and discomycetes appear to occur only on these generalized hosts; however, there is a limited specificity to host species or group of host species. The agaricicolous species are most commonly found on species of the *Russulaceae*. Some species of *Hypomyces* transform the hymenium of the host completely into the ascomycete with the host gills visible only as shallow ridges. Often it is no longer possible to determine the specific host of boleticolous species of *Hypomyces*.

The species on *Aphyllophorales* show some host specificity in that their teleomorphs occur on specific families within the order, e.g. *H. chrysostomus* is found only on members of the *Ganodermataceae*, while *H. aurantius* occurs on members of the *Coriolaceae* and *Polyporaceae*. In species of *Hypomyces* that occur on polypores, the anamorphs have a wider host range, even known on agarics. The relationship between the host and parasite in the agaricicolous and polyporicolous species of *Hypomyces* appears to be highly developed because the host continues to produce some basidiospores even when the hymenium is covered by the parasite. The groups of *Hypomyces* that correlate with their hosts are further defined by their anamorphs. The type species of *Hypomyces*, *H. lactifluorum*, parasitizes *Russulaceae*. Unusual *Cladobotryum* anamorphs have been reported for *H. lateritius*, see Plate 4 k, and *H. lithuanicus* (Helfer, 1991), both of which are closely related to *H. lactifluorum*. Despite many attempts, ascospores have never been observed to germinate in this or any other species related to it, nor has *H. lactifluorum* been consistently associated with an anamorph.

Bonordenia is typified by *Sphaeria aurantia* Pers., recognized as a species of *Hypomyces* by Rogerson & Samuels (1993). *Bonordenia* could serve as the generic name for the species of *Hypomyces* with *Cladobotryum* anamorphs that occur on members of the *Aphyllophorales* as monographed by Rogerson & Samuels (1993).

Peckiella was originally described as a subgenus of *Hypomyces* for species that have non-septate ascospores. Nine species were included although none was designated type. When the name was raised to generic rank, four more species were added along with the previous nine species. Seaver (1910a) designated *P. viridis* as the lectotype. Based on the comments in Rogerson & Samuels (1994), *Sphaeria viridis* is considered a synonym of *H. luteovirens* and, thus, *Peckiella* is a synonym of *Hypomyces*. Rogerson & Samuels (1985, 1989, 1993, 1994) did not place significance on ascospore septation because in some species variability in these features occurs, occasionally even in a single perithecium (Rogerson & Samuels, 1989). All species previously placed in *Peckiella* are considered members of the genus *Hypomyces*.

Saccardo (1883) recognized *Hypocrea* subgenus *Clintoniella* for species of *Hypocrea* having fusiform ascospores that do not separate into part-ascospores. Rehm (1900) was the first to use the name *Clintoniella* at the generic level. The lectotype, *C. apiculata*, is a synonym of *Hypomyces armeniacus* Tul. according to Rogerson & Samuels (1994), see Plate 18, e.

Apiocrea was established as a segregate of *Hypomyces* for species with unequally, one-septate ascospores; however, as mentioned above, Rogerson & Samuels (1989, 1993, 1994) observed variability in ascospore septation, and thus do not place importance on ascospore septation. The type species of *Apiocrea* is recognized in *Hypomyces* as *H. chrysospermus* by Rogerson & Samuels (1989) who provided a detailed description, illustrations, and discussion. If recognized at the generic level as a segregate from *Hypomyces*, *Apiocrea* as the generic name could serve for those species of *Hypomyces* that occur on boletes and have a *Sepedonium* anamorph.

When von Höhnel (1920) recognized the name *Chiajaea* as a new genus, he included two species, *C. rhodomela* (Fr.) Höhn. and *C. hendersoniae* (Fuckel) Höhn. Von Höhnel did not include *Calonectria hippocastani* (Otth) Sacc. in *Chiajaea*, the only name included in *Calonectria* section *Chiajaea* Sacc. 1896, because he recognized that the type specimen of *Calonectria hippocastani* was a mixed collection as discussed by Nannfeldt (1975). The origin of the generic name *Chiajaea* therefore dates from von Höhnel (1920), rather than *Calonectria* section *Chiajaea* Sacc. as listed by Rogerson (1970). Von Höhnel (1920) did not designate a type for the genus *Chiajaea*, but later Clements & Shear (1931) designated *C. rhodomela* as lectotype. Holm (1957) examined type material of *Sphaeria rhodomela* from the Fries herbarium and concluded that *Chiajaea rhodomela* is a synonym of *Hypomyces rosellus*, thus the genus *Chiajaea* is a synonym of *Hypomyces*.

Genera similar to *Hypomyces* in their hosts and general aspect include *Arachnocrea*, *Protocrea* and *Sphaerostilbella*. *Hypomyces* is similar to *Arachnocrea* in having one-septate ascospores with acute ends but the ascospores of *Arachnocrea* disarticulate as in *Hypocrea*. *Hypomyces* resembles *Sphaerostilbella* in having one-septate, non-disarticulating ascospores and a fungicolous habit; however, the anamorph of *Sphaerostilbella* is *Gliocladium sensu stricto*. Using 28S DNA sequence analysis Rehner & Samuels (1994) demonstrated that *Sphaerostilbella* and *Hypomyces* are distinct monophyletic groups within the *Hypocreaceae*.

Specimens illustrated:

H. armeniacus: UNITED STATES. Connecticut: Tolland County, Hebron, Hemlocks Education Center, on rotten wood, 15 Sep 1990, C.T. Rogerson 90-32 (NY): Plate 18 e.

H. banningiae: UNITED STATES. North Carolina: Henderson County, Green Cove Camp, S of Tuxedo, on *Lactarius* sp., 20 Sep 1980, C.T. Rogerson 80-101 (NY): Plate 18 f.

H. lactifluorum: UNITED STATES. Michigan: Che-

boygan County, woods near Topinabee, on *Russula brevipes* Peck, 25 Jul 1964, R.L. Shaffer (NY): Plate 18, b–d. — Cheboygan County, University of Michigan Biological Station, pine woods, 31 Jul 1964, C.T. Rogerson (NY): Plate 5j (page 25), 18 a-d.
H. lateritius: UNITED STATES. New Jersey: Gloucester County, vic. Glassboro, on *Lactarius* sp., 17–18 Aug 1984, S. Stein, C.T. Rogerson 84-11 (NY): Plate 4 k (page 25), 18, g–h.

PODOSTROMA P. Karst., Hedwigia 31: 294. 1892.

Type: *P. leucopus* P. Karst., a synonym of *Podostroma alutaceum* (Pers. : Fr.) G.F. Atk.

= *Podocrea* Lindau, *in* Engler & Prantl, Natürl. Pflanzenfam. 1(1): 364. 1897. — Type: *P. alutacea* (Pers. : Fr.) Lindau (≡ *Sphaeria alutacea* Pers. : Fr.), recognized as *Podostroma alutaceum*.

Stroma well-developed, light-colored, fleshy, upright, stipitate. Ascomata immersed in the stroma. Asci cylindrical. Ascospores 1-septate, disarticulating early in the development into two globose, subglobose, ovoidal, oblong or wedge-shaped part-ascospores, hyaline or green, typically spinulose or warted, also smooth. Anamorph, where known, *Trichoderma*. On decaying woody substrata.

Notes.— Karsten (1892) described the genus *Podostroma* in the *Hypocreaceae* for fungi characterized by 'stroma stipitate, clavate, erect, entomogenous, fleshy, bright-colored. Ascomata immersed in the stroma. Asci cylindrical, 16-spored. Spores globose, hyaline. Paraphyses lacking.' Lindau (1897) recognized the genus *Podocrea* for *Hypocrea*-like species that have an upright, often branched stroma. He attributed the name to Saccardo (1883) who had previously established *Hypocrea* subgenus *Podocrea* with three species, namely *H. larvata* (Mont.) Sacc., *H. petersii* Berk. & M.A. Curtis, and *H. brevipes* (Mont.) Sacc.; however, Lindau did not include any of these three species in the genus. Thus the generic name is ascribed to Lindau (1897). Three species were included by Lindau in *Podocrea*, namely *P. alutacea*, *P. solmsii* (E. Fisch.) Lindau and *P. cornu-damae* (Pat.) Lindau. The type species of *Podocrea*, *P. alutacea*, was considered by Atkinson (1905) to be a synonym of the type species of *Podostroma*, *P. leucopus*; thus *Podocrea* is a synonym of *Podostroma*.

Partial accounts of the genus *Podostroma* have been provided by Boedijn (1934; 1938), Doi (1966, 1967b, 1973a, 1987), Imai (1932), and Seaver & Chardon (1926), all of whom noted the strong similarity of *Podostroma* to members of the genus *Hypocrea* in both teleomorph and anamorph characteristics. *Podostroma* is similar to *Hypocrea* differing only in the presence of a stalked stroma. In all other characters such as habitat, anamorph, stromal and centrum morphology, *Podostroma* and *Hypocrea* are indistinguishable. In several species of *Hypocrea* the stromata become raised, narrowed at the base, and could be considered stalked (Samuels & Lodge, 1996a). At present, *Podostroma* is retained with only the type species until a more detailed study has been completed of the stipitate species of *Hypocrea*-like fungi.

Podostroma alutaceum (Pers. : Fr.) G.F. Atk., Bot. Gaz. 40: 401. 1905. — Plate 4, l (see page 25); Plate 19, a, b; Plate 20, a.

≡ *Sphaeria alutacea* Pers. : Fr., Persoon, Observ. Mycol. 2: 66. 1797 : Fries, Syst. Mycol. 2: 325. 1822.
≡ *Podocrea alutacea* (Pers. : Fr.) Lindau, Engler & Prantl's Natürl. Pflanzenfam. 1(1): 364. 1897.
= *Podostroma leucopus* P. Karst., Hedwigia 31: 294. 1892.

Anamorph: *Trichoderma* sp.

Stroma pale yellow to yellow-buff, spathulate-flattened, divided into fertile and sterile parts: stipe or sterile part cylindrical, about 0.5–1.5 cm long × 1.5–2 mm diam, longitudinally wrinkled; fertile part broad, cylindrical, sometimes flattened, 0.5 × 1–1.5 mm × 15 mm tall; surface of fertile part unwrinkled, with low tuberculations formed by individual ascomatal apices, KOH–. Cells at stromatal surface ellipsoid to globose, 5–10 µm diam, with walls less than 0.5 µm thick, appearing moniliform. Stromal surface layer 30–50 µm thick, of uniformly small pseudoparenchyma, cells ellipsoid 5–7 µm diam, wall 0.5 µm thick. Ascomata completely immersed, visible as tuberculations beneath the stromal surface, ostiolar openings appearing as vis-

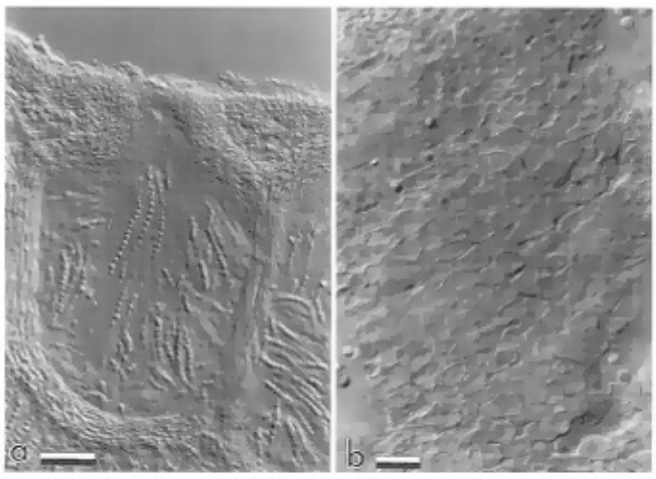


Plate 19. a, b. *Podostroma alutaceum*. a. Median section of stroma and immersed ascoma. b. Close-up of section of stroma. a, b. Holotype of *P. leucopus* – H. Scale bars: a = 50 µm; b = 10 µm.

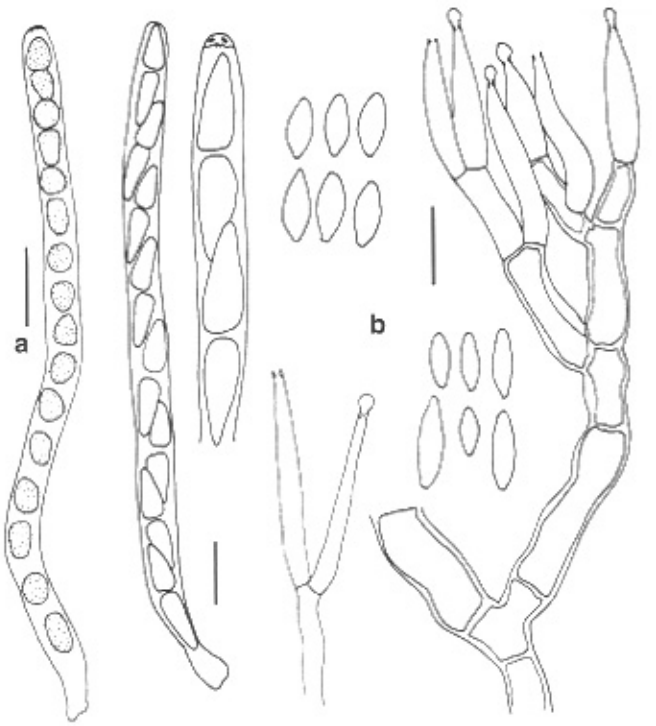


Plate 20. a. *Podostroma alutaceum*, ascus with disarticulating ascospores. **b.** *Pseudohypocrea citrinella*, ascus, ascal apex, conidiophores, and conidia. a. Holotype of *P. leucopus* – H. b. Guyana 4727 – NY. Scale bars: a, b = 10 µm.

cid dots against a dull background; ascomatal apex of small cells, not sharply differentiated from the surrounding stroma. Asci cylindrical, 62–95 × 4–6 µm, apex with ring. Ascospores 1-septate, dividing into dimorphic part-ascospores, distal part conical to subglobose or globose, 2.9–3.9 × 2.5–3.2 µm; proximal part oblong to wedge-shaped 3.1–4.9 × 1.9–2.9 µm, hyaline, spinulose.

Type.— FINLAND. Tavastia australis, Tammela, Syrja, in ?larvis, P.A. Karsten 3247, 30 Sep 1892 (H, holotype of *Podostroma leucopus*). This specimen consists of several fragments of a cylindrical stroma. The type specimen of *S. alutacea* was not located at L and apparently no longer exists.

Additional specimen examined. — FINLAND: Mustiala, versus Sarkjarvi, J. Lindroth, 8 Sep 1897, P.A. Karsten 3248 (H).

Illustrations.— Breitenbach & Kränzlin (1981, Fig. 316); Dennis (1975, Pl. XXXIC); Müller & von Arx (1962, Fig. 254, based on the type of *P. leucopus*); Tulasne & Tulasne (1865, Tab. IV, Figs. 1–6).

Notes.— The description presented here is based on an examination of the holotype of *Podostroma leucopus* and one other specimen from a similar locality. Although *P. leucopus* was recorded as occurring on insect larvae, no evidence of such a host is present on the type specimen. Later collections of *P. alutaceum* have been reported on old wood from both tropical and temperate regions, although it is likely that more than one taxonomic entity has been included under this name. Doi (1966) provided a detailed account of the *Trichoderma* anamorph of *P. alutaceum* and Eckblad & Torkelsen (1974) suggested that *P. alutaceum* is confined to the ground and decaying stumps in coniferous woods.

PROTOCREA Petch, J. Bot. 75: 219. 1937.

Lectotype, designated by Moravec (1956): *P. farinosa* (Berk. & Broome) Petch (≡ *Hypocrea farinosa* Berk. & Broome).

Subiculum thin, cottony, arachnoid, white to pink, KOH–. Ascomata partly to completely immersed in the subiculum with adjacent ascomata remaining discrete; ascomatal wall less than 25 µm thick, KOH–. Asci cylindrical. Ascospores fusiform to ellipsoid, 1-septate, disarticulating while in the asci into two part-ascospores, often of unequal size, hyaline to pale yellow-green, smooth or spinulose. Anamorphs *Acremonium*-like or *Verticillium*-like. On bark, decaying woody substrata and effused basidiomycetes.

Notes.— *Protocrea* and *Arachnocrea* are similar, differing primarily in ascospore morphology. Ascospores of *Protocrea* are fusiform with rounded ends, the septum is sub-median, and the part-ascospores are of unequal size, whereas in *Arachnocrea* the part-ascospores are conical or apiculate and equal in size. Petch (1937) established the genus *Protocrea* for species that have simple ascomata immersed in or seated upon a byssoid stroma and two-celled ascospores that disarticulate into part-ascospores. The three species originally included in *Protocrea* were *P. farinosa*, *P. delicatula* (Tul. & C. Tul.) Petch, and *P. stipata* (Lib.) Petch. Moravec (1956) designated *H. farinosa* as the lectotype of *Protocrea*, restricting the genus to those species having globose part-ascospores similar to *Hypocrea*. He removed *P. stipata* to another genus, *Arachnocrea* Z. Moravec, based on the fusiform ascospores that disarticulate into part-ascospores each with a pointed end. *Arachnocrea* is herein accepted as a distinct but related genus in the *Hypocreales*. In studying *Hypocrea*, Doi (1972) maintained the segregate genera *Arachnocrea*, *Protocrea*, and *Pseudohypocrea*. Although the ascospores of *Protocrea* and *Arachnocrea* disarticulate while in the asci, these genera are similar to *Hypomyces* and *Sphaerostilbella* in having thin, effused, prosenchymatous stromata. Within *Hypocrea*, there is a series of *Hypocrea* species, typified by *H. citrina*, that have indefinite, effused stromata, but the stromata of these species are pseudoparenchymatous rather than hyphal. Besides the type, two additional species are recognized in *Protocrea*.

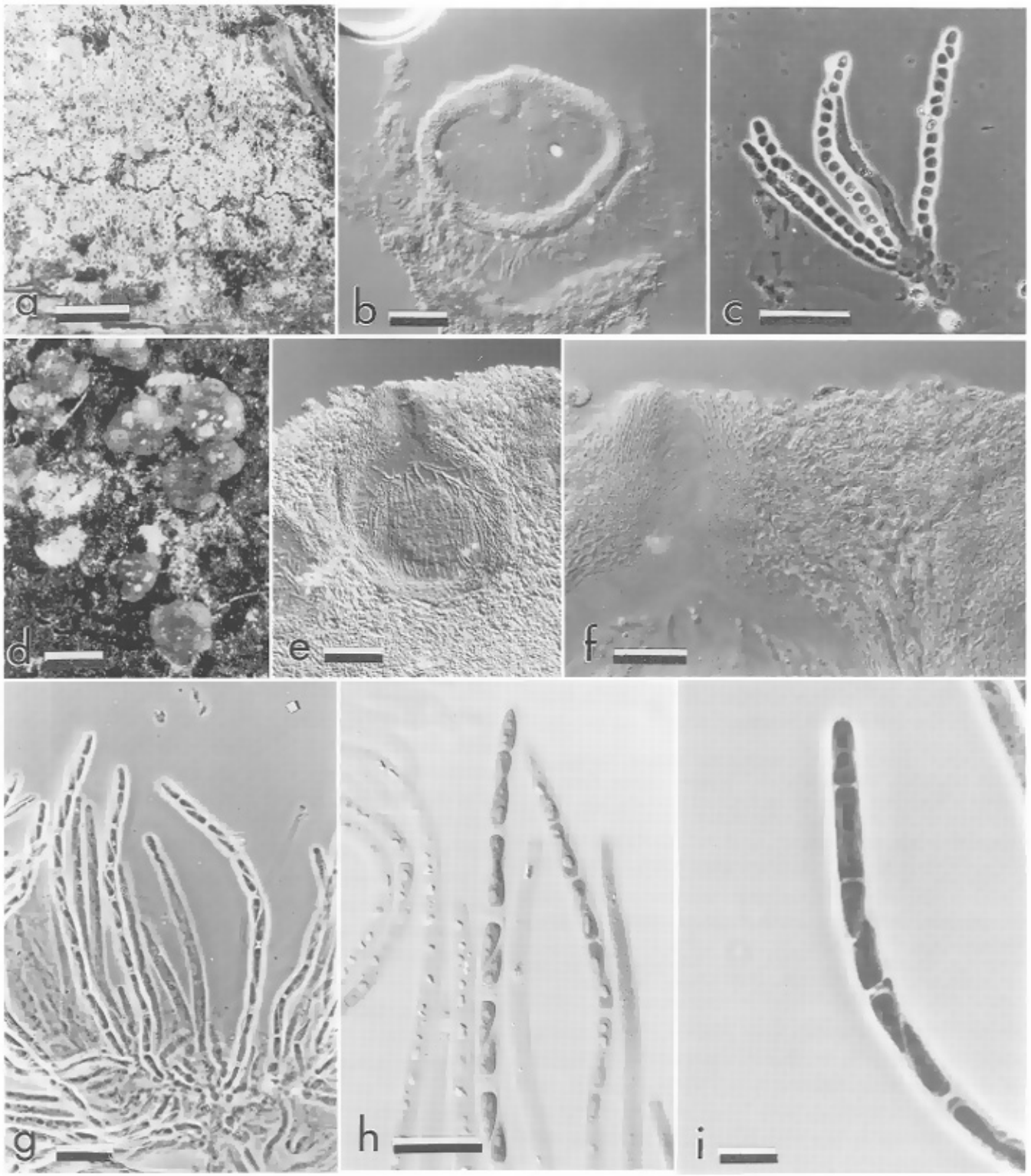


Plate 21. a–c. *Protocrea farinosa*. a. Subiculum with partially immersed ascomata. b. Median section of ascoma. c. Asci with disarticulating ascospores. **d–i.** *Pseudohypocrea citrinella*. d. Stroma with immersed ascomata. e. Median section of ascoma with surrounding stroma. f. Median section of apical portion of ascoma and surface of stroma. g. Asci with disarticulating ascospores in phase contrast. h. Asci with disarticulating ascospores. i. Apical portion of ascus with ascospores stained in cotton blue. a–c. Holotype – K. d. BPI 802549. e, f, h–i. BPI 744450. g. Holotype of *Hypocrea citrinella* – NY. Scale bars: a = 2 mm; b, f = 50 µm; c, g, h = 25 µm; d = 500 µm; e = 100 µm; i = 10 µm.

Protocrea farinosa (Berk. & Broome) Petch, J. Bot. 75: 219. 1937. — Plate 4, m–n (see page 25); Plate 21, a–c.

■ *Hypocrea farinosa* Berk. & Broome, Ann. Mag. Nat. Hist., Ser. 2, 7: 186. 1851.

Anamorph: *Acremonium*-like.

Subiculum thin, arachnoid, loosely cottony, spreading, white to cinereous, hyphae *ca* 4 µm wide, smooth, septate, branched, thin-walled, KOH–. Ascomata gregarious, seated on or immersed in subiculum, globose, 145–245 µm diam, pale yellow, KOH–, with a minute, free papilla, completely covered by densely compacted hyphae but remaining discrete. Ascomatal wall 18–20 µm thick, of a single region of small, slightly thick-walled cells. Asci cylindrical, (47–)50–60(–68) × (3.5–)4–5.5 (–6.5) µm, apex slightly thickened, sessile, ascospores uniseriate. Ascospores 1-septate, disarticulating in the asci, part-ascospores dimorphic, distal part subglobose to somewhat conical, (3–)3.4–3.7(–4.6) × (2–)2.5–3(–3.3) µm; proximal part wedge-shaped to ellipsoid, (3.2–)3.5–4.5 × 2–2.7(–3) µm, hyaline, smooth to very finely spinulose.
Habitat.— On an effused basidiomycete (*Aphyllophorales*), possibly also on wood.
Distribution.— England, Germany (Doll, 1975), Japan (Doi, 1972), and United States.

Holotype.— ENGLAND. King's Cliff, Milton, Northts., on fallen branches, Mr. Henderson; 'a more downy form occurred at Bach Hall, Chester, on decayed *Stereum*, July 1848' (K).
Additional specimen examined. — UNITED STATES. New York, Vandercamp Lake, on decorticated wood, 17 Sep 1995, C. Catranis (BPI 737716).

Illustrations.— Breitenbach & Kränzlin (1981, Fig. 321); Dennis (1975, Pl. XXXIB); Doi (1972, Fig. 1).
Specimen illustrated.— FRANCE. Mongauzy (33), on *Skeletocutis nivea*, 4 Nov 1994, J.-F. Magni, A94131.

Notes.— The type specimen of *Protocrea farinosa* was found on an effused basidiomycete. Doi (1972) reported an *Acremonium*-like anamorph for this species, but his Japanese collections were found on bark. To be absolutely certain of the anamorph of *P. farinosa*, the anamorph should be grown from a specimen more similar to the type in geographic location and host.

Protocrea delicatula Tul. & C. Tul., Ann. Sci. Nat. Bot., Sér. 4, 13: 18. 1860.
Anamorph: *Verticillium*-like.

Subiculum thin, arachnoid, loosely cottony, spreading, hyphae white, KOH–. Ascomata gregarious, immersed in mycelium, remaining discrete, subglobose, 185–240 µm high, 140–200 µm diam, orange-amber, KOH–, with an emergent papilla. Ascomatal surface of *textura epidermoidea*. Ascomatal wall *ca* 15 µm thick, of a single region of non-descript cells. Papilla of narrow hyphal elements. Asci cylindrical, *ca* 50 × 5 µm, apex simple, apparently sessile, ascospores uniseriate. Ascospores disarticulating into part-ascospores, part-ascospores dimorphic, distal part globose to subglobose, 2.7–3.6 µm diam; proximal part oblong, 2.7–3 × *ca* 2.5 µm, hyaline, smooth.

Habitat.— On decorticated wood, also on dematiaceous fungi.
Distribution.— Belgium (Beeli, 1924); England (Petch, 1937), France, Japan (Doi, 1972).

Type.— FRANCE. Clamart, on dicotyledonous sticks, leaves and moss, 4 Jan 1860, L.-R. Tulasne (PC, **lectotype**, designated herein); Chaville, on dead wood, 21 Mar 1860, L.-R. Tulasne (PC, authentic).
Illustrations.— Doi (1972, Fig. 2); Malençon (1979, Fig. 1B–E); Tulasne & Tulasne (1865, Tab. IV, Figs. 7–13).

Notes.— Two specimens are mentioned in the protologue and both were examined. The specimen collected at Clamart is in better condition and is designated as lectotype. Tulasne & Tulasne (1860) described a *Verticillium*-like anamorph of *P. delicatula*. Although the distinction between *P. farinosa* and *P. delicatula* is tenuous, they can be readily separated on the basis of their anamorphs, if the reported forms are accurate. Ascomata in the type specimen of *P. delicatula* have an orange color whereas ascomata in the type collection of *P. farinosa* are pale yellow. Ascomata of *P. farinosa* are clearly growing over an effused aphyllophoralean basidiomycete while ascomata in the type of *P. delicatula* are on decorticated wood. Doi (1972) and Petch (1937) accepted both species.

Protocrea latissima Mercuri & Ranalli, Physis (Buenos Aires) 35: 304. 1976.
Anamorph: *Acremonium*-like.

Subiculum thin, arachnoid, cottony, spreading, cream-colored to yellow, hyphae 3.5–6.5 µm wide, KOH reaction not known. Ascomata gregarious, partially to completely immersed in the subiculum, globose, 100–130 µm diam, color and KOH reaction not known, with an emergent papilla. Ascomatal wall 12–20 µm thick, of a single region of flattened cells. Asci cylindrical, 60–75 × 3.2–5.2 µm, apex thickened, sessile, ascospores uniseriate. Ascospores disarticulating into part-ascospores; part-ascospores monomorphic, subglobose, 2.6–3.2 µm diam, pale yellow-green, spinulose.
Anamorph known only in culture: Conidiophores aris-

Key to the species of *Protocrea*

1. Proximal part of ascospores wedge-shaped to ellipsoid, 3.4–3.7 × 2.5–3 µm, hyaline, smooth to very finely spinulose ..... *P. farinosa*
1. Proximal part of ascospores subglobose to oblong, less than 3.5 µm long, hyaline or yellow-green 2

2. Ascospores hyaline, smooth, proximal part oblong, 2.7–3 × *ca* 2.5 µm ..... *P. delicatula*
2. Ascospores pale yellow-green, spinulose, proximal part subglobose, 2.6–3.2 µm diam ..... *P. latissima*

ing as lateral branches of hyphae, unbranched and *Acremonium*-like or producing 2–3 branches, each branch a single phialide, 15–30 × 1.8–3 µm. Conidia subglobose to oblong, 5–10 × 1.5–3.8 µm, smooth, hyaline. Chlamydospores rare, obovate, terminal or intercalary, 6.5–7.8 × 4.5–5.2 µm, verrucose.

Habitat.— On bark of hardwood trees.

Distribution.— Argentina.

Type.— ARGENTINA. Buenos Aires: La Plata, Punta Lara, Boca Cerrada, on trunk of *Ligustrum* sp. in the forest, Apr. 1975, C. E. Gómez (BAFC 24077, holotype – not examined).

Illustrations.— Mercuri & Ranalli (1976, Pl. 1–4).

Notes.— The description given here is paraphrased from the protologue. The illustrations provided with the original description indicate that this is a species of *Protocrea*. The anamorph is strongly suggestive of the anamorphs of *Protocrea farinosa* (Doi, 1972) and *Hypocrea* species such as *H. lactea* (Fr.) Fr. that have effused stromata (Rifai & Webster, 1966b). Mercuri & Ranalli (1976) observed ascomata forming in cultures derived from single ascospores indicating that this species is homothallic.

PSEUDOHYPOCREA Doi, Bull. Natl. Sci. Mus. Tokyo 15: 655. 1972.

Type: *P. citrinella* (Ellis & Everh.) Doi (≡ *Hypocrea citrinella* Ellis & Everh.).

Stroma discrete, discoidal to pulvinate, of compact, intertwined hyphae. Asci cylindrical. Ascospores one-septate, disarticulating into two conical part-ascospores, hyaline, smooth. Anamorph *Acremonium*-like. On bark.

Notes.— Doi (1972) established the unispecific genus *Pseudohypocrea* for a *Hypocrea*-like fungus with ascospores that disarticulate into smooth, distinctly conical part-ascospores. The hyphal nature of the stroma and the conical part-ascospores distinguishes *Pseudohypocrea* from *Hypocrea*. Because no 'true' *Hypocrea* has ascospores comparable to those of *P. citrinella*, it is not necessary to detail stromal anatomy. The smooth, conical part-ascospores and the anatomy of the ascomatal apex are similar to *Hypomyces chrysostomus* and its relatives. In these fungi the ascomata are superficial on a thin subiculum on basidiomata of *Aphyllophorales*, most often members of the *Ganodermataceae*, and their anamorphs are *Acremonium*-like. Only one species of *Pseudohypocrea* is known.

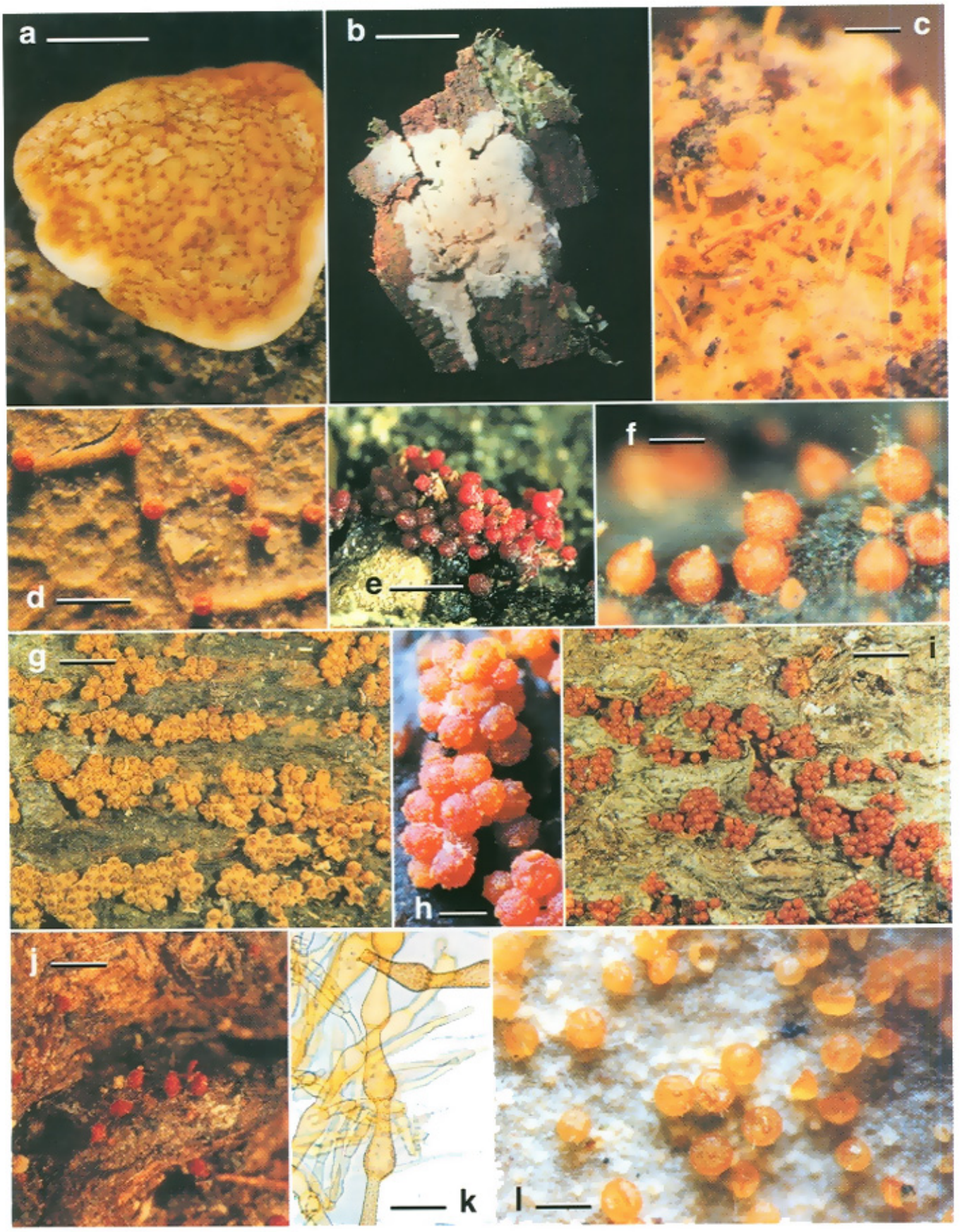
Pseudohypocrea citrinella (Ellis & Everh.) Doi, Bull. Natl. Sci. Mus. Tokyo 15: 655. 1972.— Plate 20, b; Plate 21, d–i; Plate 22, a.

≡ *Hypocrea citrinella* Ellis & Everh., Bull. Torrey Bot. Club 6: 108. 1876.
≡ *Hypomyces citrinellus* (Ellis) Seaver, Mycologia 2: 79. 1910.
≡ *Arachnocrea citrinella* (Ellis) Z. Moravec, Bull. Trimestriel Soc. Mycol. France 72: 165. 1956.

Anamorph: *Acremonium*-like.

Stromata discrete, scattered, pulvinate or discoidal, broadly attached or with margins slightly raised, 0.5–1.5 mm diam, surface smooth, outlines of ascomata not evident, ostiolar openings somewhat darker than the surrounding stromatal tissue, relatively few ascomata in each stroma with considerable sterile tissue separating the individual ascomata, pale yellow, KOH–. Stroma surface of intertwined, 5–6 µm wide hyphae, with *ca* 1.5 µm thick walls. Internal stromatal tissue homogeneous, of intertwined, 6–7 µm wide hyphae, with 1.5–2 µm thick walls. Ascomata pyriform to subglobose, 380–410 µm high × 265–285 µm diam, apex of narrow, brick-like cells, *ca* 3 µm wide, that merge with the periphyses. Asci cylindrical, (90–)100–160(–192) × (2.5–)5–6.5(–8.5) µm, apex thickened, sessile, ascospores uniseriate. Part-ascospores monomorphic, conical, (6–)10–12(–15) × (2.5–)3.5–4.5(–6.5) µm, hyaline, smooth.

Anamorph known only from culture. Conidiophores often arising from thick-walled hyphal elements, unbranched or irregularly branched, each branch a single phialide; phialides 15–40 µm long, 2–3 µm wide at the apex. Conidia ellipsoid to fusiform, 6–12 × 2–2.5 µm,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non-septate, hyaline, smooth, accumulating in hyaline drops of liquid at the apex of each phialide.

HABITAT.— On decaying wood and bark.
DISTRIBUTION.— Temperate and tropical America, Indonesia, Japan, Republic of China; probably cosmopolitan in warmer latitudes.

HOLOTYPE.— UNITED STATES. New Jersey, on dead *Vaccinium corymbosum*, 618 (NY).
ADDITIONAL SPECIMENS EXAMINED.— GUYANA. Cuyuni-Mazaruni Region, VII; Mazaruni Subregion, VII-2; vic. Chinoweing Village, 05°43′ N, 60°18′ W, elev. 450 m, 15 Feb 1987, G.J. Samuels G.J.S. 87-14, Guayana 4727 (NY). INDONESIA. Eastern Dumoga-Bone National Park, on twig of recently dead tree, Sept 1985, G.J. Samuels 2223, det. Y. Doi (BPI 744450). PUERTO RICO. Caribbean National Forest, Pal Hueco, off Rte. 186, 22 Nov. 1992, S.M. Huhndorf 209 & D.J. Lodge, det. G.J. Samuels (BPI 802549; NY); TAIWAN. Fushan Botanical Garden, on twig, 1995, M.-L. Wu, det. G.J. Samuels (BPI 744454). THAILAND. Saraburi Province, Khao Yai National Park, 11 Aug 1997, G.J. Samuels 8372 & P. Chaverri (BPI 745704). VENEZUELA. Territorio Federal Amazonas, Neblina base camp, on dead twig, 27 Jan 1985, A. Rossman 2390 (BPI 745892).

ILLUSTRATIONS.— Doi (1972, Fig. 4); Ellis & Everhart (1892, Pl. 11, Figs. 4–7).
SPECIMEN ILLUSTRATED.— TAIWAN. Fushan Botanical Garden, on twig, 21 Apr 1994, M.L. Wu F3-II-T6, det. G.J. Samuels (BPI 744474, TMTC).

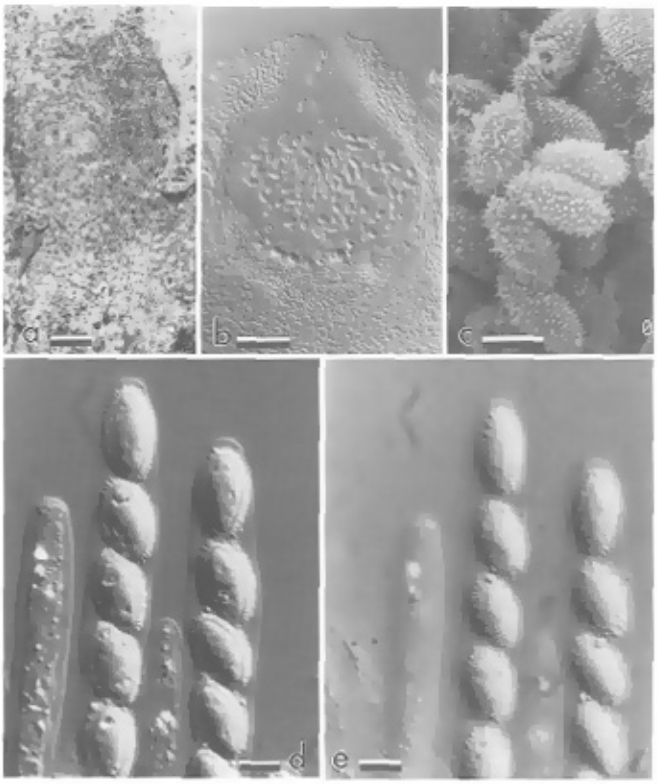

Plate 23. a–e. *Rogersonia striolata*. a. Surface view of stroma and immersed ascomata evident as darkened apices. b. Median section of ascoma. c. SEM of ascospores. d. Apical portion of asci with ascospores in median focus. e. Apical portion of asci with ascospores in off-median focus to show ascospore ornamentation. a–e. Holotype – BPI 749257. Scale bars: a = 1 mm; b = 50 µm; c = 5 µm; d, e = 10 µm.

ROGERSONIA Samuels & Lodge, Sydowia 48: 250. 1996.

Type: *R. striolata* Samuels & Lodge

Subiculum indefinitely effused, light-colored. Ascomata caespitose, numerous, partly to completely immersed throughout the subiculum, pale yellow, papillate, becoming cupulate upon drying. Ascomatal apex free, formed of clavate cells. Subiculum and ascomatal anatomy as in *Hypomyces*. Ascospores non-septate, broadly ellipsoid, hyaline, transversely striate. Anamorph unknown. On decaying woody substrata.

NOTES.— *Rogersonia* is unique within the *Hypocreaceae* in having ascomata immersed in an indefinitely effused, hyphal subiculum combined with the conspicuously transversely striate ascospores. The indefinitely effused subiculum in which numerous ascomata of *R. striolata* are aggregated is similar to the effused stromata of polyporicolous species of *Hypomyces*. In ascomatal anatomy, especially the ascomatal apex, *Rogersonia* is similar to that observed in several agaricicolous species of *Hypomyces* (Rogerson & Samuels, 1994). The combined features of the subiculum and the ascomatal anatomy suggest that *Rogersonia* is related to *Hypomyces*, however, there are significant differences. Species of *Hypomyces* are fungicolous while there is no indication of a fungal host for *R. striolata*. Asci of *Hypomyces* typically have an apical discharge mechanism and ascospores of *Hypomyces* are typically one-septate, apiculate and warted. In species of *Hypomyces* having non-septate ascospores, the ascospores are fusiform rather than broadly ellipsoid. Striate ascospores are otherwise unknown in *Hypomyces* and transversely striate ascospores are otherwise unknown in the *Hypocreaceae*. The relatively large, broadly ellipsoid, conspicuously ornamented ascospores of

Plate 22. a. *Pseudohypocrea citrinella*. **b.** *Rogersonia striolata*. **c.** *Sphaerostilbella lutea*. **d.** *Calonectria* sp. **e.** *Corallomycetella repens*. **f.** *Cosmospora vilior*. **g.** *Lanatonectria mammiformis*. **h.** *Nectria cinnabarina*. **i.** *Neonectria coccinea*. **j, k.** *Ophionectria trichospora*. k. Hyphae from living culture of anamorph, *Antipodium spectabile*. **l.** *Pseudonectria rousseliana*. a. Photograph by Mei-Li Wu, BPI 744474. b. BPI 749255. c. Holotype of *Sphaerostilbe lutea* – FH. d. Holotype of *Nectria venusta* – S. e. CUP–MJ 822. f. BPI 1107402. g. Huhndorf 2002. h. Photograph by J.-F. Magni, specimen A 9827. i. BPI 551493. j. G.J.S. 4829a – NY. k. Type culture of *Antipodium spectabile*, ATCC 28509; l. Photograph by J.-F. Magni, A9491. Scale bars: a, c–e, j = 1 mm, b = 2.5 mm, f, l = 250 µm, g = 2 mm, h = 500 µm, i = 2 mm, k = 10 µm.

Rogersonia suggest those of *Sarawakus* Boedijn (Samuels & Rossman, 1992). However, ascomata of species of *Sarawakus* form in a discrete, discoidal or pulvinate stroma and the ascal apex of species of that genus is thickened and has a shallow ring. The affinities of *Sarawakus* lie with *Hypocrea*, whereas those of *Rogersonia* lie with *Hypomyces*.

Rogersonia striolata Samuels & Lodge, Sydowia 48: 251. 1996. — Plate 22, b; Plate 23, a–e.

Subiculum indefinitely effused, thin, dissipated at the margin, light-colored, center dull yellowish, greyish yellow, pale yellow to yellowish brown, KOH–; behind the margin yellowish brown to pale yellow; white at the margin; hyphae *ca* 5.5 µm wide, tending to be vesiculose, 9–13 µm wide, thin-walled, with many erect free ends or lateral branches, 25–40 µm long, *ca* 10 µm wide, septate, tapering slightly from base to apex, hyaline, smooth-walled. Ascomata caespitose in great numbers except at the margin of the subiculum, discrete but crowded, clothed in hyphae with emergent papillae, pale yellow, KOH–, becoming cupulate on drying with erect papilla. Ascomatal wall *ca* 20 µm thick, of a single region of thin-walled, flattened cells, *ca* 15 × 4 µm. Ascomatal apex of conspicuous chains of cells that terminate in a larger clavate cell, 10–15 × 6–7 µm. Asci cylindrical, (80–)90–110(–120) × (6–)6.5–9(–11) µm, disintegrating at maturity; apex simple, 8-spored, ascospores uniseriate. Ascospores broadly ellipsoid, (10–)11.5–14(–16) × (5–)6–7.5(–8.5) µm, non-septate, hyaline, wall 1–1.7 µm thick, with conspicuous, transversely arranged, slightly anastomosing, ridge-like striations and intermittently reinforced with spinose extensions.

Habitat.— In rain forest on large fallen branches and logs of *Guarea guidonia* and *Swietenia macrophylla* at an elevation of 350 m.

Distribution.— Puerto Rico, Luquillo Mts.

Type and other specimens examined are listed in Samuels & Lodge (1996b).

Specimens illustrated.— PUERTO RICO. Luquillo Mts., El Verde Research Area, trail to Rio Sonadora, elev. 350 m, on underside of log, 4 Jul 1993, D.J. Lodge PR 1214 (Holotype – BPI 749257); same locality, on branch of *Guarea guidonia*, 4 Oct 1993, D.J. Lodge RP 1282 (BPI 749255); same locality, on log of *Swietenia macrophylla*, 16 Nov 1993, D.J. Lodge PR 1586 (BPI 749254).

Illustrations.— Samuels & Lodge (1996b, Figs. 1–11).

SARAWAKUS Lloyd, Mycol. Writings 7: 1258. 1924.

Type: *S. lycogaloides* (Berk. & Broome) Lloyd (≡ *Hypoxylon lycogaloides* Berk. & Broome).

Stroma discrete, discoidal, fleshy, pale yellow to rufous or brown, *Hypocrea*-like. Ascomata immersed in a single layer. Asci cylindrical, (6–)8-spored. Ascospores non-septate, hyaline, pale yellow to green, spinulose to tuberculate. Anamorphs *Gliocladium*-, *Trichoderma*-, or *Verticillium*-like. On decaying woody substrata.

Notes.— *Sarawakus* was established as a unispecific genus for *S. lycogaloides* which Lloyd considered unique and allied to either *Hypocrea* in having a soft-textured stroma or *Hypoxylon* in having a dark brown stroma and brown, non-septate ascospores. Boedijn (1934, 1964) provided the first complete description of the type species, placing the genus in the *Hypocreales*, and later he compared it to *Thuemenella*. Rifai (1969b) examined the type specimen and provided a detailed account of *Sarawakus* and its type species, placing it in the *Hypocreales*. Samuels & Rossman (1992) determined that *Sarawakus* is correctly placed in the *Hypocreales* and is distinct from *Thuemenella*, the latter belonging to the *Xylariales*, based primarily on characteristics of the anamorph. They provided a key, descriptions and illustrations to eleven species in *Sarawakus*, many of which have *Gliocladium*-, *Trichoderma*- or *Verticillium*-like anamorphs and show close affinities to *Hypocrea*. *Sarawakus* may eventually be restricted to *S. lycogaloides* Boedijn and *S. succisus* Rifai. Based on their anamorphs, the remaining species may by regarded as species of *Hypocrea* having non-septate ascospores. All names in *Sarawakus* were accounted for by Samuels & Rossman (1992).

Sarawakus lycogaloides (Berk. & Broome) Lloyd, Mycol. Writings 7: 1258. 1924. — Plate 24, a–f.

≡ *Hypoxylon lycogaloides* Berk. & Broome, J. Linn. Soc., Bot. 14: 120. 1873.

≡ *Sarcoxylon lycogaloides* (Berk. & Broome) Cooke, Grevillea 12: 50. 1883.

≡ *Penzigia lycogaloides* (Berk. & Broome) Sacc., Syll. Fung. 9: 569. 1891.

= *Hypocrea rhytidospora* Ces., Atti Accad. Sci. Fis. (Napoli) 8: 14. 1879.

≡ *Clintoniella rhytidospora* (Ces.) Sacc. & P. Syd., Syll. Fung. 16: 588. 1902.

Anamorph: None known.

Subiculum conspicuous to lacking, restricted to the immediate vicinity of the stroma or spreading over the substratum, nearly white to yellow, of branched, septate, thick-walled, 3–7 µm wide hyphae. Stromata discoidal, 3–10 mm diam, to 4 mm high, constricted at the base with margins free, surface papillate to slightly tuberculate from ascomatal protuberances, yellow at first, yellow-brown to rufous with age. Cells at stromal surface forming a 20–30 µm thick cortex of densely interwoven cells with 1.5–2 µm thick walls and narrow lumina; cortex continuous around the stroma to the

base, yellow. Ascomata completely immersed below the cortex, forming in a single layer, numerous, subglobose, 200–450 μm high × 270–350 μm diam. Tissue below the cortex consisting of *textura epidermoidea*, cells short, 7–10 μm wide, thin-walled, hyaline, merging below with hyphal tissue of the subiculum. Asci 120–190 × 9–13 μm, apex simple, 8-spored, ascospores uniseriate. Ascospores ellipsoid, 17–20 × 8–10 μm, non-septate, olivaceous (green in lactic acid), conspicuously tuberculate, tubercles broadly rounded, to 3 μm high.

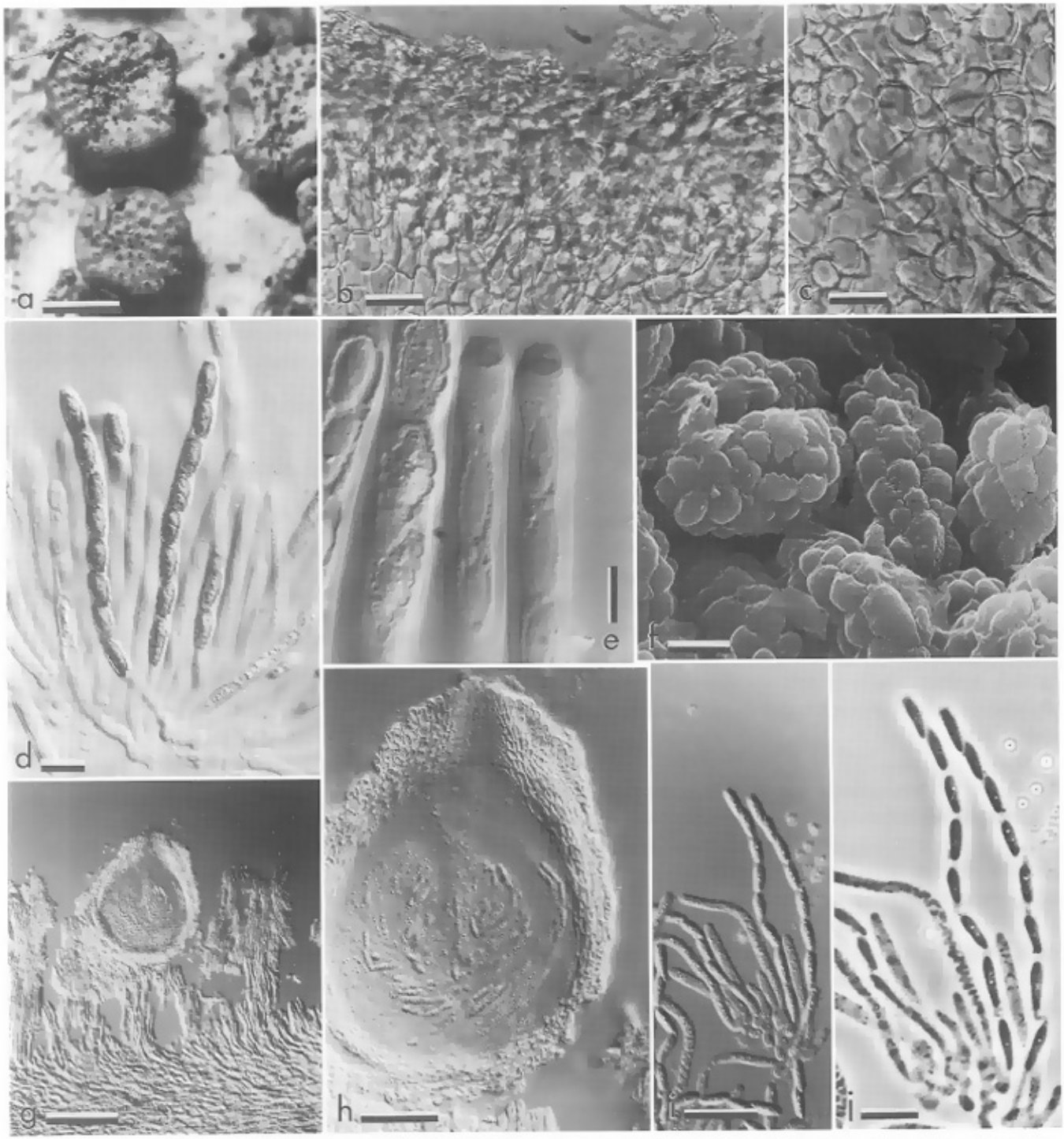

Plate 24. a–f. *Sarawakus lycogaloides*. a. Stroma with immersed ascomata. b. Section of stroma. c. Section of inner stroma. d. Asci with ascospores. e. Ascal apices and ascospores in median focus. f. SEM of ascospores showing tuberculate ornamentation. **g–j.** *Sphaerostilbella aureonitens*. g. Median section of ascoma and stroma. h. Median section of ascoma. i. Asci with ascospores. j. Asci with ascospores in phase contrast. a–e. G.J.S. 4102 – NY. f. G.J.S. 3368 – NY. g–j. Dumont VE 4752 – NY. Scale bars: a = 1 mm; b–d, h = 25 μm; e, j = 10 μm; f = 5 μm; g = 100 μm; i = 20 μm.

Habitat.— On wood and bark.
Distribution.— Costa Rica, Indonesia (Boedijn, 1934; Rifai, 1969b), French Guiana (Lusk, 1990), Sri Lanka, United States (Florida; Lusk, 1990).

Type specimens not examined.
Specimens examined.— COSTA RICA. Finca 1, Standard Fruit Co., Pandorra, host unknown, 20 June 1962, Carroll 36 (NY). FRENCH GUIANA. Paul Isnard Area, Mts. Lucifer and Decou Decou, *ca* 150 km S of St. Laurent du Maroni, on recently dead tree, 7–17 Mar 1986, Samuels 4102 (NY); Saül, elev. *ca* 200 m, on well rotted wood, 3–16 Feb 1986, Samuels 3739 (NY); *ca* 17.5 km SW of Saül (03°60′ N, 53°20′ W) toward Mt. Galbao, elev. 250 m, on bark, 24–28 Jan 1986, Samuels 3368 (CAY, NY). UNITED STATES. Florida: Alachua Co., Gainesville, San Palasco Hammock, in woods across road from nature trail, on downed sweet gum, 13 and 27 Jan 1987, Lusk 205 (NY).

Illustrations.— Boedijn (1934, Fig. 1), Rifai (1969b, Figs. 1, 2a), Samuels & Rossman (1992, Figs. 18–27).

SPHAEROSTILBELLA (Henn.) Sacc. & D. Sacc., Syll. Fung. 17: 778. 1905.

≡ *Sphaerostilbe* subgenus *Sphaerostilbella* Henn., Bot. Jahrb. Syst. 30: 40. 1901. — Type: *S. lutea* (Henn.) Sacc. (≡ *Sphaerostilbe lutea* Henn.).

Subiculum not conspicuous, at most, forming a thin compact layer on the host hymenium. Ascomata superficial, solitary to gregarious, obpyriform, non-papillate, smooth, ascomatal wall less than 25 µm thick. Asci cylindrical, apex slightly thickened, ascospores uniseriate. Ascospores naviculate to ellipsoid, with one median or slightly sub-median septum, non-disarticulating in asci, hyaline, finely spinulose.
Anamorph *Gliocladium*. On decaying Aphyllophorales, rarely wood.

Notes.— *Sphaerostilbella* was originally established as a subgenus of *Sphaerostilbe* that included one species, *S. lutea*. Seifert (1985) examined the holotype specimen and provided a detailed redescription and account of *Sphaerostilbella lutea* and its anamorph, *Gliocladium aurifilum*, as well as two additional species. Ascomata of *S. lutea* are known only from Africa and southeast Asia (Indonesia, Thailand), although its anamorph is cosmopolitan. *Sphaerostilbella aureonitens* with its anamorph, *Gliocladium penicillioides*, type of the genus *Gliocladium*, is a common cosmopolitan species, occurring in temperate and tropical regions. *Sphaerostilbella novaezelandiae* and its anamorph, *G. novaezelandiae*, are known only from New Zealand. A fourth species, *S. berkeleyana*, occurs in Europe, New Zealand, and North America in temperate regions.

Species of *Sphaerostilbella* have been variously included in *Hypomyces* because of their habit, parasitic on members of the *Aphyllophorales*, and in *Nectria sensu lato*, because of their non-apiculate, one-septate, ascospores and the lack of a conspicuous subiculum. Rehner & Samuels (1994) presented evidence from sequence analyses of 28S rDNA that *Sphaerostilbella* is distinct from both *Hypomyces* and *Nectria*, but closer to *Hypomyces*. In the anamorph, habit, and, to a lesser extent, ascospore characteristics, *Sphaerostilbella* is similar to *Hypocrea pallida*. The most obvious difference between the two is the disarticulation of the ascospores in *H. pallida*. The anamorphs of *Sphaerostilbella* and *H. pallida* are species of *Gliocladium sensu stricto* and, in the absence of the teleomorph, they could not be distinguished at the generic level. However, sequence data correlate with the teleomorph differences in distinguishing *Sphaerostilbella* from *H. pallida* (Rehner & Samuels, 1994).

Species of *Sphaerostilbella*:
Sphaerostilbella aureonitens (Tul. & C. Tul.) Seifert, Samuels & W. Gams, Stud. Mycol. 27: 145. 1985. — Plate 24, g–j.

≡ *Hypomyces aureonitens* Tul. & C. Tul., Sel. Fung. Carpol. 3: 64. 1865.
≡ *Hypolyssus aureonitens* (Tul. & C. Tul.) O. Kuntze, Rev. Gen. Pl. 3(3): 488. 1898.
≡ *Nectriopsis aureonitens* (Tul. & C. Tul.) Maire, Ann. Mycol. 9: 323. 1911.
≡ *Hyphonectria aureonitens* (Tul. & C. Tul.) Petch, J. Bot. 75: 220. 1937.
= *Nectria mycetophila* Peck, Bull. Buffalo Soc. Nat. Sci 1: 71. 1873.
≡ *Nectriella mycetophila* (Peck) Sacc., Syll. Fung. 2: 449. 1883.
= *Nectria parvispora* G. Winter, Hedwigia 25: 93. 1886.
≡ *Cucurbitaria parvispora* (G. Winter) O. Kuntze, Rev. Gen. Pl. 3(3): 461. 1898.
= *Dialonectria sulfurea* Ellis & Calk., J. Mycol. 4: 57. 1888.
≡ *Nectria sulfurea* (Ellis & Calk.) Sacc., Syll. Fung. 9: 966. 1891.
≡ *Cucurbitaria sulfurea* (Ellis & Calk.) O. Kuntze, Rev. Gen. Pl. 3(2): 461. 1898
= *Hypomyces arenaceus* A.L. Smith, J. Linn. Soc. Bot 35: 17. 1901.

Anamorph: *Gliocladium penicillioides* Corda.

This species was described and illustrated by Samuels (1976a, as *Hypomyces aureonitens*) and the anamorph by Seifert (1985).

Specimen illustrated.— VENEZUELA. Edo. Sucre, NW Irapa, trail from Los Pocitos, 11/2 h walking toward Santa Isabel, on *Stereum* sp. on unidentified wood, 11 July 1972, K.P Dumont VE 4752, *et al.* (NY).

Sphaerostilbella berkeleyana (Plowr. & Cooke) Samuels & Candoussau, Mycologist 9: 12. 1995.

≡ *Hypomyces berkeleyanus* Plowr. & Cooke, Grevillea 11: 48. 1882.
≡ *Hypolyssus berkeleyanus* (Plowr. & Cooke) O. Kuntze, Rev. Gen. Pl. 3(3): 488. 1898.
≡ *Nectriopsis berkeleyana* (Plowr. & Cooke) Maire, Ann. Mycol. 9: 324. 1911.
≡ *Hyphonectria berkeleyana* (Plowr. & Cooke) Petch, J. Bot. 75: 220. 1937.
≡ *Nectria berkeleyana* (Plowr. & Cooke) Dingley, Trans. Roy. Soc. New Zealand 79: 183. 1951.

Anamorph: *Gliocladium* sp.

ILLUSTRATIONS.— Candoussau & Magni (1995, Figs. 1, 3a); Dingley (1951b, Pl. 25, Fig. 3); Plowright (1882, Pl. 155, Fig. 1); Samuels (1976a, Fig. 5).

This species was described and illustrated by Samuels (1976a) as *Hypomyces berkeleyanus*.

Sphaerostilbella lutea (Henn.) Sacc. & D. Sacc., Syll. Fung. 17: 778. 1905. — Plate 22, c.

≡ *Sphaerostilbe lutea* Henn., Bot. Jahrb. Syst. 30: 40. 1901.

Anamorph: *Gliocladium aurifilum* (Gerard) Seifert, Samuels & W. Gams, Stud. Mycol. 27: 148. 1985.
Stilbum aurifilum Gerard, Bull. Torrey Bot. Club 5: 39. 1874.
≡ *Ciliciopodium aurifilum* (Gerard) Cooke, Grevillea 19: 14. 1890.
≡ *Dendrostilbella aurifila* (Gerard) Seifert & MacKinnon, Mycologia 75: 324. 1983.
= *Stilbum zacalloxanthum* Moore, Amer. Nat. 93: 41. 1959.
= *Stilbum mycetophilum* S. Ahmad, Biologia, Lahore 6: 136. 1961 ['1960'].

This species was described and illustrated by Samuels *et al.* (1990) and Seifert (1985). Cultures: CBS 405.59, 672.83.

SPECIMEN ILLUSTRATED.— CAMEROON. Bipende, on trunk in virgin forest, July 1899, Zenker 2110 (FH – ex herb. Theissen, holotype of *Sphaerostilbe lutea*).

Sphaerostilbella novaezelandiae Seifert, Samuels & W. Gams, Stud. Mycol. 27: 153. 1985.

Anamorph: *Gliocladium novaezelandiae* Seifert, Samuels & W. Gams, Stud. Mycol. 27: 153. 1985.

This species was described and illustrated in Seifert (1985). Cultures: CBS 646.83, 648.83.

KEY TO THE SPECIES OF *SPHAEROSTILBELLA*

1. Ascomata and subiculum dark red to purple; ascospores (8.5–)10–12(–14) × 3–4 µm ..... *S. berkeleyana*
1. Ascomata and subiculum in shades of yellow 2

2. Anamorph mononematous; ascospores (7–)8–11(–15) × 2–3 µm ..... *S. aureonitens*
2. Anamorph synnematous 3

3. Synnemata white to yellow, KOH–; ascospores (7–)8–12 × 3–4 µm .... *S. novaezelandiae*
3. Synnemata yellow to orange-yellow, KOH+ purple; ascospores (6–)7–8.5(–10) × 2–3 µm ..... *S. lutea*