KEY TO THE SPECIES OF ARACHNOCREA

1. Part-ascospores mostly 3–4 μm wide, ends acute or subacute, slightly spinulose .................................................. A. scabrīda

2. Part-ascospores mostly 2–2.5 μm wide, ends acute, smooth-walled ............................................. A. stipata


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. Ascii 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, (3.5–)4.5–5.5 × 2.5–3 μm; proximal part wedge-shaped to oblong, (3.5–)4.5–5(–6) × 2.5–3 μm, hyaline, spinulose.

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


Type: H. rufa (Pers. : Fr.) Fr. (= Sphaeria rufa Pers. : Fr.).

= Creopus Link, Handbuch Erk. Gewächse 3: 349. 1823. — 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, stromal 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−. Ascii cylindrical. Ascospores
l-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 *Hypocreæa* 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 *Hypocreæa*. 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 appear to be stalked, as in *H. poroniodæa* (Samuels & Lodge, 1996a). In some species the stroma is effused over the substratum to a greater or lesser extent. Colors of stromata in *Hypocreæa* are typically in shades of rufous to brown or black, also commonly yellow. Ascospores in *Hypocreæa* are usually hyaline, but also green. Rifai (1969b) and Samuels & Rossman (1992) segregated species of *Hypocreæa* with non-septate ascospores into *Sarawukus Boedijn*.

The genera *Chromocrea* and *Creopus* were segregated from *Hypocreæa* 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 *Hypocreæa* 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 *Hypocreæa*.

Most species of *Hypocreæa* occur on bark, deorticlated wood, or *Aphyllophorales*, although there is no apparent 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; Rifa'i & 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. Hypocreum (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 extraliminal 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.

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 perpendiculor 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. Ascii cylindrical, 100–124 × 6–7 μm, apex thickened, with a pore, ascospores uniseriate. Ascospores one-separate, disarticulating into two part-ascospores in the ascii; part-ascospores dimorphic, with distal part (to the ascus 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' Scleromycei Sueciae 303 issued as Sphaeria rufa is herein designated the neotype.

Additional specimen examined: UNITED STATES, North Carolina: Wayah Bald, on desiccated 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 conforms 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.
Genera of Hypocreales: Hypocreaceae

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

Specimens illustrated:
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).


Type: H. riccioidea (Bolton) P. Karst. (= Sphaeria riccioidea Bolton), a synonym of Hypocreopsis lichenoides (Tode) Seaver.

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. Ascii cylindrical, 8-spored. Ascospores ellipsoid to fusiform, 1-septate, rarely 3-septate, hyaline, minutely to coarsely warted. Anamorph, where known, Stromatocera. On decaying woody substrata, often on Hymenochea 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 Hypocreax. 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).


=Hypocreax digitata Ellis & Everh., J. Mycol. 1: 42. 1885.


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 cory. Surface smooth on young lobes, becoming rugose in central areas, covered by a patulae of fusiform conidiophores budding conidia from their apices, ascomatal ostioles visible as minute black dots. Stromata a uniform reticulum of intermixed hyphae forming a tectura intricata, hyphae thin-walled, branched, 3–5 μm wide, near the surface with vesicular, interzalary, swollen cells, 10–15 μm diam. Ascomata globose, 180–250 μm diam. Ascomatal wall pseudoparenchymatous. Ascii 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 Hymenochea 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 Hymenochea spp., usually above ground level.


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