

Four Species of *Hypocrea* (Hypocreaceae) Found in Taiwan

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Abstract. Four species of *Hypocrea* are described and illustrated in this study. *Hypocrea pachybasioides* and *H. sulphurea* are newly recorded in Taiwan, and *H. jecorina* and *H. rufa* are redescribed.

Key words: *Hypocrea*, Hypocreaceae, Taiwan.

INTRODUCTION

Eight species and one variety of *Hypocrea* have been reported from Taiwan (Sawada, 1919; Doi *et al.*, 1984; Chang *et al.*, 2000; Wu and Wang, 2000; Chang *et al.* 2001), including: *H. brunneolutea*, *H. cf. flavovirens*, *H. jecorina*, *H. lenta*, *H. lutea*, *H. patella*, *H. rufa*, *H. rufa* var. *formosana*, and *H. schweinitzii*. Among these, *H. brunneolutea*, *H. cf. flavovirens*, *H. jecorina*, and *H. schweinitzii* were reported as new records without a description or illustration (Wu and Wang, 2000). In this study, four species of *Hypocrea* are described and illustrated. *Hypocrea pachybasioides* and *H. sulphurea* are newly recorded from Taiwan, and *H. jecorina* and *H. rufa* are redescribed. Microscopic characteristics were examined under a light microscope attached to phase-contrast and differential interference contrast lenses, and measurements were made with material mounted in distilled water. Specimens are deposited at the herbarium (TNM) of the National Museum of Natural Science (NMNS), Taichung, Taiwan.

TAXONOMIC TREATMENT

Hypocrea jecorina Berk. & Broome. J. Linn. Soc. Bot. 1873; 14: 112.
(Figs. 1A-F, 2A-F)

Stromata dispersed, sometimes aggregate and confluent forming large irregular masses, ochre-brown or dark-brown in dried specimens, punctate

with darker ostioles; slightly constricted at bases, with undulate margins, generally 2.0~4.0(~9.1) mm in diam., 1~1.8 mm thick. In vertical section, tissue pseudoparenchymatous, with polyhedral cells, 6~10 µm in diam.; ostiolate surface tissue of *textura epidermoidea*; hyphae of ostiolate surface tissue thick-walled, walls slightly pigmented, generally brownish, 4~5 µm in diam.; tissue below stromal surface compact, composed of intertwined, hyaline hyphae. Perithecia subglobose, 120~150 µm in diam.; neck of ostioles 62.5~75 µm long. Asci cylindrical, 78~93 × 3~5 µm, with 16 part-spores arranged uniseriately; slightly thickened at tip. Part-spores hyaline, with warts, distal part-spores obovate-subglobose, 3~4 × 3~4 µm, and proximal part-spores oval, 4~5 × 3 µm.

Colonies on MEA medium spreading rapidly. Mycelia pale yellowish-green, yellowish-green on reverse, mainly submerged, margin entire, reaching 7.6~8.0 cm in diam. after 2 days at room temperature. Hyphae hyaline, branched, septate, 3~5 µm wide. Aerial hyphae dense, white, forming compacted to hemispherical, white to cyan hyphal masses. Conidiophores *Pachybasium*-like, more or less close to *Trichoderma*-type, septate, long, 3~5 µm in diam., often ending in sterile apices; apices curled and roughened with granulations; branches of conidiophores short, lateral. Phialides hyaline, crowded, flask-shaped, 7~10 × 3~4 µm. Conidia hyaline to pale green, smooth, sometimes echinulate, subglobose or ellipsoid, 3~4 × 2~2.5 µm.

Specimens examined: Taichung: NMNS, Botanical Garden, on rotten wood, coll. W.N. Chou, WAN 1209, Aug. 1, 2007 (TNM F21407).

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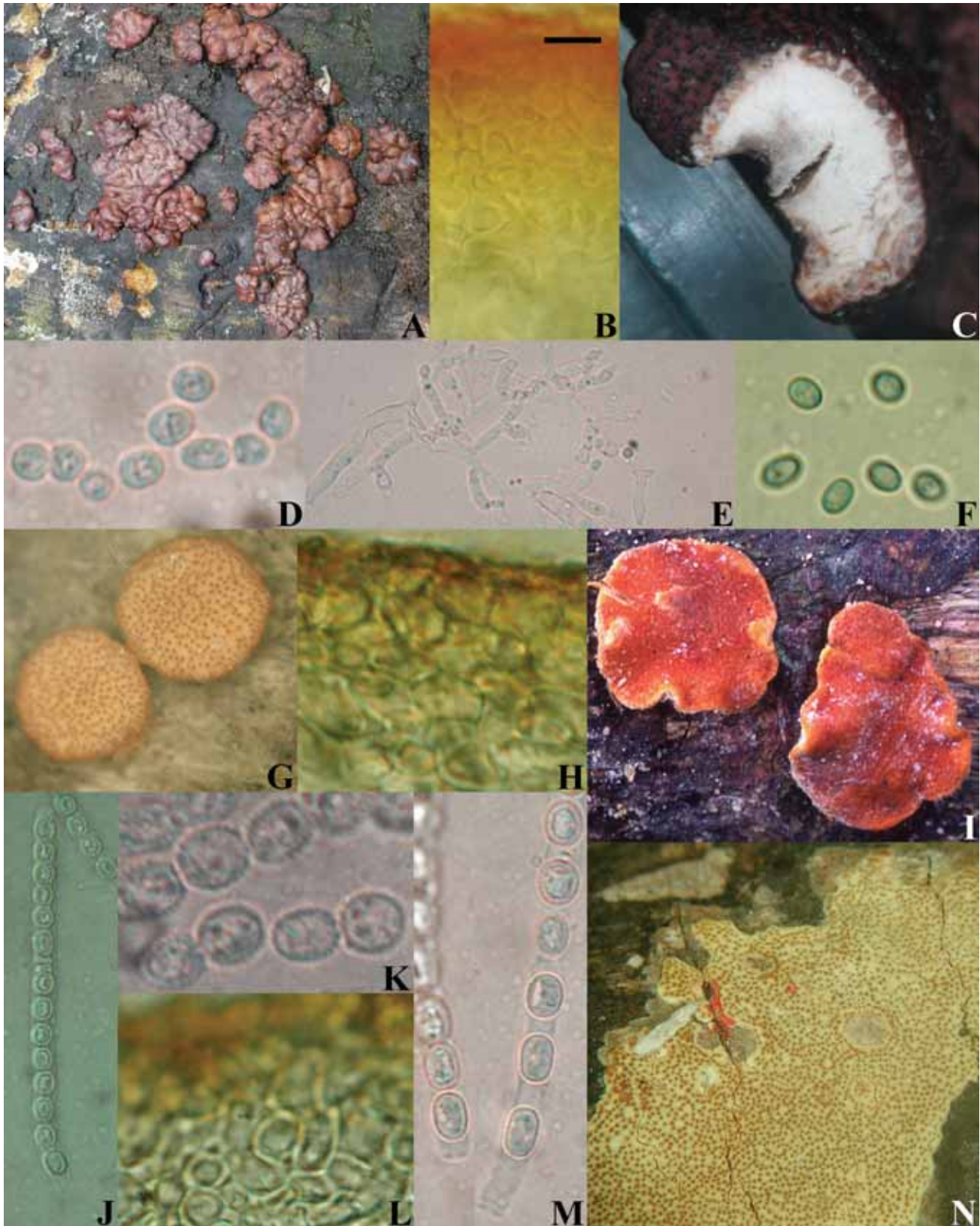


Fig. 1. A-F. *Hypocrea jecorina*. A. Solitary to confluent stromata. B. Vertical section of ostiolate surface tissue of stromata. C. Vertical section of stromata. D. Part-spores. E. Conidiophores. F. Conidia. G and H. *Hypocrea pachybasiioides*. G. Pulvinate stromata. H. Vertical section of ostiolate surface tissue of stromata. I-L. *Hypocrea rufa*. I. Pulvinate stromata. J. Asci with part-spores. K. Part-spores. L. Vertical section of ostiolate surface tissue of stromata. M and N. *Hypocrea sulphurea*. M. Asci with part-spores. N. Effuse stromata. Scale bar: A = 1 cm; B, J = 10 μm ; C, G = 600 μm ; D, H, L, M = 8 μm ; E = 20 μm ; F, K = 4 μm ; I, N = 1200 μm .

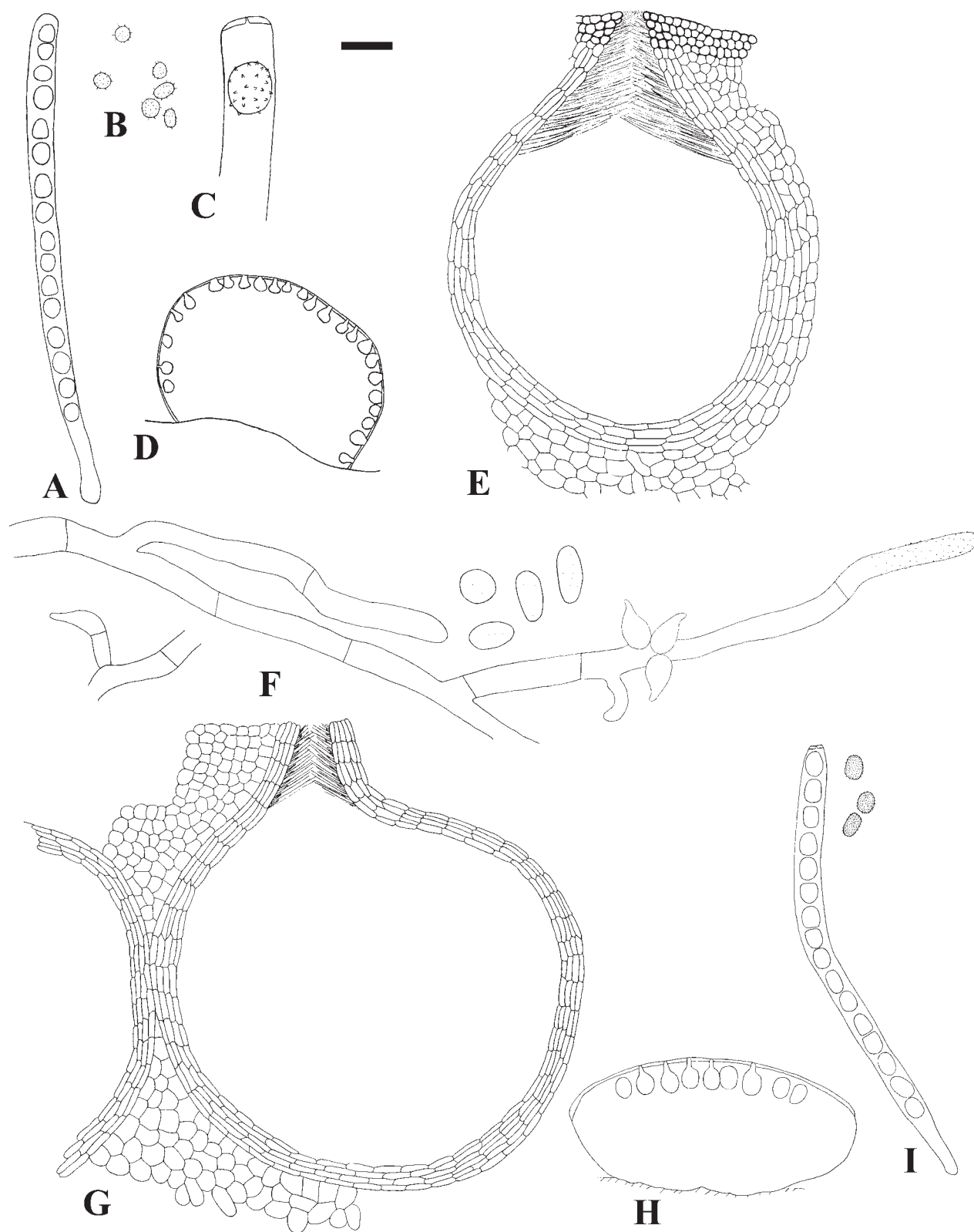


Fig. 2. A-F. *Hypocrea jecorina*. A. An ascus. B. Part-spores. C. Upper part of an ascus. D and E. Vertical section of stromata. F. Conidiophores and conidia. G-I. *Hypocrea pachybasioides*. G and H. Vertical section of stromata. I. An ascus and part-spores. Scale bar: A, F, I = 8 μ m; B = 15 μ m; C = 4 μ m; D = 600 μ m; E, G = 20 μ m; H = 200 μ m.

Pingtung: Kenting National Park, Chufengshan, on rotten wood, coll. C.C. Wen, WAN 618, Nov. 10, 1998 (TNM F8923); on twigs, coll. C.C. Wen, WAN 404, Apr. 14, 1997 (TNM F5684); Nanjenhu, on rotten wood, coll. C.C. Wen, WAN 586, Apr. 30, 1998 (TNM F8315).

Hypocrea jecorina is characterized by effused, ochre-brown stromata, dark, punctate ostioles, and thick-walled ostiolate surface tissue. *Trichoderma reesei* was reported to be the anamorph of *H. jecorina* (Samuels *et al.*, 1998). The specimen, Wang 1209, has larger stromata of up to 2.5×1.6 cm.

Hypocrea pachybasioides Yoshim. Doi, Bull. Natl. Sci. Mus. Tokyo 1972; 15: 685. (Figs. 1G, H, 2G-I)

Stromata irregularly pulvinate with a rugose surface, solitary to confluent, often converging into effused masses, yellowish-brown to bay-brown in dried specimens, punctate with darker ostioles, attaches to substratum by a slightly constricted base, 0.7~2.5(~4.5) mm in diam., 0.4~0.6 mm thick. In vertical section, tissue pseudoparenchymatous, with elongated cells, 6~10 µm in diam.; stromal surface region sharply distinguished from internal tissue, of *textura globulosa* to *textura angularis*, cells thick-walled, 4~6 µm in diam., walls slightly pigmented, yellowish-brown; tissue below stromal surface compact, composed of intertwined, hyaline hyphae. Perithecia subglobose, 130~140 µm in diam.; neck of ostioles 62~77 µm long. Asci cylindrical, 80~99 \times 5 µm, with 16 part-spores arranged uniseriately; slightly thickened at tip. Part-spores hyaline, with minute warts, distal part-spores obovate-subglobose, 4~5 \times 3~3.5 µm, and proximal part-spores oval, 4~5 \times 2.5~3 µm.

Specimens examined: Miaoli: Mapihaohsi, on rotten wood, Sy 1, Aug. 28, 1995 (TNM F3691). Nantou: Kuankao, on burnt wood, coll. W.N. Chou, WAN 188, Aug. 10, 1995 (TNM F3459); Meifeng, on dead branches, WAN 163, June 14, 1995 (TNM F3426); Sunlinksea, on dead twigs, coll. S.H. Wu, Wang 92109, Sept. 19, 1994 (TNM F325). Pingtung: Nanjenshan, on bark of dead wood, coll. C.C. Wen, WAN 348, Nov. 9, 1996 (TNM F5313).

Hypocrea pachybasioides is commonly found in central and southern Taiwan. It is characterized by pulvinate, ochre-brown stromata and dark, punctate ostioles (Doi, 1972). This species is newly recorded in Taiwan. Liu *et al.* (2002)

reported it from China and assigned the anamorph as being *Pachybasium*-like. Lu *et al.* (2004) confirmed that the anamorph of *H. pachybasioides* is *Trichoderma polysporum*.

Hypocrea rufa (Pers.) Fr., Summ. Veg. Scand. 1849; 383. (Figs. 1I-L, 3A-F)

≡ *Sphaeria rufa* Pers., Observ. Mycol. 1796; 1: 20.

≡ *Sphaeria rufa* Pers.: Fr., Syst. Mycol. 1822; 2: 335.

Stromata pulvinate with irregular margins, orange-brown in dried specimens, 0.5~0.6 cm long, 0.3~0.4 cm wide, 0.5~0.65 mm thick, punctate with reddish-brown ostioles; ostiolate surface tissue of *textura epidermoidea*, hyphae thick-walled, reddish-brown, 4~5 µm in diam.; tissue below stromal surface composed of slender, hyaline hyphae. Perithecia subglobose, 100~150 µm in diam.; neck of ostioles 90~100 µm long. Asci cylindrical, 80~100 \times 5 µm, with 16 part-spores arranged uniseriately; slightly thickened at tip. Part-spores hyaline, with minute warts, distal part-spores obovate, 4~4.5 \times 3.5~4 µm, and proximal part-spores obovate-subcylindrical, 5~6 \times 3~4 µm.

Specimens examined: Taipei: Yangmingshan, on dead twigs, coll. C.H. Huang, WAN 729, Aug. 24, 1999 (TNM F9800). Miaoli: Shihshuikeng, on rotten wood, coll. C.C. Wen, WAN 628, Nov. 30, 1998 (TNM F8933); Tahu, Shuiliutung, on branch of angiosperm, Chen 1033, Nov. 14, 2000 (TNM F12050). Taichung: Anmashan, on dead branches, coll. W.N. Chou, WAN 400, Mar. 26, 1997 (TNM F5680); on dead twigs, coll. W.N. Chou, WAN 906, June 18, 2002 (TNM F13910). Nantou: Lienhuachih, on rotten wood, coll. W.N. Chou, WAN 554, Feb. 26, 1998 (TNM F8287); Meifeng, on rotten wood, WAN 791, Aug. 10, 2000 (TNM F11310); Wushe, abandoned check post, on dead branches, coll. W.N. Chou, WAN 312, July 4, 1996 (TNM F5137). Pingtung: Kenting National Park, Chufengshan, on dead twigs, coll. S.Z. Chen, WAN 336, Oct. 15, 1996 (TNM F5292); coll. C.C. Wen, WAN 699, July 14, 1999 (TNM F9858); on rotten wood, coll. C.C. Wen, WAN 526, Dec. 10, 1997 (TNM F7708).

Hypocrea rufa is a widely distributed species, known from Australia, China, Europe, Japan, New Zealand, North America, and South America (Liu *et al.*, 2000). The distinct characteristics of this species are the pulvinate and reddish-brown stromata with thick-walled ostiolate surface tissue. The anamorph of *H. rufa* is *Trichoderma viride*

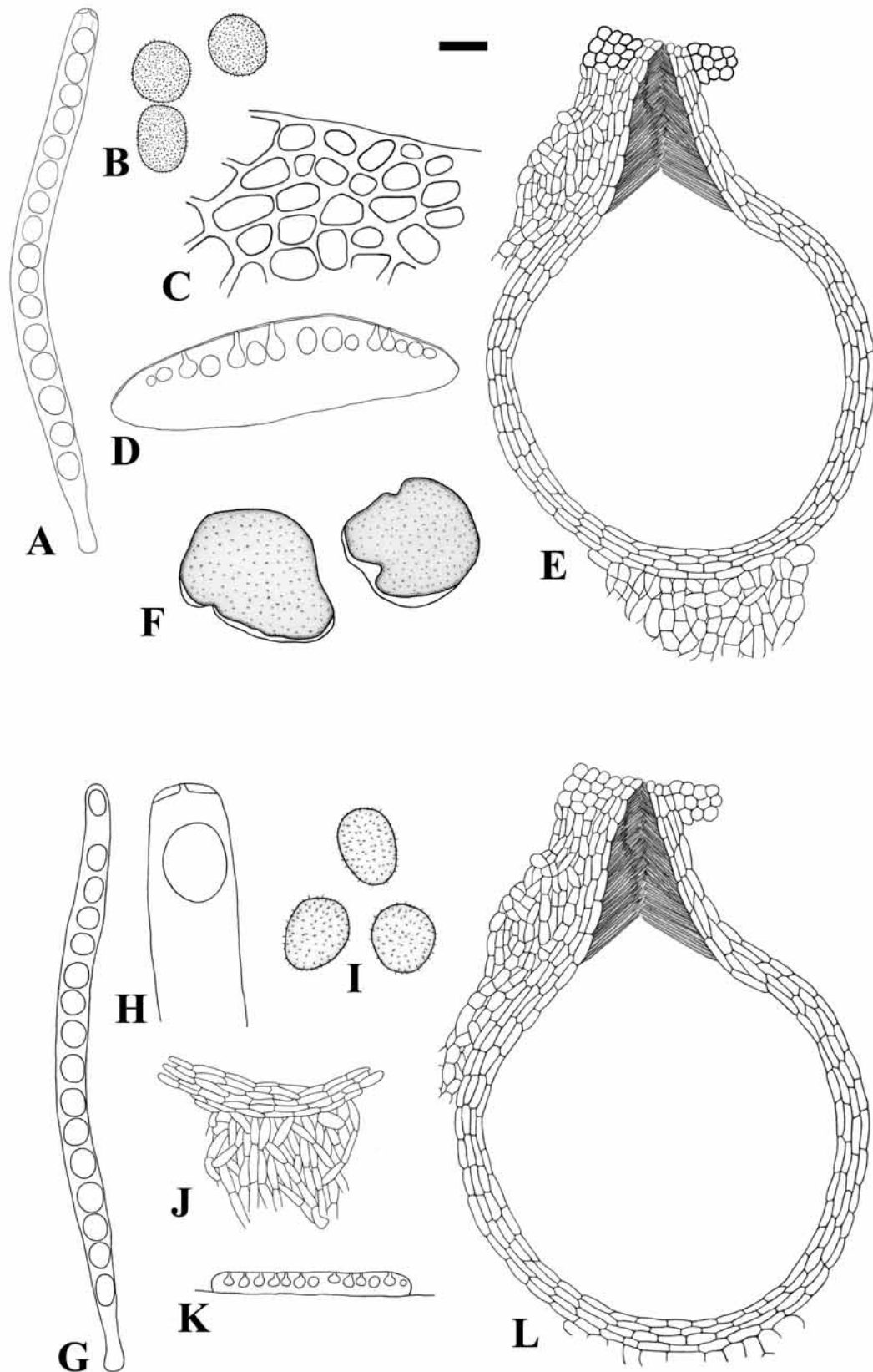


Fig. 3. A-F. *Hypocrea rufa*. A. An ascus. B. Part-spores. C. Vertical section of ostiolate surface tissue of stromata. D and E. Vertical section of stromata. F. Stromata. G-L. *Hypocrea sulphurea*. G. An ascus. H. Upper part of ascus. I. Part-spores. J. Stromatal tissue around perithecia. K and L. Vertical section of stromata. Scale bar: A, C, G = 8 μ m; B, I = 4 μ m; D = 250 μ m; E, L = 20 μ m; F = 125 μ m; H = 2.5 μ m; J = 25 μ m; K = 800 μ m.

(Doi *et al.*, 1984). This species was previously described and illustrated by Chang *et al.* (2001). In this study, we provide additional microscopic characteristics. Doi *et al.* (1984) reported *H. rufa* var. *formosana* from Taiwan which differs from var. *rufa* in its ellipsoid or obovoid-ellipsoid, and medium-sized conidia.

Hypocrea sulphurea (Schwein.) Sacc., Syll. Fung. 1883; 2: 535. (Figs. 1M~N, 3G~L)

≡ *Sphaeria sulphurea* Schwein., Trans. Am. Phil. Soc. 1832; 2: 193.

Stromata effuse, flat, light yellow in dried specimens, margins generally irregular, 1.8~2.0 cm long, 0.7~0.8 cm wide, 0.3~0.32 mm thick, punctate with grayish-brown ostioles. In vertical section, tissue pseudoparenchymatous, cells polyhedral, 5~9 µm in diam.; stromal surface region sharply distinguished from internal tissue, of *textura globulosa*, cells thin-walled, 3~7 µm in diam., walls slightly pigmented, yellowish; tissue below stromal surface composed of slender, hyaline hyphae. Perithecia subglobose, 125~155 µm in diam.; neck of ostioles 50~65 µm long. Asci cylindrical, 112.5~125 × 4~5 µm, with 16 part-spores arranged uniseriately; slightly thickened at tip. Part-spores hyaline, with minute or rough warts, with obovate distal part-spores, 4~5 × (3~) 4~5 µm, and proximal part-spores obovate-subcylindrical, 5~6(~8) × 4 µm.

Specimens examined: Kaohsiung: Liukuei, Shanping, on rotten wood, Wu 931217, Dec. 22, 1993 (TNM F1455). Pingtung: Kenting National Park, Chufengshan, on branch of angiosperm, Wu 9409-16, Sept. 1, 1994 (TNM F2500). Hualien: Fuyuan Forest Recreation Area, on branch of angiosperm, Wu 9906-28, June 26, 1999 (TNM F10560).

The specimens we examined are no longer viable. A *Verticillium*-like anamorph was connected to *Hypocrea sulphurea* by Overton *et al.* (2006). The following characteristics are distinct for this species: stromata flat, effused, and yellowish, ostiolate surface tissue of *textura globulosa*, and part-spores hyaline. It is newly recorded in Taiwan.

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四種臺灣產肉座菌

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本文描述四種臺灣產肉座菌 (*Hypocrea*)，其中 *H. pachybasioides* 與 *H. sulphurea* 為新紀錄種，並補充描述 *H. jecorina* 與 *H. rufa* 的顯微特徵。

關鍵詞：肉座菌屬、肉座菌科、臺灣。