

## Revision of the Hypocreales with Cultural Observations VIII. *Hypocrea peltata* (JUNGH.) BERK. and its Allies

By

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*Hypocrea peltata* (JUNGH.) BERK. is a species characterized by large, peltate, pale carnose or brown stromata. It has the conidial state of the Aleuriospore-type. This conidial state is quite different from the *Trichoderma*-state of the Phialospore-type, which almost all species of *Hypocrea* produce.

The species has been reported from tropical, subtropical and temperate regions such as Java (JUNGHUHN, 1838), the Philippines (BERKELEY, 1842; LLOYD, 1924), India (BERKELEY, 1851), Samoa (LLOYD, 1924), Malaysia (DOI, 1971), New Guinea (DOI, 1971), and Japan (DOI, 1971, 1972).

There seems to be some confusion in the interpretation of the present species: some specimens of this species have been reported under various names from South America, Africa, South Asia (Ceylon) and Japan. As a result of typification of *Sphaeria peltata* JUNGHUHN based on a careful examination of JUNGHUHN's collection preserved at the Rijksherbarium in Leiden (L), four of these species are reduced to synonyms of *H. peltata*.

Furthermore, some additional species which resemble *H. peltata* have been clarified by close comparisons with JUNGHUHN's collection of *Sphaeria peltata* and by observations in culture.

A new species, *Hypocrea hemisphaerica* DOI which resembles *H. peltata*, is described together with the above-mentioned species in this paper.

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***Hypocrea peltata* (JUNGH.) BERK.**

Hooker's Journ. Bot. 3: 206 (1851).

*Sphaeria peltata* JUNGH., Praemissa in Floram Cryptogamicam Javae Insulae 20 (1838).

Type collection: JUNGHUHN's collection 103, Jair JUNGH., Silvae Montis Kendang (Herb. Ludg. Bat. 20: Ind. Or. no. 910; 250-1421)—holotype ? (L).

*Hypocrea argentinensis* SPEG., An. Mus. Nac. Buenos Aires 19: 409 (1909). Type collection: *S/. Patagonula americana*, Jujuy, San Francisco, IV-1905, C. SPEGAZZINI—holotype (LPS 1724).

*Hypocrea austro-grandis* HASHIOKA et KOMATSU, Rep. Tottori Mycol. Inst. 4: 4 (1964). Type collection: On Quercus, Kamishishi-gawa, Kitakata-Mura, Higashi-usuki-Gun, Miyazaki Pref., 27-VIII-1964, NISHIGAWA (Miyazaki no. 12 in KOMATSU's collection)—isotype (TNS F-225586).

*Hypocrea gigantea* PETCH, Ann. Roy. Bot. Gard. Peradeniya 7: 131 (1920). Type collection: Waga, Ceylon, March 1917, T. PETCH 6082—syntype ? (K).

*Hypocrea paraguayensis* SPEG., An. Mus. Nac. Hist. Nat. Buenos Aires 31: 416 (1922). Type collection: *S/. Arbol tronchado* (Naranja ?), Asunción, Paraguay, IX-1919, C. SPEGAZZINI—holotype (LPS 1718).

Only one specimen of *Sphaeria peltata* from JUNGHUHN's collection (L) was available for the present study. Although JUNGHUHN cited a specimen as "Invenimense Julio in Silvis Montium Kendang, alt. 2000 pedum", the data on the specimen is a little different as indicated above. However, this seems to be the only specimen of *Sphaeria peltata* extant in JUNGHUHN's collection. Thus it may be the holotype or at least an authentic specimen.

In 1883, SACCARDO proposed the new combination *Hypocrea peltata* (JUNGH.) SACC. without knowing of BERKELEY's combination of 1851. Thus, *H. peltata* (JUNGH.) BERK. is adopted in this paper. The holotype specimen of *Hypocrea argentinensis* bears many well-matured stromata. The shape and size of stromata, t.o.s.s.<sup>1)</sup>, and p.sp. are identical to those of Asian specimens including the JUNGHUHN's specimen of *Sphaeria peltata* mentioned above. In an isotype of *H. austro-grandis* at TNS, the p.sp. are a little larger than those of JUNGHUHN's specimen as shown in Fig. 2, J-K. However, such minute variation in spore size does not seem to have systematic importance.

When PETCH (1920) described *H. gigantea*, he cited three specimens: (1) no. 2361, Peradeniya, 1907, (2) no. 4881, Henaratgoda July, 1916, and (3) no. 6032, Waga, March, 1917. A specimen of *H. gigantea* kept at K was collected at Waga in March 1917 and is numbered "6082". It is probable that the number "6032" in the original description is a misprint and the specimen numbered 6082 may be considered to be a

1) Abbreviated terms are the same as those used in the writer's previous papers.

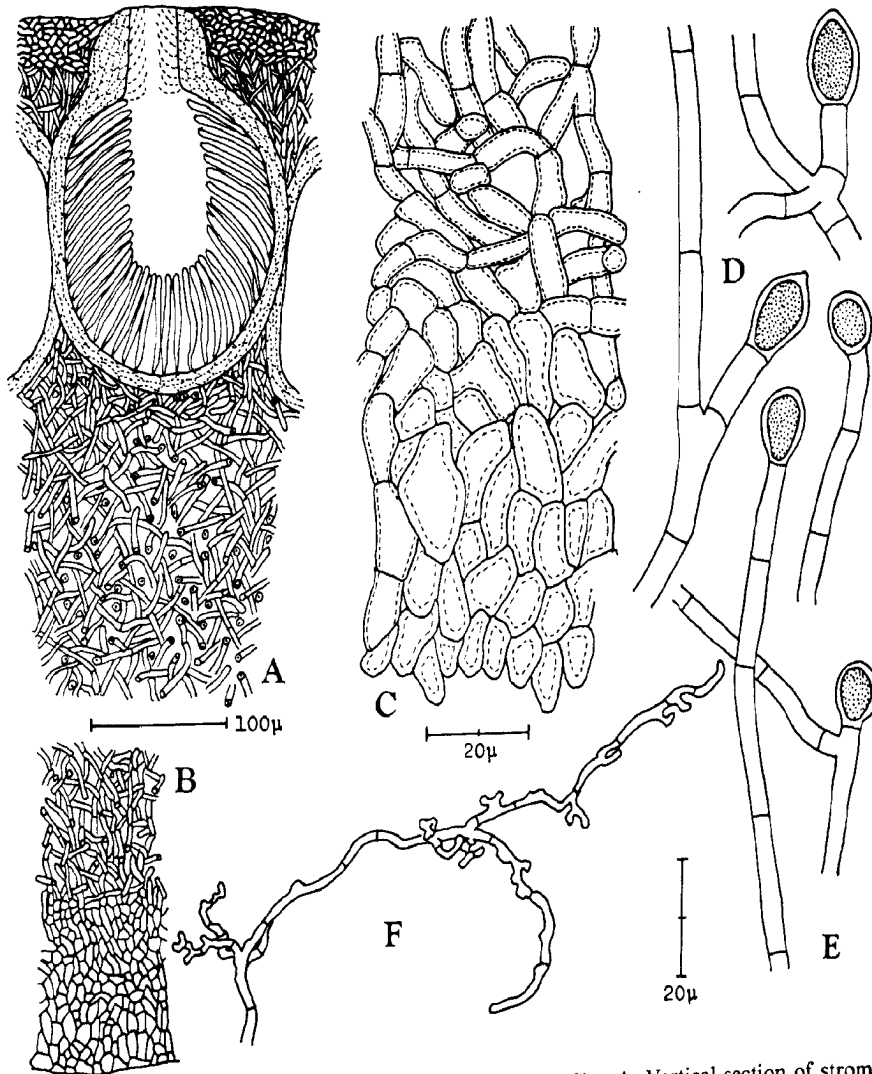


Fig. 1. *Hypocrea peltata* (JUNGH.) BERK. (F-225383 in TNS). A. Vertical section of stroma. B. Vertical section of underside of stroma. C. Vertical section of inner tissue of stroma. D. E. Aleuriopore-type conidial state. F. Hypha on culture medium.

syntype of *H. gigantea*. In specimen no. 6082, the paper packet contains only one stroma, which is rufous brown and strongly waved. The p.sp. seem to be over-matured and are completely liberated from the asci. Nevertheless, they consist of p.sp. of two different sizes, which is the characteristic of *H. peltata*. The t.o.s.s. and the loosely interwoven inn.t. composed of thick-walled hyphae of the stroma, are identical with those of JUNGHUHN's specimen.

The stromata of the holotype of *Hypocrea paraguayensis* are reddish brown and rather small (5–10 mm in diam.), and the specimen looks a little different from the specimens collected in Asia. However, the size and shape of p.sp. and pattern of

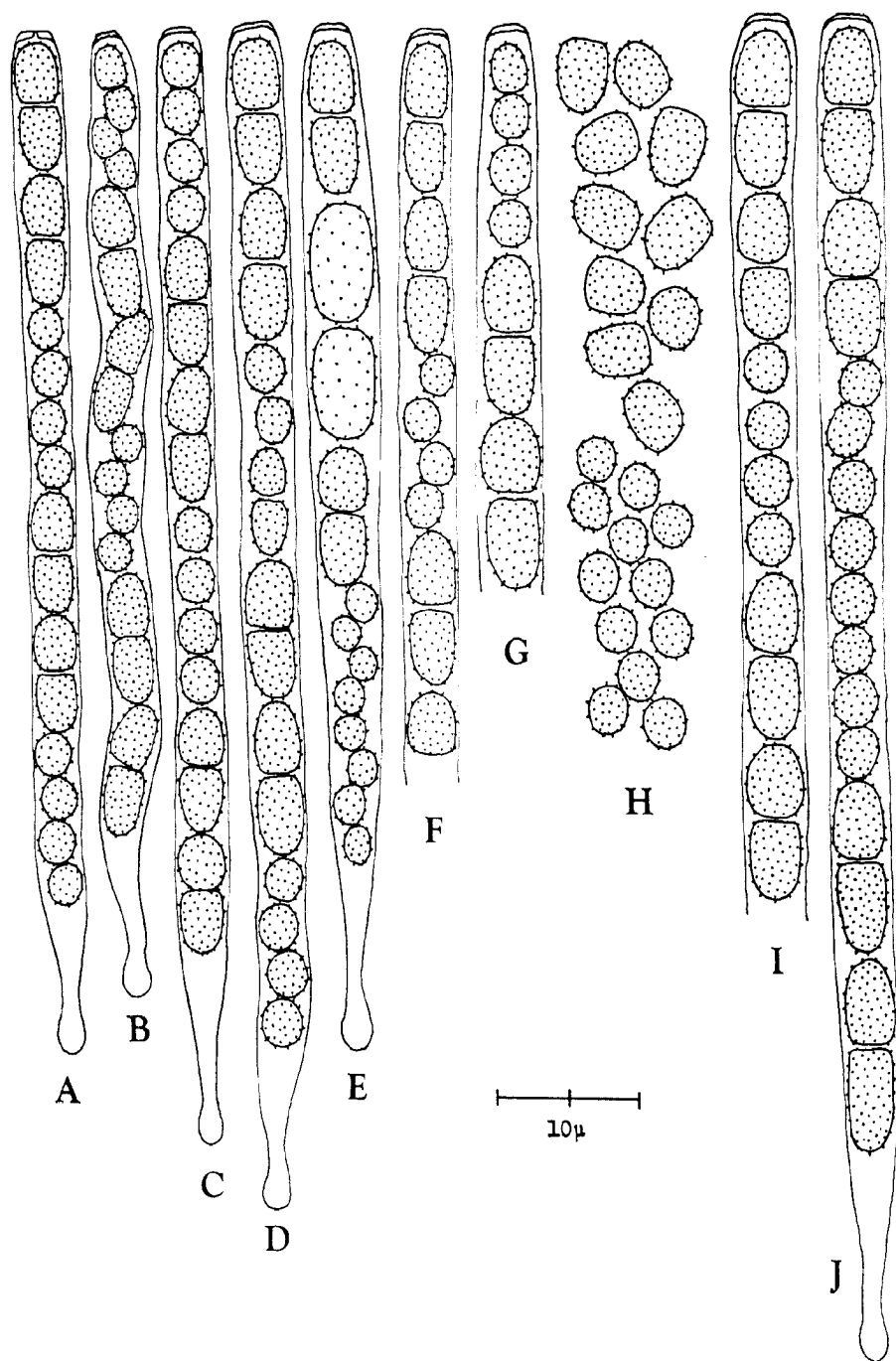


Fig. 2. Asci and p. sp. of *Hypocrea peltata* (JUNGH.) BERK. A. JUNGHUHN's collection 103 (L). B. F-225383 in TNS. C. Mme GOSSENS 1003 under *Hypocrea cerebriformis* BEELI (K). D. E. Holotype of *Hypocrea paraguayensis* SPEG. (LPS 1718). F. G. Holotype of *Hypocrea argentinensis* SPEG. (LPS 1724). H. Syntype ? of *Hypocrea gigantea* PETCH (PETCH 6082 in K). I. J. Isotype of *Hypocrea austro-grandis* KOMATSU et HASHIOKA (F-225586 in TNS).

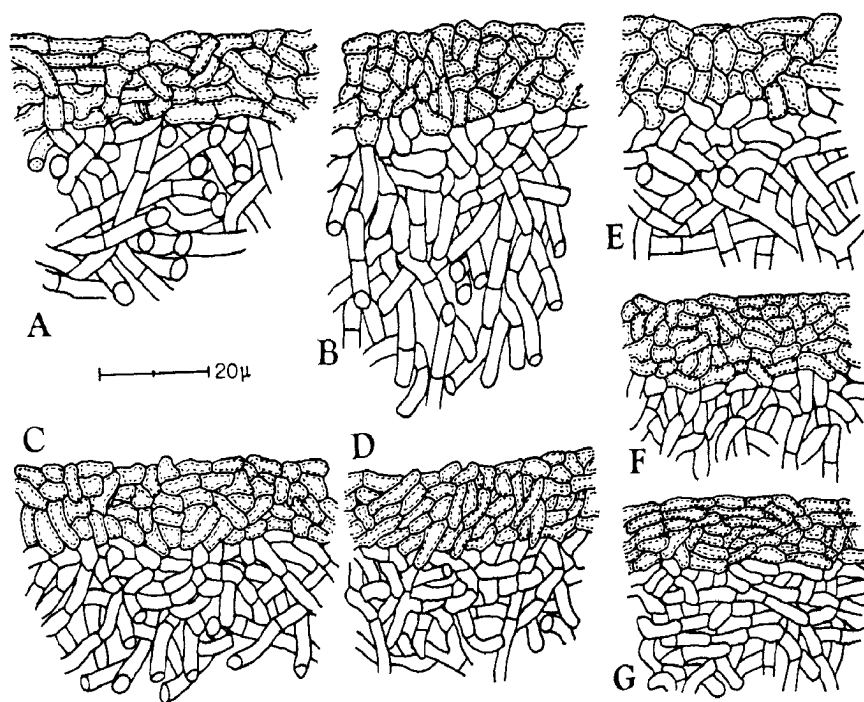


Fig. 3. Vertical sections of t.o.s.s. of *Hypocrea peltata* (JUNGH.) BERK. A. JUNGHUHN's collection 103 (L). B. Holotype of *Hypocrea paraguayensis* SPEG. (LPS 1718). C. Mme GOSSENS 1003 under *Hypocrea cerebriformis* BEELI (K). D. Isotype of *Hypocrea austro-grandis* KOMATSU et HASHIOKA (F-225586 in TNS). E. F-225383 (TNS). F. Syntype ? of *Hypocrea gigantea* PETCH (PETCH 6082 in K). G. Holotype of *Hypocrea argentinensis* SPEG. (LPS 1714).

t.o.s.s. are nearly identical with those of JUNGHUHN's specimen. In addition, the writer collected a specimen at Tomé-açu, Brazil, which very much resembles the holotype of *H. paraguayensis*. The Aleuriospore-type conidial state as well as size and shape of p.sp. and pattern of t.o.s.s. are almost identical with those of Asian specimens as shown in Figs. in 2-D, E and 3-B. Thus, the difference 1, the size of the stromata in the holotype of *H. paraguayensis* is considered here to have no taxonomic value.

P.sp. of specimens mentioned above are compared in Fig. 2 and t.o.s.s. in Fig. 3. Specimens examined. Japan, Kyushu. Miyazaki Pref.: Kadokawa-Cho, Higashi-usuki-Gun, 11-X-1968, NISHIGAWA (Miyazaki no. 38 in KOMATSU's collection) (TNS); On Quercus, Kakokawa-Cho, Higashi-Usuki-Gun, 17-VIII-1967, NISHIGAWA (Miyazaki no. 28 in KOMATSU's collection) (TNS). India. Darjeeling, no collector indicated (K). New Guinea. On rotten wood, Busu River, Lae, 28-IX-1960, E.J.H. CORNER (no number indicated); On bark, rain forest, Bulolo, 15-III-1972, J. HORAK NG-96 (TNS). Brazil. Tomé-açu, Pará, 22-24-IX-1973, Y. DOI, D. 1477 (TNS F-225383). Congo. Binga, Dec. 1934, Mme GOSSENS 1003, under *Hypocrea cerebriformis* BEELI (K).

**Hypocrea albocornea** DOI

Bull. Natn. Sci. Mus. Tokyo, 12: 712 (1972).

The stromata of this species resemble those of *H. peltata* and *H. cornea*, but the former are generally smaller. *H. albocornea* is different from *H. peltata* by the green p.sp. and *t. angularis*-type t.o.s.s. *H. albocornea* is also different from *H. cornea* by the larger p.sp. and smaller, paler-colored stromata. Its p.sp. scarcely germinated and conidial state was unknown, while p.sp. of *H. cornea* easily germinated and produced green *Trichoderma*-type conidial state.

**Hypocrea cerebriformis** BERK.

Journ. Linn. Soc. 13: 177 (1872).

Stromata irregularly pulvinate or often peltate, sometimes aggregate to form large masses up to 4 cm in diam., up to 8 mm thick, pale brown, ochre or rufous brown. In vertical section t.o.s.s. of *t. epidermoidea* close to *t. angularis* composed of comparatively thin-walled hyphae as observed in those of *H. schweinitzii* (FR.) SACC. Inn. t. of *t. intricata* close to *t. globulosa*, or vertically parallel with long filamentous hyphae. Hyphae of inn. t. slender or slightly constrict at the septa, 4–8  $\mu$  in diam. Perithecia subglobose or vertically elongated, 350–450  $\mu$  in vertical diam. Walls of perithecia slightly yellow. Ostioles not project from the surface of stromata, 100–140  $\mu$  long, 50–60  $\mu$  in diam. Ascus containing 16 p.sp. P.sp. hyaline, roughened; the distal subglobose-obovate, 3.8–5.5  $\times$  2.7–3.8  $\mu$ ; the proximal obovate or short cylindrical, 3.8–6.0  $\times$  2.5–3.2  $\mu$ .

Hab. On decayed woods.

Specimens examined. Australia. ex Herb. M. C. COOKE, under *Hypocrea cerebriformis* B. et BR. (K); the Solomon Islands. Kolombangara, 27–VIII–1965, E. J. H. CORNER, RSS 1118; North Borneo. Kinabalu, 7–IX–1961, E. J. H. CORNER, RSNB 2866; Japan. Towada, Aomori Pref., 24–XI–1964, Y. HAYASHI, under *Hypocrea grandis* IMAI det. by Y. DOI, D. 1 (TNS F-223208); on decayed log of *Pterocarya rhoifolia*, Nukumi-Daira, ca. 800 m alt., Mt. Iide-San, Oguni-Cho, Nishi-okitama-Gun, Yamagata Pref., 10–X–1973, D. SHIMIZU, D. 1496 (TNS F-224585).

Culture. The following description is taken from the cultures of F-224585 at TNS. Growth rapid. Hyphae at first submerged in upper part of slant media, later short aerial. Pale green *Trichoderma*-type conidial state produced after a week in malt agar at room temperature. Conidiophores widely diffused over media, some-

Fig. 4. *Hypocrea cerebriformis* BERK. A. Habits. B. Vertical section of stroma (F-224585 in TNS). C–H. Vertical section of t.o.s.s.: C. Australian collection (K). D. F-223208 (TNS). E. RSNB 2866 (CORNER collection). F. Australian collection (K). G. RSS 1118 (CORNER collection). H. F-224585 (TNS). I–K. Vertical sections of inner tissue of stromata: I. F-224585 (TNS). J. Australian collection (K). K. RSS 1118 (CORNER collection). L. Vertical section of underside of stroma (F-224585 in TNS). M–R. Ascus and p. sp.: M. RSNB 2866 (CORNER collection). O. F-223208 (TNS). P. Australian collection (K). Q. R. F-224585 (TNS).

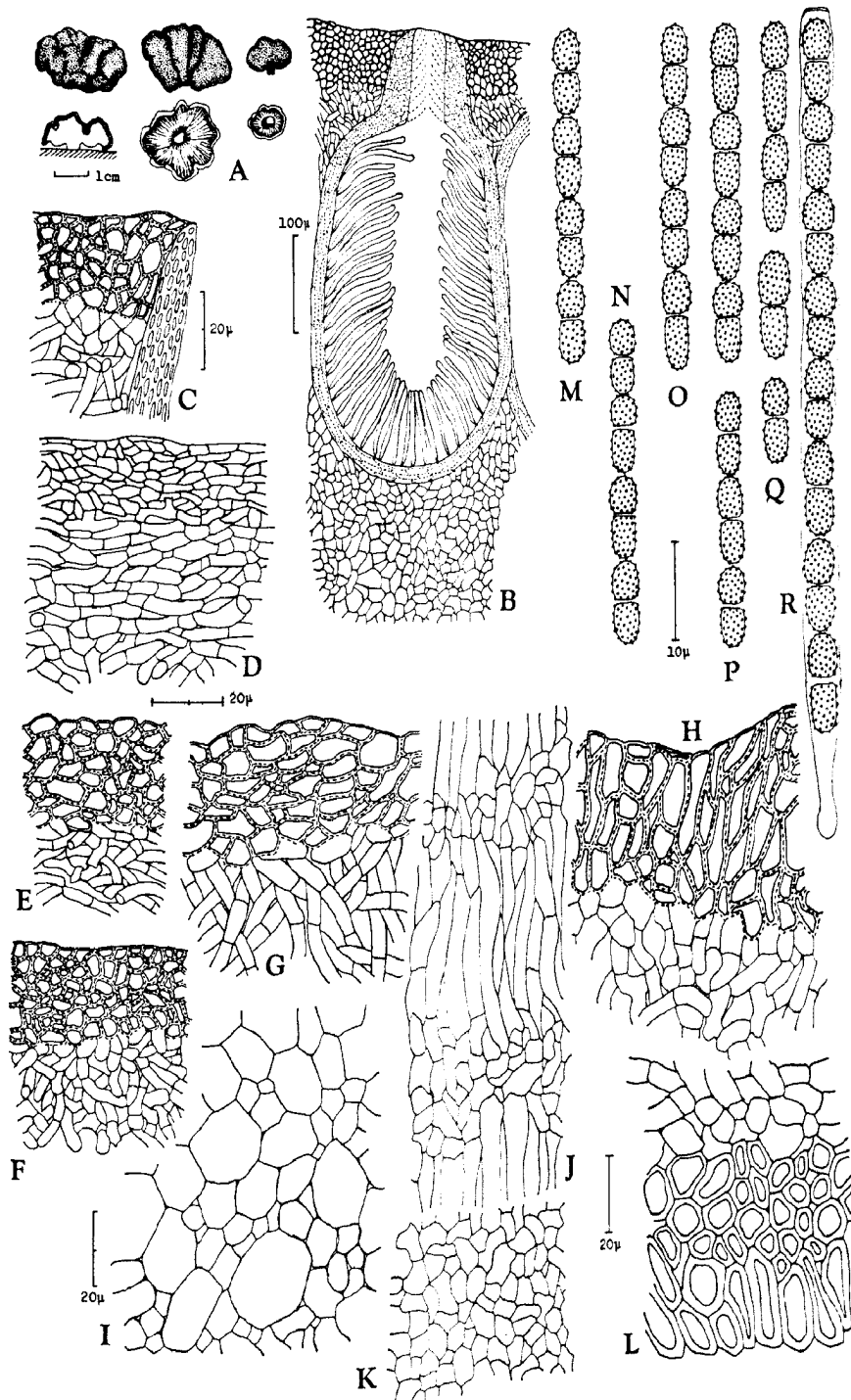


Fig. 4

what resembling those of *H. schweinitzii*, of irregular branching-type, up to  $350\ \mu$  long in main axial hyphae. Phialides slender or slightly curled,  $7\text{--}13\ \mu$  long,  $2\text{--}3\ \mu$  in diam. Conidia pale yellow-green in masses, obovate-ellipsoid, almost smooth,  $2.0\text{--}4.0 \times 1.8\text{--}2.6\ \mu$ . Chlamydospore-like cells abundantly produced in earlier stages on submerged hyphae, spear-shaped or ellipsoid,  $8\text{--}20 \times 2\text{--}7\ \mu$ .

Notes. (1) It is uncertain whether the Australian collection above-listed is an authentic material or not. The writer has not been able to find any other specimens

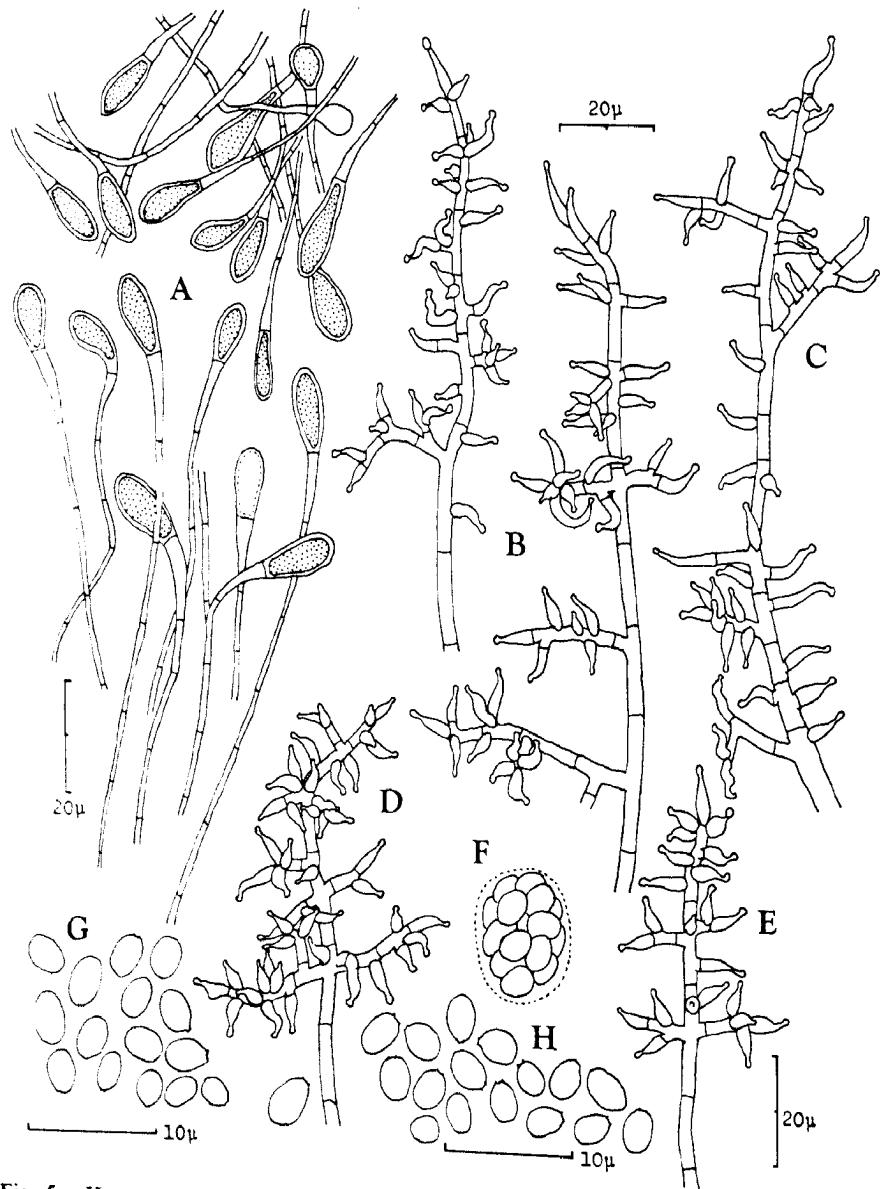


Fig. 5. *Hypocrea cerebriformis* BERK. (F-223208 in TNS). A. Chlamydospore-like cells. B-E. Conidiophores. F. Aggregated conidia. G. H. Conidia.



collected in the type locality. The characteristics of the specimen well agree with those of the original description of the present species. (2) The description of *Hypocrea grandis* IMAI (IMAI, 1935) well agrees with the above-listed Australian specimen. Unfortunately the authentic material of *H. grandis* cannot be found even by Dr. S. IMAI, the author of the species, because of the troubles at the end of War II. Therefore, the writer cannot reduce the name *H. grandis* to a synonym of *H. cerebriformis*. (3) In the writer's previous paper (1972), this species was treated as *Hypocrea grandis* IMAI and this species was erroneously treated as a species belonging to Sect. *Homalocrea* Subsect. *Pulvinatae* Series *Grandes*. The specimen which the writer had examined was TNS F-223208, and the t.o.s.s. of the specimen is not well-matured and very friable for sectioning with razor-blade. This species is now to be classified into Sect. *Hypocrea* Subsect. *Hypocrea* and placed near *H. schweinitzii* (FR.) SACC.

#### *Hypocrea cornea* PAT.

Journ. Bot. Paris 4: 64 (1890).

The stromata of this species well resemble those of *H. peltata*. But *H. cornea* is different from *H. peltata* by the green p.sp., *t. angularis*-type t.o.s.s. and the *Trichoderma*-type conidial state.

#### *Hypocrea hemisphaerica* DOI, sp. nov.

Stromata dispersa, hemisphaerica vel interdum pulvinata vel peltata, dilute carnea, usque ad 20 mm in diam., 8 mm crassa. Texturae superficialium stromatarum intricatae compactae. Ascus 16 partosporus. Partosporae hyalinae, verruculosae; partosporis distalibus subglobosis vel obovatis,  $2.7-4.3 \times 2.5-3.8 \mu$ , partosporis proximalibus obovatis vel subcylindricis,  $4.2-5.6 \times 2.7-3.4 \mu$ .

Stromata dispersed, generally hemispherical, sometimes pulvinate or peltate, pale carnose-brown, resembling those of *Hypocrea pachybasioides* Doi, up to 20 mm in diam., 8 mm thick. In vertical section t.o.s.s. of *t. intricata*. Hyphae of t.o.s.s. compactly interwoven, almost slender, scarcely colored,  $2-3 \mu$  in diam. Inn.t. of *t. intricata*. Hyphae of inn.t. loosely interwoven, hyaline, slightly constricted at the septa,  $5-8 \mu$  in diam. Ostioles not projected from the surface of the stromata,  $70-90 \mu$  long,  $20-40 \mu$  in diam. Ascus containing 16 p.sp. P.sp. hyaline, coarsely roughened; the distal subglobose-obovate,  $2.7-4.3 \times 2.5-3.8 \mu$ , the proximal obovate or short cylindrical,  $4.2-5.6 \times 2.7-3.4 \mu$ .

Hab. on decayed log of *Pandanus* sp.

Type collection. Near Markham Bridge, Lae, New Guinea, 27-XI-1971, Y. Doi, D. 1243 (TNS F-223932—holotype, duplicate in Herb. of the Dept. of Agriculture, Stock and Fisheries, Port Moresby, Papua and New Guinea).

Note. This species resembles *H. pachybasioides* rather than *H. peltata* in the shape and color of stromata and shape and size of p.sp., but the new species has larger stromata and inhabits in tropical rainforest, while *H. pachybasioides* inhabits in cooler seasons in temperate regions. The large, sometimes peltate and pale carnose-brown

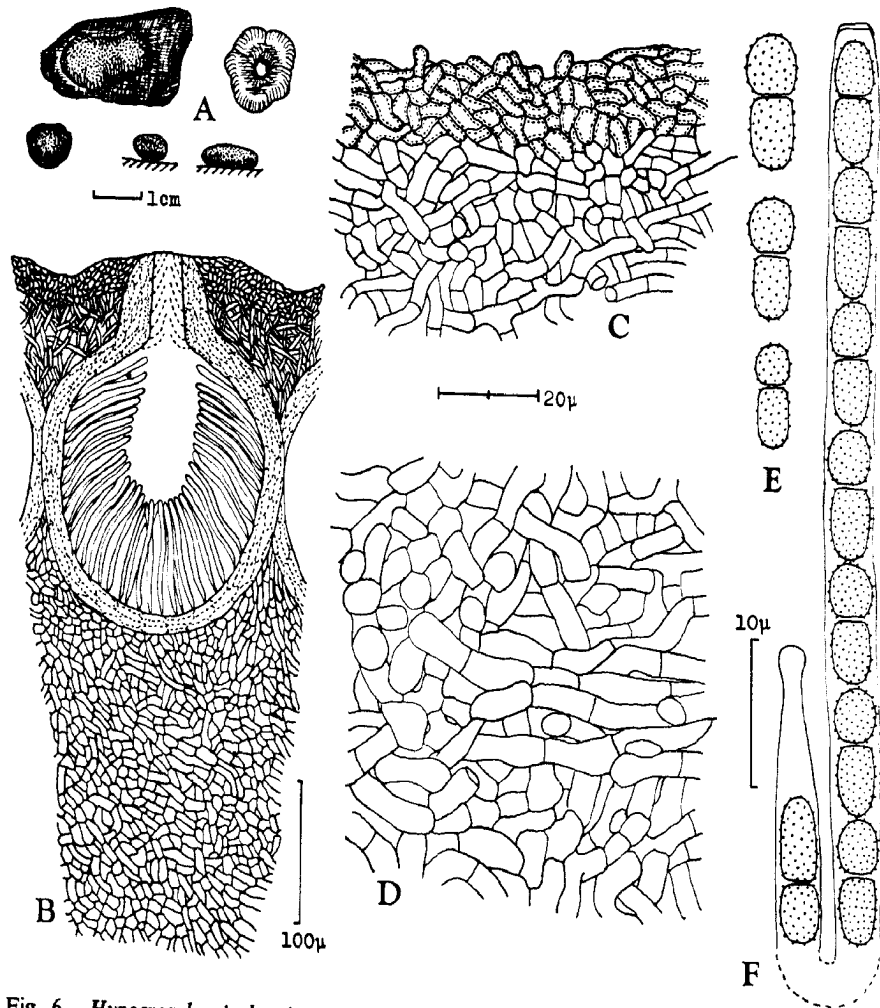


Fig. 6. *Hypocrea hemisphaerica* Doi, sp. nov. (F-223932 in TNS, holotype) A. Habit. B. Vertical section of stroma. C. Vertical section of t.o.s.s. D. Vertical section of inner tissue of stroma. E. P. sp. F. Ascus and p. sp.

stromata of this species resemble those of *H. peltata*, but it has not p.sp. of two different sizes nor very loosely interwoven *t. intricata*-type inn.t. composed of thick-walled and slender hyphae, which are characteristics of *H. peltata*.

#### *Hypocrea petersii* BERK. et CURT.

Grevillea 4: 13 (1874).

Stromata peltate, brown or reddish brown, up to 4 cm in diam. In vertical section t.o.s.s. of *t. intricata*. Hyphae of t.o.s.s. fairly compactly interwoven, slightly thick-walled and colored, almost slender, 3–4  $\mu$  in diam. Inn.t. of loosely interwoven *t. intricata*. Hyphae of inn.t. more or less vertically parallel, thin-walled, almost slender, 5–10  $\mu$  in diam. Perithecia subglobose or vertically elongated, 180–240  $\mu$

in vertical diam. Ascus containing 16 p.sp. P.sp. hyaline, verrucose; the distal subglobose-obovate,  $4.0-5.4 \times 3.8-4.7 \mu$ , the proximal  $4.8-5.8 \times 3.2-4.2 \mu$ .

Hab. unknown.

Specimen examined. Alabama, CURTS (=CURTIS ?) 5258, leg. PETERS (K).

Note. The original description was made only by Berkeley. According to the original description, the collection number of the type collection is "Peters 5251". Therefore it is doubtful that the specimen above-listed is the holotype. The above-listed specimen was collected in the type locality and its characteristics well agree with those of the original description. This specimen has larger p.sp. not of two different sizes and thin-walled hyphae of inner tissue of stromata, and mainly by these characteristics it can be separated from *H. peltata*.

#### *Hypocrea yasudae* DOI

Bull. Natn. Sci. Mus. Tokyo 12: 707 (1972).

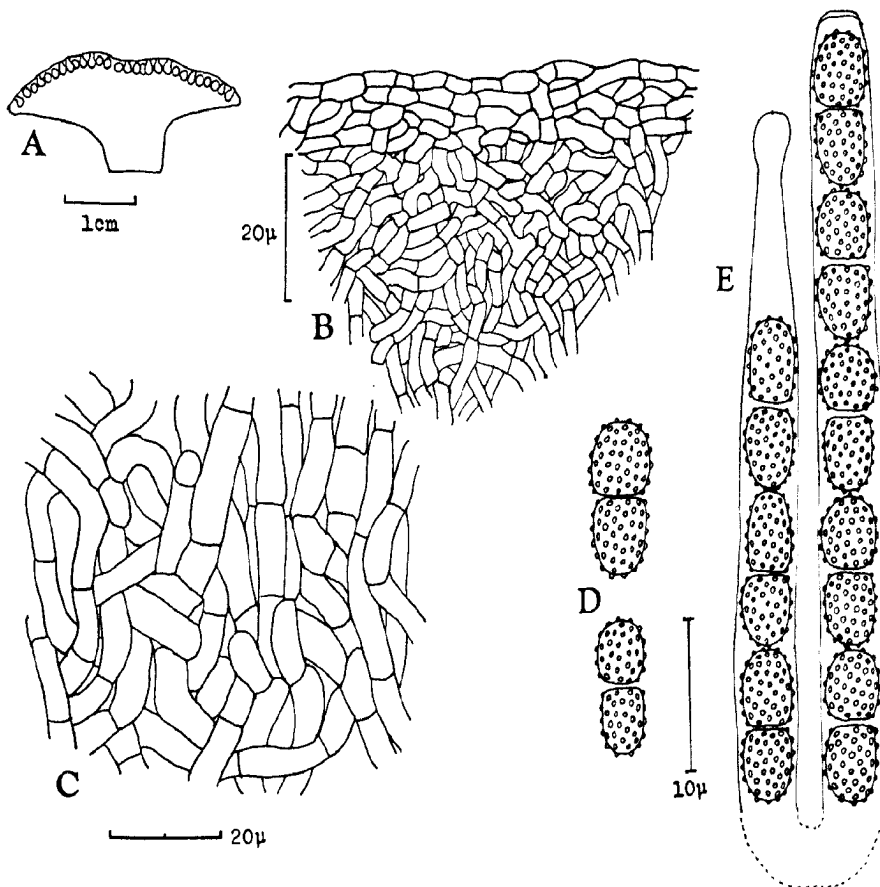


Fig. 7. *Hypocrea petersii* BERK. et CURT. (CURTS 5258 in K). A. Vertical section of stroma. B. Vertical section of t.o.s.s. C. Vertical section of inner tissue of stroma. D. P. sp. E. Ascus and p. sp.

The general aspect of this species often resembles that of *H. peltata*, especially when the stroma develops at one side of host fungus. *H. yasudae* is discriminated from *H. peltata* by the presence of host Gastromycetes under its stroma and p.sp. not of two different sizes, as well as by the presence of the *Trichoderma*-like conidial state with hyaline conidia.

***Podostroma brevipes* (MONT.) SEAVER**

*Mycologia* 2: 61 (1910).

*Cordyceps brevipes* MONT., Syll. gen. spec. Crypt. 201 (1856).

*Hypocrea brevipes* (MONT.) SACC., *Michelia*: 2: 304 (1878), as *Hypocrea brevipes* MONTG.

Stromata generally irregularly clavate and short stipitate, aggregate in a line, sometimes peltate, pale carnose or ochre-brown, up to 2 cm high, 2–5 mm in diam., or 2 cm wide and 2–5 mm thick when aggregate in a line. In vertical section t.o.s.s. of *t. epidermoidea*. Hyphae of t.o.s.s. thick-walled, slightly yellow-colored,  $8-15 \times 3-5 \mu$ . Inn.t. of *t. intricata*. Hyphae of inn.t. thick-walled, generally more or less laterally (toward the surface of stroma) parallel,  $5-8 \mu$  in diam. Perithecia subglobose or vertically (along the axis of bottom-ostiole) elongated,  $250-300 \mu$  in vertical diam. Ascus containing 16 p.sp. P.sp. hyaline, warty; the distal subglobose-obovate,  $3.0-3.9 \times 2.8-3.8 \mu$ ; the proximal obovate or short cylindrical,  $2.9-4.5 \times 2.4-3.1 \mu$ .

Hab. on decayed woods under tropical to temperate climates.

Specimens examined. ACC no. 705, El Yungue, Porto Rico, Dec. 4–1912, J. R. JOHNSTON, det. F. J. SEAVER (NY); on the stump of deciduous tree, Tagami, Niigata Pref., Japan, 9–X–1955, I. MATSUDA, no 52 in MATSUDA's collection (TNS F-225592); on *Quercus*, Downton Gorge, Herefordshire, England, 17–IX–1951, Coll. J. W., under *Podostroma alutaceum* (PERS. ex FR.) ATK. (IMI 47042).

Notes. (1) This species resembles *Hypocrea peltata* only when stromata are peltate as observed in a few stromata of the specimen ACC no. 705 (NY). It also resembles *Podostroma alutaceum* (PERS.) ATK. when stromata are stipitate and clavariiform. However, the species is different from *H. peltata* in the absence of p.sp. of different two sizes and *t. epidermoidea* type t.o.s.s., and is also different from *P. alutaceum* by fairly larger p.sp., thick-walled hyphae of inn.t., and aggregate and flattened stromata. (2) This species recorded for the first time from Japan. (3) Although the present species often produce *Hypocrea*-like stromata, it should not be classified into *Hypocrea*. Such phenomena are common in some species of *Podostroma* such as *P. cornu-damae* (PAT.) BOEDIJN, *P. alutaceum* (PERS.) ATK. (mainly in the strains with horn shaped stroma) and *P. solmsii* (E. FISCH) IMAI. As a view of natural classification, the genus *Podostroma* should be accepted only for a convenience of practical identification, and each species of the genus should be classified together with the species of *Hypocrea* by the patterns of t.o.s.s. and characteristics of the conidial state; the presence of *Hypocrea*-type stromata or *Podostroma*-type stromata is considered to be not so important characteristic for a classification above the species level in these fungi, as the writer had already discussed (DOI, 1972).

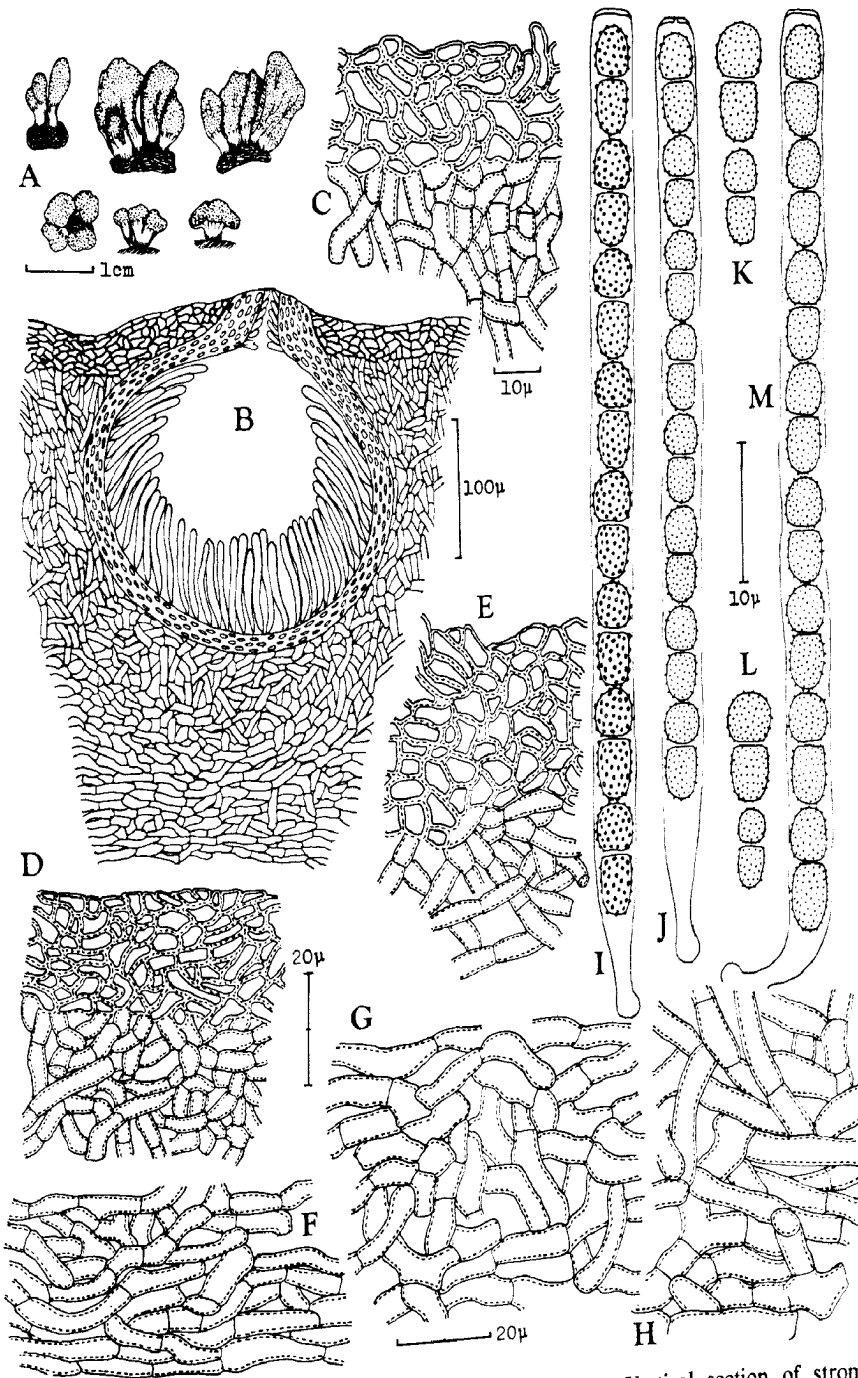


Fig. 8. *Podostroma brevipes* (MONT.) SEAVER. A. Habits. B. Vertical section of stroma (MATSUDA no. 52 in TNS). C-E. Vertical section of t.o.s.s.: C. MATSUDA no. 52 (TNS). D. IMI 47042. E. ACC no. 705 (NY). F-H. Vertical section of inner tissues of stromata: F. ACC no. 705 (NY). G. MATSUDA no. 52 (TNS). H. IMI 47042. I-M. Asci and p.sp.: I. MATSUDA no. 52 (TNS). J. L. IMI 47042. K. M. ACC no. 705 (NY).

### Summary

*Hypocrea argentinensis* SPEG., *H. austro-grandis* HASHIOKA et KOMATSU, *H. gigantea* PETCH and *H. paraguayensis* SPEG. are reduced to synonyms of *Hypocrea peltata* (JUNGH.) BERK. The following species resemble *H. peltata* in their general aspect but are clearly separable from *H. peltata*: *Hypocrea albocornea* DOI, *H. cerebriformis* BERK., *H. cornea* PAT., *H. petersii* BERK. et CURT., *H. yasudae* DOI, and *Podostroma brevipes* (MONT.) SEAVER. Another species resembling *H. peltata* in shape, size and color of stromata is described as a new species, *Hypocrea hemisphaerica* DOI.

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