

THE HYPOCREACEAE OF CHINA V. THE GENUS *PODOSTROMA*\*

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**ABSTRACT:** All of the specimens of *Podostroma* collected from China, and deposited in HMAS, HKAS and HMIGD have been restudied. Two species, *P. alutaceum* and *P. grossum* are recognized and redescribed in detail. *P. cornu-damae* is still in doubt for lack of authentic specimens. *P. yunnanensis* is a synonym of *P. grossum*.

**KEY WORDS:** Taxonomy, *Podostroma grossum*, *P. yunnanensis*, Synonym

*Podostroma*, a small genus containing about 10 species, is one of the genera easily recognized in the Hypocreaceae. It is very close to the genus *Hypocrea*, but differs in having pale to brightly colored and erect stromata. Atkinson (1905) systematically studied the morphology, life history, ecological environments, variation and nomenclature of *P. alutaceum* (Pers. Fr.) G. F. Atk. from North America. Boedijn (1934, 1938) described several species from Southeast Asia and Africa. Imai (1932), Doi (1978) and Doi & Uchiyama (1987) published several new taxa from Japan. Doi (1966, 1967) provided detailed accounts of anamorph stages of four species from Japan: *P. alutaceum*, *P. cordyceps* (Penz. et Sacc.) Yoshim. Doi, *P. cornu-damae* (Pat.) Boedijn and *P. solmsii* (E. Fisch.) S. Imai.

The earliest record of this genus from China was made by Putouillard (1895). Only a new species *H. cornu-damae* Pat. (= *P. cornu-damae*) was described from Kangding, Sichuan ("Ta-tchien-lou, Su-tchuen"). Teng (1963) recorded *P. alutaceum* from Jilin, Shanxi, Gansu, Qinghai and Fujian. Tai (1979) enumerated *P. alutaceum* and *H. cornu-damae*. A new species *P. yunnanensis* M. Zang was published and *P. grossum* (Berk.) Boedijn was recorded from South Yunnan by Zang (1976, 1996). Bi *et al.* (1990) reported *P. alutaceum* from Guangdong. Totally, four species had been reported from China.

The species of *Podostroma* are often classified based on the appearance, color, size, and consistency of stromata, partspores and perithecia. Ostiolate surface tissue of stroma was used and emphasized by Doi (1967, 1969, 1972) and has played an important role in classifying the species. Now characters in conidial states are more and more used in classification.

In this work, all available specimens in HKAS (Cryptogamic Herbarium, Kunming Institute of Botany, The Chinese Academy of Sciences), HMAS and HMIGD (Herbarium of Microbiologic Institute of Guangdong Province) were critically reexamined. The detailed descriptions and variations of the Chinese specimens are reported.

All dimensions of partspores include the ornamentation. Color rotations are from A. Kornerup & J. H. Wanscher "Methuen Handbook of Color" 3rd Ed., London (1978).

*Podostroma* P. Karst., Hedwigia 31: 294, 1892.

≡ *Hypocrea* sub *Podocrea* Sacc., Sylt. Fung. 2: 530, 1883.

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=*Podocrea* (Sacc.) Lindau in Engl. & Prantl, Die natürl. Pflanzenfamilien 111: 364, 1898.

Type species: *Podostroma alutaceum* (Pers.: Fr.) G. F. Atk., Bot. Gaz. 40: 416, 1905.

Similar to *Hypocrea* but stromata well developed, obviously erect, clavate, cylindrical to ramiferous, stipe distinct, rarely absent, lightly to brightly colored; Perithecia immersed in the stroma with the necks slightly protruding; Asci containing 8 ascospores, each ascospore with 1 septum at first and then divided into two partspores when mature (except for *P. solmsii* f. *octospora* Yoshim. Doi); Partspores warted to echinulate, rarely smooth, hyaline to yellowish brown, proximal partspores oblong to attenuate towards the end, distal partspores globose to subglobose.

1. *Podostroma alutaceum* (Pers.: Fr.) G. F. Atk., Bot. Gaz. 4: 416, 1905. Fig. 1~4

≡ *Spharia alutaceum* Pers., Observ. Myc. 2: 66, 1797; Fr., Sys. Myc. 2: 325, 1823.

Stromata fleshy, 2~11 cm high, 0.2~1.2 cm thick, mostly simple, rarely branched, clavate to cylindrical, apex blunt, stipe present, with or without a distinct line between the fertile and sterile portions, ochraceous, rarely cream. Inner tissue cream to whitish. Taste mild. Odor none.

Perithecia ovoid to ellipsoid, 162~212  $\mu\text{m}$  in vertical diam., 93~156  $\mu\text{m}$  in transverse diam.; Asci 70~90  $\mu\text{m}$  long, 3~5  $\mu\text{m}$  wide; Partspores minutely warted to almost smooth, hyaline, distal partspores [509/20/14] (2.2~)2.7~4.0(~4.5)  $\times$  (2.2~)2.5~4.0(~4.3)  $\mu\text{m}$ , proximal partspores [506/20/14] (2.0~)3.2~4.5(~5.3)  $\times$  (2.0~)2.3~3.3(~3.8)  $\mu\text{m}$ ; Ostiolate surface tissue of stroma *textura epidermoidea*, Interperithecial tissue and the tissue beneath the perithecia *textura intricata*, inner tissue *textura porrecta*.

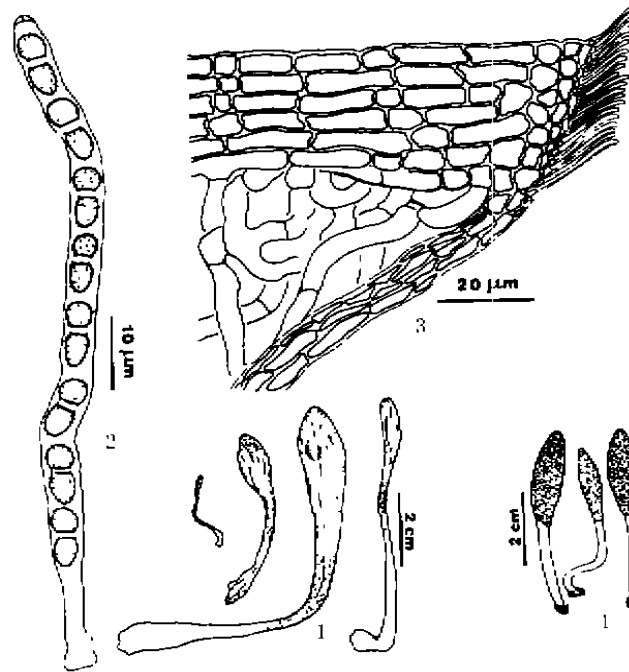


Fig. 1~4. *Podostroma alutaceum*

HMAS 28296 1. Stromata (dried) (horn-shaped); 2. Ascus and Partspores; 3. Ostiolate surface tissue of stroma (transverse section); HMIGD 18950: 4. Stromata (dried) (longly stipitate)

Hab.: On fallen leaves or decaying wood in *Abies*, *Larix*, *Quercus* or mixed forests.

Specimens Examined: Gansu: Zhangye, Dayekou, 3. IX. 1958, Q. M. Ma 890 (HMAS 23955). Inner Mongolia: Daqing Mts., Jinluan Temple, 1850 m, 18. VIII. 1988, P. G. Liu 519 (HKAS 20946). Jilin: Antu, Changbai Mts., 1350 m, 11. VIII. 1960, Y. C. Yang *et al.* 702 (HMAS 28294); the same locality, 1750 m, 5 VIII. 1960, Y. C. Yang *et al.* 599 (HMAS 28295); the same locality, 1350 m, 11. VIII. 1960, Y. C. Yang *et al.* 685 (HMAS 28296); the same locality, 1350 m, 9. VIII. 1960, Y. C. Yang *et al.* 842 (HMAS 29647); the same locality, 2000 m, 2. VIII. 1960, Y. C. Yang 523 (HMAS 28297); the same locality, 21. VIII. 1960, Y. C. Yang 888 (HMAS 28967). Qinghai: Huangcheng, Laohugou, 3100 m, 10. IX. 1958, Q. M. Ma 1053 (HMAS 27736). Shanxi: Wutai Mts., Dadonggou, 2200 m, 17. IX. 1959, J. H. Yu (HMAS 27735). Tibet: Milin, Bagagou, 2800 m, 13. VIII. 1998, T. H. Li *et al.* (HMIGD 18950). Yunnan: Xishuangbanna, 19. X. 1980, Eriksson 80 (HKAS 7111); Mengla, Menglun, 740 m, 22. X. 1989, Z. L. Yang 788 (HKAS 22605); Jiangcheng, Hongjiang, 1340 m, 6. VIII. 1989, P. G. Liu 867 (HKAS 24388); Lijiang, Yulong Snow Mts., 3100 m, 4 IX. 1993, P. G. Liu 1579 (HKAS 26297).

Observations: The combination of the cream to ochraceous stromata, the smaller partspores and the *textura epidermoidea* ostiolate surface tissue of stroma made it suitable to put all of the specimens cited above into *P. alutaceum*. As the most common species in *Podostroma*, *P. alutaceum* is variable in every aspect (Atkinson, 1905). Such case was also encountered on the Chinese specimens. The larger and smaller but mature stromata were often collected at the same time and locality. There is no obvious gap between larger and smaller stromata. By cultural method Atkinson (1905) also got some stromata with different dimensions.

The line between the fertile and sterile portions is either obvious or indistinct, and thus the stipe is either obviously or ambiguously distinguished. Both types of stromata of *P. alutaceum*: horn-shaped and longly stipitate described by Doi (1975) were found in China. Two exceptions HKAS 22605 and 26297 with ramiferous stromata were also placed in *P. alutaceum* due to the ochraceous hue of the stromata and the typical *textura epidermoidea* ostiolate surface tissue of stroma.

The partspores of *P. alutaceum*, presenting slight variations according to Atkinson (1905), are quite variable in Chinese collections. The partspores of several collections from Jilin, Qinghai and Yunnan are larger than those of the others from China, North America and Europe. The partspores of the holotype of *P. leucopus* (= *P. alutaceum*) measured by Rossman *et al.* (1999) are  $3.1\sim 4.9 \times 1.9\sim 2.9 \mu\text{m}$  for proximal partspores and  $2.9\sim 3.9 \times 2.5\sim 3.2 \mu\text{m}$  for distal partspores.

*P. alutaceum* was found in China from temperate, subtropical and tropical regions and from the altitudes 750 m to 3100 m. No correlation was found between the spore and stroma dimensions and the different geographical regions.

## 2. *Podostroma cornu-damae* (Pat.) Boedijn, Bull. Jard. Bot. Buitenzorg Sér. III 13: 273, 1934.

≡ *Hypoecrea cornu-damae* Pat., Bull. Soc. Myc. France 11: 198, Pl. XIII. 1: a, b, 1895.

Observations: In HKAS, HMAS and HMIGD, there was only HKAS 22605 under this name. However, it had been transferred into *P. alutaceum* due to the typical *textura epidermoidea* ostiolate surface tissue of stroma and the ochraceous stromata.

Because the description in the early period often fell inaccurate and there was no detailed description about its fresh and microscopic characters, *P. cornu-damae* was poorly known up to now. It is supposed here that the "ochraceo-aurantiaca" tinge of the stromata described by Patouillard (1895) should be that of the dried stromata. The stromata of *P. cornu-damae* reported from Japan (Doi, 1967; Imazeki *et al.*, 1988, Hongo

& Izawa, 1994) are all orange-reddish even to vivid red. Boedijn (1934) pointed that *P. cornu-damae* was close to *P. grossum* but differed in having smaller and smooth partspores and smaller perithecia. However, *P. cornu-damae* from Japan reported by Doi (1967) bore larger spores (proximal partspores: 4.5~5.0 × 3.0~3.5 μm, distal partspores: 3.5~4.5 × 3.5~4.0 μm). Several specimens identified as *P. cornudamae* from Japan (TNS-F-195527, 197640, 198234, 223564) (TNS = Herbarium of the Division of Cryptogams, National Science Museum, Tokyo) were examined and the partspores of them are larger too (proximal partspores: 3.0~3.8 × 4.0~6.0 μm, distal partspores: 3.5~4.0 × 3.5~4.5 μm). With similar stroma appearances and close type localities (Sikkim and Kangding, Sichuan), *P. grossum* and *P. cornu-damae* are easily supposed to be close even identical. The examination of more collections from the type localities will be helpful to deal with the status of *P. cornu-damae*.

### 3. *Podostroma grossum* (Berk.) Boedijn, Bull. Jard. Bot. Euitenzorg, Ser. III, 13: 273, 1934.

Fig. 5~12

≡ *Hypocrea grossa* Berk., Hookers Journ. of Botany and Kew Miscellany 3: 306, 1851.

= *Podostroma yunnanensis* M. Zang, Acta Bot. Yunnanica 2: 1, 1976.

Stromata fleshy, variable as to dimensions and appearance, simple to ramiferous, often with 2~4 branches, stipe absent or very short, 5~11 cm high, branches 0.5~1.2 cm wide, tips attenuate or round, sometimes with longitudinal grooves, vivid red to red (10B8), the base concolorous or yellowish orange (4A7-4B6). Ostioles covering most of the surface, minute, paler than the background, the fertile and sterile portions indistinctly separated. Context beneath the surface cream to orange, inner tissue whitish, a little tough and spongy. Taste bitter. Odor floury.

Perithecia 200~275 μm in vertical diam., 175~225 μm in transverse diam., broadly ellipsoid; Asci 80~100 μm long, 5~6 μm wide; Partspores distinctly warted to echinulate, mostly hyaline, some fully mature spores yellowish brown, proximal partspores [72/3/3] 4.5~6.0(~6.5) × (3.0~)3.2~4.5(~5.0) μm, distal partspores [71/3/3] (3.7~)4.0~5.5(~6.0) × (3.5~)3.8~5.0 μm; Ostiolate surface tissue of stroma typical *textura angularis*, isodiametric cells 5~15 μm in diam., the hyphal walls 1~1.5 μm thick, brown; Interperithecial tissue and the tissue beneath the perithecia *textura intricata*, inner tissue *textura porrecta*.

Hab.: Growing on rotten wood under broad leaf forest.

Specimens Examined: Fujian: Pucheng, Jiumu, 650 m, 11. VIII 1960, Q. Z. Wang *et al.* 613 (HMAS 28298). Guangdong: Yangshan, Chengjia, Taipingdong, 900~1000 m, 18. IX. 1985, G. Y. Zheng (HMIGD 9266). Yunnan: Lüchun, Baqishan, 17. IX. 1973, M. Zang 38 (HKAS 38) (Holotype of *P. yunnanensis*!); Tengchong, Mingguang, 2 VIII. 1980, M. Zang 6298 (HKAS 6298); Tengchong, Jietou, 1740 m, 6. VIII. 2000, X. H. Wang 1127 (HKAS 37470).

Observations: The vivid red to red ramiferous stromata, the large and obviously warted to echinulate partspores as well as the typical *textura angularis* ostiolate surface tissue of stroma are the diagnostic characters of *P. grossum* (Boedijn, 1934). All of the collections of this species deposited in China had been identified as other names before. HKAS 28298 and HMIGD 9266 were identified as *P. alutaceum* by Teng and by Bi *et al.* (1990) respectively. HKAS 6298 was identified as *P. yunnanensis* by Zang.

*P. yunnanensis* (Fig. 10-12), the species only reported from Yunnan, is characterized by the large partspores and stout orange-brownish to dark brownish ramiferous stromata (Zang, 1976). The following was observed when the holotype was reexamined: Stromata ramiferous, reddish brown to dark brown (8F6), some places grayish orange (6B6, 6D6), surface rough; Perithecia ellipsoid, 160~270 μm in vertical diam.,

112.5~225  $\mu\text{m}$  in transversal diam., necks 55~100  $\mu\text{m}$  long; Asci 80~100  $\mu\text{m}$  long, 5~6  $\mu\text{m}$  wide, spores part 70~85  $\mu\text{m}$  long; Ostiolate surface tissue of stroma *textura angularis*: Partspores echinulate, some yellowish-brown when fully mature, proximal partspores [85/2/1] (3.7)4.5~6.0(~7.0)  $\times$  (3.0~)3.2~4.5(~4.7)  $\mu\text{m}$ , distal partspores [92/2/1] (3.7~)4.0~5.5(~5.7)  $\times$  3.5~4.6(5.0)  $\mu\text{m}$ . Though there is no field note attached to the type the reddish brown tinge suggested the stromata were reddish when fresh. Due to identical characters, *P. yunnanensis* is a synonym of *P. grossum*.

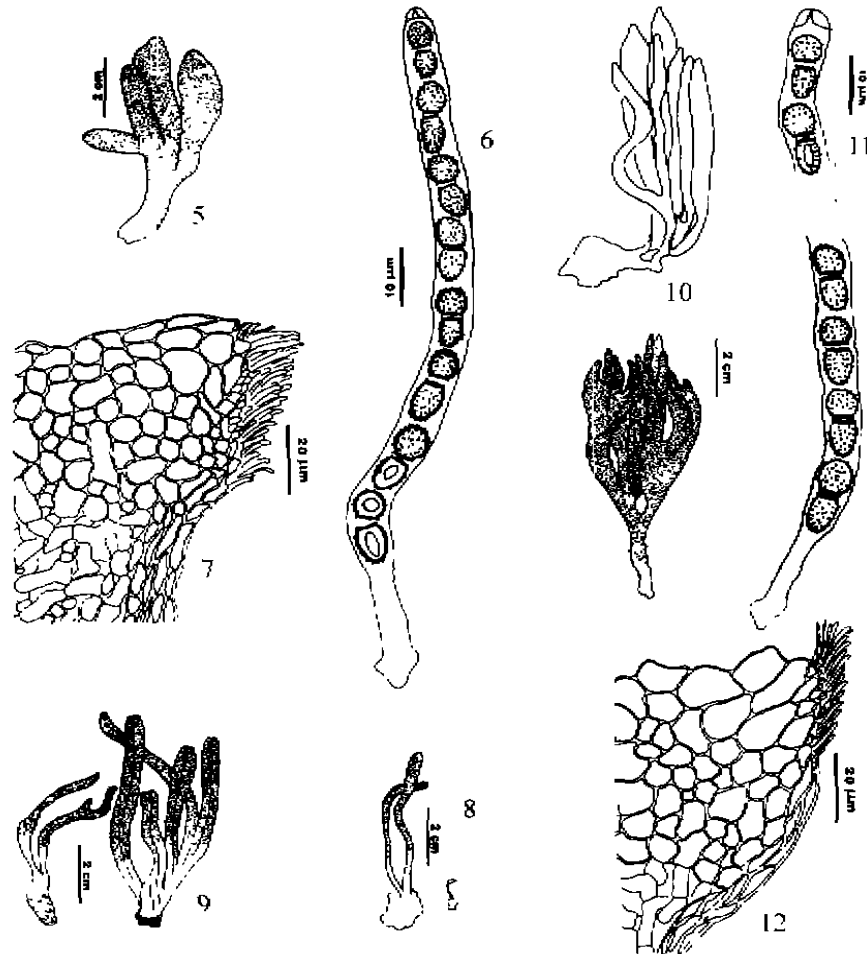


Fig. 5~9 *Podostroma grossum*

HICAS 37470: 5. Stroma (fresh); 6. Ascus and partspores; 7. Ostiolate surface tissue of stroma

HMAS 28298: 8. Stromata (dried); HMIGD 9266. 9. Stromata (dried)

Fig. 10~12. *Podostroma yunnanensis* (Holotype!)

10. Stromata (dried); 11. Ascus and partspores; 12. Ostiolate surface tissue of stroma

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## 中国的肉座菌科 V. 肉棒菌属

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**摘要:** 所有保存于 HMAS、HKAS 和 HMIGD 的采自中国的肉棒菌属 *Podostroma* 标本被重新研究, 鉴定出肉棒菌 *P. alutaceum* 和粗肉棒菌 *P. grossum* 两个种, 并对这两个种重新进行了详细的描述。鹿角状肉棒菌 *P. cornu-damae* 由于缺乏可靠的标本仍存在疑问。滇肉棒菌 *P. yunnanensis* 被作为粗肉棒菌 *P. grossum* 的异名。

**关键词:** 分类, 粗肉棒菌, 滇肉棒菌, 异名

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