

New Variety of *Cordyceps gunnii* (Berk.) Berk. and Its *Paecilomyces* Anamorph

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*Cordyceps gunnii*의 신변종과 이 균의 무성세대 *Paecilomyces*

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ABSTRACT: In the present paper, a new variety of *Cordyceps gunnii* (Berk.) Berk. is reported. It differs from *C. gunnii* by its much smaller secondary ascospores, (2.0-) 3.3 (-4.3) × 1.0~1.8 μm, as well as thinner asci and cap of the asci. Its anamorph is also reported as a new variety of *Paecilomyces gunnii* Liang, the anamorph of *C. gunnii*. Its differ from *P. gunnii* by its conidia, mostly subglobose and much bigger, (2.2-) 4.7 (-11.0) × (1.8-) 2.6 (-3.3) μm. The type specimen and dry type culture are deposited at Research Center for Entomogenous Fungi, Anhui Agriculture University, China.

KEYWORDS: *Cordyceps gunnii*, *Cordyceps gunnii* var. *minor*, *Paecilomyces gunnii*, *Paecilomyces gunnii* var. *minor*, Anamorph.

Cordyceps gunnii was first recorded by Gunn in Tasmania and parts of Australia (Cooke, 1892), and named as *Sphaeria gunnii* Berkeley (1948) and combined into *Cordyceps* as *C. gunnii* Berkeley both by Berkeley (Hooker, 1859). Its distribution in Japan was reported by Kobayashi (1941) and in China by Liang (1983). In surveys of entomogenous fungi in west and south of Anhui, southeastern China, some specimens were collected and an anamorph was isolated from them. Microscopic study reveals that the telemorph is close to *Cordyceps gunnii* (Berk.) Berk. but its secondary ascospores are much smaller; the anamorph is close to *Paecilomyces gunnii* Liang, but its conidia are much bigger and mostly subglobose. Therefore, the telemorph and the anamorph are described as new varieties of *C. gunnii* and *P. gunnii*, respectively.

Materials and Methods

Specimen

Specimens were collected from National Conservation of Guniujiang, Qimen County, western Anhui in May, 1996 and from Luoerling, Huoshan County, southern Anhui.

Isolation and Microscopic Preparation

The fresh specimens were cleaned with cotton balls soaked in sterile water and incubated in humid petri-dishes

at 17~18°C, and the cadaver part was wrapped by wet cotten. The stromata, especially the fertile part, were carefully kept over a sterile glass slide. The petri-dishes were kept humid by adding sterile water every 24 hrs. Once ascospores discharged onto the glass slide were found by naked eyes, the ascospores were gently scratched from the slide and transferred onto SDAY slant medium in test tubes and the slide was shifted with a new sterile slide. It was repeated for 3~4 times until sufficient inoculum and microscopic material were obtained. In addition, pieces of stroma tissue and pseudosclerotium (cadaver) tissue were picked off and transferred onto the slant medium for parallel isolation. The fungal material on some slides for microscopic preparation was stained with cotton blue for ascospore and secondary ascospore observation.

Microcycle Conidiation

Some glass slides with discharged ascospores were treated for microcycle conidiation according to the method by Liang (1985).

Results and Discussion

Normal conidiation of different isolates from either tissue or ascospore and microcycle conidiation both showed similar morphology of conidiogenous structure and conidia, and confirmed that the isolates were the same anamorph belong to *Paecilomyces*. Observation on the

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morphology of asci and secondary ascospores suggested that the teleomorph was closely related to *Cordyceps gunnii* (Berk.) Berk., however, with obvious differences, and its anamorph was also closed to the *P. gunnii* Liang, the anamorph of *C. gunnii*, with obvious differences as well. The teleomorph and its anamorph, consequently, were described as new varieties of *C. gunnii* and *P. gunnii*, respectively.

Teleomorph

Cordyceps gunnii (Berk.) Berkeley var. *minor* Z. Z. Li, C. R. Li, B. Huang, M. Z. Fan & M. W. Lee var. nov. Fig. 1.: (1)-(6); Fig. 2.: (1)-(3).

Stromata singularia, calvata, ecapite hospite; stipites pallidi, elongato cylindrici, 36.6~52.3 mm longi, 4.8~8.6 mm crassi; partes fertiles proximo cylindricae, griseae, definitae ad stipete ad maturitatem, 18.5~19.3 mm longae and 4.0~9.4 mm crassae, cum vel sine extremo angustato. Perithecia omnino erecto immersa, ampullacea, orificio papillato in pa-

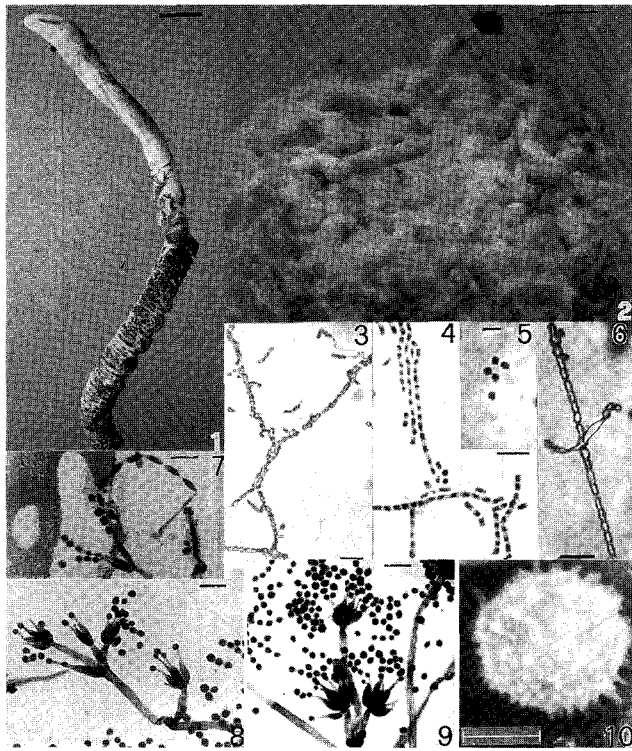


Fig. 1. (1)-(6) *Cordyceps gunnii* var. *minor* Li, Li, Huang, Fan and Lee: (1) specimen GNJ960508-106 (Typus), bar = 10 mm; (2) immature stromata from rice culture, bar = 10 mm; (3) ascospores, bar = 10 μ m; note that some of them are germinating and producing conidia; (4) ascospores, bar = 10 μ m (5) secondary ascospores, bar = 10 μ m; (6) a germinating ascospore, bar = 10 μ m. (7)-(10) *Paecilomyces gunnii* var. *minor* Li, Li, Huang, Fan and Lee: (7) phialides and conidia, bar = 10 μ m; (8) and (9) phialides and subglobose conidia, bar = 1 μ m; (10) a conidium, SEM, bar = 1 μ m.

gina, 870~920 \times 260~320 μ m. Asci cylindrici, (345-) 465 (-530) \times (4.4-) 5.5 (-6.9) μ m, 8 ascosporis. Capita ascorum (4.7-) 5.8 (-6.9) μ m. Ascosporis filiformis, hyalinis, multiseptalis. Ascosporia secundaria cylindrica, curta, (2.0-) 3.3 (-4.3) \times 1.0~1.8 μ m.

In larvis *Phassis excrescentibus* Butler.

Anhui: Chilingkou, Guniujiang, Qimen, 1000 m. 08 V 1996. Chunru Li (GNJ 960508-106, Typus!); Lanniao, Luering, Huoshan, 350 m. 14 V 1997. Chunru Li (HS970512-101).

Stromata simple, clavate, emerging from host head, with a whitish greyish stipe 36.6~52.3 mm long and 4.8~8.6 mm wide; its ascogenous portion grey, 18.5~19.3 mm long and 4.0~9.4 mm wide, with clear boundary to stipe at maturity. Perithecia ampullaceous, embedded erectly in the stroma, with papillate openings on surface, 870~920 \times 260~320 μ m. Asci cylindrical, (345-) 465 (-530) \times (4.4-) 5.5 (-6.9) μ m. having 8 ascospores. Cap of asci (4.7-) 5.8 (-6.9) μ m. Ascospores filiform, hyaline, multiseptate, breaking into cylindrical, short, 1-celled secondary ascospores, (2.0-) 3.3 (-4.3) \times 1.0~1.8 μ m.

The type specimen is deposited at Research Center for Entomogenous Fungi, Department of Forestry, Anhui Agricultural University (RCEF, AAU)

Host: Larvae of *Phassis excrescens* Butler (Lepidoptera: Hepialidae).

Based on Kobayasi's system (1941), the present specimen is assigned to Subsection Eucystocarpon, Section Cystocarpon of subgenus *Eucordyceps*. Closely related species

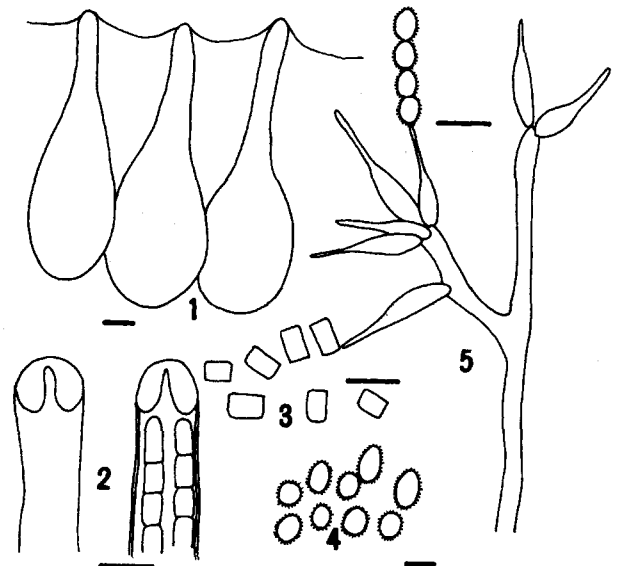


Fig. 2. (1)-(3) *Cordyceps gunnii* var. *minor* Li, Li, Huang, Fan and Lee: (1) immersed perithecia, bar = 100 μ m; (2) caps of Asci, bar = 5 μ m; (3) fragmented secondary ascospores, bar = 5 μ m. (4)-(5) *Paecilomyces gunnii* var. *minor* Li, Li, Huang, Fan and Lee: (4) conidiogenous structure, bar = 10 μ m; (5) conidia, bar = 5 μ m.

in the subsection include *C. gunnii* (Berkeley) Berkeley and *C. hawkesii* (Gray) Cooke. Morphological characters of the present specimen are mostly close to those of *C. gunnii* except that the later has much bigger secondary ascospores ($4.0\sim 6.5\times 2\sim 3\ \mu\text{m}$), broader asci (averaging $6.5\sim 7.0\ \mu\text{m}$ in breadth). The differences between *C. hawkesii* and the present specimen are more obvious, especially in the following aspects that the former has much smaller perithecia ($500\sim 550\times 175\sim 200\ \mu\text{m}$), and smaller asci ($230\sim 300\times 7\sim 9\ \mu\text{m}$) as well as cap of asci ($4\sim 5\ \mu\text{m}$ broad) (Shimizu, 1994).

Anamorph

Paecilomyces gunnii Liang var. *minor* Z. Z. Li, C. R. Li, B. Huang, M. Z. Fan & M. W. Lee. var. nov. Fig. 1.: (7)-(10); Fig. 2.: (4)-(5).

Colony in agro Czapeko doxo 29 mm diam. 24 diebus 25°C albae vel flavido-albae. Conidiophora erecta, hyalina, cylindrica, $11\sim 95\times 1.3\sim 2.2\ \mu\text{m}$. Phialides ampullaceae, e basi cylindrica gradatim in collum longum, ($12.6\sim 20.9\ (-39.6)\times (1.4\sim 1.9\ (-2.7)\ \mu\text{m}$). Conidia subglobosa vel fusiformia, hyalina, spinosa, ($2.2\sim 4.7\ (-11.0)\times (1.8\sim 2.6\ (-3.3)\ \mu\text{m}$).

Typus RCEF0199, isolatus e specimine typo GNJ960508-106.

Colonies on Czapek dox agar white or yellowish white, attaining a diameter of 29 mm within 14 days at 25°C, consisting of a velvety mycelium with branched margin and yellowish white, powdery, and localized area; reverse olive yellow to olive green, becoming dark green after 14 days. Conidiophores erect, cylindrical, hyaline, $11\sim 95\times 1.3\sim 2.2\ \mu\text{m}$. Phialides ampullaceous, ($12.6\sim 20.9\ (-39.6)\times (1.4\sim 1.9\sim 2.7\ \mu\text{m}$), consisting of a cylindrical and somewhat inflated base, tapering into a thin long neck, solitary on aerial hyphae, verticillate on conidiophores or directly from germinating secondary ascospores. Conidia subglobose or fusiform, hyaline, spinose, forming chains, ($2.2\sim 4.7\ (-11.0)\times (1.8\sim 2.6\ (-3.3)\ \mu\text{m}$), usually bigger from solitary phialides than from phialides on whirl; conidia formed by microconidiation similar to those described as above, $2.1\sim 7.3\times 1.5\sim 2.5\ \mu\text{m}$. The type culture (RCEF0199) isolated from the type specimen GNJ960508-106, Chunru Li. The dry type culture is deposited at RCEF. AAU.

The present variety differs from *P. gunnii* mainly by the colony color. The present variety differs from *P. gunnii* mainly by the colony color and conidium size. The color of colony reverse of *P. gunnii* var. *minor* is olive yellow to olive green and becomes dark green at late stage, while that of *P. gunnii* is greenish brown or darker, with margin nearly mango brown. The conidia of *P. gunnii* var. *minor* are subglobose or fusiform, while those of *P. gunnii* are ellipsoidal, ovoid or fusiform, ($1.6\sim 2.6\sim 4.0\ (-5.0)\times (1.2\sim 1.6\sim 2.5\ (-3.5)\ \mu\text{m}$ (Liang, 1985).

P. gunnii var. *minor* is somewhat close to *Paecilomyces hawkesii* Xiao *et al.* and *Paecilomyces carneus* (Duche & Heim) Brown & Smith. It differs from the 2 *Paecilomyces* spp. by characters of colony color, phialide and conidia. *P. hawkesii* has pink colony and yellowish to dark brown colony reverse, much longer phialides and broader ellipsoid conidia ($3\sim 6.5\times 2\sim 4\ \mu\text{m}$) (Chen *et al.*, 1984). *P. carneus* also has pink colony as well as smaller phialides ($9\sim 18\times 1.5\sim 2.5\ \mu\text{m}$) and conidia ($3\sim 4\times 2\sim 2.5\ \mu\text{m}$) (Samson, 1974; Brown & Smith, 1957).

From rice culture of the present isolates, stromata were induced successfully. Their shape and color looked like natural stromata, but no perithecia produced.

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