
The genus *Cordyceps* and its allies from the Kuankuoshui Reserve in Guizhou III*

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Four new species in the genus *Cordyceps* from the Kuankuoshui Reserve in Guizhou Province are described. They are *Cordyceps furcicaodata*, *C. dermapterogena*, *C. cylindrostromata* and *C. rostrata*. In addition, *Cordyceps formicarum* and *C. takaomontana* are reported for the first time in Guizhou Province, China. Specimens examined were deposited in the Laboratory of Fungus Resources, Guizhou University (LFRGU).

Key words: *Cordyceps*, China, insect fungi, new species

Introduction

Recent reports on species of *Cordyceps* in China include those of Liang *et al.* (2003) who reported new species of *Cordyceps* from the Western Sichuan Mountains and Liu *et al.* (2001) who reported on a new species of *Beauveria*, being the anamorph of *Cordyceps sobolifera*. Previously we have also reported on 15 species of *Cordyceps* from the Kuankuoshui Reserve located in Suiyang County of northern Guizhou Province (Liang *et al.*, 1996, 1997). In this paper, an additional four new species are described and two species are newly reported from this area.

Taxonomy

Cordyceps furcicaodata Z.Q. Liang, A.Y. Liu & M.H. Liu, **sp. nov.** (Figs 1, 7)

Stromata singularia, e mediis hospitis oriunda. *Stipes* cylindricus, simplex, flavus, 30 mm longus, 2 mm crassus. *Pars fertilis* cylindrica, pallide flava, 13 × 1.8 mm; peridio e cellulis clavatis vel cylindricis paliformiter compositus. *Appendix apicalis* piliformis 8 mm longa, 0.5 mm crassa, 2-3-ramosa. *Perithecia* immersa ovoidea vel pyriformia, 390-420 × 180-225 µm.

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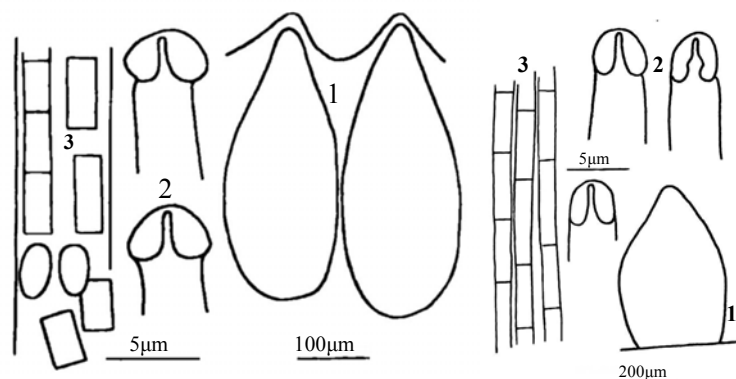


Fig. 1. *Cordyceps furcicaodata* Z.Q.Liang, A.Y.Liu & M.H Liu. **Fig. 2.** *Cordyceps dermapteroigena*. 1. Perithecia. 2. Upper parts of asci. 3. Ascospores.

Asci cylindrici, $114 \times 4.8 \mu\text{m}$, capitibus $4.2 \mu\text{m}$ diam. *Articuli ascosporarum* pro parte majore $3.6-4.8 \times (-1.2)1.5-1.8 \mu\text{m}$, utrinque truncati; pro parte minore ellipsoidei $2.4-3 \times 1.5-2.5 \mu\text{m}$.

Status conidialis ignotus.

Ex larvis lepidopterarum, $18 \times 3 \text{ mm}$.

Specimen typicum: CHINA, Provincia Guizhou, Regio Kuankoushui, August 1987, M.H. Liu. in University Guizhou conservatum (LFRGU 87-801, VIII 1987, **holotypus**).

Stroma single, arising from nearly middle part of host larva. *Stipes* cylindric, simple, pale yellow, $30 \times 2 \text{ mm}$. Fertile part cylindric, pale brown, $13 \times 1.8 \text{ mm}$, cortex palisade-like, apical appendix with 2-3 branches, $8 \times 0.5 \text{ mm}$. *Perithecia* embedded, ovate or pyriform, $390-420 \times 180-225 \mu\text{m}$. *Asci* cylindric, $390-420 \times 180-225 \mu\text{m}$, with 2-3 μm high and $4.2 \mu\text{m}$ thick cap. *Ascospores* filiform, multiseptate, finally breaking into 1-celled fragments. Most fragments cylindric, $3.6-4.8 \times (-1.2)1.5-1.8 \mu\text{m}$; others elliptic, $2.4-3 \times 1.5-2.5 \mu\text{m}$.

Cordyceps appendiculata Y. Kobayasi & D. Shimizu and *C. pilifera* Y. Kobayasi are somewhat similar to this species. This species however, differs in its cylindric fertile part, palisade-like cortex and shorter $3.6-4.8 \mu\text{m}$, secondary ascospores (see Kobayasi & Shimizu, 1983).

***Cordyceps dermapteroigena* Z.Q. Liang, A.Y. Liu & M.H. Liu, sp. nov.**

(Figs. 2, 8)

Stromata singularia, e caudis hospitis oriunda. *Stipes* simplex, cylindricus, parvus, ochraceus $15 \times 1 \text{ mm}$. *Pars fertilis* cylindrica, $7 \times 1.5 \text{ mm}$, appendix apicalis piliformis, circa 5 mm longa. *Perithecia* immersa, ovoidea, $405-450 \times 180-230 \mu\text{m}$; peridio pseudoparenchymatico. *Asci* cylindrici, $6-7.2 \mu\text{m}$ crassi-capitibus $3 \mu\text{m}$ in diam. *Articuli ascosporarum* ($4.8-$) $6-15 \times 2-3 \mu\text{m}$.

Status conidialis ignotus.

Ex larvis Dermapterarum, $15 \times 2.5 \text{ mm}$.

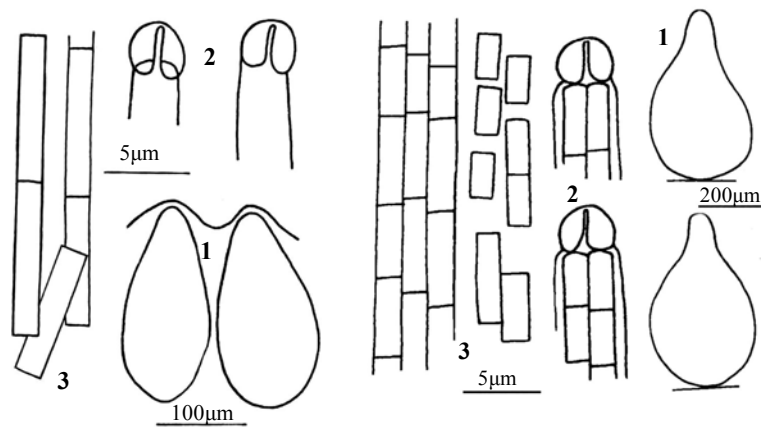


Fig. 3. *Cordyceps cylindrostromata*. **Fig. 4.** *Cordyceps rostrata*. **1.** Perithecia. **2.** Upper parts of asci. **3.** Ascospores.

Specimen typicum: CHINA, Provincia Guizhou, regio Kuankoushui, September 1987, M.H. Liu, in University Guizhou conservatum (LFRGU87-907, **holotypus**).

Stroma single, simple, emerging from host tail, slender, cylindric, pale brown, 15×1 mm. *Fertile part* thick, cylindric, distinct from stalk, *ca.* 7×1.5 mm, with a tenuous tail-like acute sterile tip *ca.* 5 mm long. *Perithecia* embedded to ovoid, $405\text{--}450 \times 180\text{--}230$ μm ; cortex having a thin layer of pseudoparenchyma. *Asci* $6\text{--}7.2$ μm thick, with hemi-globose to short cylindric cap, 2.5 μm high, 3 μm thick. Ascospores filiform, multiseptate, breaking into 1-celled fragments (4.8--) $6\text{--}15 \times 2\text{--}3$ μm .

More than 10 known species of *Cordyceps*, such as *C. appendiculata* Y. Kobayasi & D. Shimizu, *C. pilifera* Y. Kobayasi, *C. hauturu* Dingley, *C. melolonthae* Sacc., *C. ochraceostromata* Y. Kobayasi & D. Shimizu and *C. geotrupis* S.C. Teng, have a cylindric fertile part with a sterile tip and embedded perithecia. Our species has these characters, but differs in having larger secondary ascospores, (4.8--) $6\text{--}15 \times 2\text{--}3$ μm and in the host of *Dermaptera*.

***Cordyceps cylindrostromata* Z.Q. Liang, A.Y. Liu, M.H. Liu, sp. nov.**

(Figs. 3, 9)

Stromata binata, cylindrica, singularia, ex lateribus abdominis et cauda hospitis oriunda, $33\text{--}40 \times 1\text{--}1.5$ mm. *Stipes* brevis, brunneus, $8\text{--}10 \times 1\text{--}1.2$ mm. *Pars fertilis* cylindrica longa, brunneola, $25\text{--}30 \times 1.2\text{--}1.5$ mm. *Perithecia* superficialia subpyriformia, $255\text{--}375\text{--}405 \times 150\text{--}225$ μm . *Asci* cylindrici, parvi, 1600×4.2 μm , capitibus subgloboso, $3.6\text{--}4.2$ μm diam. *Ascosporae* acerosae, multiseptatae, non frangentes, cellulae $6\text{--}8 \times 1.5\text{--}2$ μm .

Status conidialis ignotus.

Ex larvis lepidopterarum, 20 × 2.5 mm.

Specimen typicum: CHINA, Provincia Guizhou, regio Kuankoushui, August 1987, M.H. Liu, in University Guizhou conservatum (LFRGU87-828, **holotypus**).

Stromata binate, cylindric, simple, 33-40 × 1-1.5 mm. *Stipe* short, 8-10 × 1-1.2 mm, dark brown. *Fertile part* cylindric, yellow-brown, 25-30 × 1.2-1.5 mm. *Perithecia* superficial, subpyriform, 255-(375)-405 × 150-225 μm. *Asci* thread-like, 1600 × 4.2 μm, with subglobose cap, 3 μm high, 3.6-4.2 μm thick. *Ascospores* multiseptate, interval cells 6-8 μm long and 1.5-2 μm thick, not breaking into secondary ascospores.

Among *ca.* 90 species with cylindric stromata in the genus *Cordyceps*, only a few species such as *C. koreana* Y. Kobayasi, *C. caloceroides* Berk. & Br., *C. jiangxiensis* Z.Q. Liang, A.Y. Liu & Y.C. Jiang and *C. aeruginosclerota* Z.Q. Liang & A.Y. Liu resemble this new species in having stromata without sterile tip, superficial perithecia and ascospores not breaking into secondary ascospores (Kobayasi & Shimizu, 1983; Liang *et al.*, 1997, 2001). This new species differs in having binate, small (40×1.5 mm) and non branched stromata and smaller interval cells in the ascospores (6-8 × 1.5-2 μm).



Fig. 5. *Cordyceps formicarum* Y. Kobayasi. **Fig. 6.** *Cordyceps takaomontana* Yakushiji & Kumazawa

Cordyceps rostrata Z.Q. Liang, A.Y. Liu & M.H. Liu, **sp. nov.** (Figs. 4, 10)

Stromata singularia, ochracea, ex mediis hospitis oriunda. *Stipes* cylindricus, simpex, 25 mm longus, 1.8 mm crassus. *Pars fertilis* cylindrica, 10 × 2 mm, attenuata. *Perithecia* dense superficialia, subglobose, longe rostrata, 420-525 × 255-375 μm. *Asci* cylindrici, 6 μm crassicapitibus subglobo, 3 μm diam. *Articuli ascosporarum* (3.6-) 4.8-6 (-7.2) × (1.2-)1.5-2 μm.

Status conidialis ignotus.

Ex larvis lepidopterarum, 28 × 3 mm.

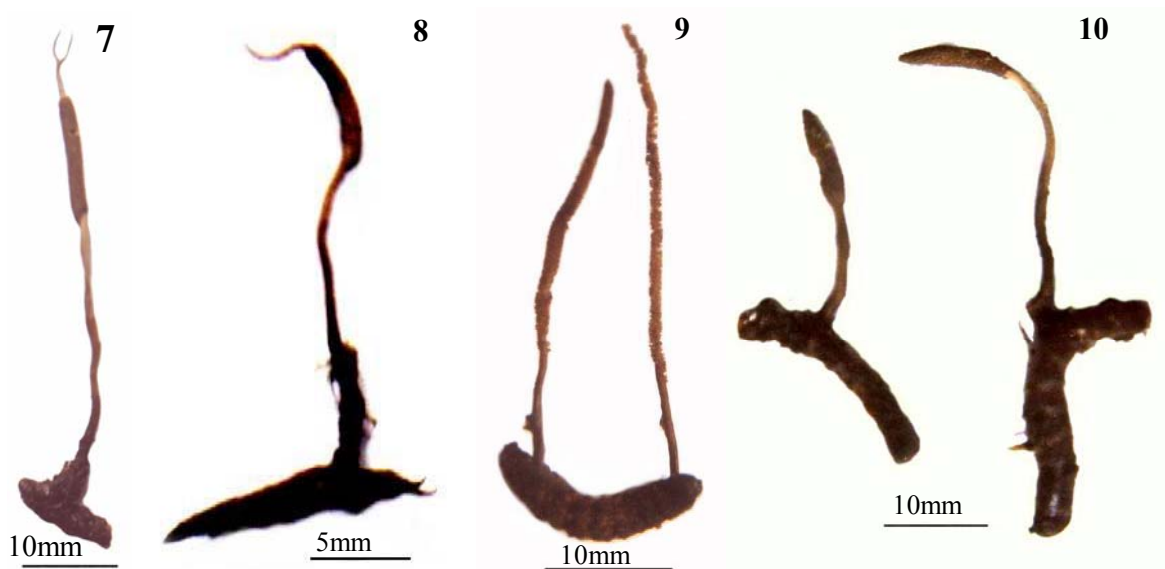
Specimen typicum: CHINA, Provincia Guizhou, regio Kuankoushui, Septemehr 1986, M.H.Liu, in University Guizhou conservatum (LFRGU86-912, **holotypus**).

Stroma single, simple, brown, arising from middle of host larva. *Stipe* cylindric, 25×1.8 mm. *Fertile part* cylindric, 10×2 mm, with a tapering tip. *Perithecia* densely superficial, subglobose, with somewhat long ostiole, $420-525 \times 255-375$ μm . *Asci* 6 μm thick with subglobose $2.5-3 \times 3$ μm cap. *Ascospores* breaking into cylindric secondary ascospores, $(3.6-4.8-6(-7.2) \times (1.2-1.5-2)$ μm .

This species is similar to *C. pruinosa* Petch, *C. takaomontana* Y. Kobayasi & D. Shimizu and *C. yahagiana* Y. Kobayasi & D. Shimizu (Kobayasi & Shimizu, 1983; Shimizu, 1994) in having a clavate fertile part without a sterile tip, superficial perithecia and ascospores breaking into secondary ascospores. However, this species differs in having single stroma and brown subglobose perithecia with a long ostiole.

Cordyceps formicarum Y. Kobayasi, Bull. Biogeogr. Soc. Jap. 9: 286, 1939.

(Fig. 5)



Figs. 7-10. Stromata of *Cordyceps* species. 7. Stroma of *Cordyceps furcicaodata*. 8. Stroma of *Cordyceps dermapterogena*. 9. Stromata of *Cordyceps cylindrostromata*. 10. Stroma of *Cordyceps rostrata*.

Stroma single, brown, arising from breast of host ,simple, 30×1 mm; *fertile part* acrogenous or intercalary, ellipsoidal to cylindric, $4-5 \times 1.5-15$ mm. *Perithecia* embedded in flask, $750-900 \times 180-210$ μm . *Asci* 5.5 μm thick with

a flat-to subglobose cap, 3-4.8 μm high, 4.2-5 μm thick. *Ascospores* breaking into fusiform secondary ascospores, 6-8 \times 1-1.5 μm .

Host: A species of ant, 12 \times 4 mm.

Specimen examined: CHINA, Guizhou Province, Kuankoushui Preserve, September 1986, M.H. Liu, in University Guizhou conservatum (LFRGU86-914).

Specimen LFRGU88-8031 collected from Maolan Preserve in Guizhou has a slender (40 \times 0.5 mm) stroma, with an ellipsoidal (1-2 \times 1.5 mm) fertile part and somewhat large perithecia (800-960 \times 220-320 μm). Asci are 7.2 μm wide with a 2 \times 3 μm cap and secondary ascospores are fusiform, 9-10 \times 1.2-1.5 μm .

Cordyceps takaomontana Yakushiji & Kumazawa, in Y. Kobayasi, Gen.

Cordyceps: 108, 1941 (Fig. 6).

Stromata single, caespitous or fasciculate, orange-colored, arising from different parts of host larva ramified. *Fertile part* acrogenous, cylindric, 8-10 \times 1.5-2 mm. *Stipe* cylindric, 10 \times 1.1-1.5 mm. *Perithecia* ampullaceous, superficial, 375-450 \times 145-195 μm . *Asci* filiform, 1200 \times 2.4-3 μm , with a depressed-globose (1.5-2 μm high, 1.8-2.5 μm thick) to globose (3 \times 3 μm) cap. *Ascospores* slender, breaking into thin cylindric secondary ascospores, 6-8 \times 0.5-0.8 μm .

Host: Larva of Lepidoptera, 38 \times 5 mm.

Specimen examined: CHINA, Guizhou Province, Kuankoushui Preserve, September 1986, M.H. Liu, in University Guizhou conservatum (LFRGU86-913).

Anamorph: *Isaris japonica* Yasuda

= *Paecilomyces tenuipes* (Peck.) Samson.

= *Paecilomyces japonica* Ellis.

In 1932, Yakusiji and Kumazawa and Kobayasi in 1934 successfully cultured the fruit bodies of *Cordyceps takaomontana* Yakushiji & Kumazawa in rice medium. Inoculated Ascospores were taken from the ostioles of perithecia by touching the ostioles with a sterile platinum needle (Kobayasi, 1941). This result indicated that *Isaria japonica* Yasuda was correct anamorph of *Cordyceps takaomontana* Yakushiji & Kumazawa (Kobayasi, 1941).

Although Samson (1974) reported that *Paecilomyces tenuipes* (Peck.) Samson (= *Isaris japonica* Yasuda) was the anamorph of *C. polyartra* Moller, he did not offer any experimental results to support his view.

Acknowledgements

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