



Systematic analyses of *Ophiocordyceps ramosissimum* sp. nov., a new species from a larvae of Hepialidae in China

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Abstract

A new species, *Ophiocordyceps ramosissimum* sp. nov., is described and illustrated. It was associated with larvae of *Phassus nodus* (Hepialidae) collected from Xuefeng Mountains, Hunan Province, China. It differs from similar species in having branched stromata without a sterile apex, superficial ascomata, and very wide asci and ascospores and in its occurrence on *Phassus nodus* in living roots or trunks of *Clerodendrum cyrtophyllum*. Multi-gene phylogenetic analysis of 5.8S-ITS rDNA, nrSSU, EF-1 α , and RPB1 gene loci also confirmed the distinctiveness of this new species.

Keywords: new species, multi-gene phylogeny, *Clerodendrum cyrtophyllum*

Introduction

The genus *Cordyceps* Fr. (*Clavicipitaceae*, *Hypocreales*, *Ascomycota*) has been separated and placed into three families and five genera—*Tyrannicordyceps* (*Clavicipitaceae*) (Kepler *et al.* 2012), *Metacordyceps* (*Clavicipitaceae*), *Elaphocordyceps* (*Ophiocordycipitaceae*), *Ophiocordyceps* (*Ophiocordycipitaceae*) and *Cordyceps* (*Cordycipitaceae*) (Sung *et al.* 2007a). Most of its members are pathogens of insects and spiders, and some grow on the hypogeous fungus, *Elaphomyces* spp. (Wen *et al.* 2013). Many *Cordyceps* species such as *Ophiocordyceps sinensis*, *Cordyceps militaris* and *C. takaomontana* are important as they have been used in traditional Chinese medicines in China, Japan, Korea and other eastern Asian countries.

Cordyceps sensu lato is one of the most important fungal groups of invertebrate pathogens (Hywel-Jones 2001) with more than 500 species (Index Fungorum 2013). Although many *Cordyceps* species have been transferred to *Ophiocordyceps* or other genera, many species have yet to be restudied in this large group.

Ophiocordyceps is the largest genus of *Cordyceps sensu lato* and Sung *et al.* (2007a) reported that there are more than 150 *Ophiocordyceps* species, while 140 species were listed by Kirk *et al.* (2008). There are more than 180 epithets assigned to *Ophiocordyceps* in Index Fungorum (2013), however, some of them have been synonymised with other genera. Most species of *Cordyceps sensu lato* have been collected from hosts on leaves or in soil, but there are about 50 species that parasitize insects in dead wood, and a few species are known from insects in living tree trunks (Kobayasi & Shimizu 1983, Samson & Evans 1985, Li *et al.* 2008).

We recently introduced a new species, *Ophiocordyceps xuefengensis*, which parasitizes *Phassus nodus* Chu & Wang collected from the living roots or trunks of the medicinal plant *Clerodendrum cyrtophyllum* Turcz (Wen *et al.* 2013). In this study, a second *Ophiocordyceps* species was found parasitizing the same insect in the living trunk or root of *C. cyrtophyllum* in south China. This species is different from all other *Cordyceps sensu lato* species in morphology and combined multi-gene phylogeny analysis.

TABLE 2 (continued)

Species	Host	Habit	Stromata	Ascomata	Asci	Ascospores	Reference
<i>O. rubiginosa-siperitheciata</i>	<i>Campsosternus auratus</i> larva	Soil	Single, 40–90 × 5 mm, with sterile apex	Superficial, elongated-ovate, 520–600 × 300 µm	6 µm wide	Long cylindrical, multiseptate, not breaking into secondary ascospores, 1–1.2 µm wide	Liang (2001)
<i>O. stylophora</i>	Elateridae larva	Dead wood	Single, occasionally 2, 15–45 × 1.5–2 mm	Entirely embedded or at right angles to the surface, ovoid, 240–420 × 144–240 µm	Cylindrical-clavate, 170–220 × 8–10 µm	Fusoid-cylindrical, multiseptate, not breaking into secondary ascospores, 102–164 × 2–3 µm	Mains (1941)
<i>O. xuefengensis</i>	Hepialidae larva	Living trunk or upper root near soil	Solitary or several, 140–460 × 2–7 mm	Superficial, long ovoid, 416–625 × 161–318 µm	Cylindrical, 191–392 × 4.5–8.9 µm	Thread-like, multiseptate, not breaking into secondary ascospores, 130–380 × 1.4–5.2 µm	Wen <i>et al.</i> (2013)

There are about 90 species of *Cordyceps sensu lato* with cylindrical stromata and only a few species (i.e., *O. gryllotalpae* Petch (1942: 255), *O. jiangxiensis* (Z.Q. Liang *et al.*) G.H. Sung *et al.* (2007a: 43), *C. aeruginosclerota* Z.Q. Liang & A.Y. Liu (in Liang *et al.* 1997: 63), *O. cylindrostromata* (Z.Q. Liang *et al.*) G.H. Sung *et al.* (2007a: 42) and *O. xuefengensis* T.C. Wen *et al.* (2013: 41) have stromata lacking a sterile apex, superficial ascomata and ascospores not breaking into secondary ascospores (Kobayasi & Shimizu 1983, Liang *et al.* 1997, 2001, 2003, Wen *et al.* 2013). The new species differs from the above species in having branched stromata and very wide asci and ascospores without breaking into secondary ascospores.

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