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

TING-CHI WEN1,2, YUAN-PIN XIAO1, WEN-JING LI2, JI-CHUAN KANG1* & KEVIN D. HYDE2

1The Engineering and Research Center for Southwest Bio-Pharmaceutical Resources of National Education Ministry of China, Guizhou University, Guiyang 550025, Guizhou Province, P.R. China
* email: bcec.jckang@gzu.edu.cn
2Institute of Excellence in Fungal Research, and School of Science, Mae Fah Luang University, Chiang Rai 57100, Thailand

**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-1α, 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.
Ophiothecium ramosissimum sp. nov. from China


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TABLE 2 (continued)

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<th>Species</th>
<th>Host</th>
<th>Habit</th>
<th>Stromata</th>
<th>Ascomata</th>
<th>Asci</th>
<th>Ascospores</th>
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<tbody>
<tr>
<td>O. rubiginosperithecicata</td>
<td>Campsosternus auratus larva</td>
<td>Soil, single, 40–90 × 5 mm, with sterile apex</td>
<td>Superficial, elongated-ovate, 520–600 × 300 µm</td>
<td>6 µm wide</td>
<td>Long cylindrical, multiseptate, not breaking into secondary ascospores, 1–1.2 µm wide</td>
<td>Liang (2001)</td>
<td></td>
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<tr>
<td>O. stylophora</td>
<td>Elaterid larva</td>
<td>Dead wood</td>
<td>Single, occasionally 2, 15–45 × 1.5–2 mm</td>
<td>Entirely embedded or at right angles to the surface, ovoid, 240–420 × 144–240 µm</td>
<td>Cylindric-clavate, 170–220 × 8–10 µm</td>
<td>Fusoid-cylindric, multiseptate, not breaking into secondary ascospores, 102–164 × 2–3 µm</td>
<td>Mains (1941)</td>
</tr>
<tr>
<td>O. xuefengensis</td>
<td>Hepialid larva</td>
<td>Living trunk or upper root near soil</td>
<td>Solitary or several, 140–460 × 2–7 mm</td>
<td>Superficial, long ovoid, 466–625 × 161–318 µm</td>
<td>Cylindrical, 191–392 × 4.5–8.9 µm</td>
<td>Thread-like, multiseptate, not breaking into secondary ascospores, 130–380 × 1.4–5.2 µm</td>
<td>Wen et al (2013)</td>
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