Research paper **研究论文**

22 June 2018, 37(6): 693-702 Mycosystema ISSN1672-6472 CN11-5180/Q DOI: 10.13346/j.mycosystema.180033

New species

中国丝盖伞属裂盖组的三个新种

图力古尔[1✪] 范宇光[1, 2]

❶吉林农业大学菌物研究所 吉林 长春 130118

❷长白山科学研究院 吉林 二道白河 133613

摘 要：丝盖伞属裂盖组 *Inocybe* sect. *Rimosae sensu lato* 是一个分类难度较大的类群，组内的一些种类被认为是复合种。分子系统发育分析表明该组并非单系群，该组成员隶属于丝盖伞科下的 2 个属级分支，Inosperma 分支和 Pseudosperma 分支。本文结合形态学特征和分子序列分析，对我国丝盖伞属裂盖组进行了分类学研究，发现 3 个新种：长白丝盖伞 *Inocybe changbaiensis*、新茶褐丝盖伞 *I. neoumbrinella* 和云南丝盖伞 *I. yunnanensis*。长白丝盖伞和新茶褐丝盖伞产自中国东北，前者生于针阔混交林下，后者生于柳树林下；云南丝盖伞产自云南省昆明市，生于阔叶树下。基于 LSU 序列的系统发育分析结果显示，长白丝盖伞隶属于 Inosperma 分支，新茶褐丝盖伞和云南丝盖伞隶属于 Pseudosperma 分支。本文对此进行了形态描述和特征图示，并讨论了新种与近缘种之间的异同。编制了中国丝盖伞属裂盖组已知种类的分种检索表。

关键词：丝盖伞科，形态，核苷酸序列，分类

Three new species of *Inocybe* sect. *Rimosae* from China

BAU Tolgor[1✪] FAN Yu-Guang[1, 2]

❶*Institute of Mycology, Jilin Agricultural University, Changchun, Jilin 130118, China*

❷*Changbai Mountain Academy of Sciences, Erdaobaihe, Jilin 133613, China*

Abstract: *Inocybe* sect. *Rimosae sensu lato* is a challenging taxonomical group mainly due to the presence of cryptic species. Species in sect. *Rimosae sensu lato* were assigned to two generic clades of Inocybaceae according to molecular phylogeny, namely Inosperma clade and Pseudosperma clade. Three new species, *I. changbaiensis*, *I. neoumbrinella* and *I. yunnanensis* were discovered during our taxonomic studies on sect. *Rimosae* in China. *Inocybe changbaiensis* and *I. neoumbrinella* were known from Northeastern China; the former grows under mixed broadleaved-conifer forest, and the latter grows under *Salix* sp. trees *Inocybe yunnanensis* is known from Kunming, Yunnan Province, and grows under deciduous trees. The LSU phylogeny shows that *I. changbaiensis* belongs to Inosperma clade, and other two new species belong to Pseudosperma clade. Illustrated description and taxonomic discussion of the three new species are given. A key to known species of *Inocybe* sect. *Rimosae* are provided.

Key words: Inocybaceae, morphology, nucleotide sequences, taxonomy

基金项目：国家自然科学基金（31270063，31093440）

Supported by the National Natural Science Foundation of China (31270063, 31093440).

✪ Corresponding author. E-mail: junwusuo@126.com

Received: 2018-02-09, accepted: 2018-04-11

丝盖伞属 *Inocybe* (Fr.) Fr.是蘑菇目 Agaricales 中较大的一个属，文献报道全世界已描述500种（Kirk *et al.* 2008）至700 种（Matheny *et al.* 2009）。近些年，来自世界各地的丝盖伞新物种陆续被报道（Kobayashi & Onishi 2010；Kropp *et al*. 2010；Kropp & Albee-Scott 2010；Bougher & Matheny 2011；Kokkonen & Vauras 2011；Bougher *et al*. 2012；Matheny *et al*. 2012；Fan & Bau 2013；Braaten *et al*. 2014；Fan & Bau 2014a，2014b；Esteve-Raventós *et al*. 2015；Latha & Manimohan 2015；Vauras & Larsson 2015，2016）。但不同学者对于丝盖伞属下分类框架有不同的理解。根据侧生囊状体的有无、担子有无、黄色色素以及缘生囊状体发育来源等特征，将丝盖伞属划分为丝盖伞亚属 subg. *Inocybe*、凹孢亚属 subg. *Inosperma* 和茸盖亚属 subg. *Mallocybe* 3个亚属；根据菌盖是否开裂及受伤变色情况，将凹孢亚属 subg. *Inosperma* 分为裂盖组 sect. *Rimosae* 和褐色组 sect. *Cervicolores*（Kuyper 1986）。然而，基于多基因分子系统发育的分析结果有学者建议将丝盖伞属提升为科来认识，该科下包含有7个分支（Matheny *et al.* 2009）；裂盖组并非单系群（Larsson *et al*. 2009），部分种类位于 Pseudosperma 分支中，该分支中包含原裂盖组的模式种裂丝盖伞 *I. rimosa* (Bull.) P. Kumm.，斑点丝盖伞 *I. maculata* Boud.等种类则与褐色组的成员共同构成了 Inosperma 分支（Larsson *et al*. 2009；Matheny *et al*. 2009）。此外，丝盖伞属的个别种类，如裂丝盖伞 *Inocybe rimosa* (Bull.) P. Kumm.具有一定药用价值（戴玉成和杨祝良 2008）。

近年来，丝盖伞属裂盖组的物种多样性研究较为活跃，在欧洲（Larsson *et al*. 2009）、北美（Kropp *et al.* 2013）、亚洲的热带地区（Latha & Manimohan 2015，2016a，2016b，2017；Pradeep *et al*. 2016）和澳大利亚（Matheny & Bougher 2017）等地发现并描述了一系列新种。此次在中国丝盖伞科真菌的分类研究中，发现了3个新种，它们在形态上隶属于丝盖伞属凹孢亚属裂盖组，本文对3个新种进行了描述并对其系统位置进行了分子系统发育分析。

1 材料与方法

1.1 实验材料

研究材料采自吉林省和云南省，凭证标本存放在吉林农业大学菌物标本馆（HMJAU）。

1.2 方法

1.2.1 形态观察：宏观形态特征来自新鲜标本的野外记录。显微特征的观察以干燥材料制成徒手切片，用 5% KOH 溶液为浮载剂，必要时用 1%刚果红染色。对每份标本随机选择 30 个成熟孢子开展尺寸测量，计算出长宽比（Q 值）。括号内的数值为极小值和极大值。干燥材料直接喷金，通过扫描电镜观察担孢子的表面纹饰。

1.2.2 DNA 的提取及序列分析：基因组 DNA 的提取采用改良的 CTAB 法（Doyle & Doyle 1987）。DNA 的检测及 PCR 产物的检测均采用1%的琼脂糖凝胶电泳法（Larsson & Örstadius 2008）。ITS 序列扩增和测序引物采用 ITS1和 ITS4（White *et al.* 1990），nLSU 序列扩增和测序引物采用 LR0R 和 LR7（Vilgalys & Hester 1990）。测序工作委托哈尔滨博仕生物技术有限公司完成。采用 BioEdit 软件读取自测序列，用 DNAMAN 软件进行序列的拼接并得到理想的序列。序列已上传至 GenBank 数据库，生成的序列号为 MG844975–MG844977，MH047249–MH047255。将自测序列输入 NCBI 中进行 BLAST 比对，选取相似性较高的序列用于系统发育分析。系统发育分析中，将裂盖组内代表物种及形态接近的物种序列一同加入分析。由于所选物种间 ITS 序列难以对齐，作者基于 nLSU 序列采用贝叶斯法构建系统发育树（Ronquist & Huelsenbeck 2003），外类群为茸盖亚属的模式种地丝盖伞 *Inocybe terrigena* (Fr.) Kuyper，模型筛选采用 MrModeltest 2.3软件（Nylander 2004），选择最优模型为 GTR+I+G。

2 分子系统发育分析结果

基于 nLSU 序列的分子系统发育结果显示，内类群分为2个高支持率的分支，即 Pseudosperma 分支和 Inosperma 分支（图1）。3个新种在系统树中分

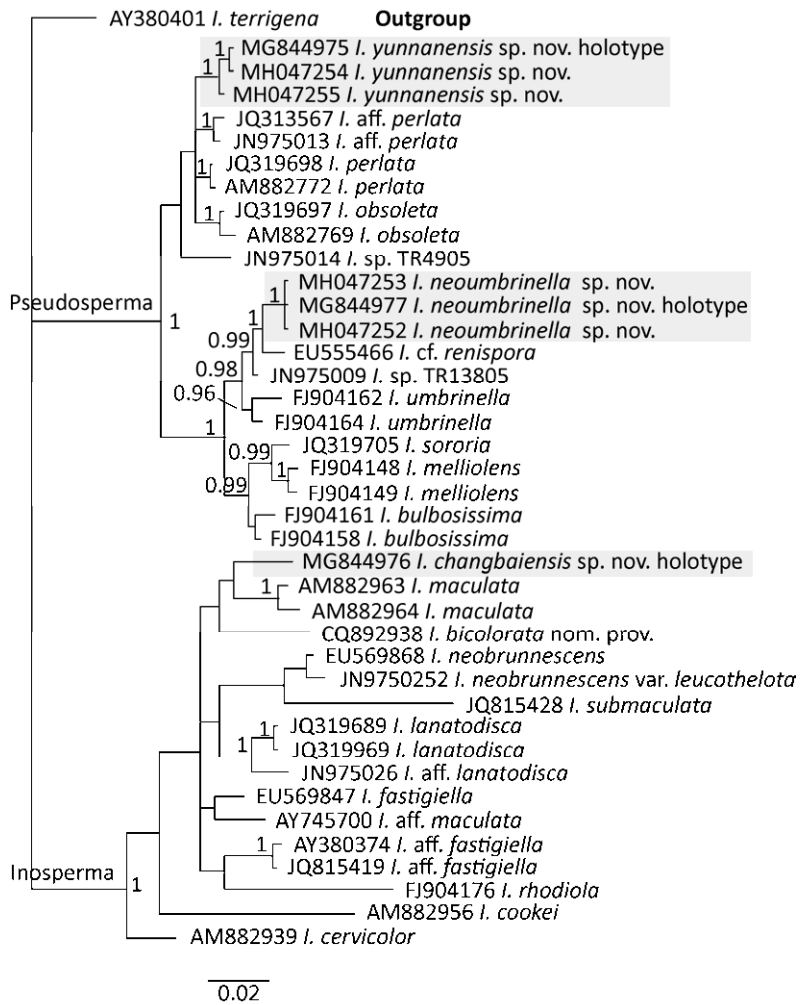

图 1 基于 nLSU 贝叶斯法构建的系统发育树 后验概率>0.95 显示在枝上或节点处，*Inocybe terrigena* 茸盖亚属为外类群，新种被用灰色标记

Fig. 1 Bayesian phylogram inferred from partial nLSU sequence data. Bayesian posterior probabilities more than 0.95 were indicated. The tree is rooted with *Inocybe terrigena* (subgen. *Mallocybe*). New species are highlighted with grey color.

别占据独特分支。新茶褐丝盖伞 *Inocybe neoumbrinella* 和云南丝盖伞 *I. yunnanensis* 位于 Pseudosperma 分支中；新茶褐丝盖伞与已知种茶褐丝盖伞 *I. umbrinella* Bres.亲缘最近，云南丝盖伞与已知种 *I. perlata* 和 *I. obsoleta* 亲缘最近。长白丝盖伞位于 Inosperma 分支中，与斑点丝盖伞亲缘最近。

3 分类

根据作者的研究，在丝盖伞属裂盖组 *Inocybe* sect. *Rimosae* 中，中国已知9种。为便于识别，特编制分种检索表如下：

3.1 中国丝盖伞属裂盖组 *Inocybe* sect. *Rimosae* 分种检索表

1. 菌盖表面被浓密放射状排列的灰白色菌幕 .... 云南丝盖伞 *I. yunnanensis*
1. 菌盖表面菌幕不明显 2
    2. 担子体全部为褐色 .... 新茶褐丝盖伞 *I. neoumbrinella*
    2. 担子体非全部褐色 3
3. 菌盖不明显开裂.....4
3. 菌盖明显开裂..... 淡黄丝盖伞 *I. flavella* P. Karst.
    4. 菌褶带黄色 .....

....新褐丝盖伞 *I. neobrunnescens* Grund & D.E. Stuntz

4. 菌褶不带黄色 5

5. 菌肉具油菜味 .....淀粉味丝盖伞 *I. quietiodor* Bon

5. 菌肉不具有油菜味..... 6

6. 担子体带红色或受伤后变红色 7

6. 担子体受伤后不变色 8

7. 担子体酒红色或菌柄老后带红色..... ..... 酒红丝盖伞 *I. adaequata* (Britzelm.) Sacc.

7. 担子体草黄色，成熟后或伤后带红色至砖红色 ....变红丝盖伞 *I. erubescens* A. Blytt

8. 担子体中等至较大，缘生囊状体宽棒状..... ..... 蜡盖丝盖伞 *I. lanatodisca* Kauffman

8. 担子体相对较小，缘生囊状体细长棒状..... .....长白丝盖伞 *I. changbaiensis*

3.2 物种描述

长白丝盖伞 图2，图3A，图5A

Inocybe changbaiensis T. Bau & Y.G. Fan, **sp. nov.** Fig. 2, Fig. 3A, Fig. 5A

MycoBank MB824144

Type: China, Jilin Province, Yanbian, Antu County, Erdaobaihe town, Toudao Protect Station, Yu-Guang Fan, 17.09.2010 (HMJAU25861, holotype).

Diagnosis: Basidiomata medium-sized. Pileus 20–35mm in diam., conical to applanate, umbonate, with a prominent umbo, fibrillose, rimulose to usually rimose at margin when young, uplifted or recurved at margin in age, yellow to ochraceous, paler outwards. Lamellae crowded, 2mm in width, adnexed, white to grayish, with olivaceous tinge when mature, edge fimbricate; not smooth. Stipe 50–65×3.5–6.5mm, solid, thicker downwards, swollen towards base, but not marginate, smooth on the stipe surface, nearly whitish tinge towards apex and base, becoming yellow to ochraceous at the center. Context with conspicuous spermatic odor, fleshy in pileus, 1–3mm in thickness, whitish, fibrillose in stipe. Basidiospores 8.5–10.5×5–6µm, Q=1.5–2.0, yellow-brown, smooth, ellipsoid to nearly phaseoliform. Basidia 30–39× 7–11µm, clavate to narrowly clavate, with 4 sterigmata, translucence, occasionally with yellowish pigments. Pleurocystidia absent. Cheilocystidia translucent, thin-walled, conspicuously septate, occasionally with gold yellowish pigments, terminal cells 22–63×10–12µm, clavate to slenderly clavate, apices obtuse to truncate. Caulocystidia present at stipe apex, 15–34×9–16µm, translucent, thin-walled, similar to cheilocystidia. Lamellar trama hyphae nearly regularly arranged, pale yellow, composed of translucent and pale yellow, thin-walled hyphae up to 18µm wide. Pileipellis a cutis, regularly arranged, orange brown to brownish, composed of swollen cylindric to incrusted hyphae 7–17µm in diam. Clamp

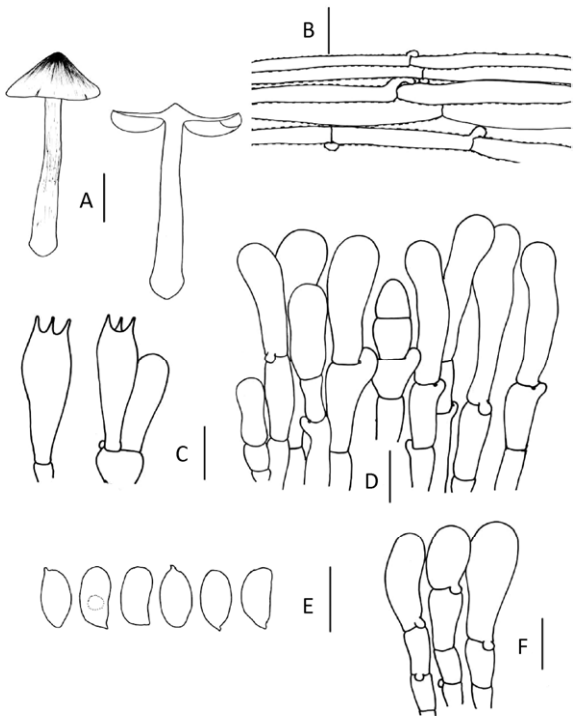

图 2 长白丝盖伞 A：担子体；B：菌盖表皮；C：担子；D：缘生囊状体；E：担孢子；F：柄生囊状体. 标尺：A=20mm，B–D，F=20µm，E=10µm

Fig. 2 *Inocybe changbaiensis.* A: Basidiomata; B: Pileipellis; C: Basidia; D: Cheilocystidia; E: Basidiospores; F: Caulocystidia. Bars: A=20mm, B–D, F=20µm, E=10µm.

connections common in all tissues. Differs from *I. lanatodisca* by its ochraceous pileus and its slender cheilocystidia.

词源：Changbai指该新种的模式产地为长白山。

担子体中等大。菌盖直径20–35mm，幼时锥形，后呈斗笠形至平展，中央具明显突起，老后边缘稍翘起，黄色至赭黄色，向边缘色渐淡，纤维丝状，有时边缘开裂。菌褶幼时近白色，密，成熟后带橄榄色或近灰色，褶缘非平滑。菌柄长50–65mm，粗3.5–6.5mm，向下渐粗，基部膨大，无边缘，中实，表面平滑，顶部和基部近白色，中部与菌盖同色。菌肉具明显土腥味，菌盖菌肉白色，肉质，1–3mm厚，菌柄菌肉纤维质，致密。

担孢子8.5–10.5×5.0–6.0μm，Q=1.5–2.0，椭圆形至近豆形，黄褐色，光滑。担子30–39×7–11μm，棒状至细长棒状，具4个担子小梗，内部透明，偶尔具淡黄色内含物。无侧生囊状体。缘生囊状体，透明，薄壁，明显分隔，偶尔内部具金黄色色素，末端细胞22–63×10–12μm，短棒状至长棒状，顶部钝圆或呈头状。柄生囊状体仅生于菌柄顶部，形态与缘生囊状体相似，15–34×9–16μm，透明，薄壁。菌褶菌髓菌丝近规则排列，淡黄色，由透明至带黄色的薄壁菌丝构成，宽达18μm。菌盖表皮菌丝规则排列，橙褐色至棕褐色，由圆柱形至膨大的被壳菌丝构成，直径7–17μm。锁状联合存在于担子体各部位。

生境：秋季单生于针阔混交林内地上，土质肥沃。

中国分布：吉林。

世界分布：中国。

研究标本：吉林：安图县二道白河镇头道管理站，图力古尔和范宇光，2010年9月17日，生于针阔混交林内地上，HMJAU25861（holotype，ITS：MH047251；nLSU：MG844976）。

讨论：此种的主要特点是菌盖平滑、纤维丝状，菌柄光滑，孢子较小，缘生囊状体多具分隔。以上特征使得此种成为裂盖组 sect. *Rimosae* 特征较为明显的种之一。nLSU序列比对结果与美国的 *I. neobrunnescens* var. *leucothelota* Grund & Stuntz 相似率最高（97%），后者的菌盖表面纤维丝状、具菌幕残留，缘生囊状体分隔较少（Grund & Stuntz 1977）。ITS 序列的比对结果显示，相似率最高的（99%）是来自日本富士山的一份菌根材料（AB848507）。基于nLSU 序列构建的系统发育树中（图1），长白丝盖伞处于 Inosperma 分支中，与蜡盖丝盖伞 *I. lanatodisca* Kauffman（=*I. maculata* f. *fulva* Bon）、斑点丝盖伞 *I. maculata* Boud 聚为一支，但支持率不高。分布于欧洲、北美及东亚的蜡盖丝盖伞与此种十分接近（Larsson *et al*. 2009；Kropp *et al*. 2013），但蜡盖丝盖伞和斑点丝盖伞的褶缘囊状体为棒状至宽棒状，不分隔，斑点丝盖伞菌盖表面具明显的灰白色菌幕残留，褶缘囊状体与蜡盖丝盖伞接近。

新茶褐丝盖伞 图3B，图4，图5B

Inocybe neoumbrinella T. Bau & Y.G. Fan, **sp. nov.** Fig. 3B, Fig. 4, Fig. 5B

MycoBank MB824201

Type: China, Jilin Province, Yanbian, Antu County, Erdaobaihe Town, Huangsongpu, Yu-Guang Fan, 17.07.2010 (HMJAU25742, holotype).

Diagnosis: Basidiomata small. Pileus 22–30mm, conical when young, then applanate, with acute umbo, coarsely fibrillose, rimulose to rimose at margin, usually split in age, chocolate brown to dark brown, ocher yellow on umbo, margin with cortina when young. Lamellae crowded, 3mm in width, adnexed, brown with olivaceous tinge; edge concolorous with face. Stipe 28–47×2–3mm, equal, solid, brownish to pale brown, entirely pruinose on stipe surface, densely pruinose at upper part, stipe base with whitish mycelium, fibrillose and thicker downwards. Context thin, odor indistinct, fleshy in pileus, brown to pale brown, 1mm in width, striate in stipe, pale brown. Basidiospores (8.5)9–12(13)× 5.5–6.5(7)μm, Q=1.5–1.9, brown, ellipsoid to nearly

phaeroliform, apex obtuse. Basidia 22–28×8–11µm, with 4 sterigmata, clavate, narrower downwards, usually with yellowish pigments. Pleurocystidia absent. Cheilocystidia 25–50×11–18µm, clavate to fusiform, thin-walled; apices obtuse to truncate, surface crystalliferous, at times septate, hyline base. Caulocystidia present at the apex only, 20–48× 10–17µm, similar to cheilocystidia, clavate to fusiform, thin-walled. Hymenial trama hyphae sub-regularly arranged, translucent and pale yellow, composed of thin-walled and swollen hyphae 24µm wide. Pileipellis a cutis, regularly arranged, reddish brown, composed of swollen cylindric to incrusted hyphae, 5–18µm in diam. Clamp connections common in all tissues. Differs from *I. umbrinella* by its entirely brown to umber brown basidiomata.

词源：“neo”意为“新”，“neoumbrinella”指与 *I. umbrinella* 在形态和系统发育上的相似性。

担子体较小。菌盖直径22–30mm，幼时锥形，后渐平展，盖中央有明显较锐的突起，粗纤维丝状，质地粗糙，除盖中央外表面呈明显的细缝裂，边缘近开裂，棕褐色至茶褐色，突起处赭黄色，幼时可见菌盖边缘具淡褐色菌幕残留。菌褶密，直生，褐色带橄榄色，褶缘非平滑，与褶面同色，宽达3mm。菌柄长28–47×2–3mm，中实，圆柱形，中下部渐粗，较菌盖色淡，表面被一层白色至污白色鳞状平伏的菌幕残留，顶部呈白霜状至头屑状，基部具白色菌丝，中下部渐粗。菌肉薄，无明显气味，菌盖菌肉肉质，褐色至淡褐色，水浸状，盖中部菌肉厚约1mm，菌柄菌肉淡褐色，纤维质，较疏松。

图 3 新种的生境照片 A：长白丝盖伞；B：新茶褐丝盖伞；C，D：云南丝盖伞. 标尺=5mm

Fig. 3 Fresh basidiomata *in situ*. A: *Inocybe changbaiensis*; B: *I. neoumbrinella*; C, D: *I. yunnanensis*. Bars= 5mm.

担孢子(8.5)9–12(13)×5.5–6.5(7)µm，Q=1.5–1.9，褐色，椭圆形，有的近豆形，两端钝圆。担子22–28×8–11µm，棒状，具4个担子小梗，内部具有亮黄色色素。无侧生囊状体。缘生囊状体丰富，25–50×11–18µm，棒状至纺锤形，薄壁至稍加厚，顶部钝或稍平，基部偶尔分隔，表面被颗粒状结晶体。柄生囊状体仅生于菌柄顶端，与缘生囊状体相似，常成串，20–48×10–17µm。菌髓菌丝亚规则排列，透明至带黄色，由薄壁的膨大菌丝构成，直径可达24µm。菌盖表皮平伏型，规则排列，红褐色，由圆柱形至膨大的被壳菌丝构成，褐色，直径5–18µm。锁状联合存在于担子体各部位。

生境：柳、栎或杨树下，沙质土壤，生于路边。

中国分布：吉林。

世界分布：中国。

研究标本：吉林：延边朝鲜族自治州安图县二道白河镇黄松蒲，图力古尔和范宇光，2010年7月15日，HMJAU25742（holotype，ITS：GenBank，MH047249；nLSU：GenBank，MG844977）；图力古尔和范宇光，2010年7月14日，HMJAU25732（nLSU：MH047253）和 HMJAU25730（nLSU：MH047252）。

讨论：此种的主要特征是担子体棕褐色至巧克力色，盖表面纤维丝状、细缝裂，较粗糙，盖中央具钝至锐突起。描述于欧洲的茶褐丝盖伞 *Inocybe umbrinella* Bres.与此种接近，但茶褐丝盖伞的菌盖暖黄色至红褐色，菌柄为白色至米色（Larsson *et al.* 2009），孢子10–14×5.5–6.5µm（Bresadolae 1905）。

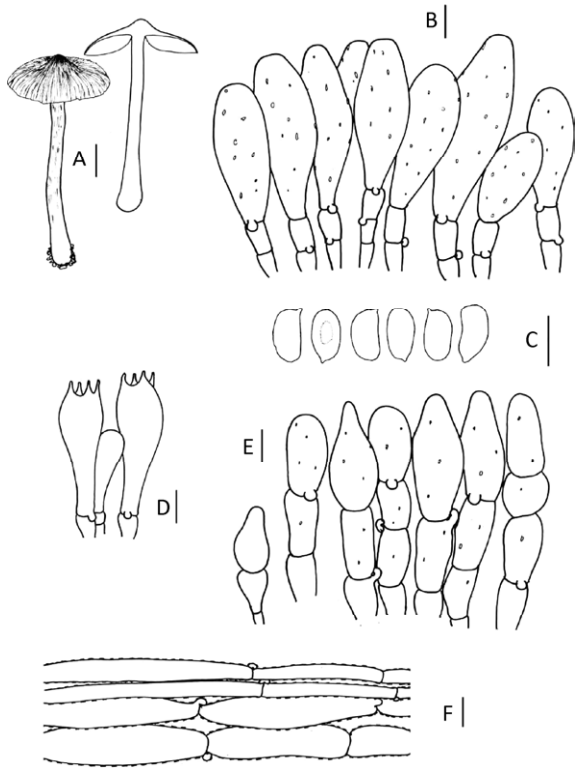

图 4 新茶褐丝盖伞 A：担子体；B：担孢子；C：担子；D：缘生囊状体；E：柄生囊状体；F：菌盖表皮. 标尺：A=10mm；B–F=10μm

Fig. 4 *Inocybe neoumbrinella.* A: Basidiomata; B: Basidiospores; C: Basidia; D: Cheilocystidia; E: Caulocystidia; F: Pileipellis. Bars: A=10mm; B–F=10μm.

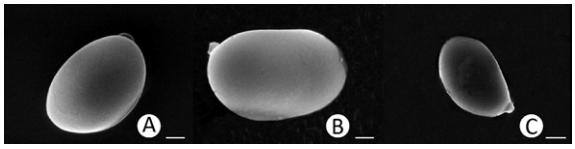

图 5 担孢子扫描电镜照片 A：长白丝盖伞；B：新茶褐丝盖伞；C：云南丝盖伞. 标尺=2μm

Fig. 5 SEM photos of basidiospores. A: *Inocybe changbaiensis*; B: *I. neoumbrinella*; C: *I. yunnanensis*. Bars=2μm.

BLAST 工具比对结果显示，新茶褐丝盖伞模式标本的 nLSU 序列与来自欧洲的材料 *Inocybe sororia* Kauffman.相似率为98%，但后者的菌柄长达13cm 宽4–10mm，无侧生囊状体和缘生囊状体，在宏观和显微形态上均存在较大区别（Stuntz 1947；Grunds & Stuntz 1975）。ITS 序列相似率最高（97%）的是产自澳大利亚的 *I.* aff. *renispora*（JQ408771）。在系统树中，新茶褐丝盖伞占据独特的分支并与 *I.* cf. *renispora*（EU555466）和 *I.* sp. TR13805（JN975009）关系最接近，这两份材料被认为是裂丝盖伞复合群的2个待描述种（Kropp *et al.* 2013），暂无法获得其形态学数据。

云南丝盖伞 图3C，3D，图5C，图6

Inocybe yunnanensis T. Bau & Y.G. Fan, **sp. nov.** Fig. 3C, 3D, Fig. 5C, Fig. 6

MycoBank MB824145

Type: China, Yunnan Province, Kunming, Heilongtan Forest Park, Yu-Guang Fan, 02.09.2010 (HMJAU25840, holotype).

Diagnosis: Pileus 30–60mm in diam., convex, dome-shaped to applanate, not umbonate, surface with a layer of grayish to whitish veilpillis when young, radically arranged; initially with appressed and decending to edge of the pileus, margin inrolled when young, pale yellow to ochraceous. Lamellae up to 4mm in width, crowded, adnexed, cream-white with olivaceous tinge. Stipe 60–70×5–15mm, equal or enlarged downwards, base slightly tappered, solid, fibrillose with densely squamules, white to grayish. Context slightly olivaceous, odor indistinct, fleshy in pileus, up to 6mm in thickness; striate, fleshy in stipe, fibrillose, pale pinkish tinge. Basidiospores (8.5)9–10.5(11)×5–6μm, Q=1.4–1.9, yellowish brown, smooth, ellipsoid or phaseoliform. Some spores significantly larger, 12.2–15.3×8–9.7μm, ellipsoid to broadly ellipsoid or irregular. Basidia 22–33×9–11μm, with 4 sterigmata, clavate, narrower downwards, apices obtuse to truncate, occasionally swollen at apex. Pleurocystidia absent. Cheilocystidia 30–47×12–15μm, thin-walled, translucent, broadly clavate or slenderly fusiform, rarely septate, hyaline

base. Caulocystidia absent. Stipitipellis a cutis, with translucent, thin-walled and cylindric, terminal cells 20–41×9–12μm; apices obtuse to truncate at stipe apex. Lamellar trama tissue composed of thin-walled, swollen to slightly thick hyphae 7–23μm wide, pale yellow to colorless, regularly arranged. Pileipellis a cutis, smooth or slightly coarse, regularly arranged, brown, composed of slightly thick-walled, cylindric to swollen hyphae 5–20μm in diam. Clamp connections common in all tissues. Differs from *I. perlata* by its dense veilpellis on pileus surface.

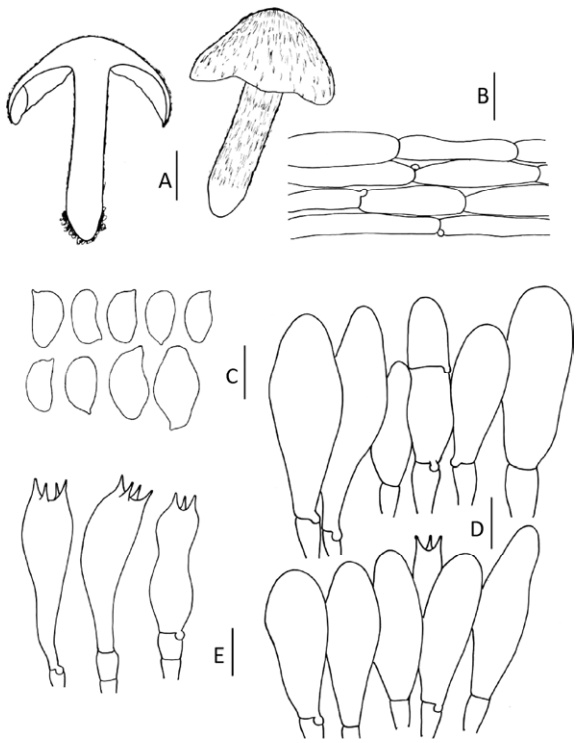

图 6 云南丝盖伞 A：担子体；B：菌盖表皮；C：担孢子；D：缘生囊状体；E：担子. 标尺：A=10mm，B–E=10μm

Fig. 6 *Inocybe yunnanensis.* A: Basidiomata; B: Pileipellis; C: Basidiospores; D: Cheilocystidia; E: Basidia. Bars: A=10mm, B–E=10μm.

词源：yunnanensis，指其模式产地为中国云南省。

子实体中等至较大。菌盖直径20–60mm，半球形至宽半球形，盖中央无明显突起，盖表面被浓密灰白色毡毛状菌幕，辐射状，平伏至稍翘起，中部浓密，向边缘渐稀疏，延伸至菌盖边缘，边缘内卷，形态完整，盖表皮土黄色至赭黄色，有时灰褐色至暗褐色，菌盖边缘初期内卷，后伸展，有时呈波状。菌褶密，直生，乳白色至带橄榄色，宽达4mm，褶缘色淡，非平滑。菌柄长55–100mm，粗5–15mm，近等粗或向下渐粗，基部稍细，中实，表面被浓密绵毛状鳞片，有时鳞片不明显。菌肉味道不明显，菌盖菌肉肉质，淡橄榄黄色，最厚处达6mm，菌柄菌肉纤维质至肉质，淡粉色，呈竖条纹。

担孢子(8.5)9–10.5(11)×5–6μm，Q=1.4–1.9，黄褐，光滑，椭圆形至豆形，偶尔孢子明显偏大且形状不规则，12.2–15.3×8.0–9.7μm，椭圆形至宽椭圆形或不规则。担子22–33×9–11μm，棒状，向基部渐细，顶部钝，偶尔顶部呈头状，具4个担子小梗。无侧生囊状体。缘生囊状体30–47×12–15μm，薄壁，透明，宽棒状至长纺锤形，偶尔分隔。无典型柄生囊状体。菌柄顶部表皮菌丝透明，薄壁，圆柱形，末端细胞顶部钝圆或呈头状，直径7–12μm。菌褶菌髓组织带黄色至无色，规则排列，由薄壁至稍加厚的膨大细胞构成，直径达7–23μm。菌盖表皮菌丝褐色，平伏型，规则排列，由稍厚壁的圆柱形至膨大菌丝构成，光滑至稍粗糙，直径5–20μm。锁状联合存在于担子体各部位。

生境：秋季单生于阔叶树下。

中国分布：云南。

世界分布：中国。

研究标本：云南：昆明市黑龙潭，图力古尔和范宇光，2010年9月2日，HMJAU25840（holotype，ITS：MH047250；nLSU：MG844975）、HMJAU25883（nLSU：MH047255）、HMJAU25841（nLSU：MH047254）和 HMJAU25843；昆明市野鸭湖，图力古尔和范宇光，2011年7月27日，HMJAU25962。

讨论：该种的识别特征为幼时菌盖及菌柄表面密被白色菌幕，菌幕在菌盖表面可保持至子实体成熟。担子体幼时粗壮，担孢子光滑，椭圆形至豆形，缘生囊状体薄壁，无侧生囊状体。以上特征表明此种隶属于裂盖组 sect. *Rimosae*。在裂盖组内，该种

在形态上与 *I. perlata* (Cooke) Sacc.及 *I. obsoleta* Romagn.接近。*Inocybe perlata* (Cooke) Sacc.子实体尺寸更大，菌盖可宽达3.5–10cm，菌柄长达8.0–12cm，成熟后期菌柄中下部变褐色至黑色（Anonymous 2004；Jacobsson 2008）。*Inocybe obsoleta* 的相似之处在于菌盖表面被明显菌幕，但它的菌盖颜色浅，孢子尺寸更大，9–15×6–8μm（Jacobsson 2008）。云南丝盖伞与描述于欧洲的 *I. arenicola* (R. Heim) Bon. 较为接近，但后者孢子较大，菌柄基部稍膨大或近球形膨大，褶缘囊状体更长，且生于海岸沙地（Kuyper 1986；Larsson *et al*. 2009）。基于 ITS 序列的 BLAST 结果显示，云南丝盖伞与产自欧洲的 *I. perlata*（AM882771）相似率最高，但仅达88%。此种在系统树中占据独特的分支并与 *I. perlata* 及 *I. obsoleta* 聚为一支，但支持率较低。

[REFERENCES]

Anonymous, 2004. Fungal portraits No. 19: *Inocybe perlata*. *Field Mycology*, 5(3): 75-76

Bougher NL, Matheny PB, 2011. Two species of *Inocybe* (fungi) introduced into Western Australia. *Nuytsia*, 21: 139-148

Bougher NL, Matheny PB, Gates GM, 2012. Five new species and records of *Inocybe* (Agaricales) from temperate and tropical Australia. *Nuytsia*, 22: 57-74

Braaten CC, Matheny PB, Viess DL, Wood MG, Williams JH, Bougher NL, 2014. Two new species of *Inocybe* from Australia and North America that include novel secotioid forms. *Botany*, 92: 9-22

Bresadola G, 1905. Hymenomycetes novi vel minus cogniti. *Annales Mycologici*, 3: 159-164

Dai YC, Yang ZL, 2008. A revised checklist of medicinal fungi in China. *Mycosystema*, 27: 801-824 (in Chinese)

Doyle JJ, Doyle JL, 1987. A rapid DNA isolation procedure for small quantities of fresh leaf tissue. *Phytochemical Bulletin*, 19: 11-15

Esteve-Raventós F, Moreno G, Bizio E, Alvarado P, 2015. *Inocybe flavobrunnescens*, a new species in section *Marginatae*. *Mycological Progress*, 14: 1-12

Fan YG, Bau T, 2013. Two striking *Inocybe* species from Yunnan Province, China. *Mycotaxon*, 123: 169-181

Fan YG, Bau T, 2014a. *Inocybe miyiensis*, a new two-spored species in section *Marginatae* from China. *Nova Hedwigia*, 98: 179-185

Fan YG, Bau T, 2014b. *Inocybe hainanensis*, a new lilac stiped species from tropical China. *Mycosystema*, 33(5): 954-960

Grund DW, Stuntz DE, 1977. Nova Scotion Inocybes IV. *Mycologia*, 69: 392-408

Jacobsson S, 2008. *Inocybe* (Fr). Fr. In: Knudsen H, Vesterholt J (eds.) Funga Nordica, Agaricoid boletoid and Cyphelloid genera. Copenhagen, Nordsvamp. 868-906

Kirk PM, Cannon PF, Minter DW, Stalpers JA, 2008. Dictionary of the fungi. 10th ed. CABI Publishing, UK. 1-771

Kobayashi T, Onishi S, 2010. *Inocybe sericella*, a new species of *Inocybe* sect. *Inocybe* [= *Cortinatae*] from Kobe, Japan. *Nova Hedwigia*, 90: 227-232

Kokkonen K, Vauras J, 2011. Eleven new boreal species of *Inocybe* with nodulose spores. *Mycological Progress*, 11(1): 299-341

Kropp BR, Albee-Scott S, 2010. *Inocybe tauensis*, a new species from the Samoan Archipelago with biogeographic evidence for a Paleotropical origin. *Fungal Biology*, 114(9): 790-796

Kropp BR, Matheny PB, Hutchison LJ, 2013. *Inocybe* section *Rimosae* in Utah: phylogenetic affinities and new species. *Mycologia*, 105: 728-747

Kropp BR, Matheny PB, Nanagyulyan SG, 2010. Phylogenetic taxonomy of the *Inocybe* splendens group and evolution of supersection "*Marginatae*". *Mycologia*, 102: 560-573

Kuyper TW, 1986. A revision of the genus *Inocybe* in Europe. I. Subgenus *Inosperma* and the smooth-spored species of subgenus *Inocybe*. *Persoonia*, 3(Suppl.): 1-247

Larsson E, Örstadius L, 2008. Fourteen coprophilous species of *Psathyrella* identified in the Nordic countries using morphology and nuclear rDNA sequence data. *Mycological Research*, 112: 1165-1185

Larsson E, Ryberg M, Moreau PA, Mathiesen AD, Jacobsson S, 2009. Taxonomy and evolutionary relationships within species of section *Rimosae* (*Inocybe*) based on ITS, LSU and mtSSU sequence data. *Persoonia*, 23: 86-98

Latha KPD, Manimohan P, 2015. *Inocybe griseorubida*, a new species of Pseudosperma clade from tropical India.

Phytotaxa, 221: 166-174

Latha KPD, Manimohan P, 2015. Five new species of *Inocybe* (Agaricales) from tropical India. *Mycologia*, 108(1): 110-122

Latha KPD, Manimohan P, 2016a. Five new species of *Inocybe* (Agaricales) from tropical India. *Mycologia*, 108: 110-122

Latha KPD, Manimohan P, 2016b. *Inocybe gregaria*, a new species of the Inosperma clade from tropical India. *Phytotaxa*, 286: 107-115

Latha KPD, Manimohan P, 2017. Inocybes of Kerala. SporePrint Books, Calicut. 1-181

Matheny PB, Aime MC, Bougher NL, Buyck B, Desjardin DE, Horak E, Kropp BR, Lodge DJ, Trappe JM, Hibbett DS, 2009. Out of the Palaeotropics? Historical biogeography and diversification of the cosmopolitan mushroom family Inocybaceae. *Journal of Biogeography*, 36: 577-592

Matheny PB, Aime MC, Smith ME, Henkel TW, 2012. New species and reports of *Inocybe* (Agaricales) from Guyana. *Tomo*, 37: 23-39

Matheny PB, Bougher NL, 2017. Fungi of Australia: Inocybaceae. CSIRO Publishing, Clayton. 1-592

Nylander J, 2004. MrModeltest 2.3. Computer program and documentation distributed by the author. Evolutionary Biology Centre, Uppsala University, Uppsala.

Pradeep CK, Vrinda KB, Varghese SP, Korotkin HB, Matheny PB, 2016. New and noteworthy species of *Inocybe* (Agaricales) from tropical India. *Mycological Progress*, 15: 24

Ronquist F, Huelsenbeck JP, 2003. MrBayes 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics*, 19: 1572-1574

Stuntz DE, 1947. Studies in the genus *Inocybe* I. New and noteworthy species from Washington. *Mycologia*, 39: 21-55

Vauras J, Larsson E, 2015. *Inocybe caprimulgi* and *I. lacunarum*, two new nodulose-spored species from Fennoscandia. *Karstenia*, 55: 1-18

Vauras J, Larsson E, 2016. *Inocybe baltica* and *I. suecica*, two new smoothspored species from the Baltic Sea region. *Karstenia*, 56: 13-26

Vilgalys R, Hester M, 1990. Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. *Journal of Bacteriology*, 172: 4239-4246

White TJ, Bruns T, Lee S, Taylor JW, 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ (eds.) PCR protocols: a guide to methods and applications. Academic Press, Inc., New York. 315-322

[附中文参考文献]

戴玉成，杨祝良，2008. 中国药用真菌名录及部分名称的修订. 菌物学报，27: 801-824

（本文责编：王敏）