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Pseudosperma citrinostipes (Inocybaceae), a new species associated with *Keteleeria* from southwestern China



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
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Abstract

Pseudosperma citrinostipes sp. nov. from southwestern China is described and illustrated based on morphological, ecological, and molecular data. The new species is characterized by a medium-sized slender habit, straw yellow to golden yellow pileus, crowded lamellae without olive tinges, an equal stipe with lemon yellow to golden fibrils, large ellipsoid to subphaseoliform basidiospores, subfusiform to lageniform cheilocystidia, and the presence of caulocystidia at the stipe apex. Phylogenetically, *P. citrinostipes* is placed in the *P. rimosum* complex and is sister to the rest of the taxa of the species complex.

Keywords: Agaricomycetes; cryptic species; taxonomy; Yunnan province

Introduction

Inocybaceae Jülich (1982: 374) is an ectomycorrhizal family associated with at least 23 families of vascular plants (Matheny *et al.* 2019). The estimated number of species in Inocybaceae has almost doubled during the last 12 years from 500 (Kirk *et al.* 2008) to 1050 (Matheny & Kudzma 2019). Earlier phylogenetic studies of Inocybaceae revealed seven major clades within the family (Matheny 2009) and a recent six-gene phylogenetic study elevated them to the rank of genus (Matheny *et al.* 2019). Genus *Pseudosperma* Matheny & Esteve-Rav., (2019: 11) now includes those species of the former *Pseudosperma* clade (Matheny 2010) or *Inocybe* sect. *Rimosae sensu stricto* (Larsson *et al.* 2009) and contains 70 described species (Matheny *et al.* 2019). The members of this genus have an ectomycorrhizal association with diverse families of plants.

The combination of a fibrillose to rimose pileus, distinctly pruinose stipe apex, elliptic to indistinctly phaseoliform basidiospores, cheilocystidia arising from modified basidia, lack of pleurocystidia, spermatic odor and ectomycorrhizal life mode characterise *Pseudosperma* (Matheny *et al.* 2019). Only limited information is available on the species diversity of *Pseudosperma* in China and only 5 species have been reported so far (Fan & Bau 2010, Bau & Fan 2018).

Keteleeria Carrière is a relic coniferous genus (Pinaceae) endemic to East Asia and reported to have a symbiotic association with a diverse group of fungi (Ge *et al.* 2011). Yunnan Province is a biodiversity hotspot of global significance with about 3000 higher fungal species (Feng & Yang 2018). A survey of ectomycorrhizal fungal diversity associated with two *Keteleeria* species in Yunnan revealed that *Inocybe sensu lato* was the second most diverse group (Ge *et al.* 2011). In this study, we propose a new *Pseudosperma* species associated with *Keteleeria* in Yunnan province, China. The uniqueness of the new species was verified by morphology and molecular phylogeny. Its ectomycorrhizal association with *Keteleeria* is also confirmed by molecular analysis.

Materials and methods

Field sampling and morphological studies

Specimens were collected from Heilongtan Park (N102°44'49", W25°08'29") and Yeya Lake Park (N102°51'34", W25°07'11") in Kunming City of Yunnan province, which has a subtropical highland monsoon climate. Basidiomes were photographed with a digital camera. Fresh materials were described soon after fieldwork and dried by an electronic drier at 50°C overnight. Dried specimens were packed in plastic bags and sealed by a plastic-sealing machine to exclude moisture. Sealed specimens were deposited in the Fungal Herbarium of Hainan Medical University (FHMU) and the Fungarium of Changbai Mountain Academy of Sciences (FCAS).

The macroscopic features were made from field notes and photographs. Color notations follow Kørnerup & Wanscher (1978). Micro-characters were observed by freehand sections in 5% aqueous KOH and 1% Congo Red using a light microscope (Olympus CX23). Microscopic structures, including basidiospores, basidia, cheilocystidia, caulocystidia, and pileipellis, were photographed from rehydrated materials. The measurements of basidiospores and basidia follow Fan & Bau (2013). The number of measured basidiospores is given as an abbreviation [n/m/p], which denotes n spores measured from m basidiomata of p collections (Zhang *et al.* 2019). The measurements and Q values are given as (a)b–c(d), “b–c” covers a minimum of 90% of the measured values, “a” and “d” represents the extreme value; Q means the ratio of length/width in an individual basidiospore, Qm refers to the average of Q value.

Molecular procedures and phylogenetic analyses

A small piece of lamellae or pileus from each voucher specimen was prepared for DNA extraction. Genomic DNA was extracted using the NuClean Plant Genomic DNA Kit (ComWin Biotech, Beijing). Primer pairs ITS1F/ITS4 (Gardes & Bruns 1993), LR0R/LR7 (Vilgalys & Hester 1990), and bRPB2-6F/bRPB2-7.1R (Matheny 2005) were used to amplify the ITS region, nrLSU and the *rpb2* gene, respectively. The amplification reaction volume was 25 µL in total, containing 12.5 µL 2xTaq Plus MasterMix (Dye) (ComWin Biotech, Beijing), 9.5 µL ddH₂O, 1 µL per primer, and 1 µL template DNA. PCR reactions were performed using a touchdown program (Yan *et al.* 2019). Sequencing work was done by Sangon Biotech (Shanghai) Co., Ltd.

Sequences of taxa belonging to *Pseudosperma* obtained from previous studies (Ryberg *et al.* 2008; Larsson *et al.* 2009; Kropp *et al.* 2013; Horak *et al.* 2015; Pradeep *et al.* 2016; Latha & Manimohan 2015, 2016, 2017; Matheny & Bougher 2017; Bau & Fan 2018; Matheny & Esteve-Raventós 2019) or BLASTn results of our ITS sequence query were selected for phylogenetic analysis (Supplementary table). Three datasets of different gene sequences were separately aligned by MAFFT online service (Katoh *et al.* 2019) and edited by BioEdit 1.8.1. *Mallocybe terrigena* (Fr.) Matheny, Vizzini & EsteveRav., was used as the outgroup (Matheny & Esteve-Raventós 2019). Phylogenetic analyses were performed using Bayesian Inference (BI) in MrBayes v3.2.6 (Ronquist *et al.* 2012). MrModeltest v2.3 was used to select the best model for each gene partition (Nylander 2004).

Results

Molecular data and phylogeny

Twenty-one sequences from nine specimens, including 9 ITS, 6 LSU, and 6 *rpb2*, were newly generated and submitted to GenBank (Table 1). BLASTn results of our ITS sequences got two matches to the environmental samples from root tips of *Keteleeria* in Yunnan province with 99% similarity. These two ITS sequences were also included in the ITS dataset. GTR+I+G was selected as the best model for each of the three datasets. The final dataset of ITS-LSU-*rpb2* sequences included 103 samples with 3014 nucleotide sites. Alignments were submitted to TreeBase (26211). A polygram inferred with MrBayes 3.2.6 was indicated with support values (Fig. 1). In the phylogenetic tree, two ectomycorrhizal samples, K1 and K4, cluster with nine collections of the new species in a strongly supported lineage (BPP = 1). The *P. rimosum* complex, recovered as a well-supported clade (BPP = 1), is nearly identical to that defined by Kropp *et al.* (2013). The lineage of the new species is placed in the *P. rimosum* complex, most closely related to PBM1889, and is sister to the others in this species complex.

TABLE 1. Newly generated sequences and their vouchers.

Taxa	Collection number (Voucher)	Locality	GenBank accession number		
			ITS	LSU	RPB2
<i>P. citrinostipes</i> sp. nov.	FYG2901 (FHMU3148)	China	MT072896	MT071201	MT086747
<i>P. citrinostipes</i> sp. nov.	FYG2903 (FHMU3149)	China	MT072897	MT071202	MT086748
<i>P. citrinostipes</i> sp. nov.	FYG2909 (FHMU3150)	China	MT072898	MT071203	MT086749
<i>P. citrinostipes</i> sp. nov.	FYG2910 (FHMU3151)	China	MT072899	MT071204	MT086750
<i>P. citrinostipes</i> sp. nov.	FYG2911 (FHMU3152)	China	MT072900	MT071205	MT086751
<i>P. citrinostipes</i> sp. nov.	FYG2015396 (FCAS3503)	China	MT072901	MT071206	MT086752
<i>P. citrinostipes</i> sp. nov.	FYG2015397 (FCAS3504)	China	MT072902	—	—
<i>P. citrinostipes</i> sp. nov.	FYG2015400 (FCAS3505)	China	MT072903	—	—
<i>P. citrinostipes</i> sp. nov.	FYG2015401 (FCAS3506)	China	MT072904	—	—

Taxonomy

Pseudosperma citrinostipes Y. G. Fan & W. J. Yu, sp. nov. Figs. 2–3

Mycobank MB 834506

Diagnosis:—Differs from *Pseudosperma rimosum* complex and other members of *Pseudosperma* by a combination of slender basidiomata with yellowish fibrils on stipe surface, non-olive tinged lamellae, larger basidiospores, an association with *Keteleeria*, and unique ITS, LSU and *rpb2* sequences.

Etymology:—“citrus” (Latin) means lemon yellow, *citrinostipes* referring to the yellow covering of stipe surface.

Type:—CHINA. Yunnan Province: Heilongtan Park, Panlong District, Kunming City, 13 July 2018, Y. G. Fan, FYG2909, FHMU3150 (Holotype), GenBank No. MT072898 (ITS), MT071203 (LSU), MT076849 (*rpb2*).

Description:—*Basidiome* slender, medium-sized. *Pileus* 25–60 mm diam, initially dome-shaped, 5–6 mm high in primordia, becoming ovoid, conical-campanulate or spherical, margin inrolled and unevenly stuck to the stipe, expanding to 10–20 mm high during early stage of fruitbody development; later obtusely conical to appanate with an obtuse to subacute umbo, margin decurved to uplifted in age; surface dry, appressed fibrillose and strongly rimose, splitting deeply radially, smooth towards umbo; brownish yellow (4B8) or straw yellow (2A6–2A8) to golden yellow (3A7) towards center, paler outwards, background ivory (1B1) to grayish ivory (2B1) towards margin; velipellis absent. Context fleshy, up to 5 mm thick near umbo, white to creamy white (1A1/1A2), hygrophanous near lamellae when young. *Lamellae* adnexed or sinuate adnexed, crowded, 2–3 mm, hygrophanous in primordium stage, white to creamy white (1A1/1A2) when young, later ivory gray, brownish gray to completely brown (2B1/4B4/5B7) with age, without olive tinge; edge pallid, fimbriate to serrate. *Stipe* 35–100 mm length, 3–6 mm diam, central, cylindric, almost equal with obtuse to even base or indistinctly tapered at apex; surface ivory to beige (1B2/1A2), pruinose at the extreme apex, covered with hairy or appressed lemon yellow (2A6) or golden yellow (3A5) fibrils downwards, base pallid with a tier of volva-like hairy remnants, distinct in young specimens; stipe context solid, striate, white (1A1) and shiny, base fleshy. *Odor* grassy or mild.

Basidiospores [80/3/3] (8.8)10–15.3(16.3) × (6.5)6.8–9(10) μm, Q = (1.29)1.32–1.86(2.13), Q_m = 1.66, ellipsoid to elongate-ellipsoid, occasionally subphaseoliform, smooth, yellowish to yellowish brown, apices obtuse, apiculus indistinct. *Basidia* 20–39 × 10–17 μm, clavate to broadly clavate, or occasionally rounded-swollen at apex and distinctly tapered downwards, 4- or occasionally 2-spored, sterigmata up to 4 μm in length, colorless at first, with oily inclusions or yellowish contents when mature. *Pleurocystidia* absent. Lamella edge sterile. *Cheilocystidia* 30–75 × 10–18 μm, in clusters, thin-walled, hyaline, covered with small pieces of scattered crystals, often with oily or golden yellow intracellular contents; ovoid, subfusiform, utriform to lageniform or occasionally cylindrical-clavate, apices usually tapered or obtusely tapered in immature specimens and tending to subcapitate to capitate when mature. *Hymenophoral*

trama subregular, yellowish, composed of smooth, cylindrical to inflated hyphae 5–27 µm wide. *Caulocystidia* present at the very apex of the stipe, in clusters 30–75 × 12–19 µm, thin-walled, similar to cheilocystidia, mostly utriform to subfusiform, at times with apices tapered or subcapitate. *Stipitipellis* a cutis, often disrupted with loose, entangled, thin-walled, hyaline and lightly encrusted hyphae at apex, 5–8 µm wide; elsewhere on stipe composed of loosely arranged, woven, cylindrical, smooth hyphae, 6–12 µm wide with yellow to golden yellow vacuolar pigment. *Pileipellis* a cutis, composed of compact hyphae, 5–13 µm diam., smooth to lightly encrusted, pale yellow to brownish yellow; pale tan in KOH. *Oleiferous* hyphae 6–12 µm wide, present in pileal and stipe trama, smooth or diverticulate, yellowish to bright yellow. *Clamp connections* common in all tissues.

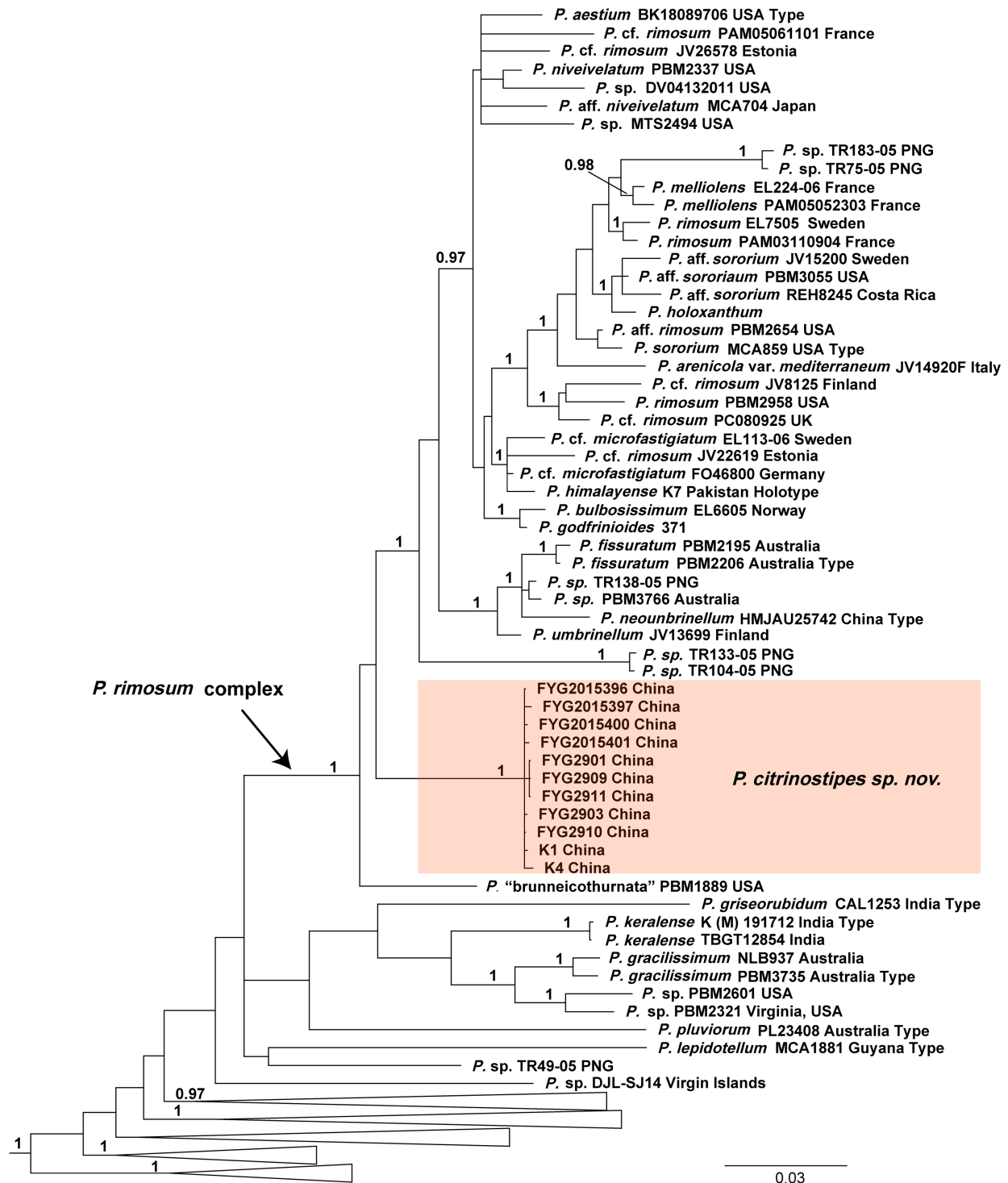


FIGURE 1. Bayesian phylogeny of *Pseudosperma* inferred from combined data of ITS, LSU, and *rpb2* (BPP ≥ 0.95 are indicated). Lineage of the new species is marked with pink color. Out group is pruned from the tree. PNG = Papua New Guinea.

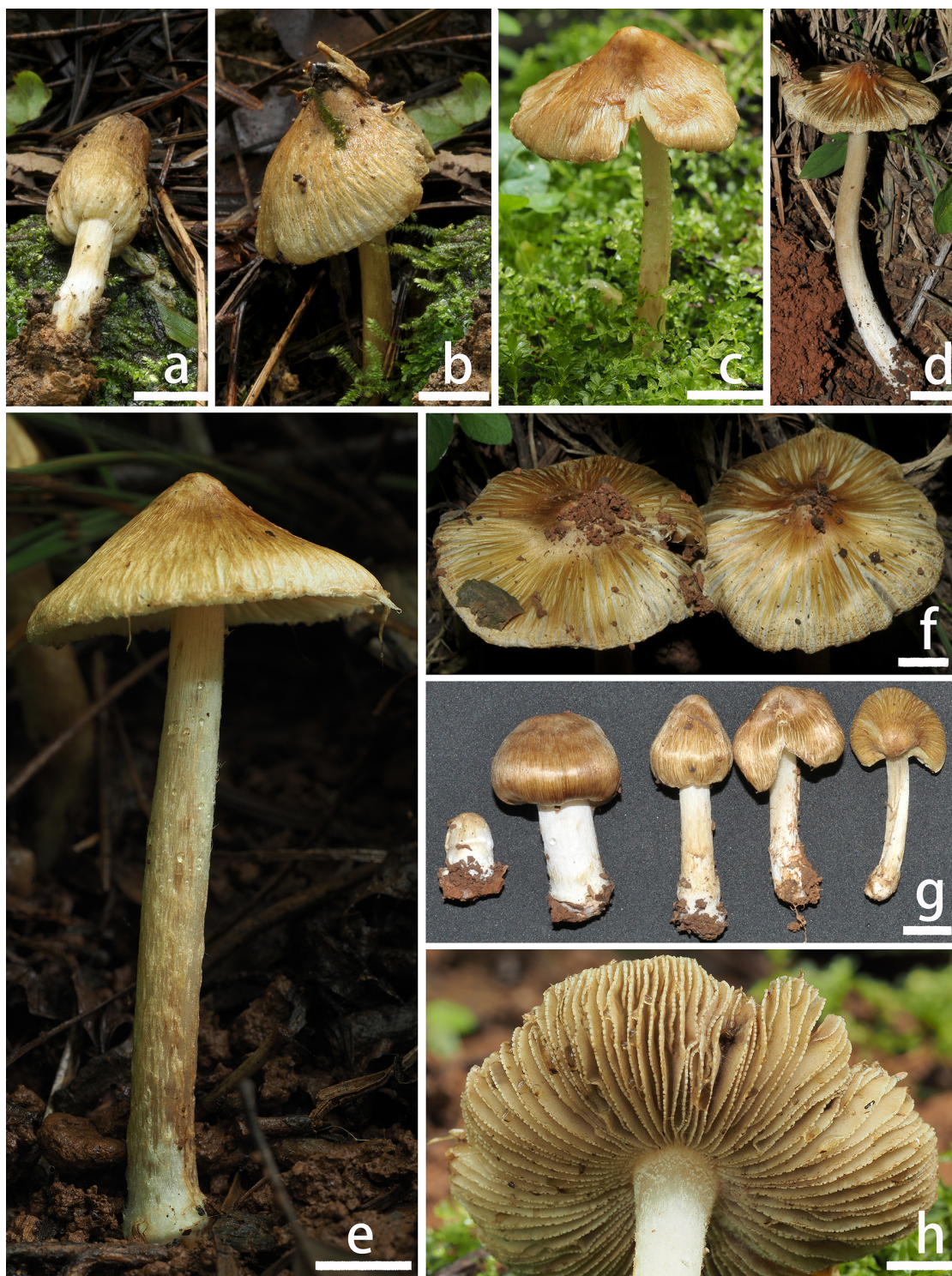


FIGURE 2. Basidiomata of *Pseudosperma citrinostipes*. a–b. FCAS3504. c., e. and h. FHMU3150 (holotype). d., f. and g. FCAS3503. Bars = 10 mm. Photos by Y.G. Fan.

Habitat: Single or scattered on the roadside under *Keteleeria*; July to September.

Distribution: Known from two localities of Kunming City, Yunnan province, China.

Additional specimens examined: CHINA. Yunnan Province: Heilongtan Park, Kunming City, elev. 1942 m, 13 July 2018, roadside under *Keteleeria*, *W. J. Yu & Y. G. Fan*, *FYG2901* (FHMU3148, paratype), *FYG2903* (FHMU3149), *FYG 2910* (FHMU3151), *FYG2911* (FHMU3152); Heilongtan Park, Kunming City, elev. 1951 m, 25 September 2015, roadside under *Keteleeria*, *Y. G. Fan & B. Wang*, *FYG2015400* (FCAS 3503), *FYG2015401* (FCAS3504); Yeya Lake Park, elev. 2133 m, 24 September 2015, under mixed forest containing *Keteleeria*, *L. W. Qin, Y. G. Fan & B. Wang*, *FYG2015396* (FCAS3505), *FYG2015397* (FCAS3506).



FIGURE 3. Microscopic features of *Pseudosperma citrinostipes* (FHMU3150, holotype). a–b. Basidiospores. c. Basidia. d. Lamella edge: cheilocystidia in clusters. e–h. Cheilocystidia. i. Pileipellis. j. Hymenial trama hyphae. k. Terminal hyphae of stipitipellis. l. A small part of diverticulate oleiferous hyphae in stipe trama. m. Caulocystidia. Bars = 20 μ m. Photos by: W. J. Yu.

Discussion

Pseudosperma citrinostipes is found at two locations in Kunming city at an altitude of 1942 m to 2133 m in mixed forests. This species tends to occur under older *Keteleeria* trees with a Diameter at Breast Height (DBH) > 60 cm. We

failed to identify the nearby *Keteleeria* trees, from where our collections were sampled, to species level. Fortunately, two ITS sequences (JN129392 & JN129393) from the root tips of *K. davidiana* clustered with the new species in a 100% supported lineage (Fig. 1). The ECM vouchers of *K. davidiana* (K1 & K4) were sampled from the Kunming Botanical Garden (Ge *et al.* 2011), near to our type location. Consequently, *K. davidiana* is proved to be at least one of its host plants. Considering that *K. davidiana* is known from southwestern, central and northwestern China, Laos, and Vietnam (Wang *et al.* 2012), it is expected that *P. citrinostipes* could be found in these regions. However, more investigations are needed to confirm the host range and distribution of the new species.

Pseudosperma citrinostipes is a medium-sized slender species recognized by its straw yellow to golden yellow pileus and stipe; crowded lamellae without olive tinge; slender stipe covered with yellow to golden-tinged fibrils; large ellipsoid to subphaseoliform basidiospores, and the subfusiform to lageniform cheilocystidia. The basidiospore size and shape of the new species were found to vary in different specimens examined (FYG2015397, FYG2901, FYG2909). They may vary from ellipsoid, elongated to elongate ellipsoid.

The new species is phylogenetically placed in the *P. rimosum* complex clade (Kropp *et al.* 2013), where it occupies a unique position. Within this clade, the lineage of *P. citrinostipes* is sister to all other taxa of the *P. rimosum* complex. It is well-known that the *P. rimosum* complex or *P. rimosum sensu lato* is a problematic and difficult group due to the existence of many cryptic species from various geographical regions (Larsson *et al.* 2009; Kropp *et al.* 2013; Matheny & Bougher 2017; Liu *et al.* 2018; Bau & Fan 2018). In the *P. rimosum* complex, certain species should be compared with the new species. *Pseudosperma sororium* (Kauffman) Matheny & Esteve-Rav. (2019: 12), the type species of the genus, shares in common the yellowish pileus and basidiospores that exceed 15 µm in length, but the former has a pinkish grey to pinkish beige pileus and an aromatic odor (Kauffman 1918; Matheny, unpublished data); *Pseudosperma fissuratum* (Matheny & Bougher) Matheny & Esteve-Rav. (2019: 28), an Australian species is similar in basidiospore outline and cheilocystidia, however, differs by a more robust habit, a pale cream stipe and by pale yellow to pale olive lamellae. Besides taxa belonging to the *P. rimosum* complex, there are still several species in the genus that resemble the new species to some extent. *Pseudosperma macrospermum* (Hongo) Matheny & Esteve-Rav. (2019: 30), described from Japan also has large basidiospores (10.5–18.3 × 6.0–11.3 µm, Q = 1.7–2.1), still, it is a smaller species with abruptly bulbous stipe base and shorter, obovoid to ellipsoid cheilocystidia (Kobayashi 2002). Another East Asian species, *P. transiens* (Takah. Kobay.) Matheny & Esteve-Rav. (2019: 32), shares the medium-sized basidiomata and yellow stipe, but differs by a darker pileus, light olive tinge in lamellae, smaller basidiospores and cheilocystidia, and strong spermatoc smell. *Pseudosperma flavellum* (P. Karst.) Matheny & Esteve-Rav. (2019: 28), a European species, resembles the new species in the slender habit, yellowish pileus, and stipe. But this species has a pale and finely tomentose pileus disc, broader lamellae (5–6 mm) with olive tinge when old, smaller basidiospores (9–12 × 5–6 µm) and clavate to utriform cheilocystidia that never tend to capitate (Stangl 1989). Another European species described from Spain, *P. aureocitrinum* (Esteve-Rav.) Matheny & Esteve-Rav. (2019: 27), resembles the new species in morphology, but has distinctly smaller and broadly ellipsoid basidiospores (8.8–10.9 × 6.15–7.3 µm, Q = 1.3–1.63) and a habitat under the Mediterranean evergreen oak forests (Esteve-Raventós 2014). Two recently described species from Australia, *P. gracilissimum* (Matheny & Bougher) Matheny & Esteve-Rav. (2019: 29) and *P. araneosum* (Matheny & Bougher) Matheny & Esteve-Rav. (2019: 27) are similar in morphology however, have smaller basidiomata, smaller basidiospores, and host plant preference and distribution make them distinct (Matheny & Bougher 2017). *Pseudosperma pakistanense* (Z. Ullah, S. Jabeen, H. Ahmad & A.N. Khalid) Matheny & Esteve-Rav. (2019: 31) another recently described species from northern Pakistan, is similar to the new species by crowded lamellae, and basidiospore morphology, but differs by smaller pileus, and shorter and more clavate cheilocystidia (Ullah *et al.* 2018).

Key to taxa of *Pseudosperma* in China

- | | | |
|----|---|--------------------------|
| 1. | Basidiomata uniformly brown to dark brown | <i>P. neoumbrinellum</i> |
| 1. | Basidiomata not uniformly brown..... | 2 |
| 2. | Pileus and stipe covered with a dense layer of velipellis | <i>P. yunnanense</i> |
| 2. | Pileus and stipe without heavy velipellis..... | 3 |
| 3. | Pileus yellowish gray to brownish gray; stipe brownish | <i>P. cf. perlatum</i> |
| 3. | Pileus yellow to brownish yellow or golden yellow, stipe pallid to yellow | 4 |
| 4. | Stipe surface with lemon yellow fibrils; basidiospores > 10 µm in length | <i>P. citrinostipes</i> |
| 4. | Stipe surface pallid, basidiospores < 10 µm in length | 5 |
| 5. | Cheilocystidia subcapitate, known from southwestern China..... | <i>P. cf. flavellum</i> |
| 5. | Cheilocystidia cylindrical to clavate, known from northeastern China | <i>P. avellaneum</i> |

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References

- Bau, T. & Fan, Y.G. (2018) Three new species of *Inocybe* sect. *Rimosae* from China. *Mycosystema* 37 (6): 693–702.
<http://dx.doi.org/10.13346/j.mycosystema.180033>
- Esteve-Raventós, F. (2014) *Inocybe aureocitrina* (Inocybaceae), a new species of section *Rimosae* from Mediterranean evergreen oak forests. *Plant Biosystems* 148 (2): 377–383.
<https://doi.org/10.1080/11263504.2013.877532>
- Fan, Y.G. & Bau, T. (2010) A revised checklist of the genus *Inocybe* (Fr.) Fr. in China. *Journal of Fungal Research* 8: 189–193.
- Fan, Y.G. & Bau, T. (2013) Two striking *Inocybe* species from Yunnan Province, China. *Mycotaxon* 123: 169–181.
<https://doi.org/10.5248/123.169>
- Feng, B. & Yang, Z.L. (2018) Studies on diversity of higher fungi in Yunnan, southwestern China: A review. *Plant Diversity* 40: 165–171.
<https://doi.org/10.1016/j.pld.2018.07.001>
- Gardes, M. & Bruns, T.D. (1993) ITS primers with enhanced specificity for basidiomycetes—application to the identification of mycorrhizae and rusts. *Molecular Ecology* 2: 113–118.
<https://doi.org/10.1111/j.1365-294X.1993.tb00005.x>
- Ge, Z.W., Smith, M. & Zhang, Q.Y. (2011) Two species of the Asian endemic genus *Keteleeria* form ectomycorrhizas with diverse fungal symbionts in southwestern China. *Mycorrhiza* 22: 403–408.
<https://doi.org/10.1007/s00572-011-0411-1>
- Horak, E., Matheny, P.B., Desjardin, D.E. & Soyong, K. (2015) The genus *Inocybe* (Inocybaceae, Agaricales, Basidiomycota) in Thailand and Malaysia. *Phytotaxa* 230 (3): 201–238.
<https://doi.org/10.11646/phytotaxa.230.3.1>
- Huelsenbeck, J.P. (2012) MrBayes 3.2: efficient bayesian phylogenetic inference and model choice across a large model space. *Systematic Biology* 61 (3): 539–542.
<https://doi.org/10.1093/sysbio/sys029>
- Katoh, K., Rozewicki, J. & Yamada, K.D. (2019) Mafft online service: multiple sequence alignment, interactive sequence choice and visualization. *Briefings in Bioinformatics* 20 (4): 1160–1166.
<https://doi.org/10.1093/bib/bbx108>
- Kobayashi, T. (2002) The Taxonomic studies of the genus *Inocybe*. *Nova Hedwigia Beiheft* 124: 1–246.
- Kornerup, A. & Wanscher, J.H. (1978) *The methuen handbook of colour 3rd ed.* Eyre Methuen Ltd. Reprint, London, UK, pp. 252.
- Kropp, B.R., Matheny, P.B. & Hutchison, L.J. (2013) *Inocybe* section *Rimosae* in Utah: phylogenetic affinities and new species. *Mycologia* 105: 728–747.
<https://doi.org/10.3852/12-185>
- Larsson, E., Ryberg, M., Moreau, P.-A., Mathiesen, A.D. & 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.
<http://dx.doi.org/10.3767/003158509X475913>
- Latha, K.P.D. & Manimohan, P. (2015) *Inocybe griseorubida*, a new species of Pseudosperma clade from tropical India. *Phytotaxa* 221 (2): 166–174.
<https://doi.org/10.11646/phytotaxa.221.2.6>
- Latha, K.P.D. & Manimohan, P. (2016) Five new species of *Inocybe* (Agaricales) from tropical India. *Mycologia* 108 (1): 110–122.
<http://dx.doi.org/10.3852/14-358>
- Latha, K.P.D. & Manimohan, P. (2017) *Inocybes of Kerala*. SporePrint Books, Calicut, pp. 181.

- Liu, L.N., Razaq, A., Atri, N., Bau, T., Lassaad, B., Ali, C.B. & Chen, L.P., Deng, C., Ilyas, S., Khalid, A.N., Kitaura, M., Sesli, E., Li, Y., Lorenz, A., Ma, Y.H. & Malysheva, E., Malysheva, V., Nuytinck, J., Qiao, M. & Zapparoli, G. (2018) Fungal systematics and evolution: FUSE 4. *Sydowia* 70: 211–286.
<https://doi.org/70.286.10.12905/0380.sydowia70-2018-0211>.
- Matheny, P.B. & Bougher, N.L. (2017) *Fungi of Australia: Inocybaceae*. CSIRO Publishing, Clayton, pp. 592.
- Matheny, P.B. (2009) A phylogenetic classification of the Inocybaceae. *McIlvainea* 18: 11–21.
- Matheny, P.B. (2005) Improving phylogenetic inference of mushrooms with RPB1 and RPB2 nucleotide sequences (*Inocybe*, Agaricales). *Molecular Phylogenetics and Evolution* 35: 1–20.
<https://doi.org/10.1016/j.ympev.2004.11.014>
- Matheny, P.B., Aime, M.C., Bougher, N.L., Buyck, B., Desjardin, D.E., Horak, E., Kropp, B.R., Lodge, D.L., Soyong, K., Trappe, J.M. & Hibbett, D.S. (2009) Out of the palaeotropics? Historical biogeography and diversification of the cosmopolitan mushroom family Inocybaceae. *Journal of Biogeography* 36: 577–592.
<https://doi.org/10.1111/j.1365-2699.2008.02055.x>
- Matheny, P.B., Hobbs A. M. & Esteve-Raventós, F. (2019) Genera of Inocybaceae: New skin for the old ceremony. *Mycologia* 112 (102): 1–38.
<https://doi.org/10.1080/00275514.2019.1668906>
- Matheny, P.B. & Kudzma, L.V. (2019) New species of *Inocybe* (Agaricales) from eastern North America. *Journal of the Torrey Botanical Society* 146: 213–235.
<https://doi.org/10.3159/TORREY-D-18-00060.1>
- Nylander, J. (2004) *MrModeltest* 2.3. Computer program and documentation distributed by the author. Uppsala: Evolutionary Biology Centre, Uppsala University.
- Pradeep, C.K., Vrinda, K.B., Varghese, S.P., Korotkin, H.B. & Matheny, P.B. (2016) New and noteworthy species of *Inocybe* (Agaricales) from tropical India. *Mycological Progress* 15: 24.
<http://dx.doi.org/10.1007/s11557-016-1174-z>
- Ryberg, M., Nilsson, R.H., Kristiansson, E., Töpelet, M., Jacobsson, S. & Larsson, E. (2008) Mining metadata from unidentified ITS sequences in GenBank: A case study in *Inocybe* (Basidiomycota). *BMC Evolutionary Biology* 8: 50.
<https://doi.org/10.1186/1471-2148-8-50>
- Stangl, J. (1989) Die Gattung *Inocybe* in Bayern. *Hoppea* 46: 1–409.
- Ullah, Z., Jabeen, S., Ahmad, H. & Khalid, A.N. (2018) *Inocybe pakistanensis*, a new species in section *Rimosae* s. str. from Pakistan. *Phytotaxa* 348 (4): 279–288.
<https://doi.org/10.11646/phytotaxa.348.4.4>
- Vilgalys, R. & Hester, M. (1990) Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. *Journal of Bacteriology* 172 (8): 4238–4246.
<https://doi.org/10.1128/JB.172.8.4238-4246.1990>
- Wang, C.Y., Ma, S.B., Lü, J. & Dang, C.L. (2012) Ecological and geographical distribution of *Keteleeria* and its systematic evolution in China. *Guihaia* 32 (5): 612–616.
- Yan, J.Q., Ge, Y., Hu, D., Zhou, J. & Huo, G.H. (2019) *Psathyrella tintinnabula* sp. nov. (Psathyrellaceae, Agaricales), a new species from southwest China. *Phytotaxa* 400 (2): 64–70.
<https://doi.org/10.11646/phytotaxa.400.2.2>
- Zhang, M., Li, T.H., Wang, C.Q., Zeng, N.K. & Deng, W.Q. (2019) Phylogenetic overview of *Aureoboletus* (Boletaceae, Boletales), with descriptions of six new species from China. *Mycologia* 61: 111–145.
<https://doi.org/10.3897/mycokeys.61.47520>