



Pluteus section *Celluloderma* (Pluteaceae): two new species in the *Pluteus podospileus* clade

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Abstract

Two new species (*Pluteus parvulus* and *P. pauxillus*) in the *Pluteus podospileus* clade are described based on morphological and molecular (nrITS) characters. *Pluteus parvulus* is characterized by small, thin, basidiomata with a brown pruinose pileus, pigmented lamella edges, polymorphic cheilocystidia and subglobose to broadly ellipsoid basidiospores. *Pluteus pauxillus* is distinguished by its small, brown pruinose pileus and stipe, dotted brown lamella edge, broadly ellipsoid to ellipsoid basidiospores, clavate, broadly clavate to fusiform cheilocystidia and abundant caulocystidia. *Pluteus parvulus* is found both in India and Korea, while *P. pauxillus* is so far known only from India.

Key words: *Hispidoderma*, Holarctic, Kerala, Korea, nrITS, phylogeny

Introduction

The genus *Pluteus* Fr. belongs to the family Pluteaceae Kotl. & Pouzar (Basidiomycota, Agaricales). The species are widespread, with basidiomata growing mostly on wood or other decaying plant material, rarely on soil. The species of the genus are characterized by basidiomata with free lamellae, pink or pinkish brown spore print, smooth, inamyloid, non-dextrinoid, cyanophilic basidiospores, and inverse hymenophoral trama (Singer 1986).

Species in the *Pluteus podospileus* clade belong in *Pluteus* section *Celluloderma* Fayod (1889: 364) and are characterized by the overall brown colors of the pileus, non-metuloid hymenial cystidia and a pileipellis arranged as a trichoderm or hymeniderm composed of clavate and/or spheropedunculate elements intermixed with elongated cells. This clade has been the focus of a recent revision (Ševčíková *et al.* 2023), which formally recognized 11 species in the Holarctic region, with 12 additional species recovered in the phylogenetic analyses, but not yet formally described and/or occurring outside the Holarctic region. Additional taxa in the *P. podospileus* clade have been recently described from Asia, including *Pluteus pygmaeus* E.F. Malysheva (2020: 102) and *Pluteus lucidus* E.F. Malysheva (2023: 13) from Vietnam, and *Pluteus fuscopunctatus* C.K. Pradeep & V. Keerthi (2023: 2) described from India.

Here we describe two new *Pluteus* species from Kerala State, India, and South Korea. Morphological and molecular (nrITS) data support their inclusion in *Pluteus* sect. *Celluloderma* in the *P. podospileus* clade; the new taxa are compared with morphologically similar species and their phylogenetic position is discussed.

Materials and methods

Morphological studies

Fresh specimens of *Pluteus* were collected from the forests of Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI) and from Republic of Korea (*P. parvulus*). JNTBGRI campus is in the southern part of Kerala State (southern India) and the forests are part of the Western Ghats. The terminology used for the macromorphological features are that of Keerthi & Pradeep (2023). The morphological descriptions of the *Pluteus* specimens were based on fresh specimens, photographs of basidiomata were made in the field, and ecological data noted. Color codes follow Kornerup & Wanscher (1978). Micro-morphological studies were based on thin free-hand sections of dried material from different parts of the basidioma. The sections were rehydrated with 3% aqueous KOH and stained with 1% aqueous solution of Congo Red. Microcharacters were examined, photographed, and measured under a calibrated Olympus CX43 optical microscope fitted with a Magcam DC10 digital camera and Olympus BX-50 light microscope with a magnification of 1000×. Twenty basidiospores per collection were measured for length and width. Basidiospore statistical dimensions include the mean for the length (avL) and the width (avW), the spore quotient (Q, length/width ratio) and its mean value (Qm). The holotype and all additional specimens examined are deposited at the Mycological Herbarium of Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Thiruvananthapuram [TBGT(M)], except for collection NIHHS 4470 is deposited at the Mycological Herbarium of National Institute of Horticultural and Herbal Science (NIHHS).

DNA extraction, PCR amplification and sequencing

Genomic DNA of Indian specimens of *Pluteus* was extracted from fresh specimens following protocols in Izumitsu *et al.* (2012). DNA from the South Korean sample (NIHHS 4470) was extracted from the dry specimen following protocols in Ševčíková *et al.* (2023) using Next-Generation Sequencing (ILLUMINA) due to the repeated failure of conventional methods. The nuclear ribosomal Internal Transcribed Spacer region (nrITS) was amplified and sequenced; PCR reactions were performed with the primer pair ITS1 and ITS4 (White *et al.* 1990). The protocols for PCR amplification and sequencing followed Kumar *et al.* (2018). The newly generated sequences are deposited in GenBank (<https://www.ncbi.nlm.nih.gov/genbank>).

Sequence alignment and phylogenetic analyses

A preliminary analysis of available (including unpublished) nrITS sequences of *Pluteus* sect. *Celluloderma* placed our five newly generated nrITS sequences in the *P. podospileus* clade (data not shown). For the phylogenetic analysis presented here, the sequences of these putative new species were included in a dataset with all known representatives of the *P. podospileus* clade (Menolli *et al.*, 2015; Malysheva *et al.* 2020, 2023; Keerthi & Pradeep 2023; Ševčíková *et al.* 2023), with *P. phlebophorus* (Ditmar) P. Kumm. (1871: 98) and *P. rugosidiscus* Murrill (1917: 129) as outgroup taxa. Sequences were aligned using MAFFT version 7 under the strategy FFT-NS-I (Katoh *et al.* 2019). The alignment was inspected and manually corrected in AliView (Larsson 2014). A Maximum Likelihood (ML) analysis was run in RaxML 8.2.12 (Stamatakis 2014), under a GTRGAMMAI model, with 1000 rapid bootstrap (BS) replicates. The phylogenetic analysis was run using resources at the CIPRES Science Gateway (Miller *et al.* 2010).

Results

Molecular phylogeny

The nrITS dataset comprises 44 sequences and 752 characters (gaps included). The best tree from the ML analysis is presented in Figure 1.

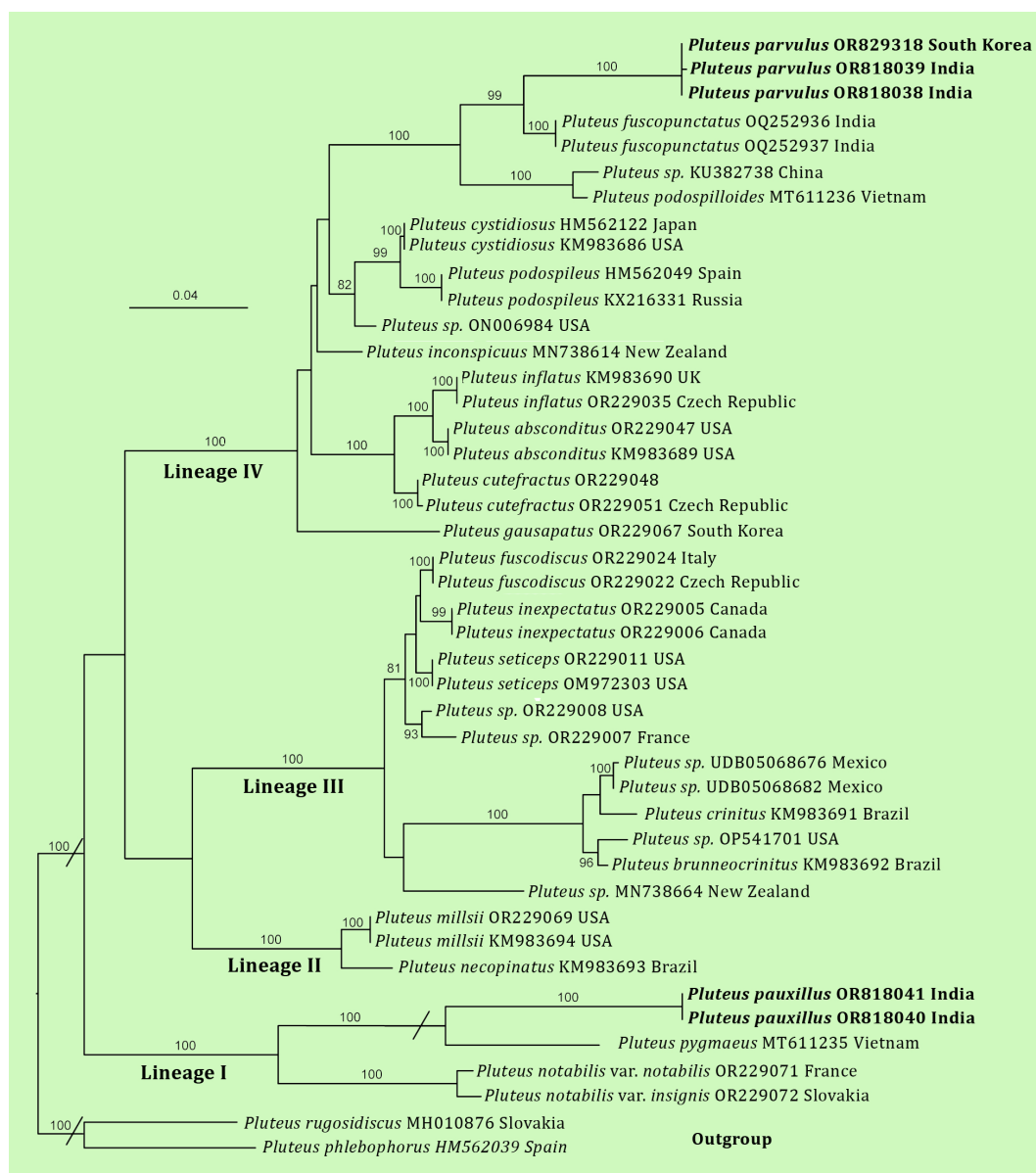


FIGURE 1. ML tree generated from nrITS dataset of the *Pluteus podospileus* clade. Bootstrap values (>70 %) are shown on or below the branches. New species are indicated in bold. The root length has been reduced to facilitate graphical representation.

Four well-supported lineages were recovered within the *Pluteus podospileus* clade, which are the same lineages as recovered in Ševčíková *et al.* (2023) and are named accordingly here as Lineages I–IV. *Pluteus parvulus sp. nov.* is recovered as the sister species to the previously described *Pluteus fuscopunctatus* from India (100 % BS), within Lineage IV. *Pluteus podospilloides* from Vietnam, and an unidentified specimen from China are recovered as the closest relatives of this species pair. *Pluteus pauxillus sp. nov.* is sister to *Pluteus pygmaeus* (100 % BS) from Vietnam in Lineage I, with *Pluteus notabilis* Eyssart. & Ševčíková (2023: 44) from France as sister to this species pair.

Taxonomy

Pluteus parvulus V. Keerthi, Ševčíková & C.K. Pradeep *sp. nov.* (Figs. 2–4)

Mycobank: MB851191

Diagnosis:—Differs from *Pluteus fuscopunctatus* by its small, thin basidiomata (pileus 3.5–22 mm diam.), marginate lamellae, subglobose to broadly ellipsoid basidiospores (5.2–6 × 4.8–6 µm), polymorphic cheilocystidia, utriform pleurocystidia, pileipellis a mixed transitional trichoderm, and by 33 positions in a pairwise comparison of the nrITS sequences.

Holotype:—INDIA. Kerala State: Thiruvananthapuram district, Palode, JNTBGRI campus, 8.75°N, 77.02°E, elev. 150 m, 23 June 2021, Keerthi TBGT(M)18608! GenBank [ITS]: OR818038
Etymology:—*parvulus* (Latin), small, referring to the small pileus.

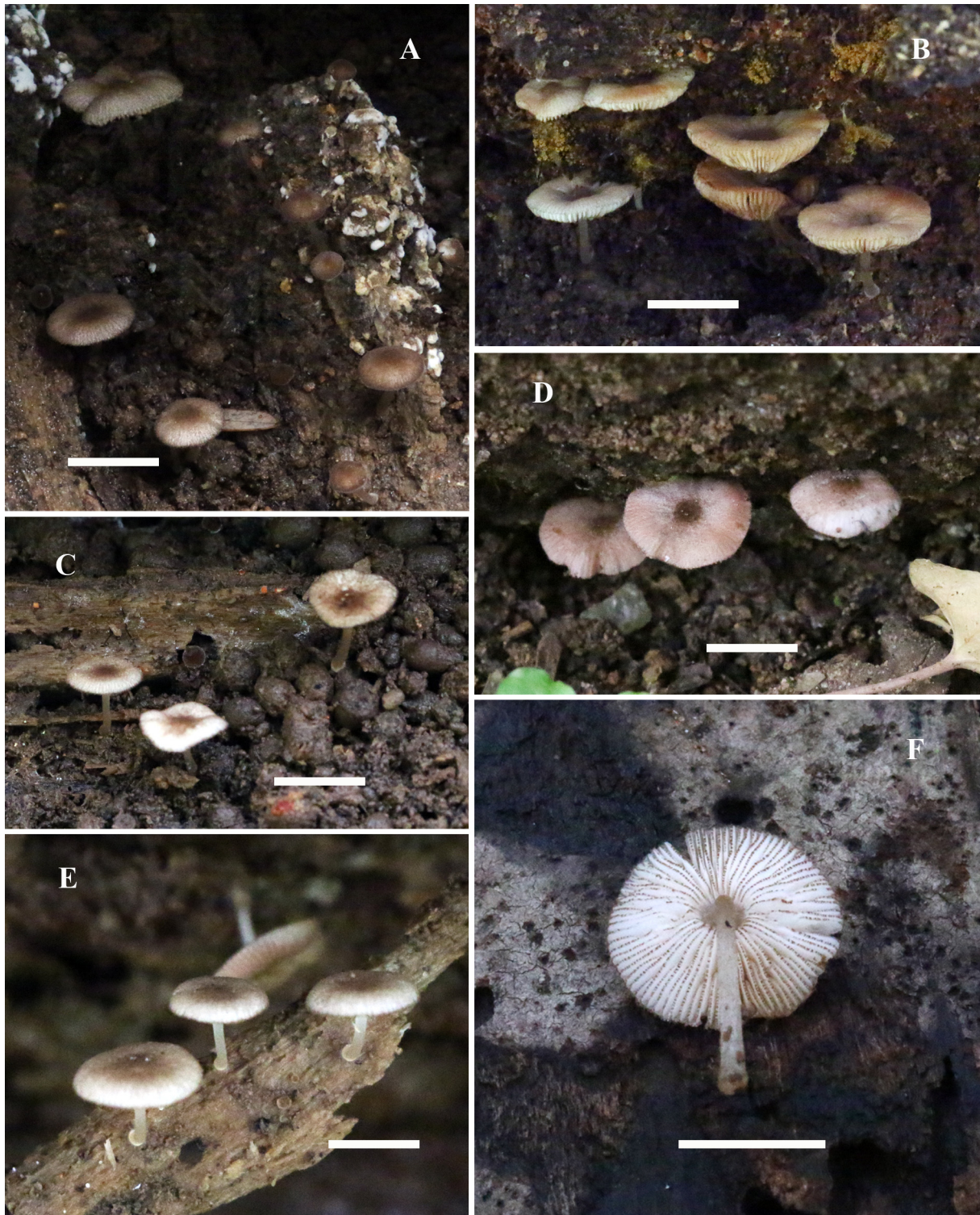


FIGURE 2. *Pluteus parvulus* [TBGT (M), 18608, holotype]. A–E. Habit *in situ*; F. Lamellae with dotted brown edges; Scale bar = 10 mm. Photos by: V. Keerthi

Description:—*Basidiomata* small, thin, fragile. *Pileus* 3.5–22 mm in diam., convex to plano-convex when young, later plano-convex to applanate with or without shallow depressed center, rarely with a small obtuse umbo; surface dark brown (6F4/6F5) in buds, then orange white to pale orange (5A2–5C4/6A2) with mustard brown to dark brown (5E4–5F7/6D4–6F6/7F4–7F5) disc, in some basidiomata reddish brown to brownish red (8C–E4–6) when old, pruinose throughout, denser at disc, sparse elsewhere, striate towards margin, dry, non-hygrophanous; margin straight, entire

to slightly incised, dry. *Lamellae* free, up to 2.5 mm wide, orange-white (5A2/6A2), pink to dark pink, crowded with lamellulae of different lengths; edge entire, dotted brownish. *Stipe* 4–45 × 0.5–1.5 mm, central, rarely excentric, cylindrical, curved in some, solid or hollow, equal with a slightly broad disc-like base; surface white with brown to dark brown (6E4/7F4) pruinae, denser at the extreme base, glabrous at the extreme apex. *Context* white, up to 1 mm thick at the pileus disc, thin, soft. *Mycelial codons* and mycelial mat absent. *Odor* none, *taste* mild.

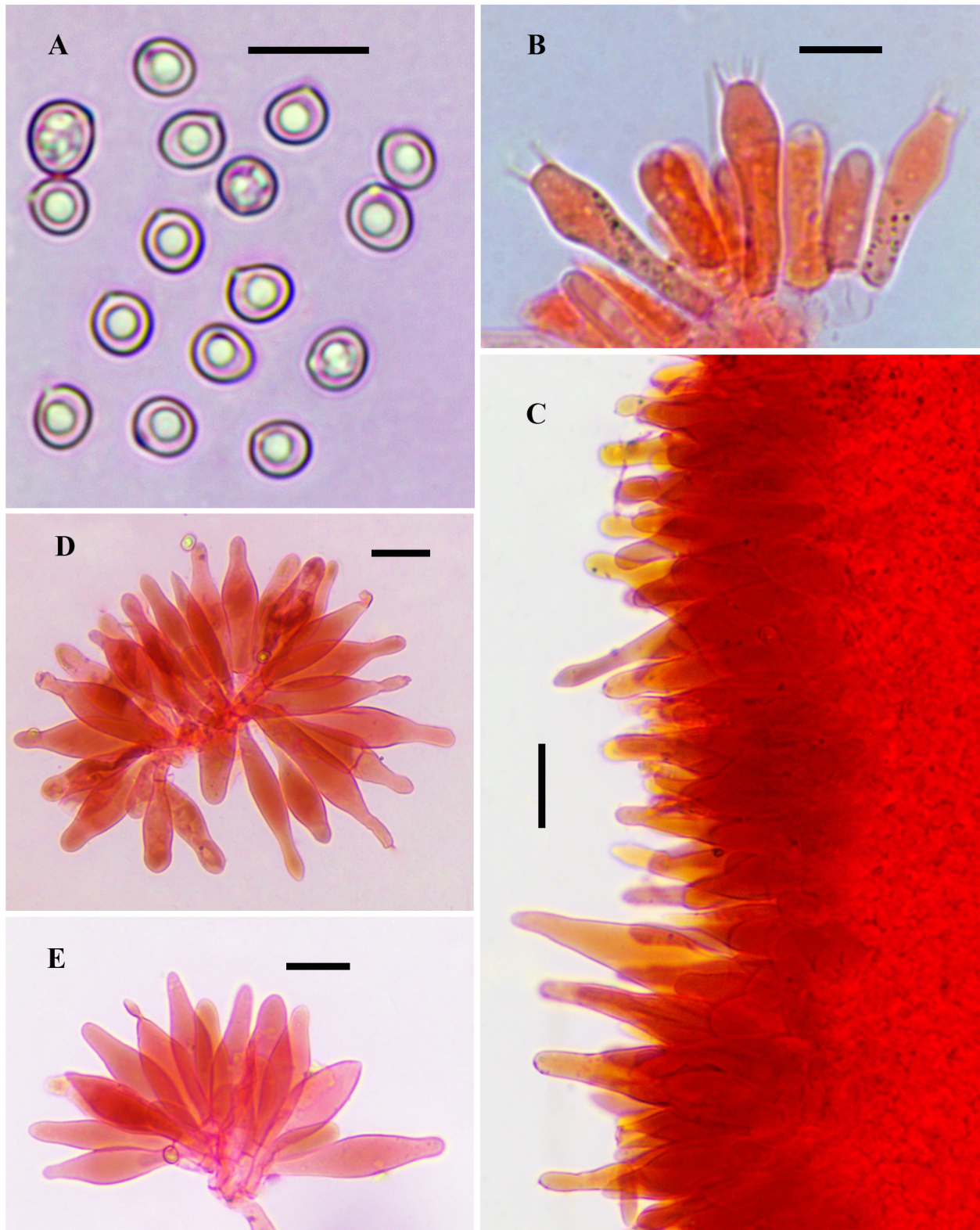


FIGURE 3. *Pluteus parvulus* [TBGT (M), 18608, holotype]. **A.** Basidiospores; **B.** Basidia; **C.** Lamella edge with cheilocystidia; **D–E.** Polymorphic cheilocystidia in groups. Scale bar: **A, B** = 10 μ m, **D–E** = 20 μ m. Photos by: V. Keerthi

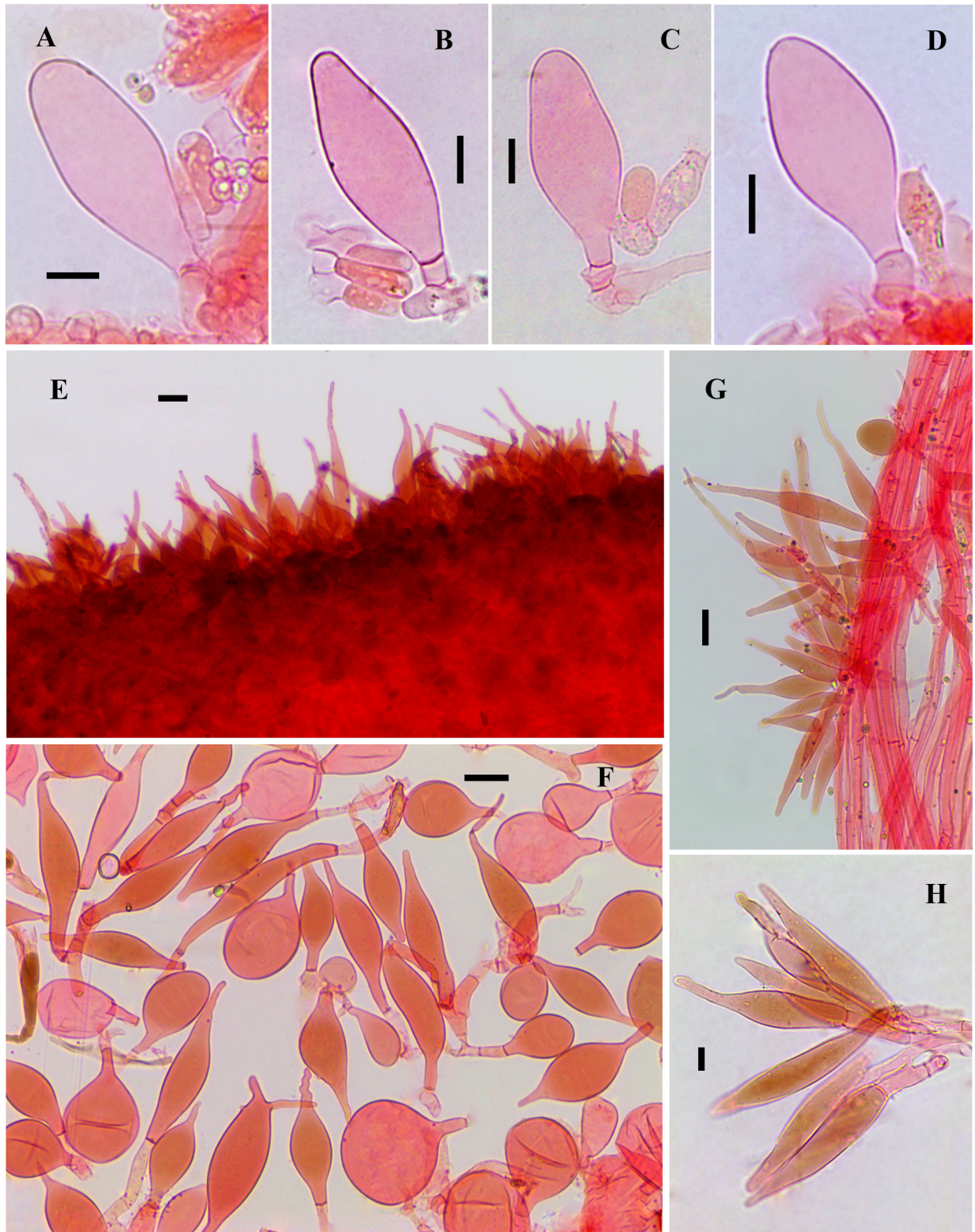


FIGURE 4. *Pluteus parvulus* [TBGT (M), 18608, holotype]. **A–D.** Pleurocystidia; **E.** Pileipellis; **F.** Pileal elements; **G–H.** Caulocystidia. Scale bar: **A–D** = 10 μm, **E–H** = 20 μm. Photos by: V. Keerthi

Basidiospores 5.2–6 × 4.8–6 μm (avL= 5.64 ± 0.37 μm, avW= 5.84 ± 0.31 μm); Q = 1.0–1.16 μm, Qm = 1.1, globose to broadly ellipsoid, most subglobose, hyaline, smooth, thick-walled. *Basidia* 16–28 × 5.2–10.8 μm, clavate to cylindro-clavate or subutriform, 4-spored, thin-walled, hyaline. *Lamella edge* sterile with crowded cheilocystidia. *Cheilocystidia* 20–65 × 6–20 μm, polymorphic, utriform, narrowly lageniform, rarely clavate to cylindro-clavate or narrowly to broadly subfusiform, often with a long narrow neck, thin-walled, with brown intracellular content.

Pleurocystidia scattered, not abundant, (28–)40–61.6 × 15.2–24 µm, fusiform to narrowly utriform, rarely broadly clavate, non-metuloidal, thin-walled, hyaline. *Hymenophoral trama* inversely bilateral with convergent hyphae, 2–38 µm wide, thin-walled, hyaline. *Subhymenium* pseudoparenchymatous. *Pileal trama* composed of interwoven, inflated hyphae, 3.9–39 µm wide, thin-walled, hyaline. *Pileipellis* a trichoderm especially towards the disc with a transition to epithelium near margin; composed mainly of two types of elements: (i) trichodermal elements 31.2–108(–255) × 6.5–32.5 µm, mostly clustered on the disc and elsewhere in tufts, polymorphic, narrowly lageniform to fusiform with rostrate to mucronate apex, often with long whip-like flexuous apex, containing brown intracellular pigment, and (ii) globose, subglobose, vesiculose, clavate to subclavate cells, 17.5–63.2 × 8.4–62 µm, with brown intracellular content. *Stipitipellis* a cutis composed of parallel hyphae, 5.2–10 µm wide, thin-walled, hyaline. *Caulocystidia* scattered throughout the surface of the stipe, 32–100.5 × 10–16.3(–26.4) µm, polymorphic, narrowly fusiform to lageniform, some with long narrow neck, rarely with excrescence at apex, thin-walled with brown intracellular contents. *Clamp connections* absent. *Oleiferous hyphae* present.

Habitat and phenology:—Solitary, paired, scattered to gregarious on dead decaying tree stumps in tropical evergreen forest, Kerala State, India and Jeju island, South Korea. January, June–July, September–November.

Additional specimens examined:—INDIA. Kerala State, Thiruvananthapuram district, Palode, JNTBGRI campus, 14 September 2020, *Keerthi TBGT(M)18290*; *ibid.*, 15 September 2020, *Keerthi TBGT(M)18300*; *ibid.*, 18 September 2020, *Keerthi TBGT(M)18318*; *ibid.*, 20 September 2020, *Keerthi TBGT(M)18321*; *ibid.*, 29 September 2020, *Keerthi TBGT(M)18357*; *ibid.*, 17 October 2020, *Keerthi TBGT(M)18390*; *ibid.*, 18 October 2020, *Keerthi TBGT(M)18392*; *ibid.*, 20 October 2020, *Keerthi TBGT(M)18400*; *ibid.*, 21 October 2020, *Keerthi TBGT(M)18403*; *ibid.*, 14 November 2020, *Keerthi TBGT(M)18421*; *ibid.*, 25 November 2020, *Keerthi TBGT(M)18438*; *ibid.*, 27 November 2020, *Keerthi TBGT(M)18443*; *ibid.*, 09 January 2021, *Keerthi TBGT(M)18461*; *ibid.*, 14 January 2021, *Keerthi TBGT(M)18478*; *ibid.*, 15 January 2021, *Keerthi TBGT(M)18484*; *ibid.*, 12 June 2021, *Keerthi TBGT(M)18596*; *ibid.*, 21 June 2021, *Keerthi TBGT(M)18604*. REPUBLIC OF KOREA. Jeju-do, Seogwipo-si, Yeomiji, 5 July 1992, Seok, *NIHHS 4470-1A*.

Notes:—The nrITS based phylogeny together with the nonmetuloidal pleurocystidia and transitional trichodermal pileipellis supports the placement of *Pluteus parvulus* in *Pluteus* sect. *Celluloderma*. Owing to its small brown punctate squamulose pileus, *P. parvulus* should be compared to a number of species having similar basidioma morphology in *Pluteus* sect. *Celluloderma* such as *P. atypicus* E.F. Malysheva & A.V. Alexandrova (2020: 93), *P. podospilloides* E.F. Malysheva & O.V. Morozova (2020: 100), *P. cutefractus* Ferisin, Dovana & Justo, (2020: 182), *P. pygmaeus* E.F. Malysheva (2020: 102), *P. gausapatus* Ševčíková & Antonín (2023: 42), *P. inexpectatus* Lebeuf, Justo & Ševčíková (2023: 37), *P. subminutus* Singer (1958: 269), *P. crinitus* Menolli & Capelari (2015: 1212), *P. brunneocrinitus* Menolli, Justo & Capelari (2015: 1209), *P. podospileus* Sacc. & Cub. (1887: 672), *P. necopinatus* Menolli & Capelari, (2015: 1216), and *P. eugraptus* (Berk. & Broome) Sacc. (1887: 678).

Morphologically, *Pluteus parvulus* is close to *P. atypicus*, a recently described small brown species from Vietnam (Malysheva *et al.* 2020). However, that species differs by its small (7–12 mm), strongly venose pileus, subfree lamellae, subglobose to broadly ellipsoid and slightly larger basidiospores (5.5–6.8 × 4.5–5.5 µm), utriform hymenial cystidia, hymenidermal pileipellis and cylindrical caulocystidia (Malysheva *et al.* 2020). *Pluteus podospilloides*, another species described from Vietnam, is similar in the pileus structure, dark lamella edge, pileipellis structure, presence of caulocystidia and clampless hyphae (Malysheva *et al.* 2020). However, *P. podospilloides* differs by smaller basidiomata (Pileus 9–12 mm), felty hairy squamulose pileus, smaller basidiospores (4.5–5.5 × 4–5 µm), larger cheilocystidia, and smaller pleurocystidia (Malysheva *et al.* 2020). Moreover, the nrITS (661bp) sequence of *P. parvulus* differs at 50 positions with only 91.76 % sequence similarity. *Pluteus cutefractus* differs from *P. parvulus* mainly by its larger cracked pileus, lamella edge without dark lamella edge, larger basidiospores (4.9–7.1 × 5.0–5.8 µm), and mostly clavate to broadly clavate hymenial cystidia; moreover, it can also grow on soil (Song *et al.* 2019, Ševčíková *et al.* 2023). *Pluteus pygmaeus*, originally described from Vietnam, is distinct by its extremely small basidiomata (pileus 4–9 mm diam.), white stipe, lamellae without dark lamella edge, small globose to subglobose basidiospores (4.5–5.3 × 4.2–4.7 µm), inflated fusiform hyaline cheilocystidia, and hymenidermal pileipellis (Malysheva *et al.* 2020). *Pluteus gausapatus*, a recently described species from Republic of Korea (Ševčíková *et al.* 2023), is distinct by its much smaller basidiomata (pileus 9–10 mm) with plush brown pileus and hairy margin, finely pubescent stipe, and molecular differences. A uniformly granulose reddish brown to reddish blonde pileus, lamellae without dark lamella edge, white stipe with blackish brown squamules at the base of the stipe, globose to subglobose basidiospores, ellipsoid, clavate to sphaeropedunculate cheilocystidia and pileipellis a hymeniderm distinguish *P. inexpectatus* (Ševčíková *et al.* 2023). *Pluteus subminutus*, a species described from Bolivia, is distinct by its small basidiomata (pileus 6–11 mm), rugose pileus, white stipe, lamellae without dark lamella edge, and smaller globose to subglobose basidiospores, 3.7–5.7 ×

3.7–5.5 µm, (Singer 1958). Two Brazilian species, viz., *P. crinitus* and *P. brunneocrinitus*, are distinct by their smaller basidiomata (pileus 7–16 mm; 6–12 mm), cracked pileus, smaller basidiospores (4–5 × 4.5 µm; 4.5–5.5 × 4.5–5 µm), lack of pleurocystidia and predominantly clavate and smaller cheilocystidia (Menolli *et al.* 2015). *Pluteus podospileus* though comparable to the present species, is distinct by its velvety to pilose scaly comparatively large (9–34 mm) pileus, without dark lamella edge, rugose pileus (Orton 1986; Vellinga 1990; Ševčíková *et al.* 2023) and slightly narrower basidiospores (4.4–)4.5–6.0(–6.4) × (2.7–)3.5–5.1(–5.2) µm (Ševčíková *et al.* 2023). *P. necopinatus*, another species originally described from Brazil, is distinguished mainly by its small, punctate fibrillose pileus (14 mm) with sulcate-striate margin, slightly smaller basidiospores, large hyaline cheilocystidia and lack of pleurocystidia and caulocystidia (Menolli *et al.* 2015). *Pluteus eugraptus* seems morphologically similar but differs mainly by its velutinous, radially striate pileus, larger ellipsoid to broadly ellipsoid basidiospores (5.7–8 × 4.7–6 µm), and hymeniform pileipellis (Pegler 1977, 1986; Singer 1956, 1958).

Some of the recently described *Pluteus* species in sect. *Celluloderma* with mixed epithelium from Kerala State, India are *Pluteus fuscopunctatus* (Keerthi & Pradeep 2023), *P. brunneosquamulosus* C.K. Pradeep & K.B. Vrinda (2012: 870) and *P. delicatulus* C.K. Pradeep & K.B. Vrinda (2006: 95). The key characters that distinguish *P. fuscopunctatus* is its larger basidiomata (pileus 22–60 mm), lamella edges without dark color, slightly larger subglobose basidiospores (5.6–6.0 × 5.2–6.0 µm), and larger hymenial cystidia (Keerthi & Pradeep 2023). *Pluteus brunneosquamulosus* is morphologically distinct by its comparatively large brown squamulose, cracked pileus (8–26 mm diam.), lamella edges without dark color, subglobose to broadly ellipsoid basidiospores, lageniform hymenial cystidia, and epithelial pileipellis composed of clavate, vesiculose to pyriform elements (Pradeep & Vrinda 2006). *Pluteus delicatulus* can be distinguished from the new species by its small, delicate basidiomata (pileus 7–10 mm), white stipe, slightly globose basidiospores, clavate to vesiculose hymenial cystidia and lack of caulocystidia.

Pluteus psychiophorus (Berk. & Broome) Sacc. (1887: 670) and *Pluteus stigmatophorus* (Berk. & Broome) Sacc. (1887: 674) were originally described from Sri Lanka. *Pluteus psychiophorus* differs by heterogenous, concolorous lamella edge with hyaline cheilocystidia, a stipe without brown pruina, larger basidiospores 6–8 × 5–6.5 µm, smaller pleurocystidia (35–48 × 18–23 µm), predominantly clavate and smaller elongated elements in the pileipellis (up to 70 µm long) (Pegler 1986). *Pluteus stigmatophorus* differs by its blackish brown depressed pileus, larger basidiospores (5.2–7.5 × 4.5–6 µm), predominantly clavate, pigmented, and shorter pleurocystidia (up to 48 µm long), and predominantly clavate, shorter cheilocystidia (up to 47 µm long) (Pegler 1986).

***Pluteus pauxillus* V. Keerthi & C.K. Pradeep *sp.nov.* (Figs. 5, 6)**

Mycobank: MB851192

Diagnosis:—It can be distinguished from the closely related *Pluteus pygmaeus* by its slightly larger basidiomata (Pileus 10–17 mm), pruinose nonhygrophanous pileus, dark lamella edges, larger, broadly ellipsoid to ellipsoid basidiospores (5.6–6.0 × 4.0–4.4 µm), and molecularly by 59 positions in a pairwise comparison of the nrITS sequences.

Holotype:—INDIA. Kerala State: Thiruvananthapuram District, Palode, JNTBGRI campus, 8.75°N, 77.02°E, elev. 150 m, 13 July 2022, Keerthi TBGT(M)18904! GenBank [ITS]: OR18040.

Etymology:—*pauxillus* (Latin), small, referring to the small basidiomata.

Description:—*Basidiomata* small, thin. *Pileus* 10–17 mm in diam., applanate, plano-convex with a shallow depressed center disc; surface camel brown to brown (6D4/6E4) with minute pruina, denser at the disc, sparse elsewhere, striate towards margin; margin straight, entire to slightly incised; dry, non-hygrophanous. *Lamellae* free, up to 2 mm wide, orange-white (5A2/6A2), crowded with lamellulae of different lengths; edge entirely brownish dotted. *Stipe* 10–15 × 1–1.5 mm, central, rarely excentric, cylindric, curved, hollow, equal with a slightly broad base; surface white with light brown pruina throughout. *Context* white, up to 1 mm, soft. *Mycelial cords* and mycelial mat absent. *Odor* none.

Basidiospores 5.6–6.0 × 4.0–4.4 µm, (avL = 5.78 ± 0.20 µm, avW = 4.16 ± 0.20 µm), Q = 1.2–1.5, Qm = 1.39, broadly ellipsoid to ellipsoid, smooth, thick-walled. *Basidia* 14–32 × 4.0–7.6 µm, clavate to cylindro-clavate, 4-spored, thin-walled, hyaline. *Lamella edge* sterile with crowded cheilocystidia. *Cheilocystidia* 15–75 × 7.2–27 µm, abundant, clavate to broadly clavate, narrowly to broadly fusiform, with obtuse to subacute apex, thin-walled with brown homogenous contents. *Pleurocystidia* scattered, rare, 32.4–48 × 24–32.4 µm, broadly fusiform to lageniform, thin-walled, hyaline. *Hymenophoral trama* inversely bilateral with convergent hyphae, 2.4–21 µm wide, thin-walled, hyaline. *Subhymenium* pseudoparenchymatous. *Pileal trama* composed of interwoven, inflated hyphae, 2.6–32.5 µm wide, thin-walled, hyaline. *Pileipellis* a mixed epithelium composed mainly of two types of elements: (i) narrowly conic, narrowly fusiform, broadly fusiform to lageniform cystidioid elements with acute to subacute apex, 53.3–156 ×

19.5–32.5 μm , which are more clustered near the disc and elsewhere in tufts, containing brown intracellular pigment, and (ii) globose, subglobose, clavate to subclavate cells, 13–91 \times 6.5–32.5 μm , with brown intracellular content. *Stipitipellis* a cutis composed of parallel hyphae, 2.6–19.5 μm in wide, thin-walled, hyaline. *Caulocystidia* scattered throughout the surface of the stipe, 52–143 \times 13–15.6 μm , polymorphic, narrowly fusiform to narrowly lageniform with subobtuse, subacute to mucronate apex or with a long narrow flexuous neck, thin-walled with brown intracellular contents. *Clamp connections* absent. *Oleiferous hyphae* present.

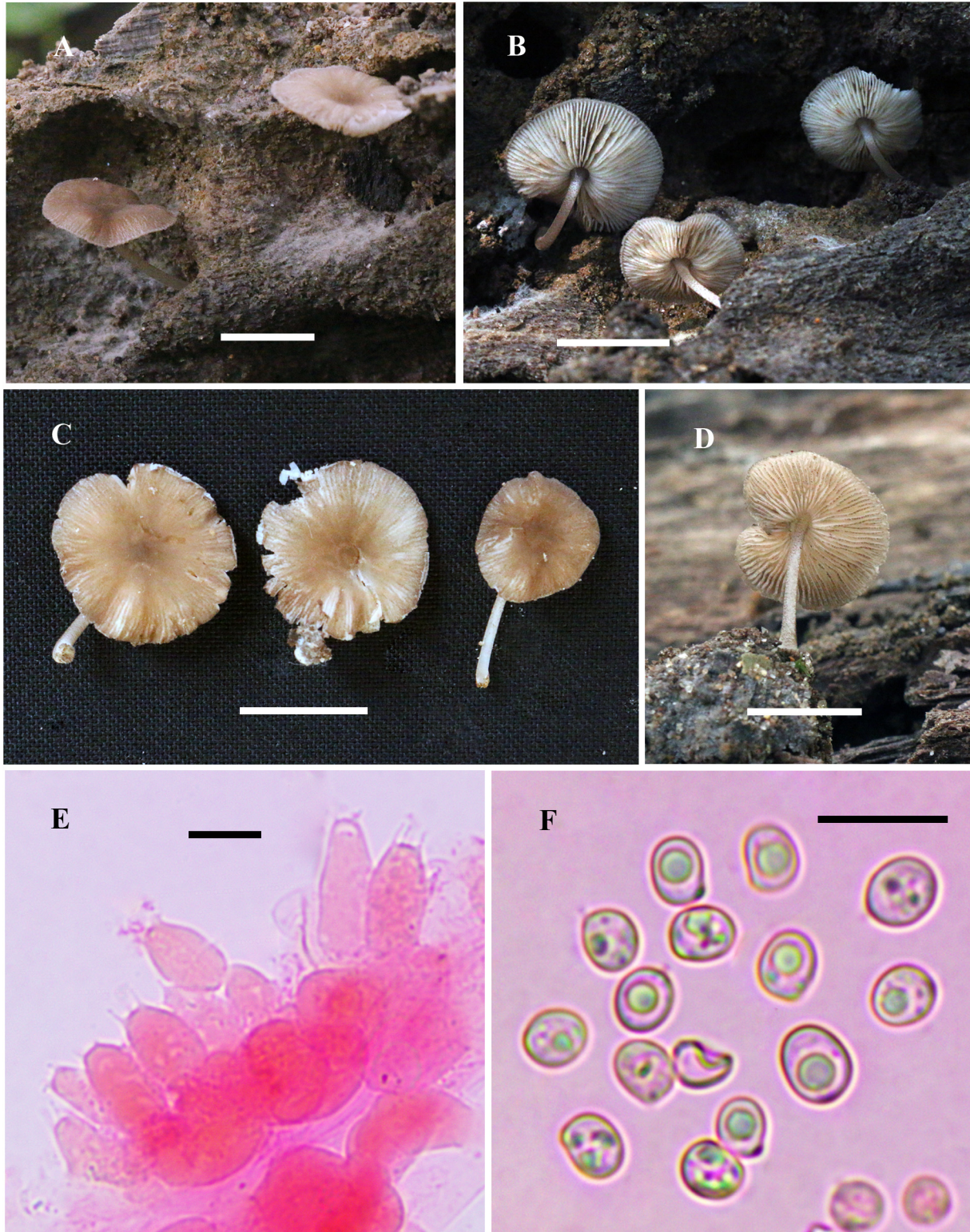


FIGURE 5. *Pluteus pauxillus* [TBGT (M), 18904, holotype]. **A.** Habit *in situ*; **B.** Basidiomata lower view; **C.** Pileus surface view; **D.** Lamellae with dotted brown edges; **E.** Basidia; **F.** Basidiospores. Scale bar: **A–D** = 10 mm; **E–F** = 10 μm . Photos by: V. Keerthi

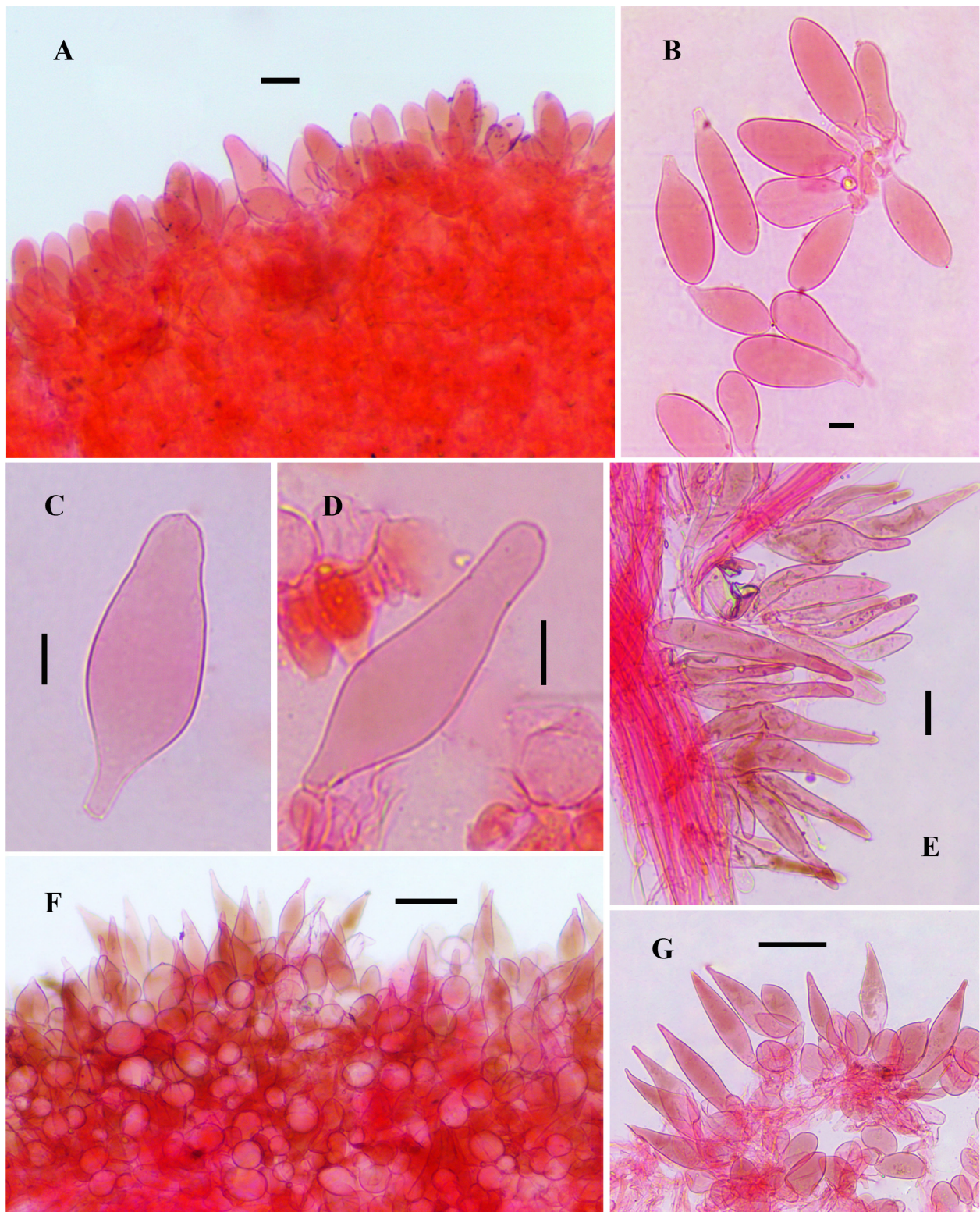


FIGURE 6. *Phuteus pauxillus* [TBGT(M)18904, holotype]. **A.** Lamella edge with cheilocystidia; **B.** Cheilocystidia in groups; **C, D.** Pleurocystidia; **E.** Caulocystidia in groups; **F.** Pileipellis; **G.** Pileal elements. Scale bar: **A–C** = 20 µm; **D** = 10 µm; **E–G** = 50 µm. Photos by: V. Keerthi

Habitat and phenology:—Solitary to scattered on dead decaying tree stumps in tropical evergreen forest, Kerala State, India. July, October.

Additional specimens examined:—INDIA. Kerala State, Thiruvananthapuram district, Palode, JNTBGRI campus, 22 July 2022, *Keerthi* TBGT(M)18926; *ibid.*, 31 October 2022, *Keerthi* TBGT(M)18979; *ibid.*, 31 October 2022, *Keerthi* TBGT(M)18980.

Notes:—An exhaustive literature search was made for morphological comparison of *Pluteus* species (Singer 1956, 1958; Smith & Stuntz 1958; Horak 1964; Homola 1972; Pegler 1977, 1983, 1986; Orton 1986; Vellinga 1990; Banerjee & Sundberg 1993; Minnis & Sundberg 2010), which confirmed the distinctiveness of this species. *Pluteus pauxillus* is characterized by a set of features such as small, plano-convex, depressed, brown pruinose pileus, dotted brown lamellar edge, brown pruinose stipe, broadly ellipsoid to ellipsoid basidiospores (5.6–6.0 × 4.0–4.4 μm), clavate to broadly clavate, narrowly to broadly fusiform, cheilocystidia with brown homogenous contents, fusiform to lageniform pleurocystidia, pileipellis a mixed epithelium, presence of abundant caulocystidia, and lignicolous habitat.

Molecular analyses based on nrITS sequence shows that *P. pauxillus* is placed within the podospileus clade, forming a sister clade to *P. pygmaeus* E.F. Malysheva (2020: 102). The close relationship between *P. pygmaeus* and *P. pauxillus* is evident in both morphological and molecular data. *Pluteus pygmaeus*, originally described from Vietnam, looks similar in gross macromorphology and in some microscopic features such as shape of hymenial cystidia, nature of pileipellis, presence of caulocystidia and clampless hyphae (Malysheva *et al.* 2020). But *P. pygmaeus* differs markedly in its extremely small basidiomata (4–9 mm), white or pellucid stipe, smaller globose to subglobose basidiospores (4.5–5.3 × 4.2–4.7 μm) and in the size of cheilo and pleurocystidia (Malysheva *et al.* 2020). Moreover, BLASTn results using the nrITS (661bp) sequence of *P. pauxillus* showed only 87.62 % sequence identity with *P. pygmaeus* and it differs at 59 positions which confirms that these two are different species.

Some of the other related species in the podospileus clade include *P. podospileus*, *P. cutefractus*, *P. necopinatus*, *P. brunneocrinitus*, *P. crinitus* and *P. podospilloides*. *Pluteus podospileus* though morphologically somewhat similar but differs by its comparatively large (9–34 mm) rugulose pileus, without dark lamella edge, and predominantly ovoid, broadly clavate to clavate or narrowly to broadly utriform pleurocystidia (Orton 1986; Vellinga 1990; Ševčíková *et al.* 2023). *Pluteus cutefractus*, originally described from Slovenia, differs by its large, cracked pileus (22–25 mm), without dark lamella edge, white pubescent stipe, large globose to broadly ellipsoid basidiospores (4.9–7.1 × 4.5–5.8 μm), mostly clavate to broadly clavate hymenial cystidia; this species can also grow on soil (Song *et al.* 2019; Ševčíková *et al.* 2023). *Pluteus necopinatus* originally described from Brazil is distinguished mainly by its punctate fibrillose pileus, sulcate-striate margin, concolorous lamella edge, globose to subglobose basidiospores, lack of pleurocystidia, and caulocystidia (Menolli *et al.* 2015). *Pluteus brunneocrinitus* and *P. crinitus* were also originally described from Brazil and are distinct by their smaller basidiomata, tomentose fibrillose cracked pileus, smaller basidiospores, lack of pleurocystidia and smaller cheilocystidia (Menolli *et al.* 2015).

Two species described from India in *Pluteus* sect. *Celluloderma* with mixed epithelium are *P. brunneosquamulosus* (Pradeep *et al.* 2012) and *P. delicatulus* (Pradeep & Vrinda 2006). *Pluteus brunneosquamulosus* phylogenetically shows vast differences with *P. pauxillus* (176 bp difference) and is placed in a different clade and is morphologically also quite distinct from *Pluteus pauxillus*. *Pluteus delicatulus* can be distinguished by its small, delicate basidiomata (Pileus 7–10 mm), white stipe, concolorous lamella edge, globose basidiospores, clavate to vesiculose hymenial cystidia, and lack of caulocystidia (Pradeep & Vrinda 2006).

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