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Research Article

Psilocybe (Fr.) P. Kumm. from Punjab, India

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Keywords
Clamp connections, India, *Psilocybe*.

Abstract

Four species of *Psilocybe* have been worked out for their morphological and anatomical details, namely *P. sabulosa*, *P. moelleri*, *P. uda* var. *elongata* and *P. coprophila*. Out of which *P. moelleri* and *P. uda* var. *elongata* are recorded for the first time from India and *P. sabulosa* and *P. coprophila* are first time reports from North India.

Introduction

Genus *Psilocybe* belongs to family *Strophariaceae* which is characterized by cylindric-conic or semiglobate to convex pileus, pileus usually with shade of brown, pileus context sometimes bluing or stipe bluing when touched or bruised. Lamellae adnexed to adnate, narrow to broad, even extremely broad, often with decurrent tooth. Spore print deep lilac to fuscous-sepia or purplish brown. Hyphae with clamp connections. *Psilocybe* is the principal genus of hallucinogenic or magic mushrooms. Mostly they contain psilocybin and or psilocin, and cause amazing changes in one's perceptions and sensations if consumed in sufficient quantity (Arora, 1986). Genus *Psilocybe* is known by 300 species world over (Kirk *et al*., 2008). During the fungal forays to various localities of Punjab, collections belonging to genus *Psilocybe* were collected of which 02 species viz. *P. moelleri* and *P. uda* var. *elongata* are recorded for the first time from India and *P. sabulosa* and *P. coprophila* are first time reports from North India.

Materials and Methods

Standard methods for collection, preservation and description of agarics were followed, using the terminology and Field key to mushroom collector described by Atri *et al.* (2005). The terminology used for describing the color tone of carpophores parts and spore print is after Kornerup and Wanscher (1978). The identified specimens have been deposited in the Herbarium, Department of Botany, Punjabi University, Patiala (Punjab) India, under the Accession No. PUN. For taxonomic studies, Rea (1922), Murrill (1923), Arora (1986), Watling and Gregory (1987), Guzmán (1995), Stamets (1996), Kirk *et al*. (2008) and Kroeger (2009) have been followed.

Key to the investigated species of the genus *Psilocybe*

1 Carpophores growing among grasses or on sand dunes; pileal veil appendiculate.....**2**

1′ Carpophores growing on dung; pileal veil absent.....**3**

2 Pileus covered with white powdery scales when young; surface dry; cuticle fully peeling; rhizomorphs not visible; stipe base covered with white mycelial mat just above the ground…….....…***P. sabulosa***
2′ Pileus surface smooth, moist; cuticle not peeling; few rhizomorphs visible at the stipe base; no mycelial mat ..... ***P. moelleri***

3 Pileus surface moist; lamellae equal, crowded, narrow (0.2–0.3 cm broad); stipe with small pseudorrhiza; basidiospores guttulate.....***P. uda*** var. ***elongata***
3′ Pileus surface dry; lamellae unequal (in 3 lengths), subdistant, moderately broad (0.5 cm broad); stipe without pseudorrhiza; basidiospores without guttules..... ***P. coprophila***

Taxonomic observations

Psilocybe sabulosa Peck, *Bulletin of the Torrey Botanical Club*, **24:** 144, 1897

Fig. 1. A–F; 2. A–C.

Carpophores 2.3–9 cm in height. Pileus 0.4–2.8 cm broad; convex; broadly umbonate; surface orange white ($5A_2$)

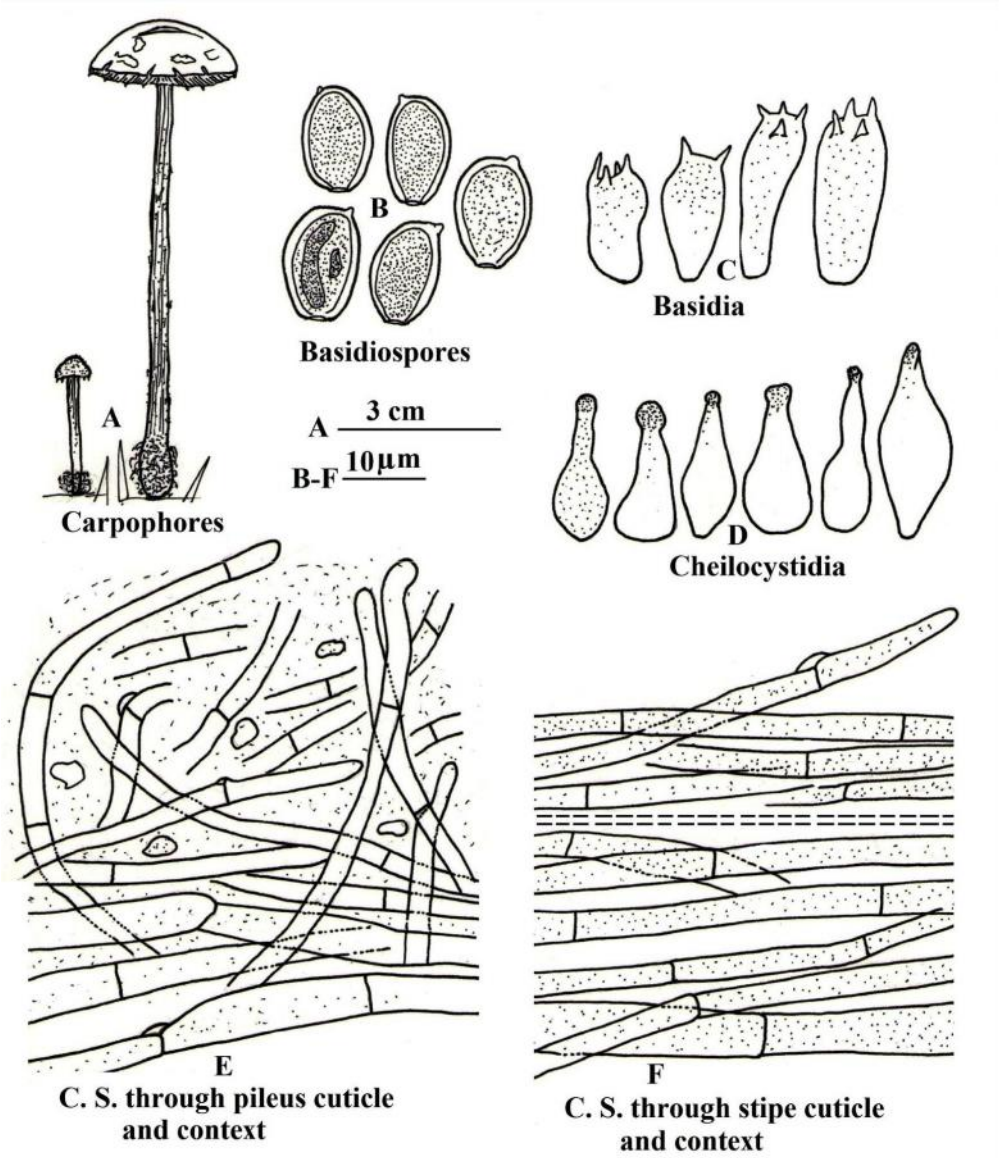

Fig. 1 A–F– ***Psilocybe sabulosa*** Peck : A Carpophores. B Basidiospores. C Basidia. D Cheilocystidia. E C. S. through pileus cuticle & context. F C. S. through stipe cuticle & context.

all over when young, light brown ($6D_4$) centre with orange white ($5A_2$) along periphery at maturity; dry; scaly, scales white, powdery, shed off at maturity; margin irregular, splitting at maturity; cuticle fully peeling; flesh 0.1–0.2 cm thick, membranous, white ($5A_1$), unchanging; taste and odour mild. Pileal veil appendiculate, white. Lamellae broadly adnate to decurrent; unequal, in 3 lengths; subdistant; narrow (0.3– 0.4 cm broad); light brown ($6D_8$), unchanging; gill edges smooth to wavy; normal. Stipe central, 2.2–8.5 cm long, 0.2–0.3 cm broad, equal in diameter with bulbous base; base completely covered with white mycelial mat just above the ground; greyish orange ($5B_3$), concolorous with pileus, usually unchanging, but changing to pale greenish on handling some; hollow; scaly, scales fibrillose; longitudinal striations visible all over the stipe; exannulate.

Basidiospores 11.83–14.36 (16.9) × 8.45–9.29 (10.14) µm (excluding apiculus), (Q=1.4), lentiform; smooth, double walled; light golden brown; granular; truncated with a slightly oblique germ pore; apiculate, apiculus upto 0.84 µm long. Basidia 13.52–20.28 × 6.76–8.45 µm, clavate, weakly granular, –2, –4 spored; sterigmata 2.53–3.38 µm long. Pleurocystidia absent. Cheilocystidia (13.52) 16.9–22.81 × 6.76–10.14 µm, bottle like, lecythiform, granular at the apices, abundant; gill edges sterile.

Carpophore context homoiomerous. Pileus cuticle hyphal, gelatinized, made up of a regular loose network of horizontally tangled, 2.53–9.85 µm broad, septate hyphae; pileus context hyphal, made up of 6.76–12.67 µm broad, septate hyphae. Hymenophoral trama irregular. Subhymenium cellular. Stipe cuticle hyphal, made up of longitudinally, tangled, compactly arranged, 3.38–7.88 µm broad, septate, thin walled hyphae with a few projecting hyphae. Clamp connections present throughout.

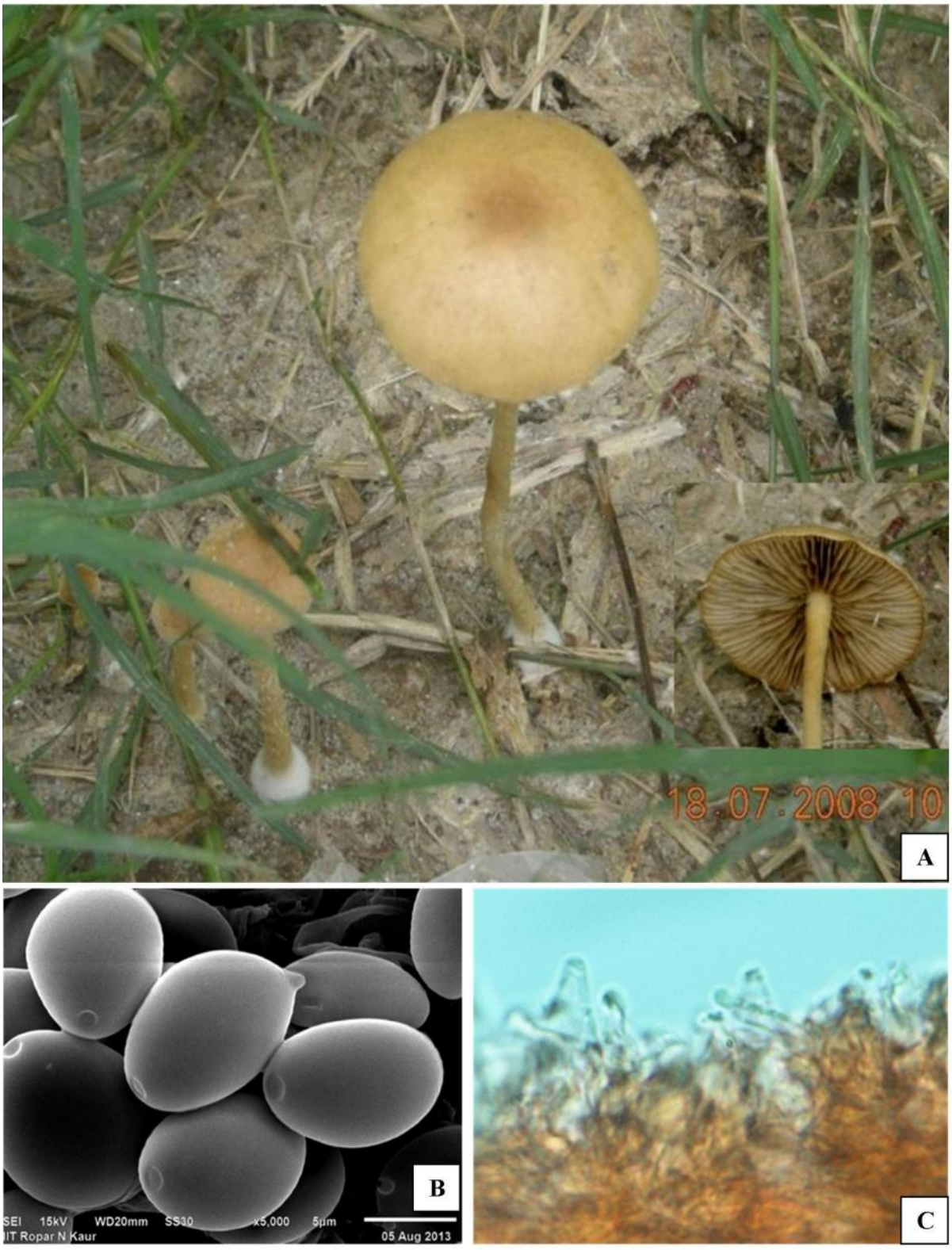

Fig. 2 A–C– ***Psilocybe sabulosa*** Peck: **A** Carpophores growing in their natural habitat and showing underview of cap. **B** SEM of Basidiospores. **C** Gill edge showing Cheilocystidia.

Collection examined: India, Punjab, Hoshiarpur (295 m), Village Khadiala, growing scattered in groups among grasses on soil, Yadwinder Singh, PUN 5977, July 18, 2008; Hoshiarpur (295 m), Village Chak Sadhu, growing in groups on sand dune like soil among cultivated groundnut crop, Harwinder Kaur, PUN 5976, July 22, 2011.

Distribution and ecology: Murrill (1923) reported *P. sabulosa* from New York, growing on sandy soil in pastures, often from clumps of living grasses. Guzmán (1995) found *P. sabulosa* growing on sand or sandy soil in U.S. and Argentina. Kroeger (2009) reported *P. sabulosa* growing in sand, in coastal dunes with dune grass *Ammophila* and *Carex macrocephala* or in dry sandy soil of arid bunchgrass and antelope-brush steppes of Canada. The present examined collections too have been collected growing in scattered groups amongst grasses in sand dune like soil in late July.

Remarks: The external and internal details of above examined collections match well with the details given for *Psilocybe sabulosa* Peck by Murrill (1923), Guzmán (1995) and Kroeger (2009). This species is mainly found in arid zone on sandy dune or sandy soil, also the stipe base is completely covered with white mycelial mat just above the ground as described by Kroeger (2009). According to Guzmán (1995) *P. squarrosipes* reported by Natarajan and Raman (1983) from South India is actually *P. sabulosa* Peck. Thus, presently this is first time report from North India.

Psilocybe moelleri Guzmán, *Mycotaxon*, 7 (**2**): 245, 1978. **Fig. 3. A–F; 4. A–E.**

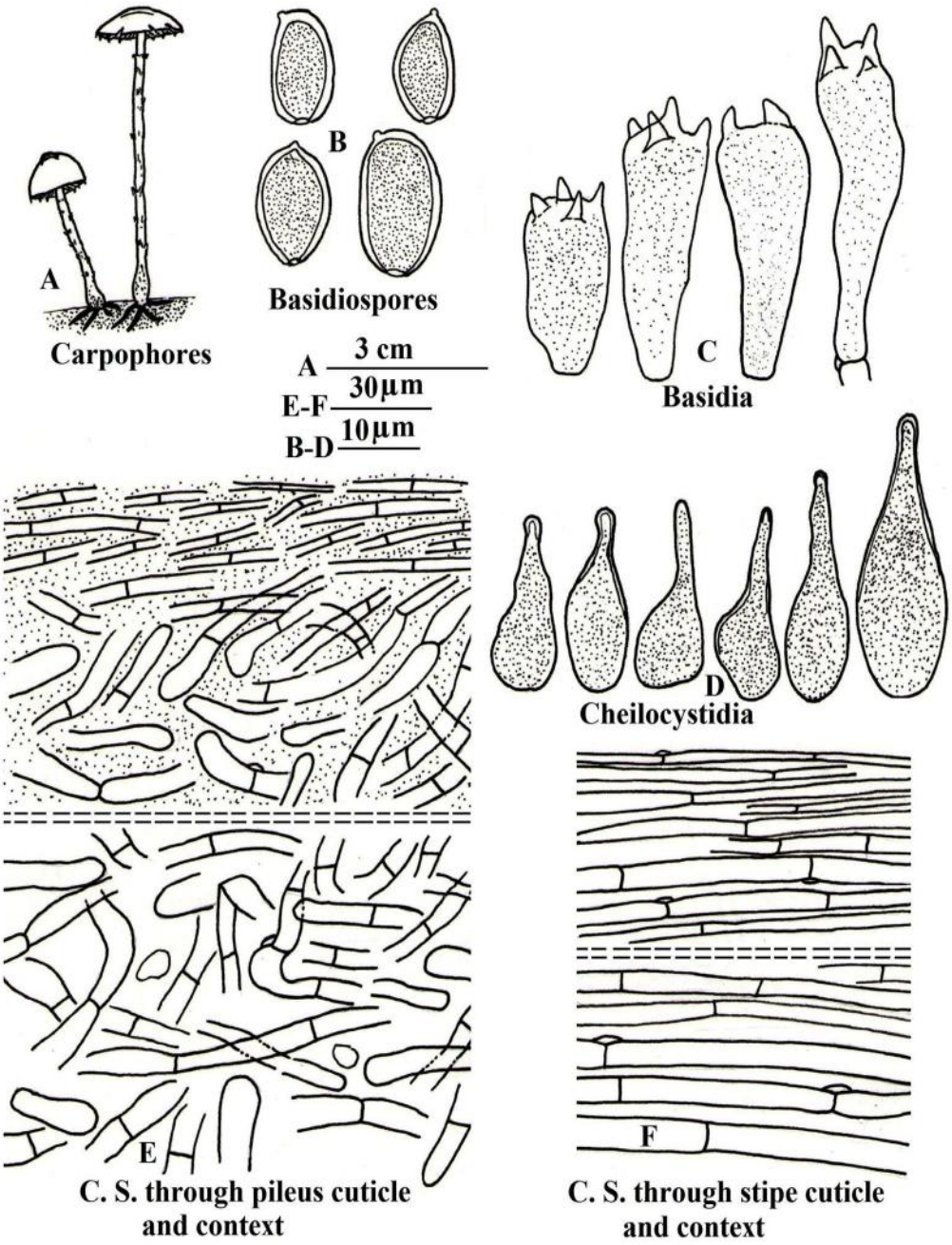

Fig. 3 A–F– ***Psilocybe moelleri*** Guzmán: A Carpophores. B Basidiospores. C Basidia. D Cheilocystidia. E C. S. through pileus cuticle & context. F C. S. through stipe cuticle & context.

Carpophores 2.6–5.3 cm in height. Pileus 1–1.4 cm broad; hemispherical when young, convex to applanate at maturity; surface pale with brownish orange ($6C_6$) centre, greyish orange ($5B_4$) periphery; moist; scaly, scales more concentrated in the centre and scattered towards the periphery; margin regular, splitting at maturity; cuticle not peeling; flesh 0.1 cm thick, membranous, creamish white, unchanging; taste mild; odour spicy. Pileal veil appendiculate, white. Lamellae broadly adnate; unequal, in 3 lengths; distant; narrow (0.2 cm broad); orange grey ($5B_2$) in young, light brown ($5D_6$) at maturity, mottled, unchanging; gill edges wavy; normal. Spore print dark brown ($6F_4$). Stipe central, 2.5–5.2 cm long, 0.1–0.2 cm broad, equal in diameter throughout, swollen base, rhizomorphs present at the base; creamish white to light orange ($5A_5$), unchanging; solid; scaly, scales white, fibrillose, all over the surface; striate; annulate, anuulus powdery, ring like, evanescent.

Basidiospores 11.83–16.05 × 7.6–9.29 µm (excluding apiculus), (Q=1.6) broadly ellipsoid; smooth; double walled; golden brown, granular; truncated with a moderate broad germ pore; apiculate, apiculus 0.84–1.69 µm long. Basidia 20.28–33.8 × 10.14–10.98 µm, clavate, granular, –2, –4 spored; sterigmata 3.38–5.07 µm long, swollen. Pleurocystidia absent. Cheilocystidia 20.28–32.11 × 6.76–10.14 µm, fusoid to ventricose with long tubular necks and swollen base, heavily granular; capitate to tubular apices, encrustrated in few, abundant; gill edges sterile.

Carpophore context homoiomerous. Pileus cuticle hyphal, gelatinized, made up of horizontally, tangled, loosely arranged 1.97–3.94 µm broad, septate, hyphae; pileus context hyphal, made up of 7.88–11.82 µm broad, septate hyphae. Hymenophoral trama less irregular. Stipe cuticle hyphal, made up of longitudinally tangled 3.94–7.88 µm broad, closely septate, thin walled hyphae. Clamp connections present throughout.

Chemical colour reaction: Basidiospores not darkening in KOH.

Collection examined: India, Punjab, Jalandhar (233 m), NIT campus, growing scattered on grassy lawn, Harwinder Kaur, PUN 5981, June 29, 2011.

Distribution and ecology: Watling and Gregory (1987) reported *P. moelleri* growing on horse dung and described that this is the only British record that is based on Rea's interpretation of *S. merdaria* and *S. ventricosa*, thus the distribution of *P. moelleri* in Britain is unknown. Kroeger (2009) reported it from Canada. Presently found scattered in grassy lawn during early monsoon from India.

Remarks: The macroscopic and microscopic details of presently examined collection are in close proximity with *Psilocybe moelleri* Guzmán as given by Watling and Gregory (1987) and Kroeger (2009). It is characterized by convex to planoconvex to applanate cap with brownish cinnamon to ochraceous to straw color while the stipe is scaly having a powdery, evanescent, ring like annulus, the gills are broadly adnate, orange grey when young, light brown at maturity, mottled as described by Watling and Gregory (1987). This is first time report from India.

Psilocybe uda var. ***elongata*** (Pers.) Gillet, *Les Hyménomycètes ou Description de tous les Champignons qui Croissent en France*, **1**: 586, 1878. **Fig. 5. A–G; 6. A–F.**

Carpophores 1.7–7.5 cm in height. Pileus 1.7–3.2 cm broad; somewhat convex to applanate; broadly umbonate; surface moist; greyish orange ($5B_3$) to brownish orange ($5C_4$) in centre, cracking on drying; scaly, scales powdery, washed out; margin regular, splitting at maturity, striate at margin; cuticle fully peeling; flesh upto 0.1 cm thick, pale brownish, unchanging; taste mild and odour sour. Pileal veil absent. Lamellae adnate; equal; crowded; narrow (0.2–0.3 cm broad); dark brown ($7F_5$), fuscous in mass, unchanging; light brown ($6D_5$) on drying; gill edges smooth; normal. Stipe central, 6.5–7.2 cm long, with small pseudorrhiza, 0.2–0.4 cm broad, equal in diameter throughout; white ($1A_1$), changing to pale yellow ($2A_3$) on handling; hollow; scaly, scales powdery, white; exannulate.

Basidiospores (6.8) 8.45–10.2 × 5.1–6.8 µm (excluding apiculus), (Q=1.8) ellipsoid, amygdaliform; smooth; double walled; outer wall thick; granular, apical pore present; guttulated, 1–2 guttules per spore; apiculate, apiculus less than 0.83 µm long. Basidia 10.14–25.35 × 6.76–11.83 µm, clavate, hyaline, –2, –4 spored, –2 spored more in percentage; sterigmata 1.69–2.53 µm long. Pleurocystidia 11.9–25.5 × 6.8–10.2 µm, lageniform. Cheilocystidia 20.4–27.2 × 6.8–10.2 µm, similar in shape to pleurocystidia; gill edges sterile.

Carpophore context homoiomerous. Pileus cuticle hyphal, gelatinized, made up of tangled 1.7–6.8 µm broad, septate hyphae. Hymenophoral trama parallel. Stipe cuticle hyphal, made up of longitudinally tangled, 4.7–14 µm broad, septate hyphae. Clamp connections present in pileus cuticle.

Chemical color reaction: Basidiospores turning darker brown in KOH and do not bleach in Conc. H_2SO_4 even after one hour.

Collection examined: India, Punjab, Sangrur (231 m), Village Nadampur, growing scattered in groups on dung, Harwinder Kaur, PUN 5980, July 26, 2009.

Distribution and ecology: Rea (1922) reported *P. uda* var. *elongata* growing amongst *Sphagna* in mountain pine woods, during September to November. Murrill (1923) reported this from Europe, growing among *Sphagnum* and other mosses and grasses. The present Indian collection was found scattered in groups on dung in late July.

Remarks: The external and internal details of the presently examined collection are in agreement with those of *Psilocybe uda* var. *elongata* (Pers.) Gillet given by Rea (1922) and Murrill (1923). This variety is characterized by

greyish orange to brownish orange cap, which is convex then applanate, there is cracking in the centre and it is striate along the periphery, the gills are fuscous to dark brown in mature carpophores while it possesses a membranous flesh, the stipe is white changing to pale yellow on handling (Rea, 1922). *Psilocybe uda* var. *elongata* is first time report from India.

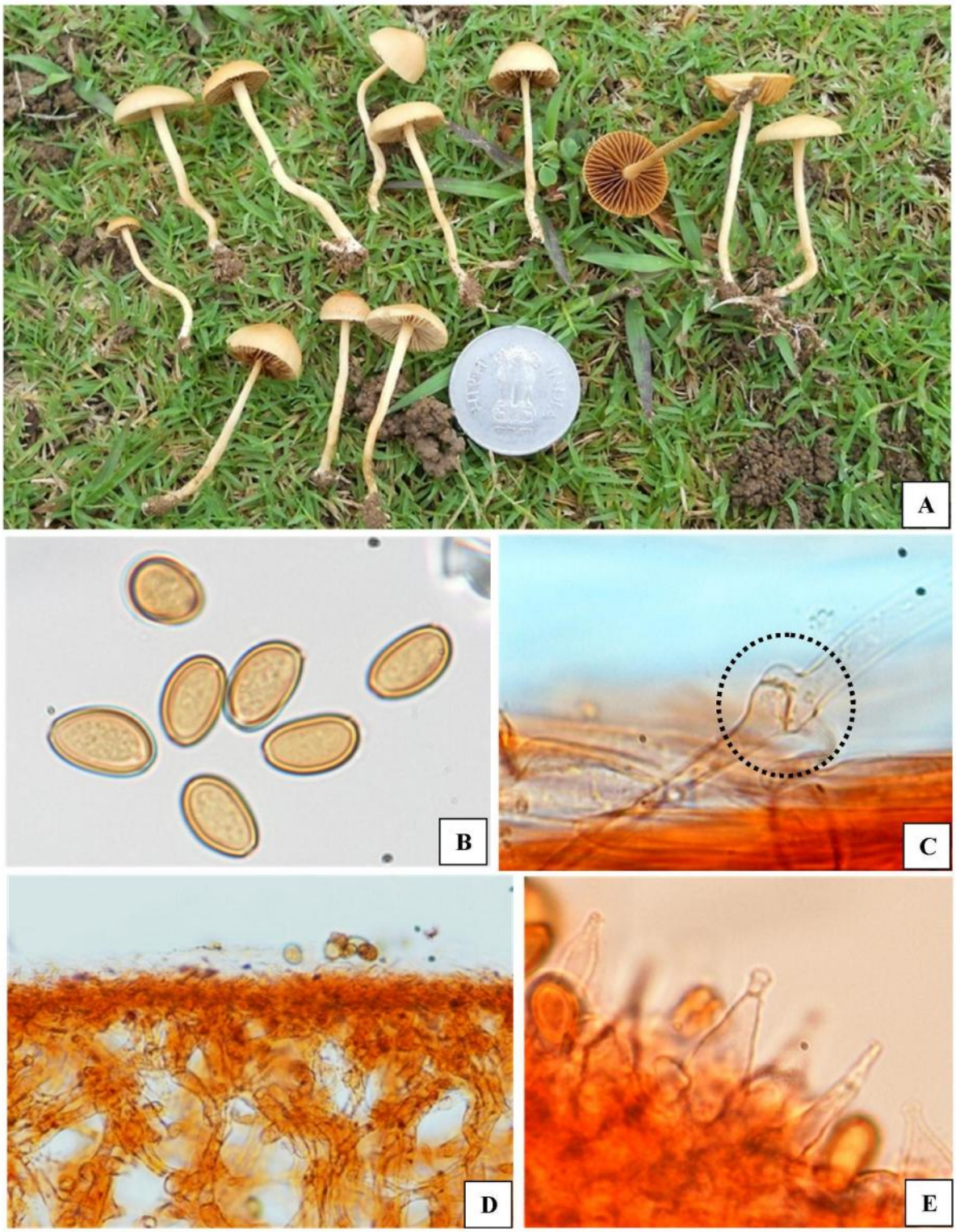

Fig. 4 A–E– ***Psilocybe moelleri*** Guzmán: A Carpophores in their natural habitat and showing underview of cap. B Microphotograph of basidiospores. C Clamp connection in stipe hyphae. D C. S. through Pileus showing gelatinized cuticle. E Gill edge showing Cheilocystidia.

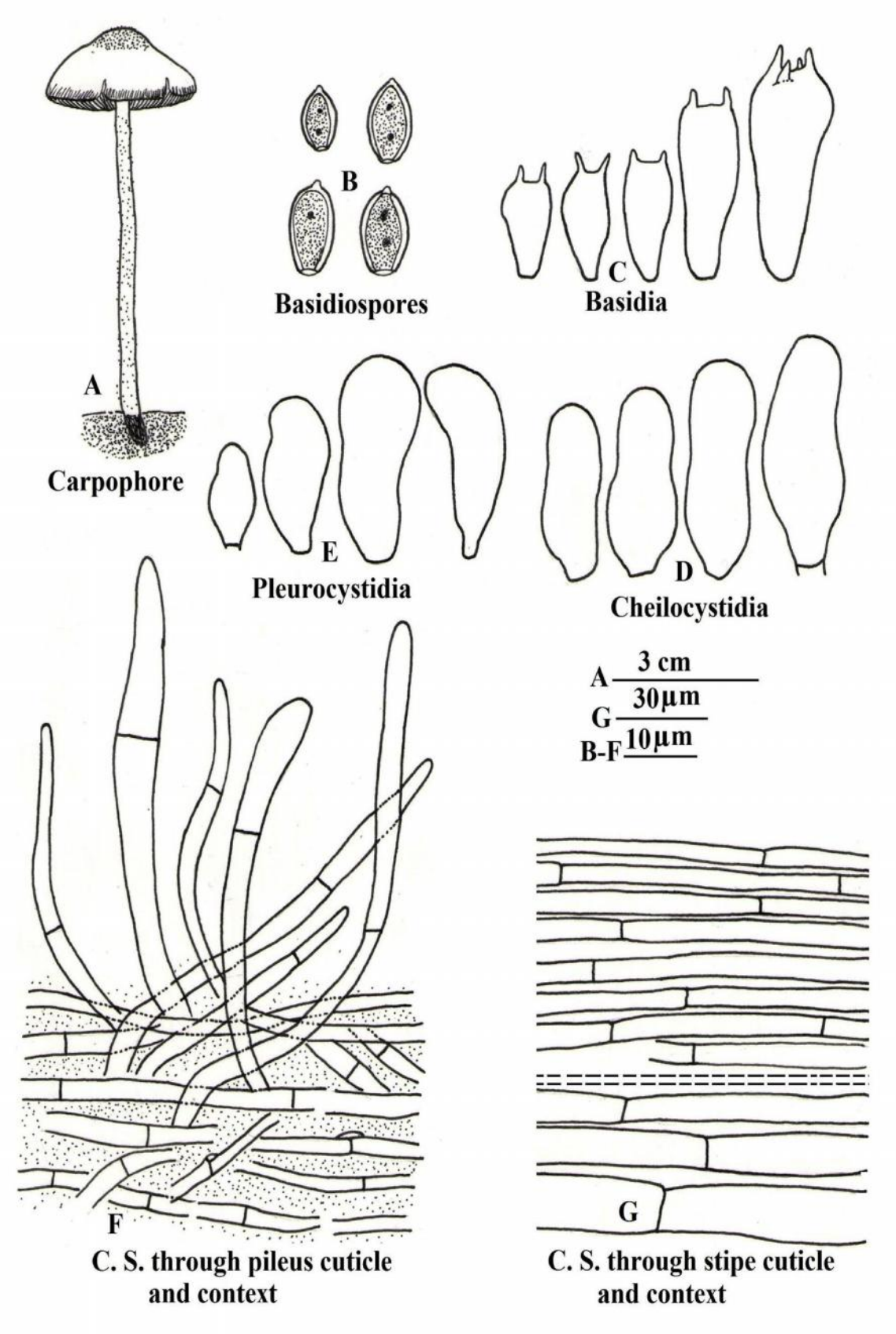

Fig. 5 A–G– ***Psilocybe uda*** var. ***elongata*** (Pers.) Gillet : A Carpophore. B Basidiospores. C Basidia. D Cheilocystidia. E Pleurocystidia. F C. S. through pileus cuticle & context. G C. S. through stipe cuticle & context.

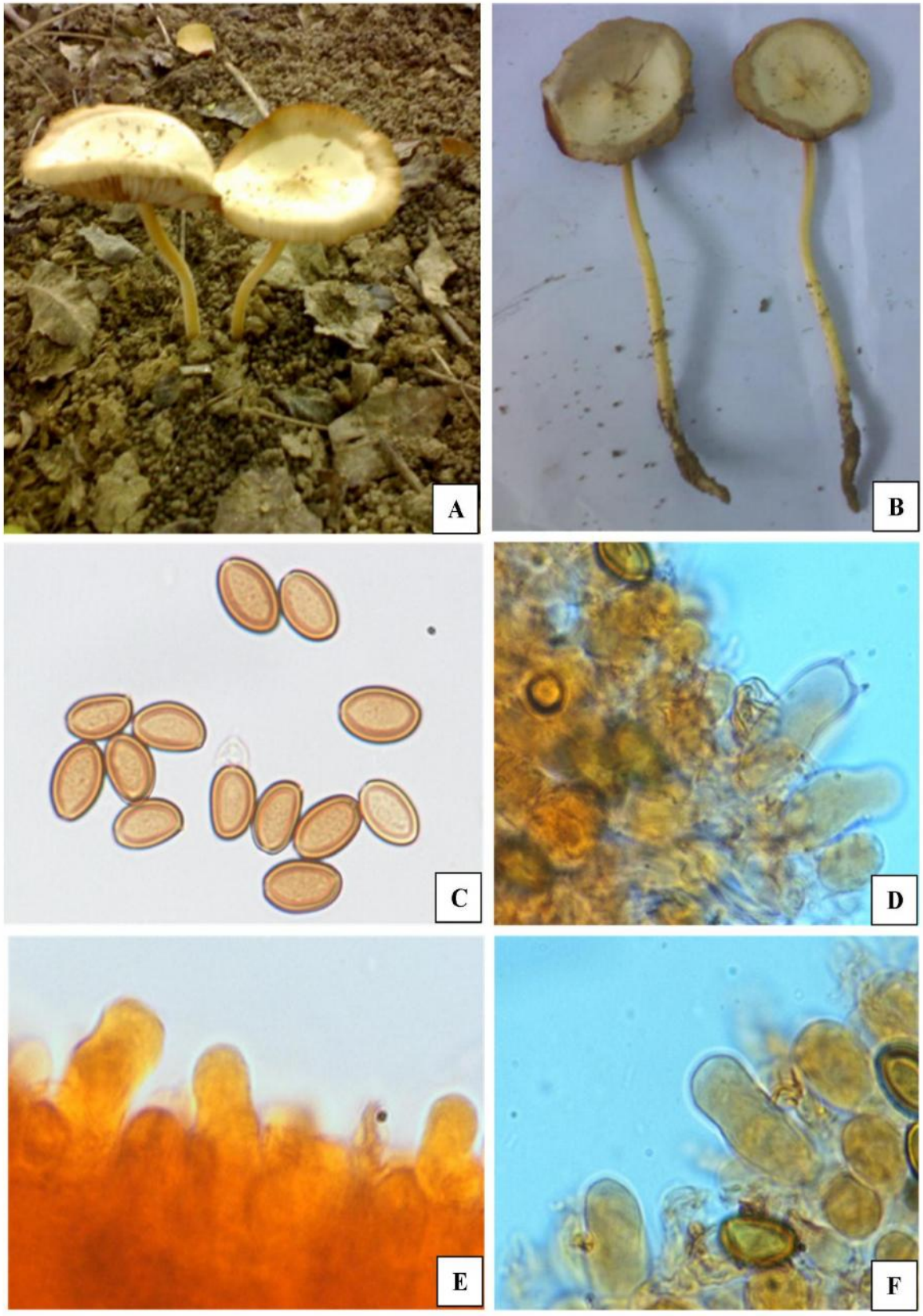

Fig. 6 A–F– ***Psilocybe uda*** var. ***elongata*** (Pers.) Gillet: **A** Carpophores growing in their natural habitat. **B** Carpophores with small pseudorrhiza. **C** Microphotograph of basidiospores. **D** Basidia. **E** Pleurocystidia. **F** Gill edge showing Cheilocystidia.

Psilocybe coprophila (Bull.) P. Kumm., *Der Führer in die Pilzkunde*: **71**, 1876. **Fig. 7. A–H; 8. A–C.**

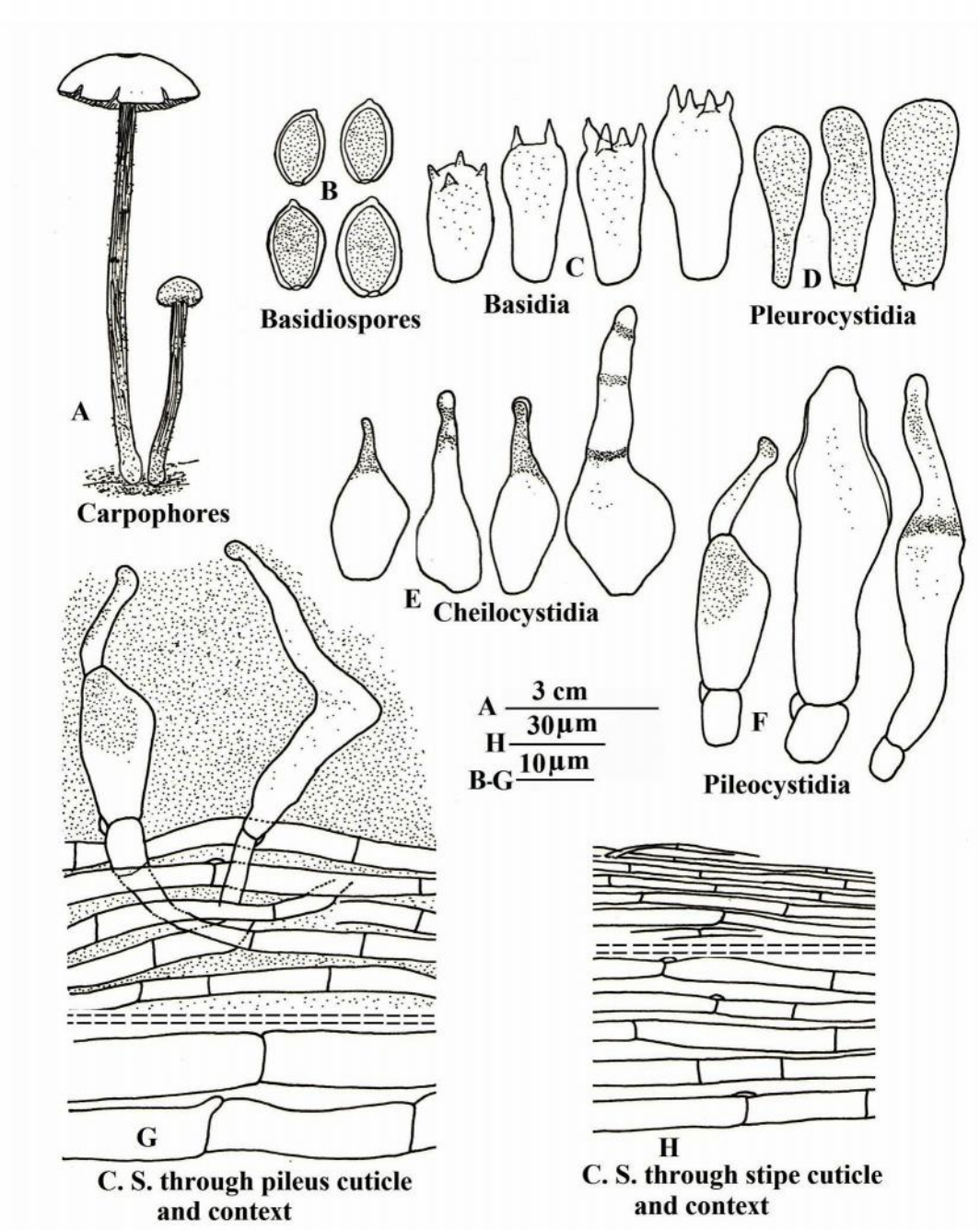

Fig. 7 A–H– ***Psilocybe coprophila*** (Bull.) P. Kumm.: A Carpophores. B Basidiospores. C Basidia. D Pleurocystidia. E Cheilocystidia. F Pileocystidia. G C. S. through pileus cuticle & context. H C. S. through stipe cuticle & context.

Carpophores 3.5–8.5 cm in height. Pileus 0.7–2.7 cm broad; convex with depressed centre to applanate; surface brownish yellow ($5C_7$) when young, brownish orange ($5C_4$) to greyish orange ($5B_3$) in mature; dry; scaly, scales white present all over the pileus, more aggregated along periphery in young carpophores, shed off towards maturity; margin irregular, splitting at maturity; cuticle fully peeling; flesh 0.2 cm thick, membranous, creamish pale, unchanging; taste and odour mild. Pileal veil absent. Lamellae broadly adnate; unequal, in 3 lengths; subdistant; moderately broad (0.5 cm broad); greyish brown ($6D_3$), unchanging; gill edges lacerate; normal. Spore print dark brown ($6F_6$). Stipe central, 3.2-8.3 cm long, 0.1–0.3 cm broad, equal in diameter throughout with slightly bulbous base; surface shiny, orange white ($5A_2$) to greyish orange ($5B_4$), brown near pileus due to spore deposition; twisted with longitudinal striations; solid; scaly, scales fibrillose to pruinosefibrillose, white creamish scattered all over the stipe; exannulate.

Fig. 8 A–C– ***Psilocybe coprophila*** (Bull.) P. Kumm.: A Carpophores growing in their natural habitat. B Microphotograph of basidiospores. C Gill edge showing Cheilocystidia.

Basidiospores 10.14–12.67 × 6.76–8.45 µm (excluding apiculus), (Q=1.5) ellipsoid, lentiform; double walled; smooth; golden brown, granular; truncated with a slightly narrow apical germ pore; apiculate, apiculus 0.84–1.69 µm long. Basidia 15.21–21.97 × 8.45–10.98 µm, claviform, weakly granular, –2, –4 spored, mostly –4 spored; sterigmata 2.53–3.38 µm long, swollen. Pleurocystidia 20.28–23.66 × 6.76–9.29 µm, claviform to lageniform, granular. Cheilocystidia 20.28–35.49 × 8.45–13.52 µm, versiform, long necked, few lecythiform, with tubular, granular tips; abundant; gill edges sterile.

Carpophore context homoiomerous. Pileus cuticle hyphal, gelatinized, made up of horizontally tangled, 3.94–7.88 µm broad, septate hyphae giving rise to pileocystidia. Pileocystidia 32.11–49.01 × 8.45–13.52 µm, versiform, with long tubular neck, granular, single basal cell in few pileocystidia; pileus context hyphal, made up of 7.88–17.73 µm broad, septate hyphae. Hymenophoral trama regular. Stipe cuticle hyphal, made up of longitudinally, arranged 3.94–5.91 µm broad, septate hyphae; stipe context hyphal, made up of 7.88–15.76 µm broad, septate hyphae. Clamp connections present throughout.

Collection examined: India, Punjab, Ropar (394 m), Village Jhajan, growing scattered on dung, Harwinder Kaur, PUN 5978, July 13, 2012.

Distribution and ecology: Arora (1986) collected *P. coprophila* growing solitary or in small colonies on dung and manure from California, while, Stamets (1996) found it usually gregariously scattered on cow or horse dung during spring, summer and fall throughout North, Central and South America, Europe, Russia, Japan, Australia, New Zealand, Hawaii and Southern Africa. Watling and Gregory (1987) found it as growing gregarious or in small clusters on cow, horse and sheep dung in grasslands from Ireland. Breitenbach and Kränzlin (1995) found it usually gregarious on manured meadows and pastures, on horse or sheep manure, on old cow pies, during summer and fall from Europe, North America and Asia. From India Natarajan and Raman (1984) reported this species on dung, growing solitary and in groups from Tamil Nadu in mid August. Presently, this species has been found growing scattered on dung in mid July.

Remarks: The external and internal details of above examined collection matches well with the details given for *Psilocybe coprophila* (Bull.) P. Kumm. by Guzmán (1983), Natarajan and Raman (1984), Arora (1986), Stamets (1996), Watling and Gregory (1987), Breitenbach and Kränzlin (1995), Bougher and Syme. (1998), Bas *et al.*, (1999), Doveri (2004), Noordeloos (2011). This species is characterised by its medium sized, brownish yellow to brownish orange cap, purple brown to dark brown spore print, absence of pileal veil and annulus. This species has been reported from South India by Bhavani Devi (1995) from Kerela and from Tamil Nadu by Thomas *et al*. (2002). It is first time reported from North India.

Edibility: Arora (1986) regarded it as harmless, but according to him some strains apparently contain enough psilocybin to be rewarded with the euphemistic label "active". However, a large number would be needed to produce any noticeable effects.

Discussion

As these four species of Genus *Psilocybe* viz. *Psilocybe sabulosa* Peck, *P. moelleri* Guzmán, *P. uda* var. *elongata* (Pers.) Gillet and *P. coprophila* (Bull.) P. Kumm. have been worked out for their taxonomic details. Out of which *P. moelleri* and *P. uda* var. *elongata* are reported for the first time from India and *P. sabulosa* and *P. coprophila* are first time reports from North India.

Acknowledgments

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