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Diversity of genus *Marasmius* sect. Marasmius from North India

Munruchi Kaur and Aakriti Gupta

Department of Botany, Punjabi University, Patiala-147002, India
Corresponding author; E-mail: aakritigupta1991@gmail.com

ABSTRACT

Seven marasmioid fungi belonging to section Marasmius viz. *Marasmius aspilocephalus* (Singer), *Marasmius baumannii* (Henn.), *Marasmius curreyi* (Berk. and Broome), *Marasmius griseoviolaceus* (Petch)*, Marasmius guyanensis var. guayarensis* (Singer), *Marasmius nigrobrunneus* (Pat.) Sacc., and *Marasmius rotalis* (Berk. and Broome) are described in this paper. A comprehensive description with detailed illustrations to aid the identification, comparisons with respect to morphological and anatomical characters and an artificial key to the described species of *Marasmius* sect. Marasmius are provided. This work serves as a preliminary part of series dealing with macroscopic fungi of North India. All the taxa described here belong to section Marasmius, which is characterized by unique characters like institious stipes and collariate lamelle. These characters distinguish this section from other remaining sections of the genus *Marasmius*. Five species including *Marasmius aspilocephalus* (Singer), *Marasmius baumannii* (Henn.), *Marasmius griseoviolaceus* (Petch)*, Marasmius guyanensis var. guayarensis* (Singer) and *Marasmius nigrobrunneus* (Pat.) Sacc. are first reports from India. *Marasmius rotalis* (Berk. and Broome) is reported for the first time from North India while *Marasmius curreyi* (Berk.and Broome) is new to Punjab. This research enriches our knowledge of species in the section Marasmius.

Key words: Macrofungi, *Marasmius*, taxonomy, morphology, anatomy

Genus *Marasmius* Fr. (*Marasmiaceae*, *Agaricales*) is mostly represented by saprotrophic members found worldwide growing on leaves and wood debris in plains as well as forest litter. A noticeable diversity of this genus has been observed in tropical regions. Worldwide this genus is represented by 500 species (Kirk *et al.,* 2008). From India, 96 species are known so far (Farook *et al*., 2013; Upadhyay *et al*., 2017; Bhosale *et al.,* 2019; Chakraborty, 2019 and Jha *et al.,* 2022). This genus constitutes an essential component of forest ecosystem playing a significant role in capturing and binding falling leaf litter and degrading the litter and wooden debris. The section Marasmius is characterized by collariate lamellae and institious stipes. A detailed investigation was carried out in various states of North India to check the diversity of genus *Marasmius*. In this paper 07 species of genus *Marasmius* has been worked out for their external and internal details. In addition, a key to identification for these species has been given. Species discussed here are delimited on the basis of morphological and taxonomical details. A dichotomous key to aid in identification, illustrations of apposite micromorphological features, color photographs of basidiocarps, comprehensive descriptions and commentaries are provided in this manuscript.

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Major objective of this work is to study the taxonomical diversity of genus *Marasmius* from North India. Current systematic and taxonomic research focuses on classifying and organizing species and genera using a combination of characters including morphological, anatomical and ecological data. This study samples members of section Marasmius currently recognized and reported for the first time from North India. All these taxa discussed here are identified using extensive morphological and taxonomical examination, compared with other closely allied taxa using pertinent characters to reach out to final conclusions.

MATERIALS AND METHODS

For collection of healthy and fresh specimens, various states of North India were visited during late monsoon season. Field survey, collection, preservation of specimens was done following standard methods given by Atri *et al*. (2005, 2017). Small and fragile carpophores of genus *Marasmius* were handled with extreme care and precaution to avoid any kind of damage while transporting them from field to laboratory. Special care was taken while collection to note down presence or absence of mycelia mat at the base of stipes to delimit them in particular sections. Carpophores were dried on the uppermost chamber of dryer to avoid excessive heat exposure to them. Thin sections were made to study taxonomical characters to combine the results with other morphological and ecological characters to conclude final results. The terminology followed for describing the colors of various parts of carpophores following Kornerup and Wanscher (1978). All of the examined collections have been deposited in the Herbarium of Botany Department, Punjabi University Patiala under PUN.

KEY TO THE INVESTIGATED SPECIES

1 Caps with creamish orange, orange to brown color tones; centrally placed apical papilla usually present; collariate lamellae usually present.....…….**2**

12 Caps with reddish brown, brownish orange, grayish orange, grayish black or violet brown tinge; centrally placed apical papilla lacking; lamellae always collariate.....…….**5**

2 Lamellae non-collariate; pileocystidia and caulocystidia present; on grass litter ……. ***Marasmius guyanensis* var. *guayarensis***

22 Lamellae always collariate; pileocystidia and caulocystidia absent; growing on bamboo leaf…. litter or stump.…….....**3**

3 Apical papillae absent on pileus; cheilocystidia and epicuticular elements of rotalis type broom cells…….....***M. rotalis***

32 Apical papilla sometimes lacking on pileus; cheilocystidia and epicuticular elements of siccus type broom cells……**4**

4 Centrally placed apical papilla always present on pileus; basidiospores with prominent plage, setules of both cheilocystidia and epicuticular broom cells are of broad and blunt tips…….....***M. baumanni***

42 Centrally placed apical papilla lacking on pileus; basidiospores without plage; broad and blunt tipped setules absent in both cheilocystidia and epicuticular broom cells…….....***M. aspilocephalus***

5 Carpophore growing on wheat straw; caps with reddish brown to brownish orange color.....***M. curreyi***

52 Carpophore growing on bamboo litter; caps grayish brown to black with violet tinge….....……..**6**

6 Caps grayish brown to black lacking any violet tinge; epicuticular broom cells of three distincttypes…….....***M. nigrobrunneus***

62 Caps grayish brown with violet brown tinge; epicutis lacking three distinct types of broom cells.....***M. griseoviolaceus***

TAXONOMY

Marasmius guyanensis var. guayarensis Singer, *Sydowia* **18:** 187, 336 (1965). **Figs. 1(a-k)**

Carpophores 4.1–4.5 cm in height. Pileus 0.5–1.0 cm broad, convex; umbonate, umbo acute; margin regular, not splitting at maturity, non-striate; scales absent; surface orange ($6A_8$); moist; cuticle not peeling; flesh membranous (up to 0.5 cm thick), creamish white ($1A_2$), unchanging; odour and taste mild; pileal veil absent. Lamellae free, close, unequal, up to 3 lengths; narrow (up to 0.1 cm broad); creamish white ($1A_2$), unchanging; gill edges smooth, normal; lamellulae present. Stipe central, 4.0–4.4 cm long, up to 0.2 cm broad, equal in diameter throughout; three toned, surface creamish white ($1A_2$) near apex to orange ($6A_8$) at middle and brown ($6D_4$) towards

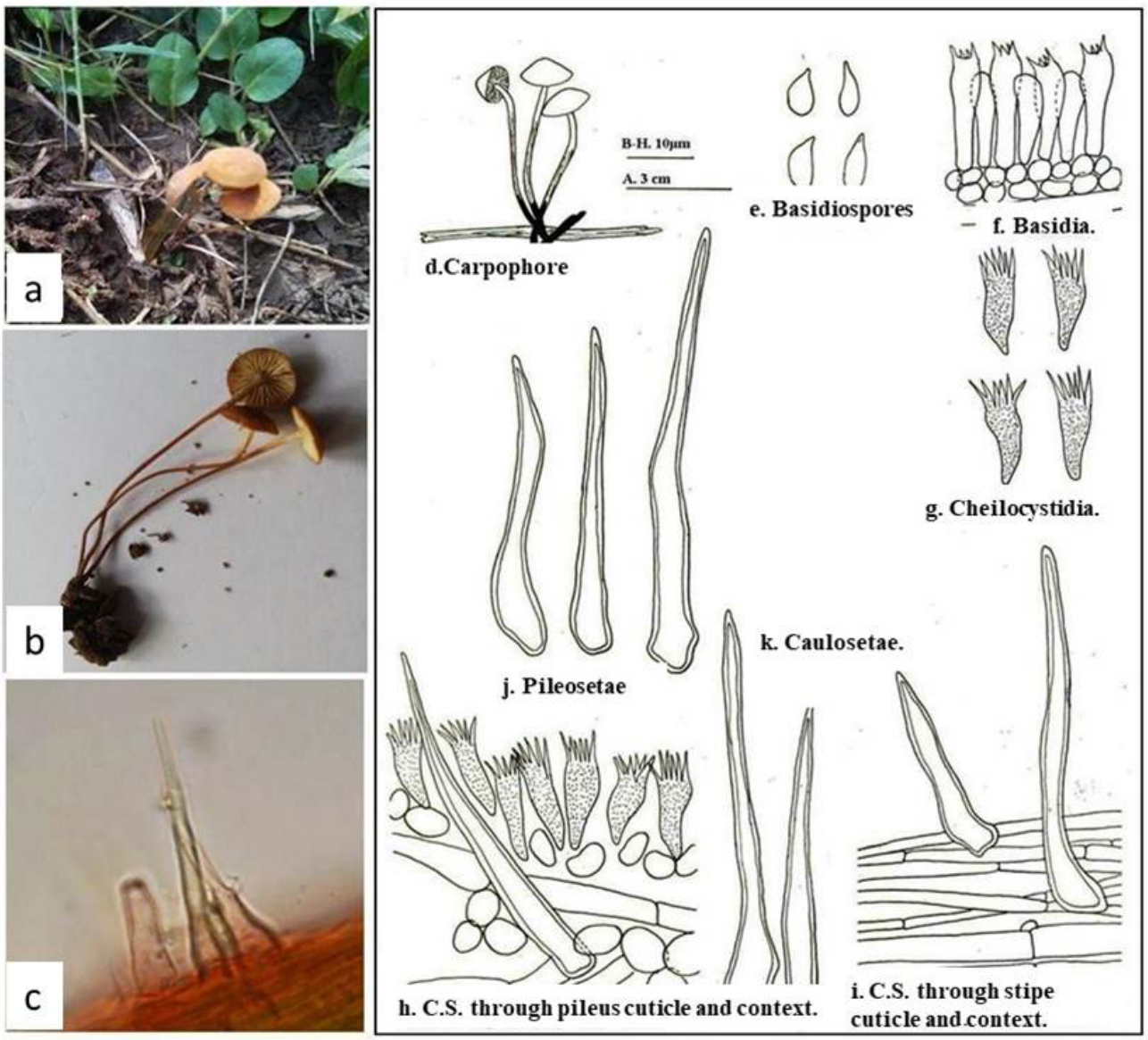

Fig. 1. *Marasmius guyanensis* var. *guayarensis* 1(a-k): a.Carpophores growing in caespitose clusters on decomposing stolons of grass. b. Underside of pileus showing free, close, creamish white lamellae. c. C.S. of stipe cuticle showing occasionally present filiform caulosetae. d. Carpophore.e. Basidiospores f. Basidia. g. Cheilocystidia. h. C.S. through pileus cuticle and context. i. C.S. through stipe cuticle and context. j. Pileosetae k. Caulosetae

the base, unchanging; smooth, scales absent; institious, mycelial mat absent at the base of the stipe; solid; exannulate.

Basidiospores 8.0–11.2 × 4.0–4.8 µm, (Q = 2.0), oblong to cylindric, inamyloid, thin walled, smooth, hyaline; apiculate, apiculus up to 0.8 µm long, centric to excentric in position. Basidia 16.0–21.0 × 4.8–5.6 µm, clavate, hyaline; tetrasterigmate, sterigmata 1.6–2.4 µm long, pointed, hyaline. Hymenophoraltrama regular. Pleurocystidia absent. Cheilocystidia 17.6–24.0 × 4.8–5.6 µm (including setules), clavate, siccus type broom cells with apical setules, granular, 5–6 apicalsetules per cystidia, abundant. Gill edges sterile. Pileus cuticle hymeniform made up of a regular turf of dextrinoidsiccus type broom cells 17.6–24.0 × 4.8–5.6 µm broad (including setules), clavate, siccus type, granular bearing 6–7 apical setules per broom cell interspersed with pileosetae; pileosetae 72.0–83.2 × 4.8–7.2 µm broad, double walled, filiform with an acutely pointed apex, broad footed, abundant; context made up of 6.4–8.0 µm broad, septate, hyaline hyphae intermixed with 6.4–10.4 µm broad, hyaline round cells. Stipe cuticle hyphal, made up of longitudinally arranged, 4.8–5.6 µm broad, septate, hyaline hyphae giving rise to occasionsalcaulosetae; caulosetae 52.8–92.8 × 4.8–8.0 µm broad, filiform, double walled, few broad footed, apex pointed, occasional; context hyphal, made up of 7.2–8.0 µm broad, septate, hyaline hyphae. Clamp connections present throughout.

Collection Examined: Punjab: Patiala, S. S. Bir Botanical Garden of Punjabi University Patiala (251 m) 30°21’28"N–76°27’27"E, growing in caespitose cluster on decomposing stolons of grass along road side, Aakriti Gupta, PUN 11093, 17 July, 2015.

Distribution and Ecology: *Marasmius guyanensis var. guayarensis* was found growing on both dicotyledonous as well as monocotyledonous leaves, petioles and stems rarely occur on wooden debris from tropical rain forests of South America by Singer (1965 a). Present collection has been made during the monsoon season growing in caespitose cluster on decomposing stolons grass litter along road side from Punjab.

Remarks: The above examined marasmioid collection matches well in both its morphological and anatomical characters with the description provided for *Marasmius guyanensis* var. *guayarensis* Singer as given by Singer (1965). It is characterized in having convex orange caps, free, close lamellae, three toned institious stipe, small basidiospores, altogether absent pleurocystidia, siccus type broom cells as cheilocystidia as well as epicuticular elements. Presently examined collection differs in lacking a well distinguishable collarium and rarely occurring rotalis type epicuticular elements as described by Singer (1965). Here it is a first-time report from India.

Marasmius rotalis Berk. and Broome, *Journal of the Linnean Society. Botany* **14:** 40 (1875).

Figs. 2(a-i)

Carpophores 1.4–2.0 cm in height. Pileus 0.1–0.2 cm broad, convex; umbo absent, depressed at centre; margin regular, not splitting at maturity, striate, striations run up to the centre; scales absent; surface creamish white ($1A_2$) with pale brownish centre ($5C_4$) in mature carpophores; moist; cuticle not peeling; flesh membranous (up to 0.1 cm broad), white ($1A_1$), unchanging; odour and taste mild; pileal veil absent. Lamellae collariate, distinct collarium present, adnexed, equal, distant, broad (up to 0.2 cm); white ($1A_1$), unchanging; gill edges smooth, normal; lamellulae absent. Stipe central, 1.3–1.9 cm long, up to 0.1 cm broad, wiry, equal in diameter throughout; surface three toned, white ($1A_1$) near apex, greyish yellow ($4B_3$) to brownish orange ($7C_5$) at middle and brown ($7D_6$) towards the base, unchanging; smooth, scales absent; institious, mycelial mat absent at the base of the stipe; solid; exannulate.

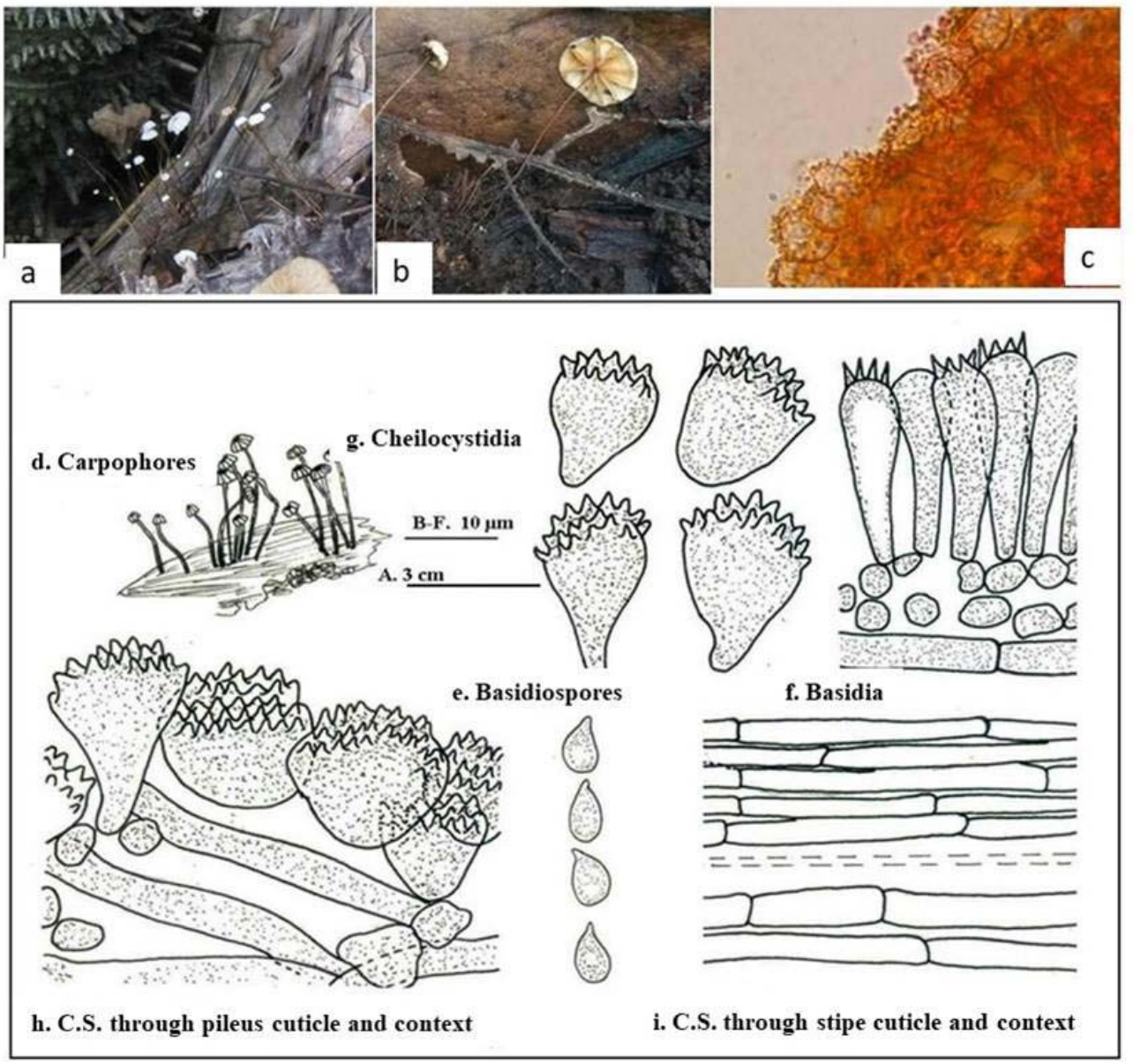

Fig. 2. *Marasmius rotalis* 2(a-i): a.Carpophores growing scattered on decomposed Bamboo twigs. b. Underside of cap showing collariate lamellae . c. C.S. through pileus showing rotalis type epicuticular broom cells.d. Carpophores.e. Basidiospores.f. Basidia.g. Cheilocystidia.h. C.S. through pileus cuticle and context.i. C.S. through stipe cuticle and context

Basidiospores 6.4–8.8 × 3.2–4.0 µm, (Q = 2.4), ellipsoidal, inamyloid, single walled, smooth, granular; apiculate, apiculus up to 0.8 µm long, centric to excentric in position. Basidia 12.8–19.2 × 6.4–8.0 µm broad, clavate, granular, few with heavy granulations near the apex, abundant; tetrasterigmate, sterigmata 4.8–5.6 µm long, pointed, granular. Hymenophoral-trama regular. Pleurocystidia absent. Cheilocystidia 11.2–17.7 × 8.8–11.2 µm (including setules), clavate to broadly clavate, subglobose to pyriform, dendrophysoid, rotalis type with numerous apical, small, obtuse setules, granular, abundant. Gill edges sterile. Pileus cuticle hymeniform made up of uniform turf of dendrophysoid, rotalis type broom cells, clavate to pyriform, 12.8–16.0 × 9.1–14.4 µm broad, arranged in 1–2 layers, bearing numerous apical, obtuse, small

setules; pileocystidia absent; context made up of 5.6–7.2 µm broad, septate, granular hyphae intermixed with 6.4–11.2 µm broad, granular, round cells. Stipe cuticle hyphal, made up of longitudinally arranged, 4.0–4.8 µm broad, septate, hyaline hyphae; caulocystidia absent; context hyphal, made up of 5.6–6.4 µm broad, septate, hyaline hyphae. Clamp connections absent throughout.

Collection Examined: Punjab: Nangal, Village Manakpur (333 m) 31°20'06"N–76°21'30"E, growing scattered on decomposed Bamboo twigs, Ritu Bala, PUN 11094, 17 August, 2015.

Distribution and Ecology: Petch (1948) collected *Marasmius rotalis* from Sri Lanka growing on dead leaves and wet forest litter while later in 1977 and 1986, Pegler collected the same growing frequently either solitary or clustered on various foliocolous substrates like fallen twigs, dead leaves on forest floor from different districts of Sri Lanka. Singer (1965) reported *M. rotalis* growing solitary on dead fallen dicotyledonous leaf in tropical rain forest from South America. Natrajan and Manjula (1982) reported it from Tamil Nadu growing on fallen twigs. Grace *et al*. (2019) collected this species growing solitary on dicot leaf litter from Africa, Kenya, Indonesia, Madagascar and South America. Presently, this collection was found growing scattered on fallen Bamboo twigs from Punjab.

Remarks: Present collection falls within the section *Marasmius* of genus *Marasmius* due to presence of a central, institious stipe and collariate lamellae. Further, with in this section on the basis of its morphological and anatomical details, it falls under species *Marasmius rotalis* Berk. and Broome given by Petch (1948), Singer (1965) and Pegler (1977, 1983).This species is characterized in having white pileus, collariate lamellae and institious stipe. Microscopically, the spore range (6.4–8.8 x 3.2–4.0 µm) and presence of dendrophysoid cheilocystidia and epicuticular elements with numerous small, obtuse verrucae in the presently examined species confirms its taxonomic identification with *M. rotalis*. Earlier it has been reported from Tamil Nadu by Natrajan and Manjula (1982). Presently it is a new record from North India.

Marasmius baumannii Henn., *Botanische Jahrbücherfür Systematik Pflanzengeschichte und Pflanzengeographie* **23:** 548 (1897) **Figs. 3 (a-j)**

Carpophores 2.6–3.0 cm in height. Pileus 0.3–0.6 cm broad, convex with depressed centre, umbo absent; margin irregular, not splitting at maturity; striate, striations run up to the centre, scales absent; surface cream to yellowish white ($1A_2$), pale orange centre ($5A_3$) with centrally placed black apical papilla; dry; cuticle not peeling; flesh membranous (less than 0.5 cm broad, white ($1A_1$), unchanging; odour and taste mild; pileal veil absent. Lamellae collariate, distinct collarium present, distant, equal; moderately broad (up to 0.4 cm broad); creamish white ($1A_2$), unchanging; gill edges smooth, normal; lamellulae absent. Stipe central, 2.2–2.8 cm long, up to 0.1 cm broad, wiry, equal in diameter throughout; two toned, surface white ($1A_1$) near apex to dark brown ($9F_6$) towards the base; institious, mycelial mat absent at the base, unchanging; smooth, scales absent; solid; exannulate.

Basidiospores 7.0–9.8 × 4.2–5.0 µm, (Q = 2.0), oblong to ellipsoidal, inamyloid, thin walled, smooth, with prominent plage, granular; apiculate, apiculus up to 0.7–1.4 µm long, centric to excentric in position. Basidia 24.0–28.0 × 4.2–5.6 µm broad, clavate, granular; tetrasterigmate, sterigmata 2.1–2.8 µm long, pointed, granular. Hymenophoraltrama regular. Pleurocystidia absent. Cheilocystidia 16.8–22.4 × 8.4–11.2 µm broad (including setules), clavate, siccus type with broad, blunt tipped apical projections, 6–7 setules per cystidia, hyaline, abundant. Gill edges sterile. Pileus cuticle hymeniform made up of dextrinoid broom cells arranged in 1–2 layers, 14.1–18.3 × 8.4–

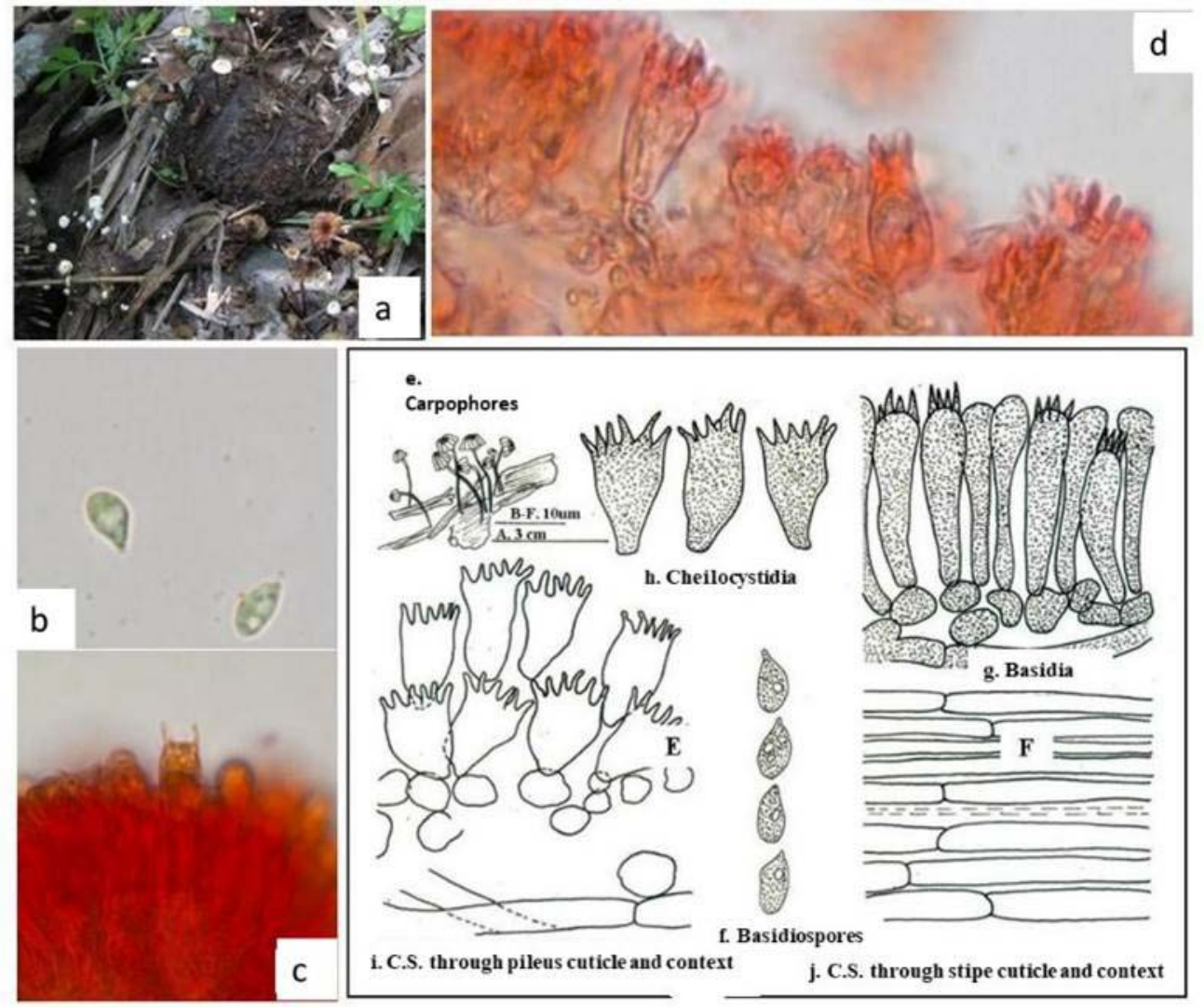

Fig. 3. *Marasmius baumannii* 3(a-j): a. Carpophores growing gregariously on dead Bamboo stump and leaves. b. Microphotograph of ellipsoid basidiospores with prominent plage. c.C.S. through hymenium showing clavate basidium. d. C.S. through pileus cuticle showing hymeniform pileus with epicuticular broom cells having broad and blunt tipped setules. e. Carpophores.f. Basidiospores. g. Basidia. h. Cheilocystidia. i. C.S. through pileus cuticle and context.j. C.S. through stipe cuticle and context

11.2 µm (including setules) broad, clavate hyaline, bearing 6–7 blunt tipped apical setules per broom cell; pileocystidia absent; context made up of 5.0–5.6 µm broad, septate, hyaline hyphae intermixed with 5.0–7.7 µm broad, hyaline round cells. Stipe cuticle hyphal, made up of longitudinally arranged, 3.5–4.2 µm broad, septate, hyaline hyphae; caulocystidia absent; context hyphal, made up of 5.6–7.0 µm broad, septate, hyaline hyphae. Clamp connections absent throughout.

Collection Examined: Punjab: Nangal, Village Manakpur (333 m) 31°20’06"N–76°21’30"E, growing gregariously on fallen bamboo stump and leaves, Aakriti Gupta, PUN 11095, 14 September, 2016.

Distribution and Ecology: *Marasmius baumannii was* found from Togo, West Africa and described by Hennings (1897). Singer (1964) reported this species growing in caespitose clusters on branches from

Central Africa. This species is thought to be found throughout equatorial Africa. Pegler (1977) reported it from East- Central Africa. Present collection has been found growing on dead bamboo stump and leaf litter from Punjab.

Remarks: As in present collection the stipe is central, institious and lamellae are collariate it falls under the section *Marasmius* of genus *Marasmius.* Further in this section considering the morphological and anatomical details of this collection, it matches well with the description provided for *Marasmius baumannii* Henn. by Pegler (1977). This distinctive species is characterized by creamish yellow pileus with a centrally placed black apical papilla, single walled ellipsoidal spores with a prominent plaque, and broad blunt tipped setules on both cheilocystidia and epicuticular broom cell. This species is a first-time report from India.

Marasmius aspilocephalus Singer, *Sydowia***18:** 176, 334 (1965) **Figs. 4(a-g)**

Carpophores 1.3–2.4 cm in height. Pileus 0.1–0.3 cm broad, convex with depressed centre, umbo absent; margin irregular, not splitting at maturity; striate, striations run up to the centre, scales absent; surface creamish white ($1A_2$), orange brown near centre ($7C_4$), grayish orange ($6B_4$) to brownish orange ($7C_5$) in and around central depression, centrally placed black apical papilla absent; dry; cuticle not peeling; flesh membranous (less than 0.5 cm broad, white ($1A_1$), unchanging; odour and taste mild; pileal veil absent. Lamellae collariate, distinct collarium present, subdistant, equal, narrow, white ($1A_1$), unchanging; gill edges smooth, normal; lamellulae absent. Stipe central, 1.2–2.3 cm long, up to 0.1 cm broad, equal in diameter throughout, wiry; two toned, surface light brown ($6D_4$) near apex to brown ($6E_3$)

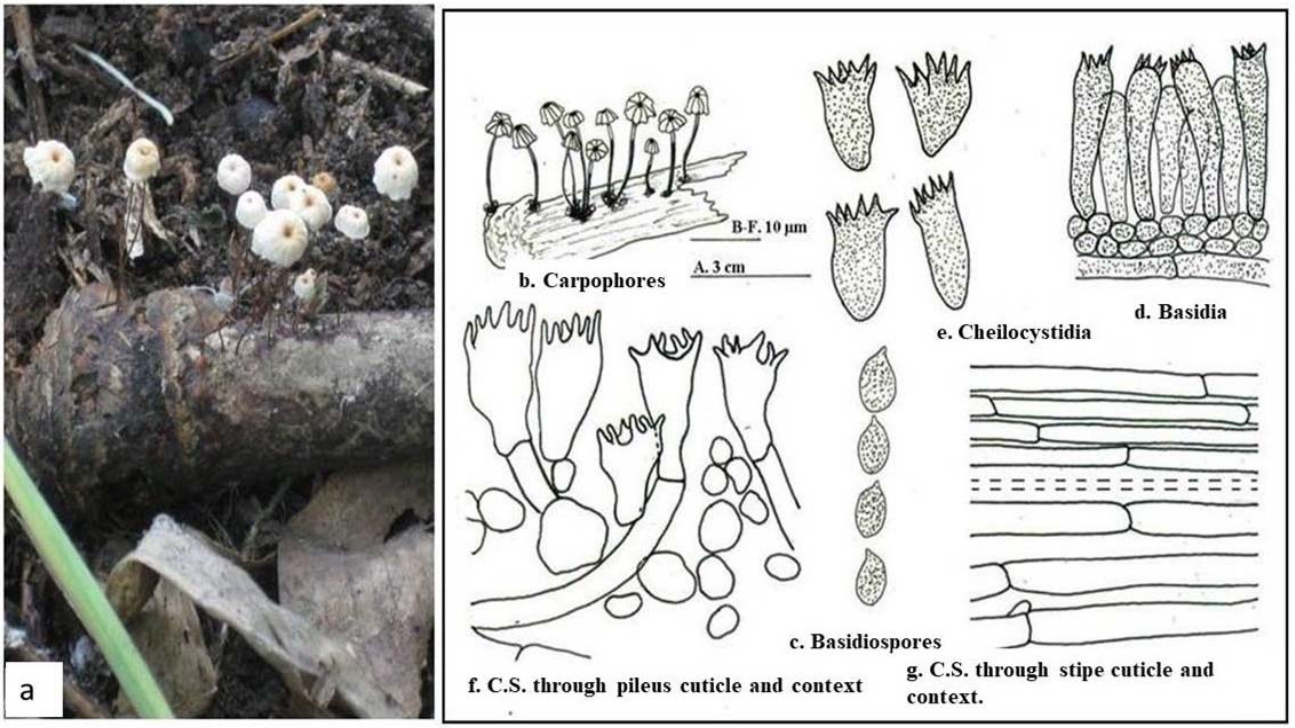

Fig. 4. *Marasmius aspilocephalus* 4(a-g): a.Carpophores growing gregariously on Bamboo twigs and stumps. b. Carpophores c. Basidiospores d. Basidia. e. Cheilocystidia.f. C.S. through pileus cuticle and context.g. C.S. through stipe cuticle and context

at middle and towards the base; institious, mycelial mat absent at the base, unchanging; smooth, scales absent; solid; exannulate.

Basidiospores 8.4–11.2 × 4.2–5.0 µm, (Q = 2.2), ellipsoid to oblong, inamyloid, thin walled, smooth, plaque absent, granular; apiculate, apiculus up to 0.7 µm long, centric to excentric in position. Basidia 15.4–22.4 × 5.0–5.6 µm broad, clavate, granular; tetrasterigmate, sterigmata 2.8–4.2 µm long, pointed. Hymenophoraltrama regular. Pleurocystidia absent. Cheilocystidia 15.4–21.0 × 7.0–8.4 µm broad (including setules), clavate, siccus type, granular with 6–7 apical setules per cystidia, abundant. Gill edges sterile. Pileus cuticle hymeniform made up of uniform layer of dextrinoidsiccus type broom cells 16.8–25.2 × 9.8–14.0 µm (including setules), bearing 6–7 apical setules per broom cell, hyaline; pileocystidia absent; context made up of 5.6–7.0 µm broad, septate, hyaline hyphae intermixed with 4.2–8.4 µm broad, round, hyaline cells. Stipe cuticle hyphal, made up of longitudinally arranged, 4.2–5.0 µm broad, septate, hyaline hyphae; caulocystidia absent; context hyphal, made up of 5.6–8.4 µm broad, septate, hyaline hyphae. Clamp connections present in stipe hyphae.

Collection Examined: Punjab: Nangal, Village Manakpur (333 m) 31°20’06"N–76°21’30"E, growing gregariously on dead Bamboo twigs and stump, Aakriti Gupta, PUN 11096, 14 September, 2016.

Distribution and Ecology: Singer (1965) reported *Marasmius aspilocephalus* growing on leaves and culms of Bamboo plant from South America. Presently also the Indian collection was picked growing gregariously on fallen Bamboo twigs and stump.

Remarks: Present examined marasmioid collection belongs to section *Marasmius* of genus *Marasmius* due to the presence of a central institious stipe and distinct collarium. Further considering both morphological and anatomical details of this collection, it matches well with the description given for *Marasmius aspilocephalus* Singer provided by Singer (1965). This species is quite similar in its morphology to *Marasmius baumannii* Henn. (Pegler, 1977) but differs from it in certain external as well as internal details. In *M. baumannii*, off white cap possess a centrally placed black papilla, basidiospores with plaque, broad and blunt tipped setules on both cheilocystidia and epicuticular broom cells while *M. aspilocephalus* lacks a centrally placed black papilla on caps, plaque is absent in basidiospores and setules comparatively not as broad as in *M. baumannii*. This species is a first-time report from India.

Marasmius curreyi Berk.and Broome, *Annals and Magazine of Natural History* **3:** 209 (1879)

Figs. 5(a-h)

Carpophores 1.0–3.9 cm in height. Pileus 0.5–0.9 cm broad, convex; umbo absent, depressed; margin regular, not splitting at maturity, translucent striations present, sulcate; scales absent; surface reddish brown ($7C_6$) in young carpophores to brownish orange ($7C_4$) at maturity; dry; cuticle not peeling; flesh membranous (less than 0.5 cm), creamish white ($1A_2$), unchanging; odour and taste mild; pileal veil absent. Lamellae collariate, adnate, equal, distant, narrow (up to 0.2 cm broad); creamish white ($1A_2$), unchanging; gill edges smooth, normal; lamellulae absent. Stipe central, 0.7–3.6 cm long, up to 0.1 cm broad, equal in diameter throughout, wiry; surface two toned, white ($1A_1$) near apex, dark brown ($8F_8$) to black at middle and towards the base, unchanging; institious, mycelial mat absent at the base, smooth, scales absent; solid; exannulate.

Basidiospores 8.4–10.5 × 5.0–6.3 µm, (Q = 1.5), ellipsoidal, inamyloid, thin walled, smooth, granular; apiculate, apiculus up to 0.7 µm long, centric to excentric in position. Basidia 19.6–26.6 × 6.3–7.0 µm broad, clavate, granular; tetrasterigmate; sterigmata up to 2.8–4.2 µm long, not acutely pointed.

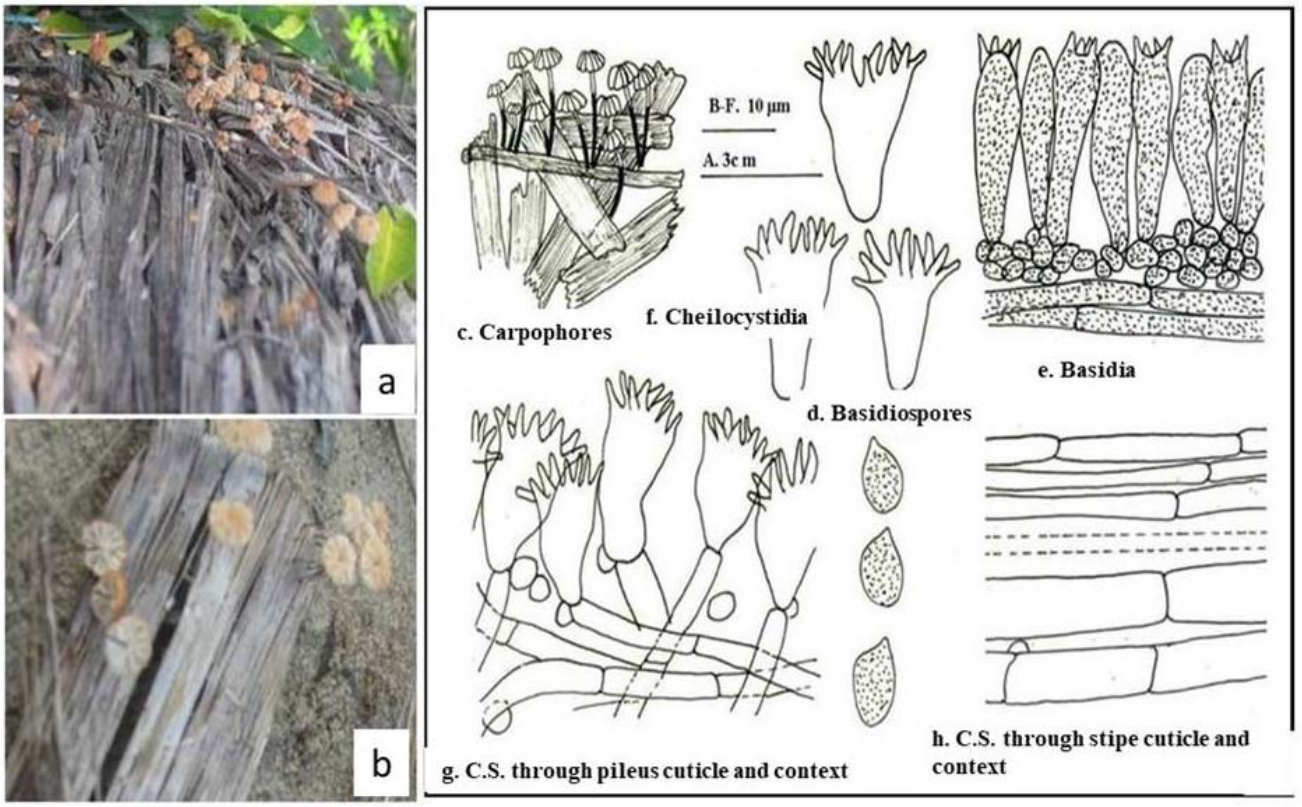

Fig. 5. *Marasmius curreyi* 5(a-h): a. Carpophores growing gregariously scattered on wheat straw. b. Institious stipes and underside of cap showing collariate lamellae. c. Carpophores.d. Basidiospores. e. Basidia. f. Cheilocystidia.g. C.S. through pileus cuticle and context h. C.S. through stipe cuticle and context

Hymenophoral trama regular. Pleurocystidia absent. Cheilocystidia 11.2–16.8 × 8.4–12.6 µm broad (excluding setules), clavate, siccus type broom cells with numerous apical projections, 4.2–5.6 long, thick walled, blunt tipped, 8 11 setules per cystidia, hyaline, abundant. Gill edges sterile. Pileus cuticle hymeniform, made up of densely packed dextrinoid siccus type broom cells 12.6–22.4 × 8.4–12.6 µm (excluding setules), arranged in single uniform layer, apically beset with abundant thick walled, 4.2–5.6 µm long setules, dark brown to yellowish brown in color; pileocystidia absent; context made up of 4.2–5.6 µm broad, septate, clamped, hyaline hyphae intermixed with 4.2–7.0 µm broad, round, hyaline cells. Stipe cuticle hyphal, made up of longitudinally arranged, 3.5–4.2 µm broad, septate, hyaline hyphae, orange brown in KOH solution; caulocystidia absent; context hyphal, made up of 6.3–7.5 µm broad, septate, hyaline hyphae. Clamp connections present throughout.

Chemical Color Reaction: Hyphal elements of stipe show orange brown color in KOH solution.

Collection Examined: Punjab: Patiala, Bhadson road, Village Bhedpura (251 m) 30°22’15"N–76°21’43"E, growing gregariously scattered on straw, Aakriti Gupta, PUN 11097, 27 August, 2019.

Distribution and Ecology: *Marasmius curreyi* was reported growing on dead stems of plants from coastal humid forests of Madagascar by Antonin and Buyck (2006). Hennings (1900) found this species growing on dead leaves, from Saharanpur, Uttar Pradesh. Presently, this species has been found growing gregariously scattered on straw litter from Punjab.

Remarks: Presently investigated collection falls under the section *Marasmius* of genus *Marasmius* due to

presence of a distinct collarium and institious stipe. Under this section, it falls within the subsection *Sicciformes* because of presence of siccus type broom cells. In its morphology as well as anatomy, it matches with the description provided for *Marasmius curreyi* Berk. and Broome by Antonin and Buyck (2006) and Shay *et al*. (2017). Morphologically, it is characterized by reddish brown small convex caps, collariate lamellae, and short wiry stipe. Anatomically, it shows the presence of inamyloid, ellipsoid basidiospores, clavate siccus type broom cells like cheilocystidia with thick walled setules, similar epicuticular elements with dark brown to yellowish brown apical setules, hyphal stipe elements giving orange brown color in KOH solution and abundant clamp connections. Earlier, it has been reported by Hennings (1900) from Uttar Pradesh growing on dead leaves. Presently, it is a first-time report from Punjab.

Marasmius nigrobrunneus (Pat.)Sacc.,*Sylloge Fungorum* **11:** 37 (1895) **Figs. 6 (a-h)**

Carpophores 3.6–5.0 cm in height. Pileus 0.4–0.6 cm broad, convex; umbo absent, depressed; margin irregular, not splitting at maturity, translucent striations present up to the centre, sulcate; scales absent; surface grayish brown ($6F_3$) to grayish black ($9E_7$) with dark centre; dry; cuticle not peeling; flesh membranous (up to 0.1 cm), dirty white ($1A_2$), unchanging; odour and taste mild; pileal veil absent. Lamellae collariate, adnate, equal, distant, narrow (up to 0.2 cm broad); creamish white ($1A_2$) with brownish gray ($9F_2$) edges, unchanging; gill edges smooth, normal; lamellulae absent. Stipe central, 3.3–4.4 cm long, up to 0.1 cm broad, wiry, equal in diameter throughout; surface brown ($8F_7$) to dark brown ($8F_8$), unchanging; institious, mycelial mat absent at the base, smooth, scales absent; solid; exannulate.

Basidiospores 7.0–10.0 × 4.2–5.0 µm, (Q = 2.0),ellipsoidal to oblong, inamyloid, thin walled, smooth, granular; apiculate, apiculus up to 0.7 µm long, centric to excentric in position. Basidia 14.0–25.2 × 5.0–7.0 µm, clavate, granular; tetrasterigmate, sterigmata up to 2.8–4.2 µm long, pointed. Hymenophoral trama regular. Pleurocystidia absent. Cheilocystidia 11.2–19.6 × 7.0–8.4 µm (excluding

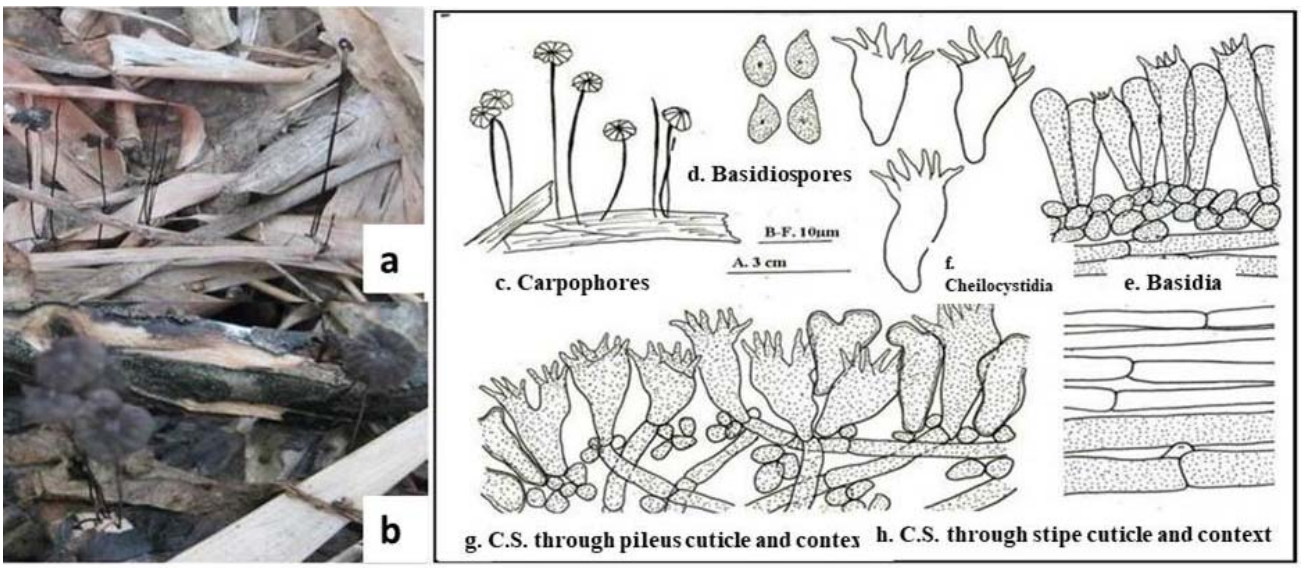

Fig. 6. *Marasmius nigrobrunneus* 6(a-h): a. Carpophores growing scattered on Bamboo leaf litter and twigs. b. Carpophores showing grayish brown to grayish black sulcate depressed caps and institious stipes. c. Carpophores d. Basidiospores. e. Basidia. f. Cheilocystidia g. C.S. through pileus cuticle and context h. C.S. through stipe cuticle and context

setules), clavate, hyaline, unbranched, siccus type broom cells with numerous apical setules, 4.2–7.0 µm long, thick walled, blunt 6–7 setules per cystidia, abundant. Gill edges sterile. Pileus cuticle hymeniform made up of densely packed dextrinoid 3 distinct types of cells; a) clavate, branched, siccus type broom cells, wavy in outline 11.2–18.2 × 7.0–10.0 µm (excluding setules), arranged in single layers, apically beset with abundant thick walled, 4.2–5.6 µm long dark brown to yellowish brown setules; b) 10.0–16.8 × 7.0–9.1 µm broad, clavate, smooth cells; c) transitional cells 11.2–18.2 × 9.0–12.6 µm broad without setules, with lobed apices; pileocystidia absent; context made up of 4.2–5.6 µm broad, septate, granular clamped, hyphae intermixed with 5.0–7.0 µm broad, granular, round cells. Stipe cuticle hyphal, made up of longitudinally arranged, 3.5–4.2 µm broad, septate, hyaline hyphae; caulocystidia absent; context hyphal, made up of 5.6–8.4 µm broad, septate, granular hyphae. Clamp connections present throughout.

Collection Examined: Punjab: Rupnagar, Boat club (275 m) 30°55'56"N–76°31'48"E, growing gregariously scattered on bamboo leaf litter and twigs, Aakriti Gupta, PUN 11098, 08 September, 2019.

Distribution and Ecology: Wannathes *et al.* (2009) reported *Marasmius nigrobrunneus* growing scattered to gregarious on leaves and stems of Bamboo plant from Africa, South America, Caribbean region, India, Sri Lanka, Papua New Guinea, Vietnam and Thailand. Antonin and Buyck (2006) found *M. nigrobrunneus* growing on Bamboo leaves in Antananarivo, Botanical Garden of Tsimbazaza of Madagascar. Manimohan and Leelavathy (1989 a) reported this species growing gregariously on litter from Kerala. Presently too this species was found growing gregariously scattered on Bamboo leaves and twigs from Punjab.

Remarks: Presently investigated collectionfalls under the section *Marasmius* of genus *Marasmius* due to the presence of a distinct collarium and institious stipe. Under this section, it falls within the subsection *Sicciformes* because of presence of siccus type broom cells. In its morphology as well as microscopic features, it matches well with the description provided for *Marasmius nigrobrunneus* (Pat.) Sacc. by Wannathes *et al.* (2009), Antonin and Buyck (2006) and Manimohan and Leelavathy (1989). This species is characterized by small, convex grayish-brown to grayish-black caps, creamish white lamellae with dark colored edges, a long wiry stipe always found growing on bamboo leaf litter, ellipsoid basidiospores and very dark pigmented variously shaped pileus cuticle cells. Earlier, it has been reported by Manimohan and Leelavathy (1989) from Kerala. Presently, it is a first-time report from North India.

Marasmius griseoviolaceus Petch, *Transactions of the British Mycological Society* **31** (1): 42 (1948)
Figs. 7(a-h)

Carpophores 2.7–3.9 cm in height. Pileus 0.2–0.4 cm broad, convex; umbo absent, depressed at centre; margin irregular, not splitting at maturity, striate, translucent striations run up to the centre, feebly pleated; scales absent; surface grayish brown ($10E_3$) to violet brown ($10E_4$); dry; cuticle not peeling; flesh membranous (up to 0.2 cm broad), white ($1A_1$), unchanging; odour and taste mild; pileal veil absent. Lamellae collariate, distinct collarium present, free to adnexed, equal, subdistant, narrow (up to 0.2 cm broad); creamish white ($1A_2$) with grayish tinge at the edges, unchanging; gill edges wavy, normal; lamellulae absent. Stipe central, 2.6–3.8 cm long, up to 0.1 cm broad, wiry, equal in diameter throughout; surface brownish black ($7E_5$), unchanging; smooth, scales absent; institious, mycelial mat absent at the base of the stipe; solid; exannulate.

Basidiospores 7.0–10.0 × 3.5–5.0 µm (Q = 2.0), ellipsoidal to oblong, inamyloid, single walled, smooth, granular; apiculate, apiculus up to 0.7 µm long, centric

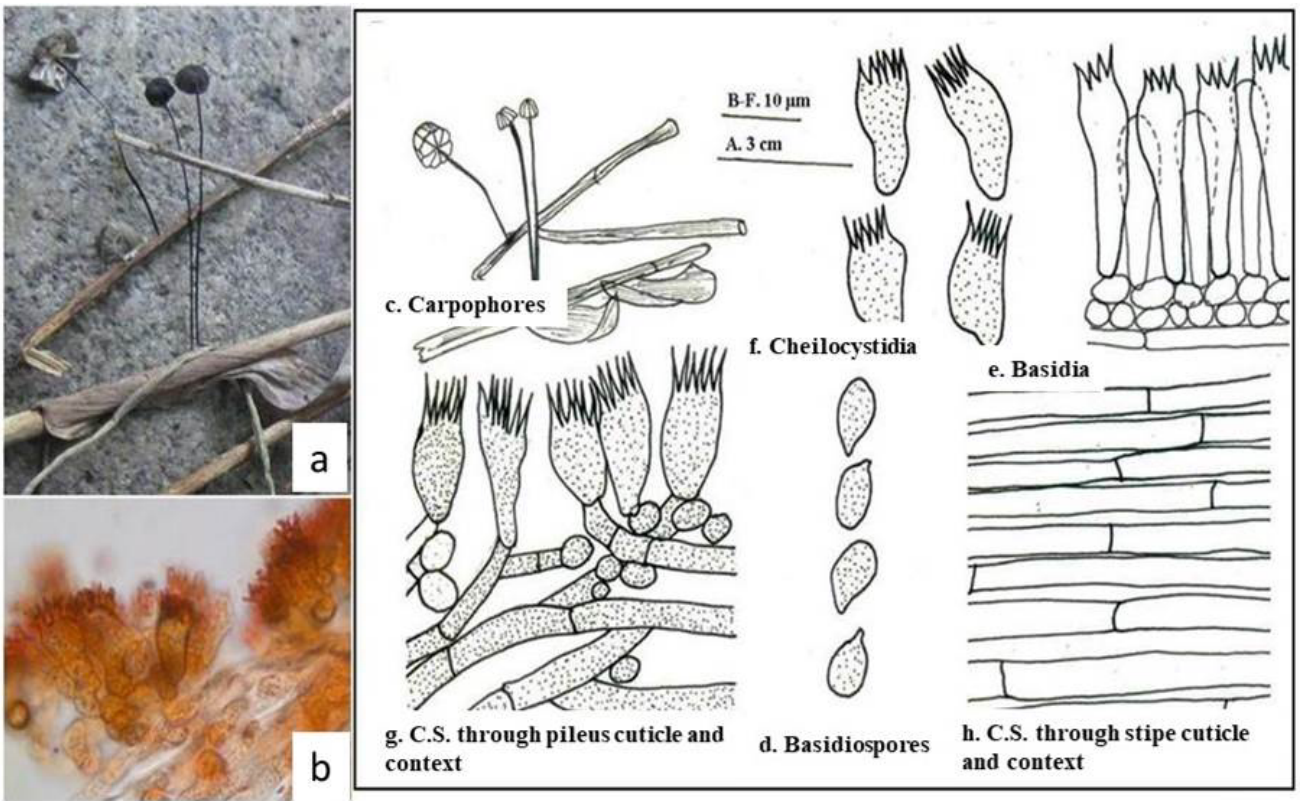

Fig. 7. *Marasmius griseoviolaceus* 7(a-h): a. Carpophores growing scattered on decomposed Bamboo leaves. b. C.S. through pileus cuticle with siccus type broom cells. c. Carpophores d. Basidiospores. e. Basidia. f. Cheilocystidia. g. C.S. through pileus cuticle and context. h. C.S. through stipe cuticle and context

to excentric in position. Basidia 19.6–28.0 × 5.0–6.3 µm broad, clavate, hyaline, abundant; tetrasterigmate, sterigmata 2.1–3.5 µm long, pointed, hyaline. Hymenophoral trama regular. Pleurocystidia absent. Cheilocystidia 14.0–21.0 × 6.3–7.0 µm (including setules), clavate, siccus type with 6–7 apical setules, granular, abundant. Gill edges sterile. Pileus cuticle hymeniform made up of uniform turf of siccus type broom cells 15.4–22.4 × 7.7–8.4 µm broad, granular, bearing 6–7 apical setules; pileocystidia absent; context made up of 5.0–5.6 µm broad, septate, granular hyphae intermixed with 4.2–6.3 µm broad, granular, round cells. Stipe cuticle hyphal, made up of longitudinally arranged, 3.5–4.2 µm broad, septate, hyaline hyphae; caulocystidia absent; context hyphal, made up of 4.2–5.6 µm broad, septate, hyaline hyphae. Clamp connections absent throughout.

Collection Examined: Punjab: Nangal, Village Manakpur (333 m) 31°20’06"N–76°21’30"E, growing scattered on decomposing Bamboo leaf litter and twigs along backyard, Aakriti Gupta, PUN 11099, 14 August, 2016.

Distribution and Ecology: *Marasmius griseoviolaceus* was collected growing most frequently on dead leaves and culms of plants belonging to family *Bambuseae* like *Bambusa*, *Chusquea* etc. from tropical rain forest of South America by Singer (1965). Presently, this collection was found growing scattered on fallen Bamboo leaves and twigs from Punjab.

Remarks: The above examined collection falls within the section *Marasmius* of genus *Marasmius* due to presence of a central and institious stipe and collariate

lamellae. Further, taking in account both morphological as well as anatomical features, it agrees with the details given for *Marasmius griseoviolaceus* Petch provided by Singer (1965). Macroscopically, this species is characterized in having small convex grayish brown to violet brown caps, collariate lamellae with grayish tinge on their edges, thin, wiry and institious stipe inhabiting bamboo leaf litter. Microscopically, it possesses ellipsoidal, inamyloid basidiospores, sterile gill edges with abundant clavate cheilocystidia and hymeniform pileus cuticle. Present collection differs only in lacking small hair or sausage to cylindrical shaped thick walled, black setose elements on stipe cuticle which are mentioned in the description provided by Singer (1965). Presently it forms a new record from India.

RESULTS

Present context highlights the detailed morphological and anatomical characters of seven marasmoid species of Marasmius section of genus *Marasmius*. Moreover, with this work there has been an addition of five new records including *Marasmius aspilocephalus* Singer, *Marasmius baumannii* Henn., *Marasmius griseoviolaceus* Petch, *Marasmius guyanensis var. guayarensis* Singer and *Marasmius nigrobrunneus* (Pat.) Sacc. to already recorded 96 taxa from India. Amongst, newly documented five species are first reports from India while *Marasmius rotalis* (Berk. and Broome) is reported for the first time from North India and *Marasmius curreyi* (Berk.and Broome) is new to Punjab.

CONCLUSION

This treatise serves as a contribution in the field of taxonomy with addition of 05 new marasmoid taxa from India and remaining 02 taxa are reported for the first time from Northern tropical regions.

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