

***Cyclocybe parasitica* var. *microspora* var. nov and two new records of family *Strophariaceae* (Agaricales, Basidiomycota) from India**

Harwinder K^{1*}, MK Saini² and Shivani³

^{1,3}Department of Botany, Akal University, Talwandi Sabo, Bathinda, India.

²Department of Botany, Punjabi University, Patiala, 147002, India.

*Corresponding author, E-mail: harwinderkaur.1@gmail.com

ABSTRACT

The diversity of *Agrocybe* and *Cyclocybe* species has been studied from the various habitats throughout the Punjab state from 2008 to 2012. Total 08 collections belonging to five taxa namely *Cyclocybe parasitica* var. *microspora* var. nov., *C. parasitica*, *Agrocybe pediades*, *A. splendida*, *A. sacchari* are reported usually growing in caespitose clusters. Out of these, *C. parasitica* var. *microspora* var. nov., proposed as new variety. *C. parasitica*, *A. sacchari* forms new records for India and *A. splendida* is first time report from North India. *A. pediades* is being recorded for the first time from district Patiala, Punjab.

Key words: *Agrocybe*, basidiomycota, caespitose clusters, *Cyclocybe*, diversity, taxonomy

Family *Strophariaceae* Singer & A. H. Sm. characterized by thin hyaline filamentous, clamped hyphae are bundled together and ascendant to form scales, or epithelium, component elements are broad, firm- to thick walled; hypodermium often subcellular; hymenophore lamellate; lamellae adnexed, sinuate, adnate, or adnate-decurrent, very rarely subfree; spore print cinnamon brown, deep rusty; basidiospore smooth; cystidia present only on the edges (cheilocystidia), or scattered to numerous on sides of the lamellae; all hyphae with clamp connections. Carpophores agaricoid, lignicolous, terrestrial or coprophilous; growing in caespitose clusters, solitary, scattered on a great variety of substrata, on dung, on living or decayed wood, on living trees etc. According to Kirk *et al.* (2008) the family *Strophariaceae* has 18 genera with 1376 species. MycoBank record shows 66 genera attributed to this family. Presently, two genera namely *Agrocybe* Fayod and *Cyclocybe* Velen. of this family were studied.

Cyclocybe Velen. is belonging to the family *Strophariaceae*. The genus has cosmopolitan distribution. (<https://eol.org/pages/6718163/articles>). Mycobank (2021) shows 11 records of this genus till September 11, 2021. Genus *Agrocybe* Fayod is characterized by the collybioid to tricholomatoid carpophores with a hymeniform covering forming the epicutis and consisting of globose or short pyriform cells; spore print with brown rusty to dark spore-print, and basidiospores with germ-pore which is either broad and truncate or narrow, stipe white, smooth or rough- fibrillose, with or without veil, pileus context consisting of hyphae with clamp connections. It belongs to the family *Strophariaceae* (Agaricales, Basidiomycota), comprising about 100 described species (Kirk *et al.*, 2008). Mycobank (2021) shows 190 records of this genus till September 11, 2021. In comparison to this, 13 species of this genus namely *A. broadwayi*, *A. calicutensis*, *A. fimicola*, *A. guruvayoorensis*, *A. manihotis*, *A. manihotis* var.

microspora, *A. munnarensis*, *A. musicola*, *A. pediades*, *A. retigera*, *A. semiorbicularis*, *A. temulenta*, *A. wayanadensis* are reported from South India (Natarajan and Raman, 1983; Natarajan and Purusothama, 1989; Thomas and Manimohan, 2003) and 07 species namely *A. cubensis*, *A. lazoi*, *A. pediades*, *A. platensis*, *A. semiorbicularis*, *A. sororia* and *A. xuchilensis* from North India (Hennings, 1901; Rawla *et al.*, 1982; Saini and Atri, 1982; Atri *et al.*, 1992; Saini and Atri, 1995; Atri *et al.*, 2000). *Agrocybe guruvayoorensis* was reported growing on elephant dung from Kerala (Thomas and Manimohan, 2003; Manimohan *et al.*, 2007). Kaur *et al.* (2014) reported *A. microspora* and *A. pediades* from coprophilous habitats of Punjab state. Debnath *et al.* (2020) reported *A. splendida* from North east India. The genus has wide distribution, occurring in natural environment found growing on plant debris, dead tree stump and humicolous soil, on mixed cattle dung or anthropical areas (Nauta, 2005; Kuo, 2006; Niveiro *et al.*, 2020, Doveri, 2010; Calaca and Xavier-Santos, 2020) reported species of *Agrocybe*, growing on dung or heavily manured soils. During the fungal forays to various localities of Punjab, collections belonging to genus *Agrocybe* were collected of which 02 species viz. *C. parasitica*, *A. sacchari* forms a new record for India and *A. splendida* is first time report from North India. *A. pediades* is being recorded for the first time from district Patiala, Punjab.

MATERIALS AND METHODS

The macroscopic features and habitat characteristics of the collected materials were documented on the 'Field key to Mushroom collector' (Atri and Saini 2000; Atri *et al.*, 2005; Atri *et al.*, 2017) like pileus and stipe measurements (length, breadth), surface features, colour, lamellar spacing, and attachment, habit and substrate, etc. were observed and noted from the fresh material and documented on the field key to mushroom collector. The color terminology used for noting the color of various parts of the mushrooms, and spore print, etc.

colour codes given in brackets refer to that of Kornerup and Wanscher (1978). The manually hand cut sections of various parts of basidiocarp such as pileus, gills, gill edge, stipe, annulus, and basidiospores details were studied under the microscope after reviving a part of the dried specimens in 10% KOH solution and staining the sections in 1% Cotton blue or 2% Congo red, along with chemical colour reaction of basidiospores in conc. H₂SO₄ is noted down for each basidiocarp. Spore measurements are based on more than 30 observations. Basidium length excludes the length of sterigmata. The Line drawings of microscopic structures were drawn with the aid of Camera Lucida under oil lens. The magnification of each line drawing has been mentioned at the plate of individual specimen. Edibility status according to the available literature is also given for individual specimen. The correct names, synonyms of the investigated taxa are according to Dictionary of Fungi by Kirk *et al.* (2008) and the information available on MycoBank (2021) (www.mycobank.org). These basidiocarps have been deposited in the Herbarium of Punjabi University (PUN), Patiala, India. Herbarium acronym follows Holmgren and Keuken (1974).

Preservation of specimens: All collected specimens from different types of habitats have been studied in detail. Then the collected mushrooms were hot air dried in a three raked wooden drier especially designed for this purpose (Atri *et al.*, 2005). The mushrooms were finally packed in the moisture proof cellophane paper packets along with their collection number. To avoid insect infestations small packets of crystals of 1-4 Para-dichlorobenzene were placed in these cellophane paper packets (Smith, 1949; Atri and Saini, 2000).

Study Area: Punjab state is located between 29°32' to 32°32'N latitude and 73°55' to 76°70'E longitude, in the north-western part of India and it occupies an area of 50,362 sq. km., which constitutes 1.57% of the total area of country (Fig. 1). It is primarily an agrarian state having diverse flora and fauna. Punjab has four main seasons: summer, monsoon, winter and

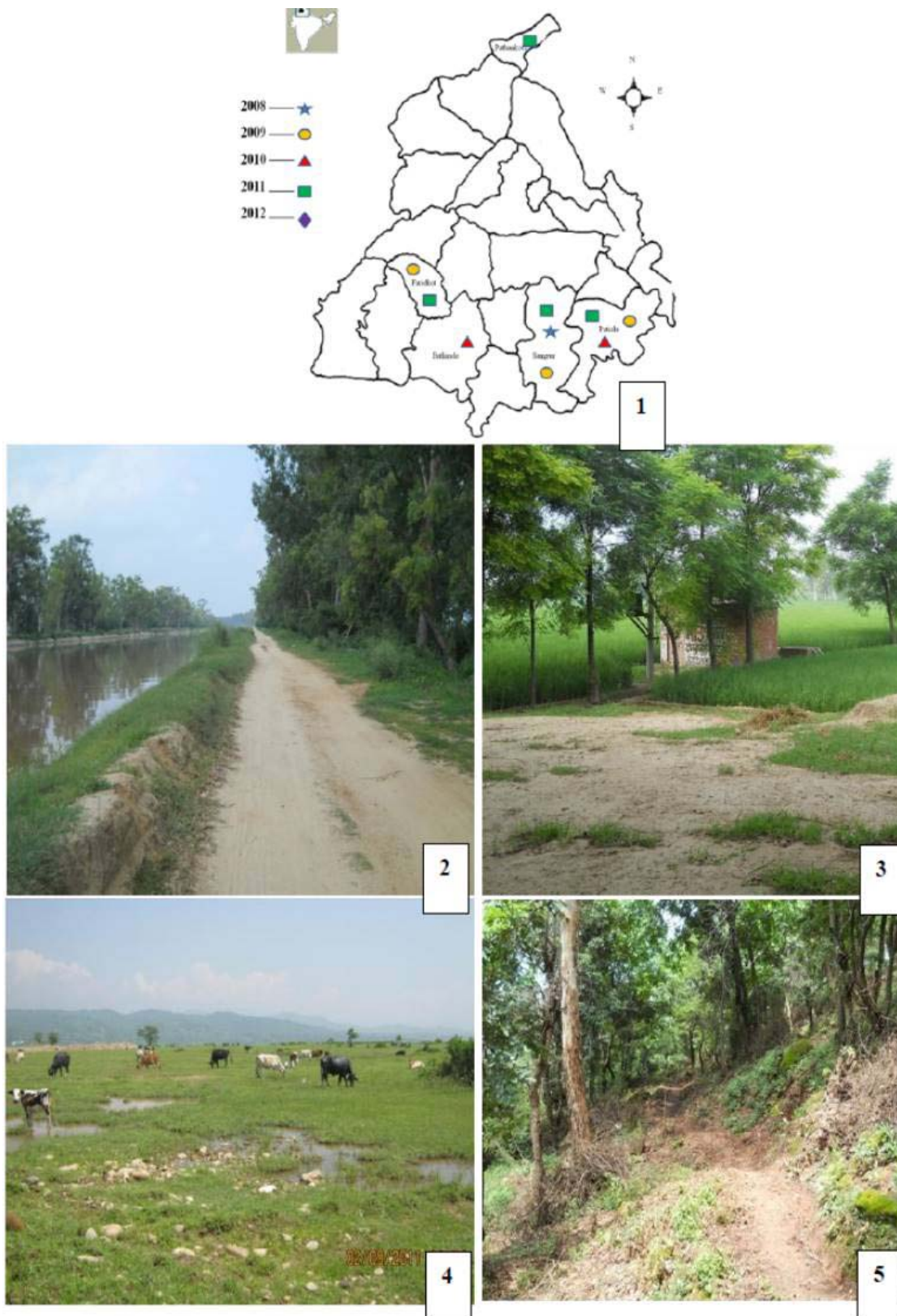


Fig. 1. General Map of Punjab state- 1. The Area of study showing the various districts of Punjab surveyed during the present investigation along with the year of survey. **Figs. 2-5.** Field views

Table 1. Distribution, growing habit, habitat type, and locality of studied basidiocarps

Species	Locality (altitude)	Month and date of collection	Growing habit	Habitat type	Herbarium number
Genus <i>Cyclocybe</i> Velen.					
<i>Cyclocybe parasiticavar. microspora</i> var. nov.	Faridkot (196m)	September 12, 2009	Caespitose clusters	On and around stump of <i>Azadirachta</i>	PUN 5916
<i>C. parasitica</i>	Bathinda (211m)	July 31, 2010	Caespitose clusters	On and around trunk of living angiospermic tree	PUN 5917
Genus <i>Agrocybe</i> Fayod					
<i>Agrocybe pediades</i>	Patiala (251m)	January 12, 2010	Scattered	Humicolous soil, among grasses	PUN 5924
	Sangrur (231m)	August 14, 2008	Groups	Mixed dung	PUN 4226
<i>A. splendida</i>	Patiala (251m)	July 23, 2009	Scattered	Humicolous soil, among grasses	PUN 5926
	Patiala (251m)	June 29, 2011	Scattered	Grassy lawn	PUN 5925
<i>A. sacchari</i>	Sangrur (231m)	July 24, 2009	Scattered	Humicolous soil	PUN 4085
	Sangrur (231m)	July 14, 2011	Gregarious	Humicolous soil	PUN 5918

autumn season. Rainfall in Punjab ranges between 250 mm to 1000 mm. Maximum annual rainfall is experienced during the arrival of southwest monsoon in the area. About 80% of the total rainfall is appeared during July, August and September and the rest occurs during the winter months. The study area has 7-8 months of mean monthly temperature of $>20^{\circ}\text{C}$. The Area of study showing the various districts of Punjab surveyed during the present investigation along with the year of survey shown in table 1, Fig. 1. Field Views showing various types of habitats of collected mushrooms shown in Figs 2– 5.

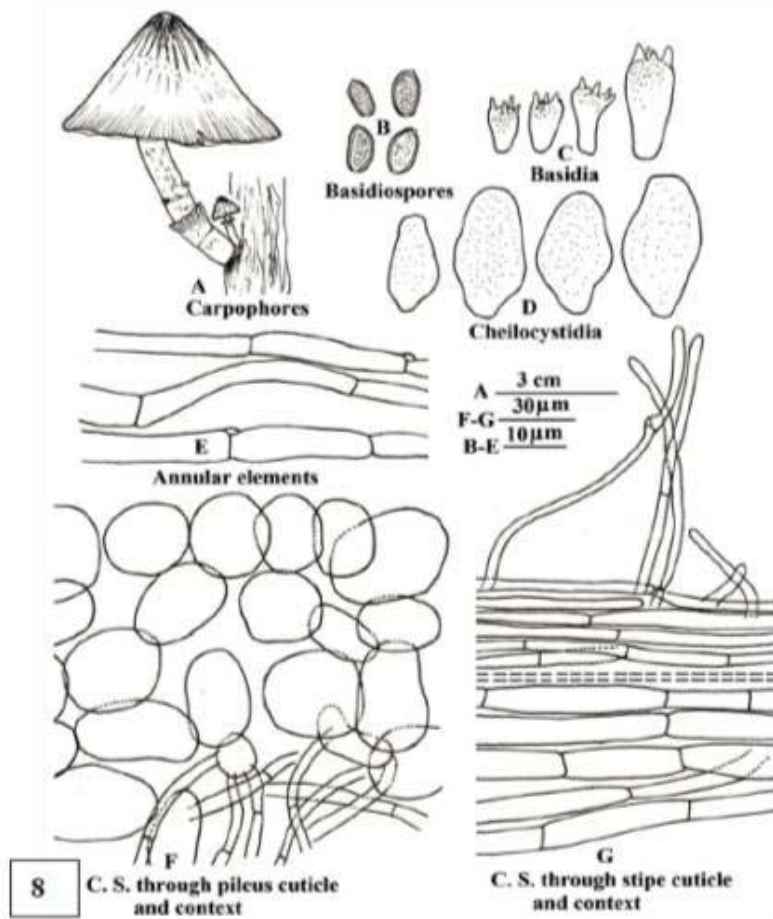
RESULTS AND DISCUSSIONS

Taxonomic observations

Cyclocybe parasitica (G. Stev.) Vizzini, Index Fungorum 154:1, 2014. var. *microspora* Harwinder Kaur and Munruchi Kaur var. nov.

Figs 6–8; Mycobank number: MB 840980; Facesoffungi number: FoF10426 Etymology – The name of variety is based on small size of the basidiospores.

Carpophores 1.8–6.5 cm in height. Pileus 1.5–5.5 cm broad, convex when young, plano–convex at maturity; broadly umbonate; surface moist, white ($6A_1$) when young, turning creamish white to brownish grey ($6C_2$) with orange grey ($6B_2$) centre at maturity; wrinkled, scaly, scales powdery, cover the entire pileus; margin irregular, splitting at maturity, translucent striations visible; cuticle half peeling; flesh 0.2 cm thick, off white, unchanging; taste sour; odour mild. Pileal veil patchy. Lamellae broadly adnate; unequal, lamellulae present, in 4 lengths; subdistant, moderately broad (0.6 cm broad); white ($6A_1$) when young, brownish grey ($6C_2$) at maturity, unchanging; gill edges finely dentate, whitish with floccose depositions; normal. Spore print brownish grey ($6C_2$). Stipe excentric, 2.3–5.5 cm long, 0.4–0.7 cm broad, equal in diameter throughout, cylindrical; white ($6A_1$), unchanging; solid with persistent pith; scaly, scales floccose, cottony at the base of the stipe; annulate, annulus single, superior, funnel shaped in young carpophores, evanescent in mature carpophores. Basidiospores $6-7.6 \times 3.38-5.07 \mu\text{m}$ (excluding apiculus), ($Q=1.6$) ellipsoid; smooth; double walled; dark brown, granular; apex truncated with a narrow



Figs. 6-8. *Cyclocybe parasitica* (G. Stev.) Vizzini var. *microspora* Harwinder Kaur & Munruchi Kaur var. nov.: 6. Underview of cap, 7. Carpophores growing on angiospermic tree, 8. Camera Lucida drawings (A. Carpophores, B. Basidiospores, C. Basidia, D. Cheilocystidia, E. Annular elements, F. C.S. through pileus cuticle & context, G. C.S. through stipe cuticle & context)

apical pore; apiculate, apiculus 0.84–1.69 μm long, inconspicuous. Basidia 7.6–16.9 \times 5.07–7.6 μm , clavate, weakly granular, –4 spored; sterigmata 2.5–3.38 μm long. Pleurocystidia not found. Cheilocystidia 16.9–22 \times 8.45–13.52 μm , utriform, thin walled, granular; gill edges sterile. Carpophore context homoiomerous. Pileus cuticle cellular, made up of spherical to pyriform, hyaline cells, individual elements measuring 31.52–47.28 \times 23.64–31.52 (43.34) μm ; pileus context made up of interwoven, loosely arranged hyphae. Hymenophoral trama less regular. Stipe cuticle hyphal, made up of longitudinally, parallel compactly arranged, thin walled, 4–12 μm broad hyphae; stipe context hyphae 7.88–19.7 μm broad. Annular elements hyphal, 3.4–6.76 μm broad. Clamp connections present throughout.

Chemical color reaction: Basidiospores do not loose color in conc. H_2SO_4 .

Collection examined: Punjab, Faridkot (196 m), Village Bajakhana, growing in caespitose clusters on and around living stump of *Azadirachta indica*, along roadside, Harwinder Kaur, PUN 5916, September 12, 2009 (Type).

Remarks: The above examined collection belongs to *Cyclocybe cylindracea* group, according to Watling and Taylor (1987) in this group the carpophores are always lignicolous and are growing on trunks of living trees, the pileus flesh is white, flesh taste is mild and the odour is pleasant, the stipe of the carpophores are annulate and all these features are present in our collections. The macroscopic and microscopic details match with that of *Cyclocybe parasitica* (G. Stev.) Vizzini given by Watling and Taylor (1987), except spore size and absence of pileocystidia and caulocystidia. The presently examined collection has been collected growing on the trunk of a living angiospermic tree as is the habit given for *C. parasitica*. The spore size is comparatively smaller in our specimen, it varies from 6–6.76 \times 3.38–5.07 μm rather than (8.5) 9.5–12 \times (5.5) 6–6.5 μm given for *C. parasitica*; further, pileocystidia and caulocystidia are absent, while these are always present in this

species as recorded in the literature. On the basis of these differences a new variety *Cyclocybe parasitica* var. *microspora* var. nov. is proposed.

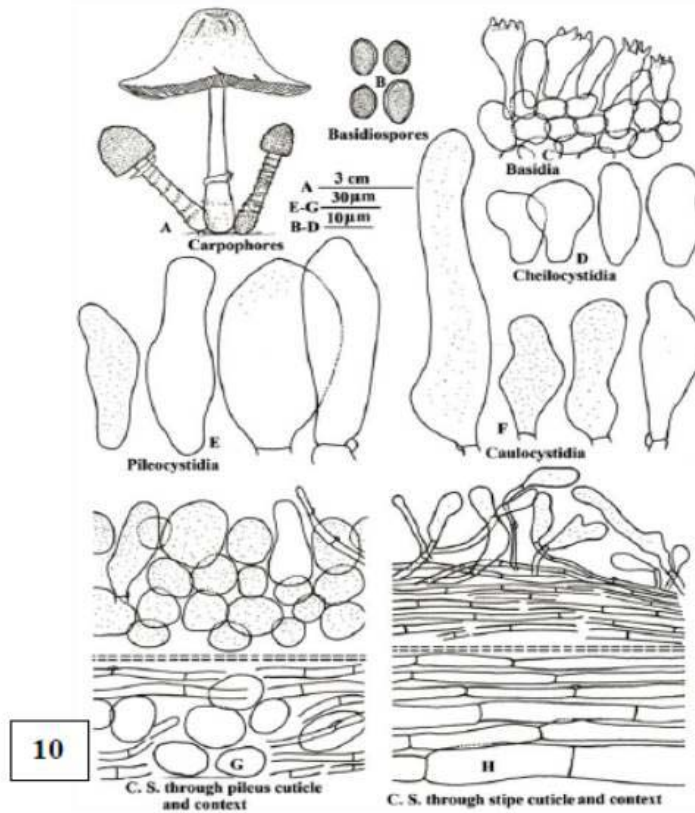
Consumption Habit – Edibility unknown.

Cyclocybe parasitica (G. Stev.) Vizzini, Index Fungorum 154:1, 2014.

Figs 9–10; Mycobank number: MB 550603; Facesoffungi number: FoF10426

Basionym- *Agrocybe parasitica* G. Stev., *New Zealand Journal of Forestry*, 27 (1): 132, 1982.

Carpophores 4.5–8 cm in height. Pileus 1.5–6 cm broad, campanulate; broadly umbonate; surface moist, greyish orange ($5B_3$) when young, white at maturity, cracking in centre; scaly, scales powdery, white, cover the entire pileus; margin irregular, splitting at maturity; cuticle fully peeling; flesh 0.1–0.3 cm thick, membranous, white, unchanging; taste and odour mild. Pileal veil patchy, white. Lamellae adnate; unequal, in 3 lengths; lamellulae present; subdistant; moderately broad (0.5 cm broad); greyish brown ($6D_3$), unchanging; gill edges lacerate; normal. Stipe central; 4.5–7.9 cm long, 0.4–0.8 cm broad, obclavate; white, unchanging; hollow; scaly, scales warty, scattered all over the stipe in young, maximum near the base in mature carpophores; annulate, annulus single, movable, superior in young carpophores, inferior in mature specimens, funnel shaped, membranous, attached. Basidiospores 6.76–8.45 (10.14) \times 5.07–6.76 μm (excluding apiculus), (Q=1.6) ellipsoid; double walled; smooth, dark brown, granular; apex truncated with apical pore; apiculate, apiculus less than 0.84 μm long, inconspicuous. Basidia 11.83–20.26 \times 5.07–8.45 μm , clavate, –4 spored, granular; sterigmata 2.5–3.38 μm long. Pleurocystidia not found. Cheilocystidia 16.9–23.66 \times 8.45–13.52 μm , claviform, lageniform, thin walled, hyaline; gill edges sterile. Carpophore context homoiomerous. Pileus cuticle cellular, made up of 2–4 layers of spherical, granular cells interspersed with pileocystidia, individual elements measuring 15.76–39.4 \times 15.76–31.52 μm . Pileocystidia 33.6–47.32 \times 13.52–



Figs. 9-10. *Cyclocybe parasitica* (G. Stev.) Vizzini: 9. Carpophores growing in their natural habitat, 10. Camera Lucida drawings (A. Carpophores, B. Basidiospores, C. Basidia, D. Cheilocystidia, E. Pileocystidia, F. Caulocystidia, G. C.S. through pileus cuticle & context, H. C.S. through stipe cuticle & context)

25.35 µm, lageniform, thin walled, weakly granular, few hyaline, some with clamp connection at the base, scattered, numerous; pileus context made up of intermingled hyphal and cellular elements. Hymenophoral trama regular. Stipe cuticle hyphal, made up of longitudinally tangled, compactly arranged, 3.94–7.88 µm broad, thickly granular hyphae, giving rise to a regular turf of projecting caulocystidia. Caulocystidia 27.04–47.32 (72.67) × 11.83–15.21 µm, lageniform, thin walled, granular, few hyaline, abundant, mostly with clamp connections at the base; stipe context 11.82–27.56 µm broad, septate, granular hyphae. Clamp connections present throughout.

Chemical color reaction: Basidiospores do not lose color in conc. H₂SO₄.

Collection examined: Punjab, Bathinda (211 m), Village Dialpura, lignicolous, growing in caespitose clusters on and around trunk of living angiospermic tree, along roadside, Harwinder Kaur, PUN 5917, July 31, 2010.

Distribution and ecology: According to Watling and Taylor (1987) *Cyclocybe parasitica* is widespread in New Zealand and it commonly grows in gigantic clusters or singly on introduced and native dicotyledonous trees especially on *Beilschmiedia tawa* and *Dysoxylum spectabilis*. Colenso (1890) and Masee (1898) reported it as *Agaricus pudicus* growing single or 2–3 together on trunk of living *Beilschmiedia tawa* while Taylor (1970) reported it on standing *Weinmannia racemosa* tree in New Zealand.

Remarks: The above examined collection has been identified as *Cyclocybe parasitica* (G. Stev.) Vizzini. The presently worked out collection falls under *Cyclocybe cylindracea* group as in this group carpophores are always lignicolous and are growing on trunks of living trees, the pileus flesh is white, flesh taste is mild and the odour is pleasant, the stipe of the carpophores are annulate (Watling and Taylor, 1987). The macroscopic and microscopic details of this collection are in complete conformity with those

given for *C. parasitica* by Watling and Taylor (1987). The presently examined collection has also been collected growing on and around trunk of living angiospermic trees as is the habitat given for *C. parasitica* by Watling and Taylor (1987). This is first time record for India.

Consumption Habit: It is an excellent mushroom for eating and is very closely related to *Cyclocybe cylindracea* (Watling and Taylor, 1987). It is an edible mushroom with meaty savoury taste. It can be collected in the wild or cultivated on logs, it consists of 20% protein in dry mass, while the essential amino acid composition is similar to white button mushroom. Carbohydrate content is almost three times higher (Mitchell & Savage, 1990). It is known for culinary value, tawaka was historically used by Māori people as a traditional medicine. (https://eol.org/pages/46706311/articles#cite_ref-nzffa_3-0).

Agrocybe pediades (Fr.) Fayod, *Annales des Sciences Naturelles Botanique*, **9**: 358, 1889.

Figs 11–12; Mycobank number: MB 355818; Facesoffungi number: FoF10428 Synonyms:

Agaricus pusillus Schaeffer in *Fung. Bavar. Palat. Nasc.* 4: 45, 1774.

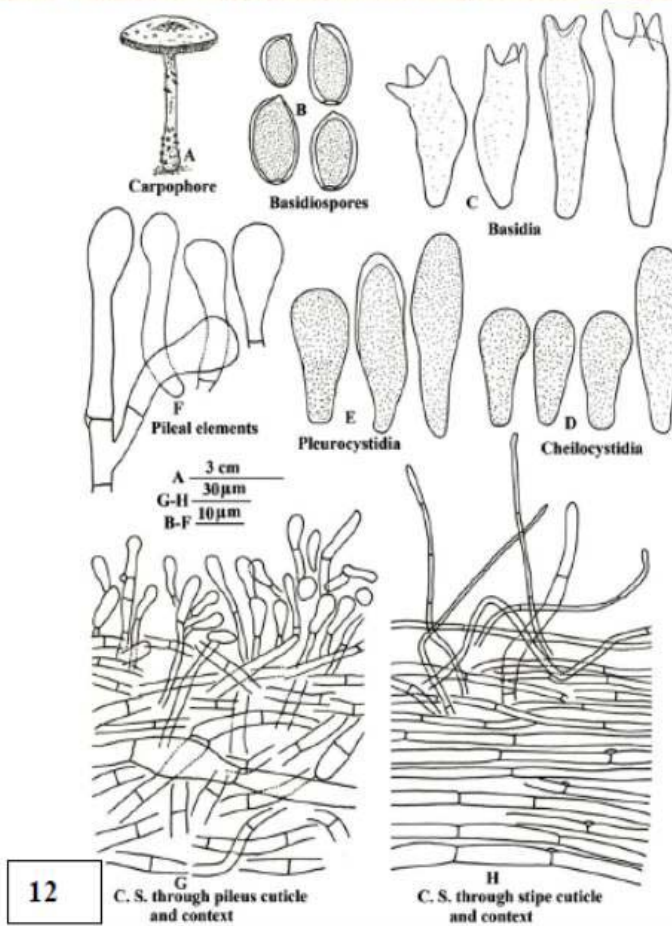
Agaricus semiorbicularis Bulliard in *Herb. France* 9: 422, 1789.

Agaricus arenicola Berkeley in *London J. Bot.* 2: 511, 1843.

Naucoria subpediades Murrill in *Lloydia* 5: 150, 1942.

Agrocybe splendida Cléménçon in *Nova Hedwigia* 28 (1): 8, 1977.

Carpophores 3.5–4.5 cm in height. Pileus 2.2–3.1 cm broad, convex, broadly umbonate; surface moist, pale orange (5A₃) with brownish orange (5C₄) centre; scaly, scales appressed fibrillose, cover the entire



Figs. 11-12. *Agroclybe pediades* (Fr.) Fayod: 11. Carpophores growing in their natural habitat, 12. Camera Lucida drawings (A. Carpophores, B. Basidiospores, C. Basidia, D. Cheilocystidia, E. Pleurocystidia, F. Pileal elements, G. C.S. through pileus cuticle & context, H. C.S. through stipe cuticle & context)

pileus; margin regular, slightly uplifting; cuticle not peeling; flesh upto 0.2 cm thick, yellowish white (4A₂) unchanging; taste disagreeable; odour spicy. Pileal veil absent. Lamellae broadly adnate; unequal, in 5 lengths; branched; gills extending beyond the pileus; subdistant; narrow (0.2–0.4 cm broad); light orange (6A₃), unchanging; gill edges smooth; fragile. Stipe central, 3.2–4.3 cm long, 0.2–0.3 cm broad, slightly tapering upward with bulbous base; pale orange (5A₃), light orange (6A₄) near the pileus, unchanging; solid; scaly, scales white, fibrillose all over the stipe, maximum near the base; exannulate. Basidiospores (10.14) 11.83–16.9 × 7.6–10.14 μm (excluding apiculus), (Q=1.6) ellipsoid, lentiform; smooth; double walled, pale brown, granular; truncated with apical germ pore; apiculate, apiculus 0.84–1.69 μm long, prominent. Basidia 25.35–37.18 × 10.14–11.83 μm, clavate, –2, –3, –4 spored, –4 spored very rare, hyaline to weakly granular; sterigmata 5.07–6.76 μm long. Pleurocystidia 27.04–40.56 × 8.45–11.83 μm, clavate, granular, double walled. Cheilocystidia 23.66–37.18 × 8.45–10.14 μm, clavate, granular, few double walled; gill edges heteromorphous. Carpophore context homoiomerous. Pileus cuticle cellular, hymeniform, made up of clavate cells with rounded apex, individual elements measuring 23.66–42.25 × 8.45–10.14 μm, branched with clamp connections, hyaline; pileus context hyphal, made up of network of 7.88–11.82 μm broad, septate hyphae; caulocystidia not seen. Hymenophoral trama regular. Stipe cuticle hyphal, made up of longitudinally tangled, 7.88–15.76 μm broad, closely septate, hyphae with few projecting 1.97–7.88 μm broad, closely septate hyphae. Clamp connections present throughout.

Collection examined: Punjab, Patiala (251 m), Punjabi University Patiala, growing scattered on humicolous soil among grasses along roadside, Harwinder Kaur, PUN 5924, January 12, 2010. Punjab, Sangrur (231m), Village Kelon, coprophilous growing in groups on mixed cattle dung, Amandeep Kaur, PUN 4226, August 14, 2008.

Distribution and ecology: Watling and Taylor (1987) found *A. pediades* as a widespread species on lawns

and in grasslands. Breitenbach and Kränzlin (1995) reported it growing gregarious in meadows and pastures on roadsides in grasses during late spring to late summer the world over. Although, it has been recorded from a number of localities from South India growing as scattered or in groups as enlisted by Farook *et al.* (2013). Present collection was found scattered among grasses along roadside in winters from district Patiala, Punjab.

Remarks: The macroscopic and microscopic details of the above collections are in full conformity with the details of *Agrocybe pediades* (Fr.) Fayod previously known as *Agrocybe semiorbicularis* given by Watling (1982), Watling and Taylor (1987) and by Breitenbach and Kränzlin (1995). The caulocystidia are reported from the sections cut from the apical part of the stipe only by Breitenbach and Kränzlin (1995), but in our collections the caulocystidia were not seen. Further in present collection pleurocystidia are present which are not described in the available literature. It is a well documented fungus from India named under *Agrocybe semiorbicularis*. Earlier Indian record was by Rawla *et al.* (1982) from Chandigarh; Abraham (1991) recorded it from Kashmir. Later Natarajan and Raman (1983) reported it from Tamil Nadu; Farook *et al.* (2013) documented it in a checklist of agarics from Kerala, India that Mohanan (2011) and Thomas and Manimohan (2003) reported this as *Agrocybe temulenta* (Fr.) Singer which is distributed over Wayanad, Malappuram and Idukki in Kerala. The present documentation of species is first of its kind from district Patiala of Punjab.

Consumption Habit: It is an edible fungus according to Wood & Stevens (1997–2013). But according to Phillips (2001–2013), it is too small and easily confused with other Little Brown Mushrooms and hence is a poisonous suspect too, thus should be avoided.

Agrocybe splendida Cléménçon, *Nova Hedwigia*, 28 (1): 8, 1977.

Figs 13–16; Mycobank number: MB 308403; Facesoffungi number: FoF10429

Synonyms

Agaricus pusillus Schaeff., *Fungorum qui in Bavaria et Palatinatu circa Ratisbonam nascuntur Icones*, 4: 45, t. 203, 1774.

Agaricus semiorbicularis Bull., *Herbier de la France*, 9: t. 422:1, 1789.

Agaricus pediades Fr., *Systema Mycologicum*, 1: 290, 1821.

Agaricus arenicola Berk., *London Journal of Botany*, 2: 511 [‘411’], 1843.

Naucoria pediades var. *obscuripes* Fayod: 226, 1889.

Naucoria arenaria Peck, *Bulletin of the New York State Museum*, 157: 29, 1912.

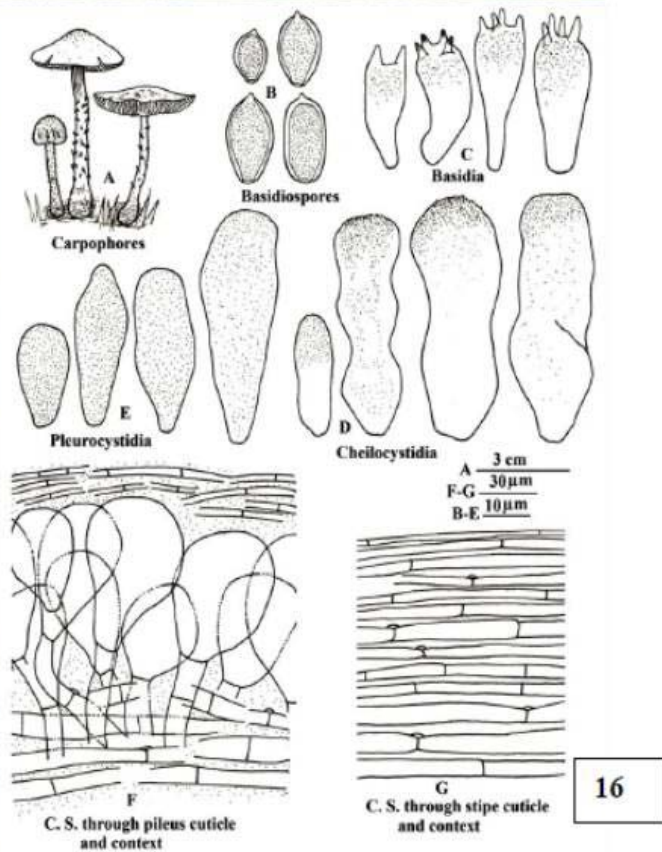
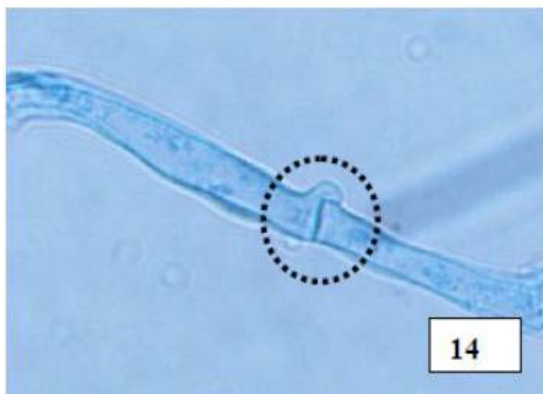
Naucoria subpediades Murrill, *Lloydia*, 5: 150, 1942.

Carpophores 3.2–6 cm in height. Pileus 1.2–3.4 cm broad, dome like when young, applanate at maturity; broadly umbonate; surface moist; yellowish white (4A₂) to greyish orange (5B₃) with light yellow (4A₄) to pale orange (5A₃) centre; rough and wrinkled; scaly, scales powdery, washed out at maturity; margin regular, splitting at maturity; cuticle fully peeling; flesh 0.2–0.3 cm thick; offwhite to light yellow, unchanging; taste sour; odour spicy. Pileal veil absent. Lamellae adnexed to sinuate, notched; unequal, in 4 lengths; lamellulae present; trabeculate; distant; moderately broad (0.4 cm broad); white (4A₁) when young, greyish yellow (4B₄) in mature, unchanging; gill edges white, serrate; normal. Spore print brown (6E₄). Stipe central, 3–5.7 cm long, 0.1–0.5 cm broad, equal in diameter with distinctly bulbous base covered with white mycelium; pale yellow (4A₃), unchanging; solid when young, hollow at maturity; scaly, scales white,

fibrillose, scattered all over the stipe, longitudinally striate; exannulate. Basidiospores 10.74–16.9 × 7.6–8.45 (10.14) μm (excluding apiculus), (Q=1.6) elongate, lentiform; smooth, double walled; golden orange, slightly granular; truncated with an apical germ pore; apiculate, apiculus 0.84–1.69 μm long, prominent. Basidia 20.28–28.64 × 8.95–11.83 μm, clavate, upper part granular, –2, –4 spored; sterigmata 2.53–5.07 μm long, granular in few basidia. Pleurocystidia 20.28–46.54 × 7.16–17.9 μm, claviform to lageniform, fully granular, few with constricted apices, abundant. Cheilocystidia 23.66–48.33 × 7.16–18.59 μm, lageniform, few pedicellated, fully granular, encrustations in and on upper part, few hyaline; gill edges heteromorphous sometimes sterile. Carpophore context homoiomerous. Pileus cuticle cellular, made up of pyriform to spherical, hyaline elements, individual elements measuring 11.82–30.42 × 13.52–23.64 μm, covered with gelatinous layer of broken hyphae; pileus context hyphal, made up of hyphal network mixed with cellular elements. Hymenophoral trama regular. Stipe cuticle hyphal, made up of longitudinally, parallelly arranged, 3.94–11.82 μm broad, septate hyphae. Clamp connections present throughout.

Chemical color reaction: Basidiospores do not lose color in conc. H₂SO₄ and turn brown in KOH.

Collection examined: Punjab, Patiala (251 m), Village Sheikhupura, growing scattered on humicolous soil among grasses along roadside, Harwinder Kaur, PUN 5926, July 23, 2009; Punjabi University campus, growing scattered on grassy lawn, Harwinder Kaur, PUN 5925, June 29, 2011. Distribution and ecology: Breitenbach and Kränzlin (1995) reported *A. splendida* as growing solitary to gregariously, in parks, gardens and in lawns during summer to fall from Europe. Present collections were found scattered in grassy lawn between June and July at a low altitude of 251 m. Debnath *et al.* (2020) reported this species growing saprobically on decomposed paddy straw collected from Debdabari (23°54.64'88"N, 91°62.81'97"E), Gomoti District, North east India.



Figs. 13-16. *Agrocybe splendida* Clemençon: 13. Carpophores showing undersurface of cap and distinctly bulbous stipe, 14. Clamp-connection in pileus cuticle, 15. Gill edge showing Cheilocystidia, 16. Camera Lucida drawings (A. Carpophores, B. Basidiospores, C. Basidia, D. Cheilocystidia, E. Pleurocystidia, F. C.S. through pileus cuticle & context, G. C.S. through stipe cuticle & context)

Notes – The gross external and internal details of the presently worked out collections match well with the details given for *Agrocybe splendida* Cléménçon by Breitenbach and Kränzlin (1995). They cited Cléménçon (1976) and commented that some fruiting bodies of this species have many pleurocystidia while the others are with a few pleurocystidia, in the presently examined collection the pleurocystidia are abundant. The collections were also compared with another allied species *A. arenaria* (Peck) Singer, but the abundance of pleurocystidia in the present collections puts them under *A. splendida* as in *A. arenaria* the pleurocystidia are very rare. *A. splendida* constitutes a first time report from India.

Consumption Habit: Edibility unknown.

Agrocybe sacchari (Murr.) Dennis, *Bull. Soc. Myco. Fr.* 69 (2): 180, 1953.

Fig. 17; Mycobank number: MB 292343; Facesoffungi number: FoF10427

Synonym:

Naucoria sacchari Murrill, *Mycologia*, 4 (2): 79, 1912.

Carpophores 3–18.5 cm in height. Pileus 2.3–5.8 cm broad, convex when young, applanate at maturity; broadly umbonate; light brown (6D₄) with brownish orange (5C₃) center; scaly, scales powdery; surface moist; margin regular, splitting at maturity; cuticle fully peeling; flesh upto 0.1–0.4 cm thick, offwhite, membranous, unchanging. Pileal veil absent. Lamellae adnexed; subdistant; equal; moderately broad (upto 0.4 cm); brown (6E₇), unchanging; gill edges smooth; normal. Spore print pale yellow (4A₃). Stipe central, 2–18 cm long, 0.1–0.6 cm broad, equal in diameter throughout; white (5A₁), unchanging on exposure; hollow; smooth; exannulate. Basidiospores 10.2–13.6 × 6.8–8.5 μm (excluding apiculus) (Q=1.5) ellipsoid, lentiform; no decoloration in conc. H₂SO₄; turning dark brown in KOH; granular; apical pore present; apiculate, apiculus upto 1.7 μm long. Basidia 15.3–17

× 7.7–8.5 μm, clavate, –4 spored; sterigmata 1.7–2.6 μm long. Pleurocystidia absent. Cheilocystidia 22.1–37.4 × 8.5–13.6 μm, cylindrical to lageniform; gill edges sterile. Carpophore context homoiomerous. Pileus cuticle cellular, gelatinized, made up of spherical, hyaline, 37.8–61.5 × 18.9–28.4 μm cells, interspersed with pileocystidia. Pileocystidia 17.74–44.78 × 8.45–13.52 μm, claviform, hyaline; pileus context made up of 11.8–16.6 μm broad hyphae. Stipe cuticle hyphal, made up of longitudinally tangled 18.9–33.1 μm broad, septate hyphae. Clamp connections present in pileus context.

Chemical color reaction – Basidiospores do not loose color in conc. H₂SO₄ and turn dark brown in KOH.

Collection examined: Punjab, Sangrur (231 m), Village Nadampur, growing solitary, scattered on humicolous soil, Jagdeep Kaur, PUN 4085, July 24, 2009; Sangrur (231 m), growing gregarious on humicolous soil along road side, Harwinder Kaur, PUN 5918, July 14, 2011.

Distribution and ecology: Singer (1977) reported *Agrocybe sacchari* growing solitary or in fascicles on the ground in shady places under trees and bushes, among litter and grasses, during May until summer. Presently examined collections found growing solitary, scattered or gregarious on humicolous soil during July.

Remarks: The above examined collections belong to section *Pediadeae* of subgenus *Agrocybe* of family *Strophariaceae*. The gross external and internal details of this collection match well with those given for *Agrocybe sacchari* (Murr.) Dennis by Singer (1977). It is characterized by having a broadly umbonate pileus, long, white, unchanging stipe with smooth surface, microscopically basidiospores do not decolor in conc. H₂SO₄, turning dark brown in KOH, cheilocystidia present while pleurocystidia are lacking and pileus cuticle cellular with abundant pileocystidia present and clamp connections present in pileus context. This is a new fungus record from India.

Consumption Habit: Edibility unknown.

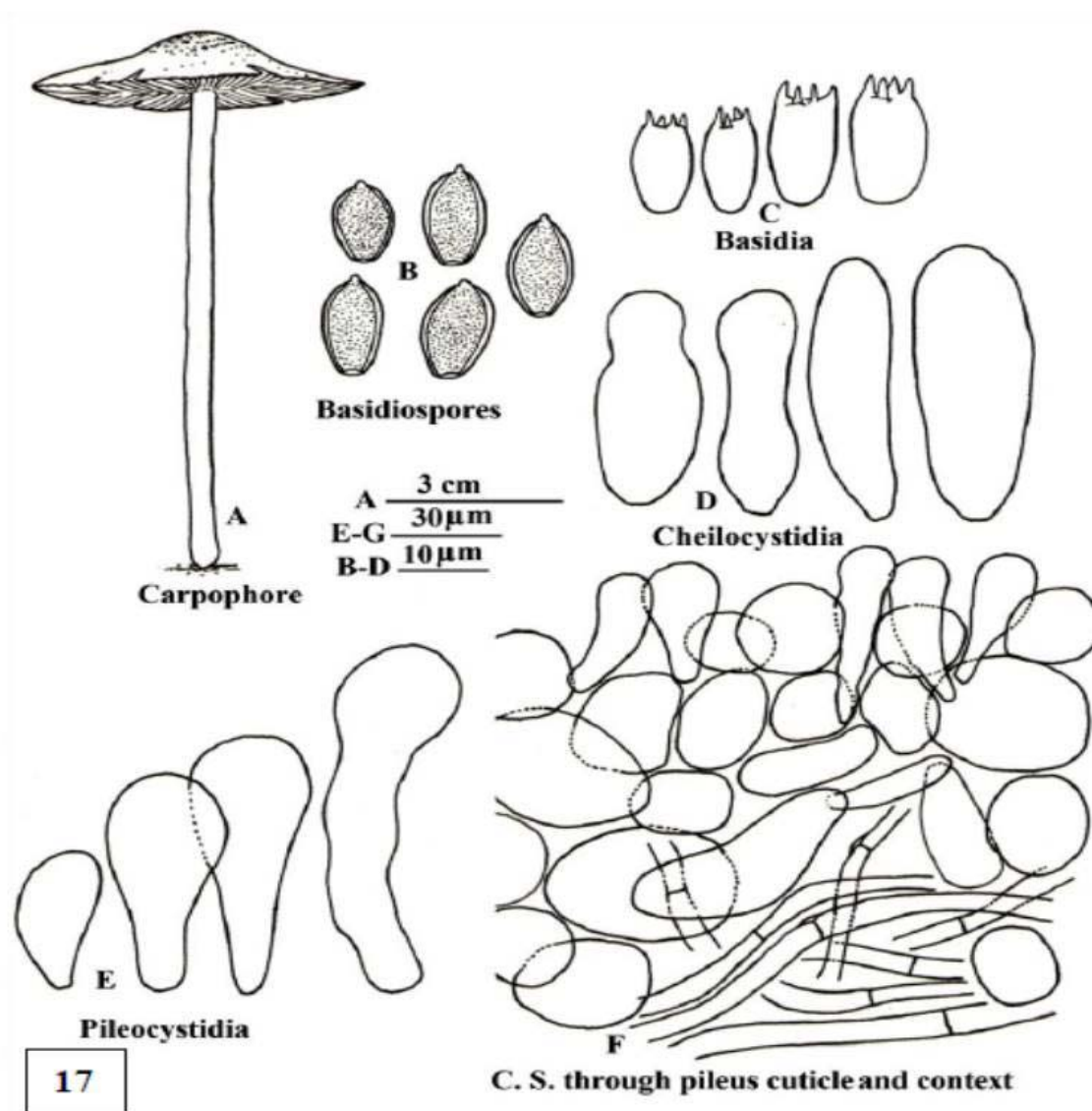


Fig. 17. *Agrocybe sacchari* (Murr.) Dennis: Camera Lucida drawings (A. Carpophores, B. Basidiospores, C. Basidia, D. Cheilocystidia, E. Pileocystidia, F. C.S. through pileus cuticle & context)

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REFERENCES

1. Abraham, S.P. 1991. Kashmir fungal flora – An Overview. In: Indian Mushrooms, Dr. M.C. Nair (ed.), Kerala Agricultural University, Velenikkara, 6806554. pp. 13–24.
2. Agaricina Neerlandica: Critical monographs on families of agarics and bolete occurring in the Netherlands. Boca Raton: Taylor & Francis; pp 204–221.

3. Atri, N.S. and S.S. Saini. 2000. Collection and study of Agarics- An introduction. *Indian J. Mush.* **18(1&2)**: 6-14.
4. Atri, N.S., A. Kaur. and H. Kour. 2005. Wild mushrooms- Collection and identification. In *Frontiers Mushroom Biotechnology*, R. D. Rai, R. C. Upadhyay and S. R. Sharma (eds.), pp. 9–26.
5. Atri, N.S., M. Kaur. and S. Sharma. 2017. Characterization of Lamellate Mushrooms – An Appraisal. In: *Developments in Fungal Biology and Applied Mycology*. Satyanarayana T, Deshmukh S, Johri B (eds.). Springer, Singapore. pp. 471–500.
6. Atri, N.S., S.S. Saini. and G. Kaur. 1992. Taxonomic studies on some members of family *Bolbitiaceae* Sing. from Punjab. *J. Indian Bot. Soc.* **71(1 – 2)**: 87–89.
7. Breitenbach, J. and F. Kränzlin. 1995. Fungi of Switzerland. Vol. 4. Verlag *Mykologia*. pp. 368.
8. Calaça, F.J.S., V.G. Cortez. and S. Xavier-Santos. 2020. Dung fungi from Brazil: *Agrocybe pediades* (Fr.) Fayod (Basidiomycota) in Cerrado. *Scientia Plena* **16(6)**:
9. Cléménçon, H. 1976. Neue Arten von Agaricalen und Notizen zu bemerkenswerten Funden aus der Schweiz. *Nova Hedw.* **28**: 1-44.
10. Colenso, W. 1890. An enumeration of fungi recently discovered in New Zealand with brief notes on the species novae. *Trans. Proc. N. Z. Inst.* **23**: 391-398.
11. Debnath, S., R.C. Upadhyay., P. Das. and A.K. Saha. 2020. Characterization of wild mushrooms from Tripura, Northeast India. *Indian Phytopathology* **73**: 97-110.
12. Doveri, F. 2010. Occurrence of coprophilous Agaricales in Italy, new records, and comparisons with their European and extra european distribution. *Mycosphere* **1**: 103–140.
13. Farook, V.A., S.S. Khan. and P. Manimohan. 2013. A checklist of agaricus (gilled mushrooms) of Kerala State, India. *Mycosphere* **4(1)**: 97–131.
14. Hennings, P. 1901. Fungi Indiae Orientalis II. *Hedwigia* **40**: 323–342.
15. Holmgren, P.K. and Keuken, W. 1974. Index Herbariorum, Part I. Regnum Veg. 92: pp 1-397. <https://doi.org/10.1007/s42360-019-00188-9>
16. Kaur, A., N.S. Atri. and M. Kaur. 2014. Taxonomic study on species of *Agrocybe* Strophariaceae, Agaricales collected on dung from Punjab, India. *KAVAKA* 43: 46-49.
17. Kirk, P.M., P.F. Cannon., D.W. Minter. and J.A. Stalpers (eds). 2008. *Dictionary of Fungi*, 10th edn. CABI Publishing, UK.
18. Kornerup, A. and J.H. Wanscher. 1978. *Methuen Handbook of Colour*, 3rd ed., Eyre Methuen, London.
19. Kuo, M. 2006. The genus *Agrocybe*. Available at: <http://www.mushroomexpert.com/agrocybe.html>. Accessed 13 June 2019.
20. Manimohan, P.K., A. Thomas. and V.S. Nisha. 2007. Agarics on elephant dung in Kerala State, India. *Mycotaxon* **99**: 147–157.
21. Masee, G. 1898. The fungus flora of New Zealand. *Proc. N. Z. Inst.* **31**: 282-349.
22. Mitchell, A. and G.P. Savage. 1990. “*Agrocybe parasitica*: The mushroom of future?” *Proceedings of the Nutrition Society of New Zealand.* **15**: 175–178.
23. Mohanan, C. 2011. Macrofungi of Kerala. KFRI Handbook No. 27, Kerala Forest Research Institute, Peechi, Kerala, India.

24. Mycobank. 2021. <http://www.mycobank.org/BioloMICS> (Accessed on September 10, 2021).
25. Natarajan, K. and N. Raman. 1983. South Indian Agaricales. *Bibliotheca Mycol.* 89: pp 1–203.
26. Nauta, M.M. 2005. *Agrocybe* Fayod. In: Noordeloos ME, Kuyper TW, Vellinga EC, (eds.).
27. Niveiro, N., M. Uhart. and E. Albertó. 2020. Revision of the genera *Agrocybe* and *Cyclocybe* (Strophariaceae, Agaricales, Basidiomycota) in Argentina. *Rodriguésia.* **71**: 1– 26, doi: 10.1590/2175-7860202071038.
28. Phillips, R. 2001–2013 – <http://www.rogersmushrooms.com>.
29. Rawla, G.S., B.M. Sarwal. and S. Arya. 1982. Agarics new to India I. *Nova Hedwigia* **36**: 433-43.
30. Saini, S.S. and N.S. Atri. 1982. North Indian Agaricales – I. *Indian Phytopath.* **35(2)**: 265–272.
31. Saini, S.S. and N.S. Atri. 1995. Mushroom flora of Punjab. In: *Advances in Horticulture Vol. 13- Mushrooms* (Eds.: Chadha, K.L. and Sharma, S.R.). Malhotra Publishing House, New Delhi, India, pp 375–386.
32. Singer, R. 1977. Keys for the identification of the species of *Agaricales* I. *Sydowia* Vol. XXX, Heft.
33. Smith, A.H. 1949. Mushrooms in their Natural Habitats. Hafner Press, New York, 626 pp.
34. Taylor, G.M. 1970. Mushrooms and Toadstools in New Zealand, Wellington.
35. Thomas, K.A. and P. Manimohan. 2003. The genus *Agrocybe* in Kerala state, India. *Mycotaxon* **86**: 317–333.
36. Watling, R. 1982. British Fungus Flora– Agaric and Boleti 3. *Bolbitiaceae: Agrocybe, Bolbitius, Conocybe*, Edinburgh, HMSO, U.K.
37. Watling, R. and G.M. Taylor. 1987. Observations on the *Bolbitiaceae*. *Bibliotheca Mycologia* **27**: J Cramer Berlin Stuttgart.
38. Wood, M. and Stevens, F. 1997–2013. <http://www.mykoweb.com/CAF/species/Agrocybe>.