

Studies on the genus *Agaricus* L.: Fr. the subgenus *Agaricus* from North West India

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ABSTRACT

This paper records 6 taxa of genus *Agaricus* L.: Fr. from (Sub genus *Agaricus* L.: Fr. Section *Agaricus* L.: Fr.) from various localities of North West India. Out of these five taxa, namely, *A. spissicaulis* Moller, *A. subhortensis* Murrill, *A. praemagnus* Murr, *A. cupreo-brunneus* (Schaeff. et steer) Pilat and *A. subperonatus* (Lange) Sing, are reported for the first time from India, one species, namely, *A. campester* L. is a new record for Punjab plains.

Key words: *Agaricus*, Placomycetiod, Schaeffer's Reaction, Cheilocystidia

The genus *Agaricus* L.:Fr. comprises predominately large fleshy economically important mushrooms having homoiomerous carpophore context. This genus is different from the other agaric genera in possessing umbrella like scaly pileus, rosy-purple brown to dark brown free lamellae, fleshy stipe bearing annulus ring, purple to coca brown or even dark brown spore print and spores with or without germ pore. The world over, attention is being paid to the systematics of this genus because of its edible and commercially exploited species like *A. bisporus* (Lange) Sing. and *A. bitorquis* (Quel.) Sacc. belonging to this genus. Such an exploration is useful for assessing the availability of the local germplasm and discovery of new desirable characters which can be exploited for improvement of commercial species.

The genus *Agaricus* is said to be derived from 'Agarica of Sarmatica', a district in Russia (Donk, 1962). Before Linnaeus (1753) the generic name *Agaricus* was in use for polypores and some lamellate

bract fungi. In 'Species Plantarum', Linnaeus (1753) took exception to it and used the genus *Agaricus* in the modern sense for fungi bearing lamellate hymenophore. The various taxonomic categories in the systematic hierarchy of this genus (Order-Agaricales, Suborder-Agaricineae, Family-Agaricaceae) owe their origin to it (Singer, 1986). This is the position which has been accepted for the present investigation.

It is a cosmopolitan genus in distribution and grows in varying habitats. Its species are abundant in the soil and on dung, around heaps of organic matter such as compost piles, straw stacks, on manure piles, pastures, in gardens, on humus, on termite nests and even on ant-hills. These can be found during the spring, summer and falls, though in spring they are relatively rare. Mycelium of the genus *Agaricus* is heterothallic and dikaryotic. The primary mycelium is of short duration in nature. It is the secondary dikaryotic mycelium which is more abundant, perennating and producing mushrooms year after

year. Growth of the mycelium has a tendency to grow in all the directions from a central point, ultimately forming a large, invisible circular colony. When the time for sporulation arrives, the sporophores are produced at the periphery of the colony and thus a 'fairy ring' is resulted. These rings are commonly formed in the open grassy lawns by many species of *Agaricus* including *A. arvensis* Schaeff.:Sacc.; *A. campestris* L.: Fr.; *A. placomyces* Peck and *A. praerimosus* Peck (= *A. tabularis* Peck). The fairy ring of *A. praerimosus* Peck grows at the rate of 12 cm in radius every year. Hawksworth *et al.* (1985) has recorded over 600 years old fairy rings of *A. praerimosus* Peck. Some of the species of *Agaricus* growing in forests may be living in close harmony with the roots of living plants. One such species of *Agaricus*, namely, *A. trisulphuratus* Berk. Form ectotrophicmycorrhizae with *Shorea robusta* Gaertn. (Bakshi, 1974).

Economically, this genus is quite significant for its food value. The genus is edible throughout its range and is from fair to excellent in taste. Some of its species have been grown commercially e.g. *A. bisporus* (Lange) Sing. (most widely used by commercial growers) and *A. bitorquis* (Qué.) Sacc. The most important edible mushroom in temperate regions of Europe and North America is undoubtedly *A. bisporus*. The production of carpophores for the food market has become a major industry, at first in France, and later in other countries. Now, according to volume of production, the United States ranks first. In India, the commercial cultivation of *A. bisporus* was started in Himachal Pradesh in 1961 after the implementation of a scheme jointly sponsored by the Indian Council of Agricultural Research (ICAR) and the government of Himachal Pradesh. The success of mushroom cultivation at Solan (H.P.) prompted others to grow mushrooms in other regions of the country viz. Delhi, Kashmir Valley, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal. The agro-climatic conditions of Himachal Pradesh and Kashmir Valley seem to be most suitable for the -cultivation

of button mushroom, although hilly regions in North, South and Eastern India are also favourable for growing this species.

Aside from the cultivated species many other species like *A. arvensis*

Schaeff.: Sacc. (Horse Mushroom); *A. campestris* L.: Fr. (Field Mushroom); *A. silvaticus* Schaeff.:Sacc. (Brown Wood Mushroom); *A. silvicola* (Vitt.) Fr. (Silvan Mushroom or Wood Mushroom), etc. are often collected by the inhabitants of various regions for consumption as food. Wild agarics are especially in demand in Europe, all parts of Asia, especially Transcaucasia, Siberia, Indochina, China, Pakistan, Java, Japan, Philippines and also in Chile (Singer, 1986).

The food value of various edible mushrooms has been worked out by large number of workers. These are not a staple food, but are a good food supplement. Because of their low caloric value (16 C/100gms of fresh weight) and low carbohydrate content in comparison to the other food items, mushrooms are considered good for the diabetic patients. Calcium is useful in the formation of bones and teeth. Other minerals like phosphorus, potassium, copper and iron play an important role in various metabolic activities in the human body. Folic acid, a blood building vitamin is good for persons suffering from anaemia. Ascorbic acid increases resistance in human body. Vitamins like niacin and pantothenic acid are also very important.

Only few species are slightly poisonous or hallucinogenic. These include *A. hondensis* Murr., *A. vaporarius* Vitt., *A. xanthodermus* Genev., etc. *A. vaporarius* causes sickness. *A. xanthodermus* contains a phenolic poisonous substance and causes alarming symptoms of coma, vomiting and diarrhoea, but with complete recovery in a few days.

The World over, as many as 400 species of the genus *Agaricus* are known (Bas, 1991). Zhao *et al.* (2011) recognized 386 species in the genus, and from

this publication to the end of 2015, 48 new species have been introduced. No Work with regard to the taxonomy of this genus is available in India excepting isolated reports. Of the total 400 species of this genus known the World over so far, only 126 taxa have been reported from India (Saini *et al.*, 2018).

India being a vast country with varying topography and climate supports a rich agaric flora. Despite this only meager work has been done on the systematics of this genus and the species which are reported by the other authors are mostly in the form of mere lists. The detailed descriptions are almost lacking for majority of the species reported. No systematic account pertaining to this genus is available from any part of India, when this work was started in 1988. The reported taxa of this genus includes 18 species and 7 varieties from Punjab plains (including 14 species and 7 varieties from this laboratory), 14 species from South West India, 10 species from Himachal Pradesh, 9 species from Uttar Pradesh, 7 species from Jammu & Kashmir, 6 species from West Bengal, 5 species from Orissa, 2 species each from North-West Himalayas, Eastern Himalayas and Andhra Pradesh, one species each from Delhi, Gujarat, Bihar and Tamil Nadu. Almost the complete Indian subcontinent including the present area of investigation remains unexplored. It is a well known fact that many fleshy fungi have a specific taste for certain type of habitats. But the genus *Agaricus* grows in varying habitats and can be easily found in gardens, lawns and villages.

Keeping in view the meager amount of work done on taxonomy, ecology, distribution and edibility of the genus, the present problem was undertaken in 1988 with North-West India as the area for explorations. The period of most of the collections during the present investigation varies from the start of July to the beginning of October. This period coincides with the monsoon period in India which favours maximum development of these fungi. Local observations for the collection of the species of *Agaricus* were also done during the remaining months of the year.

MATERIALS AND METHODS

Collection of the material

The materials in the present investigation were collected from the various localities of North West India. For this purpose extensive collection tours were undertaken during the months of July to October in the years 1998 to 2013. Local collection tours were undertaken throughout the year but the material was observed in abundance only during the *rainy* season.

The various species of the genus *Agaricus* are cosmopolitan in distribution. They exhibit wide range of habitats, varying from an open grassy lawn to the deep thick forests. They generally come up in humid and warm conditions which coincide with the monsoon period in India. For the collection of agarics a collection basket, a hunting knife, a hand lens (10X), a pencil, a pad of note papers, wrapping papers, SLR camera with close ups and other accessories are required. In the field, fresh and healthy specimens with all the developmental stages were selected and collected in sufficient amount. Every time precaution was taken not to collect old and decaying fructifications, and to collect the carpophores along with spawn and pseudorrhiza if any. The field notes regarding the date of collection, locality, substratum, forest type especially the vegetation around and the collection number, etc. were recorded. To avoid any damage to small and brittle specimens these were placed above the stout and larger specimens in the collection basket. Due care was taken to avoid the mixing of different collections while taking them to the laboratory.

Macroscopic observations

Forstudying the macroscopic features with respect to the pileus, lamellae, stipe, colour changes on exposure, macro-chemical reactions, etc. a temporary laboratory was set up at each collection site. The observations were recorded in an especially designed field key prepared for the purpose well in advance before proceeding on a collection tour.

Spore deposit

The colour of the spore deposit is an important character and plays a vital role in the generic segregation of agarics. It is obtained from the fresh mature carpophores. For this purpose, the pileus was separated from the stipe by cutting it near the point of attachment with the pileus. The cap was then horizontally placed on a white chart paper measuring 14×7.5 cm with gills facing downward. Then a water soaked cotton plug was placed near the paper to provide humidity for the pileus to remain turgid. Afterwards, the whole arrangement was covered with a petridish. In the genus *Agaricus*, it took about half an hour to obtain a thick spore deposit. It varies from brown to sepia in various species of *Agaricus*. The paper containing the spore deposit was first dried and then placed in a cardboard box (13×8×8cm) especially designed for the purpose. The length of the paper for taking spore deposit was kept longer than the cardboard box so that its edges fitted well in the box and it did not move freely even if the cardboard box was tilted upside down. To avoid damage by the insects, crystals of 1,4-dichlorobenzene were placed in each spore print box below the paper. The boxes were labeled with relevant information and then placed in polythene packets so as to keep them free from moisture.

Preservation of the material

For preservation, the material of each collection was divided into two unequal parts. A small part of each collection was preserved in a liquid preservative¹ (Hawksworth et al., 1985) while the major portion of the same collection was hot air dried in a wooden drier especially designed for this purpose. The drier measuring 115×45×45 cm has three compartments partitioned by wire gauge. Each compartment is closed from all the sides except for a movable door on one side. In the lowest chamber, a low voltage heater (500

Watt) was placed for drying. If the electricity is not available, a kerosene oil stove was used. The materials to be dried were placed on the wire gauge compartment. Larger and fragile materials were placed in the middle and the lower chambers while the delicate and smaller specimens in the upper chamber.

The materials were allowed to dry at a temperature varying from 45-60°C. The dried materials were packed in cellophane paper packets along with collection number so as to keep them free from moisture. To avoid insect infestations 1,4-dichlorobenzene crystals were put in each packet. The cellophane paper packets containing materials were further packed in standard herbarium packets (15×12 cm) of thick white paper and a herbarium label with relevant data for each specimen is pasted on the packet. The packets were then arranged in cardboard boxes (38×17×13 cm) in a vertical fashion so as to avoid any damage to them due to mutual pressure. During the present investigation, 266 collections belonging to 66 taxa of *Agaricus* have been examined for their macroscopic and microscopic details. The studied collections have been deposited in herbarium of Botany Department, Punjabi University, Patiala, Punjab, India (PUN)².

Chemical colour reactions

Macro-chemical colour reactions have their own place in the taxonomy of the genus *Agaricus*. These were performed on various parts of the carpophore including pileus cuticle, flesh, etc. by using various dyes, stains and chemical reagents.

1. Cotton blue³: It is a hyphal stain and on its application the context becomes more clear for study under the microscope. This dye is readily absorbed by the hyphal walls.

¹25 ml. Formaldehyde (40%), 150 ml. Alcohol (95%), 1,000 ml. Distilled water.

²PUN: It is an abbreviation allotted to the Herbarium of Botany Department, Punjabi University, Patiala by the International Bureau for plant taxonomy and nomenclature of the International association for plant taxonomy, Netherlands (Holmgren and Keuken, 1974).

³0.05 gm Cotton blue, 30 ml. Lactic acid.

2. Potassium hydroxide (10%)⁴: It is a standard reagent for all groups of Agaricales and is mainly used to revive the dried materials for anatomical study.
3. Ammonium hydroxide: It is used to study its effect on flesh and cuticle.
4. Sulphuric acid (conc.): It is used to note the colour reaction of cuticle and flesh when fresh.
5. Nitric acid (conc.): It is also used to note the colour reaction of the cuticle and flesh when fresh. It is an important chemical for the Schaeffer's reaction (cross marking reaction).
6. Aniline oil: It is used for performing the Schaeffer's reaction along with conc. HNO₃.

For performing Schaeffer's reaction a line of conc. HNO₃ is drawn on the pileus surface with a glass rod and second line of Aniline Oil is drawn at right angle to the line of conc. HNO₃. If at the point of confluence of these two lines on the pileus surface orange (*flame*) colour appears, the 'Schaeffer's reaction is referred to as positive, otherwise, negative.

Microscopic observations

The microscopic observations were made for studying the spore morphology and internal details of the carpophore. The examination of the spores was done under the oil immersion lens. For this purpose, the spores from the spore print were taken on the glass slide in a drop of absolute alcohol. Then, these were mounted in 10% KOH and were allowed to stabilize before making observations. The various characters of the spores with respect to their shape, size, wall thickness, presence or absence of germ pore, whether truncate at the apex or apiculate, etc. were recorded.

Internal structures of the carpophore were studied by cutting free hand sections of the preserved materials or the material revived from dry collections. For reviving the dried material, first, it is soaked in absolute alcohol to drive out air then put in lukewarm 10% KOH solution for 10-15 minutes, then washed with water. The sections were mounted in lactophenol⁵ (Hawksworth *et al.*, 1985). The observations on various internal parts of the carpophore like cuticle, basidia, cystidia, hymenophore, clamp connections, etc. were taken and recorded.

Camera lucida has been used to draw various internal details of the carpophore at appropriate magnifications which have been mentioned with the diagrams. The measurement of the spores and internal carpophore parts was taken and recorded. The morphology of the carpophores in majority of the cases has been drawn to their natural size. Sincere efforts were made to take photographs of as many species of *Agaricus* as possible in their natural habitat. In the text the figures/photographs have been cited as Fig 115 where nominator denotes plate number while the denominator denotes the figure/photograph number.

Identifications

The generic identification was ascertained from Singer (1986). In the present study various taxa of the genus *Agaricus* have been identified by making frequent references to the authenticated publications such as Murrill (1922), Hotson and Stuntz (1938), Møller (1950, 1952), Pilát (1951), Heinemann (1956a, 1977b, 1987a,b, 1990a,b), Freeman (1979a,b), etc.

RESULTS AND DISCUSSION

This paper is in continuation (Atri *et al.*, 1991, 1992; Gupta *et al.*, 1994; Saini *et al.*, 1991, 1992, 1997) to our earlier contributions on the systematics

⁴10 g KOH pellets, 100 ml. Distilled water.

⁵20 g Phenol (pure crystals), 20 g Lactic acid, 40 g Glycerol, 20 g Water and a little dye such as Cotton blue, if desired.

of genus *Agaricus* L.: Fr from North West India. The present paper deals with the 6 taxa of the genus belonging to sub genus *Agaricus* L.: Fr. are characterized by reddening of the context of the piles on bruising. The flesh becomes slightly reddish in age. Schaeffer's reaction may be positive or negative. Spores globose or ovoid -ellipsoid.

Cheliocystidia varying from practically absent to numerous. Rest of the features are typical of *Agaricus*. In the present paper 6 taxa are described. Out of these *A.spissicaulis* Moller, *A. Subhortensis* Murrill, *A.praemagnus* Murr. *A. cupreo-brunneus* (Schaeff. et steer) Pilat and *A. subperonatus* (Lange) Sing are new records for India, whereas *A. campester* L. is reported and described for the first time from Punjab plains. The materials were deposited under PUN in the Herbarium of Botany department, Punjabi University, Patiala. Duplicate collection of *A. subperonatus* (Lange) Sing have been deposited under BR in the Herbarium of Faculte Des Sciences Agronomiques De L'etat, Gambroux, Belgique. In the text colour terminology used after Kornerup and Wanscher (1978) and Kelly (1958).

Agaricus spissicaulis Moller. *Friesia* 4:43-44, 1950.

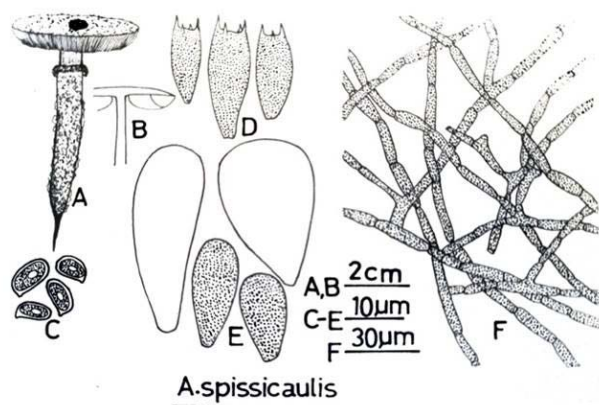


Fig. 1. *A. Spissicaulis* Møll.

A. Carpophore; B. V.S. of Carpophore; C. Basidiospores;
D. Basidia; E. Cheilocystidia; F. Universal veil tissue

Carpophores 5.5-7 cm in height, placomycetoid (Fig. 1). Pileus 3.6-6.8 cm broad, globose when young,

convex to convexly applanate in partially mature carpophores, infundibuliform at maturity, broadly umbonate with ruptured umbo in some carpophores; surface dry, non-hygrophanous, yellowish white when young. dull red (IOD4) at maturity with pastel red (IOD5) to violet brown (IOE5) centre, which is formed by the remnants of universal veil, squamulose, squamules powdery to fibrillose, white to pinkish white, equally distributed throughout the surface, more in young pilei; margin irregular, splitting with cortinal remnants, feebly striate near the margin, reflexed; cuticle fully peeling, turns light yellow on bruising in young carpophores; flesh up to 3 mm thick, white underneath, turns first yellowish then pastel red to brownish in young carpophores, light brown in mature carpophores on exposure. Lamellae free, close to crowded, moderately broad (up to 0.5 cm), unequal, not in series, yellowish white to pinkish white in young carpophores, finally dark greyish brown to dark brown at maturity, edges serrate. Spore deposit greyish brown (5D3). Stipe 5.4-5.8×0.3-1.1cm, cylindrical with pseudorrhiza in some and clavate to obclavate in others, concolorous with the pileus, turns yellow on bruising, pinkish near the base on drying, silky above and white fibrillose below the annulus ring, fleshy to cartilaginous, flesh turns pink to violet brown on exposure, first solid then hollow, annulus ring simple, fibrillose, white, sheathed above, superior to middle, evanescent, cortinal veil present in young carpophores.

Spores 4.5-7.5×3-5.25 μm, broadly ellipsoidal, double walled. outer wall thick and dark, pigmented, apiculate, apiculus nodulose. guttulate with 1-guttule, apical pore absent. Basidia 12-19.5×4.5-7.5 μm, 4-spored. ovoid to pyriform, pigmented, sterigmata up to 3.5 μm long. Pleurocystidia none. Cheilocystidia 10-33×4.5-15 μm, broadly clavate to balloon shaped, hyaline to pigmented; gill edges heteromorphous. Carpophore context homoiomerous. Pileus cuticle formed of slightly interwoven 2-12 μm broad pigmented hyphae. Pileustrama composed of tangled 3-28.7 μm broad hyaline to weakly pigmented hyphae. Sub-hymenium cellular, formed of 3-13.5 μm broad hyaline to weakly pigmented cells. Gill trama irregular,

made up to 4.5-19.5 μm broad hyaline to weakly pigmented hyphae. Stipe cuticle hyphal, cuticle hyphae narrow, pigmented; context hyphae broad, hyaline to weakly pigmented, vacuolated, overall measurement of stipe hyphae range from 3-22 μm . Universal veil tissue cellular, cells 2-10 μm broad, pigmented, branching along with protuberances, vacuolated. Annulus ring hyphae 2-12 μm broad, pigmented, branched, vacuolated. Clamp connections absent throughout.

Chemical colour reactions: Schaeffer's reaction negative. Pileus cuticle and flesh turns orange in conc. HNO_3 , brown in conc H_2SO_4 , and greyish brown in NH_4OH . Collections examined: Punjab plains: Patiala, Baradari gardens (250 m), scattered on humicolous soil among grasses near the hedge, Anil Gupta, PUN 1787, July 23, 1990; PUN 1788, July 24, 1990; Botanic gardens, Punjabi University, Patiala (250 m), growing in groups on grassy soil, Anil Gupta, PUN 1791, Aug. 7, 1990; PUN1992, Aug. 19, 1990.

Uttar Pradesh: Dehradun, Prem Nagar (640 m), in small groups on pasture land. Anil Gupta, PUN 2244, Sept.2, 1991; PUN 2245, Sept.2, 1991; FRI (640 m), in groups on pasture land, Anil Gupta, PUN 2246, Sept.3, 1991.

Remarks: The above-examined collections have been identified as *Agaricus spissicaulis* as described by Moller (1950) and keyed out by Pilat (1951) and Heinemann (1977b) The Indian collections have striations near the margin, narrow stipe and smaller basidia. The other features pertaining to macroscopic and microscopic details are in complete conformity with the earlier reports. This species constitutes a new record for India.

Culinary properties: Taste good with fragrant odour. Edibility is questionable due to thin flesh and small size of the carpophore.

Agaricus subhortensis Murrill. *Lloydia* 9: 328, 1946.

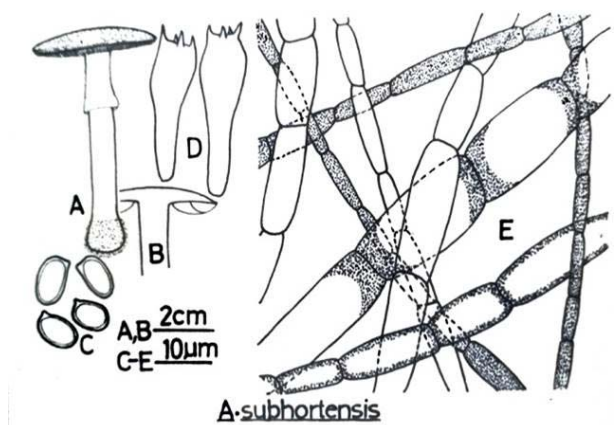


Fig. 2. A. *Subhortensis* Murr.

A. Carpophore; B. V.S. of Carpophore; C. Basidiospores; D. Basidia; E. Universal veil tissue

Carpophore up to 6.7 cm in height, placomycetoid (Fig. 2). Pileus up to 4.1 cm broad, reflexed; surface moist, scaly, scales covering the entire pileus surface, orange white (6A2); margin regular, translucent striate; flesh white, turns slowly pinkish on exposure. Lamellae free, crowded, moderately broad, unequal, not in series, brown (7E4), unchanging on bruising, edges smooth. Spore deposit dark brown (6F7). Stipe up to 6.2 \times 0.5-1 cm, cylindrical with slightly bulbous base, white, golden when dried (more towards brownish side), smooth, cartilaginous, flesh unchanging on exposure, solid; annulus ring simple, sheathed above.

Spores 7-8.5 \times 4.3-5.7 μm , ellipsoidal, double walled, outer wall thick and dark, apiculate, apical pore absent. Basidia 20-27 \times 7-8.5 μm , 4-spored, clavate, sterigmata up to 5.7 μm long. Both pleurocystidia and cheilocystidia absent: gill edges fertile. Carpophore context homoiomerous. Pileus cuticle hyphal, composed of 5.7-9.9 μm broad hyphae. Pileustrama consists of 3-5.7 μm broad interwoven hyphae. Sub-hymenium cellular. Gill trama regular to sub-regular, composed of 2.9-7 μm broad hyphae. Stipe cuticle and context composed of longitudinally running parallel hyphae. Universal veil tissue cellular, cells up to 12 μm broad hyaline to pigmented. Annulus ring hyphae 4.3-11.4 μm broad. Clamp connections absent throughout.

Chemical colour reaction: Schaeffer's reaction negative.

Collection examined: Punjab plains: Patiala, Punjabi University Campus (250 m) growing in open grassland, GurjeetKaur, PUN 1585, July 30, 1989.

Remarks: The above-examined collection fully agrees with the details given by Freeman (1979a,b) for *A.subhortensis* except for the longer stipe (up to 6 cm long instead of 4 cm) in the Indian collection. This fungus is not known earlier from India and it constitutes a new record,

Culinary properties: Taste slightly acrid with disagreeable odour. Edibility is unknown.

Agaricus praemagnus Murr. *Mycologia* 10:78. 1918.

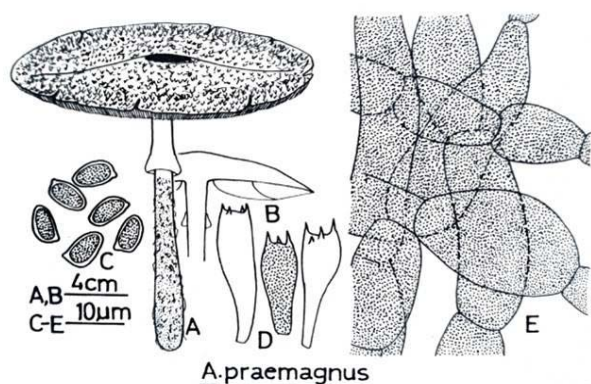


Fig. 3. *A. praemagnus* Murr.

A. Carpophore; B. V.S. of Carpophore; C. Basidiospores; D. Basidia; E. Universal veil tissue

Carpophores 20-23 cm in height, campestroid (Fig. 3). Pileus 18-20 cm broad, convex to expanded; surface dry, light brown (6D4) with darker centre, scaly, scales recurved fibrillose, aggregated towards the periphery; margin irregular, splitting at maturity, cuticle fully peeling: flesh up to 2 cm thick in the centre, white, turns light pinkish on exposure. Lamellae free, close, broad (1.2 cm), unequal, not in series, flesh coloured when young and greyish brown at maturity, edges serrate Spore deposit brown (6F8). Stipe up 19×1.9-3.3 cm, obclavate to distinctly

bulbous, whitish with appressed scales which turns brown on bruising, light greyish brown above the ring, pruinose, cartilaginous, first solid then hollow: annulus ring simple, dull white on the upper surface and white with creamy appressed scales on the lower side, superior, skirt like, pendulous, sheathed above. Cog wheel prominently covers the lamellae in the young pilei, white with bunches of creamy scales.

Spores 6-6.75 (7.5) × (4) 4.5 (5) μm, ellipsoidal, double walled, outer wall thick and dark, pigmented, apiculate, apiculus papillate to beak like, guttule none. apical pore absent. Basidia 16.5-25.5×6-7.5 μm, 4-spored, pyriform to clavate, hyaline to pigmented, sterigmata up to 3 m long. Pleurocystidia absent. Gill edges fertile with basidia and basidioles but in mature gills basidia could not be observed and only hyphal structures seen. Carpophore context homoiomerous. Pileus cuticle formed of interwoven 4-8 μm broad pigmented hyphae; some surface hyphae projecting. Pileustrama composed of tangled 4.5-27 μm broad inflated hyaline to weakly pigmented hyphae. Subhymenium cellular, cells 4.9 μm broad, weakly pigmented. Gill trama irregular made up of 4.5-22.5 μm broad weakly pigmented hyphae. Stipe hyphae compact and parallel 3-27 μm broad, inflated, weakly pigmented. Universal veil tissue cellular, cells 5-19.5 μm broad, inflated, pigmented. Clamp connections absent throughout.

Chemical colour reaction: Schaeffer's reaction negative.

Collection examined: Himachal Pradesh Manali, near Hadimba Temple (2030m). scattered on humic soil, N.S.Auri, PUN 2239, 2240, 2241, 2242, 2243, Aug 9, 1992

Remarks: The above-examined collection resembles in all its diagnostic features with those of *A. praemagnus* as given by Freeman (1979a,b) The Indian collections have longer stipe than the earlier report. Here, it constitutes a new fungus record for India.

Culinary properties: Taste and odour mild. Edibility is unknown.

Agaricus cupreo-brunneus (Schaeff. et Steer) Moller. *Freisia* 4:54-55, 1950.

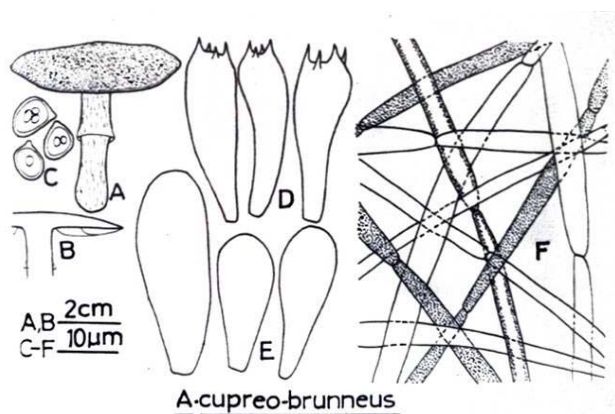


Fig. 4. *A. cupreo-brunneus*(Schaeff. et Steer) Pilát
A. Carpophore; B. V.S. of Carpophore; C. Basidiospores;
D. Basidia; E. Cheilocystidia; F. Universal veil tissue

Carpophore up to 5.5 cm in height, campestroid (Fig. 4). Pileus up to 5.4 cm broad, convex when young, reflexed at maturity, surface dry, brown (7E6), scaly, scales appressed fibrillose, equally distributed throughout the surface, margin regular, flesh white, up to 5 mm thick on the disc, unchanging on exposure Lamellae free, crowded, narrow (0.3 cm), unequal, not in series, pale orange (5A3) when young, reddish brown (8D5) at maturity, edges smooth. Spore deposit dark brown (6F5) Stipe up to 4.6×1 cm, slightly obclavate with bulbous base, yellowish white (4A2), smooth, striate, with persistent pith; annulus ring simple, sheathed above fugacious.

Spores 5.7-8×4.3-5.7 μm, ellipsoidal, smooth, double walled, outer wall thick and dark, apiculate, guttulate with 1-3 guttae, apical pore absent. Basidia 27 30×5.7-8.6 μm, 4-spored, clavate, sterigmata up to 3 μm long Pleurocystidia absent Gill edges sterile with scattered sterile cells. Cheilocystidia 21.3-34×5.7-11.4 μm, clavate, hyaline Carpophore context homoiomerous. Pileus cuticle formed of interwoven 2.9-4.3 μm broad hyphae Pileustrama composed of 4.3-7 μm broad hyphae. Sub-hymenium cellular, cells 3-7 μm broad,

weakly pigmented. Gill trama sub regular, made up of 2.9-4.3 μm. board hyphae. Annulus ring hyphae 3.3-5 μm broad, narrow. Universal veil tissue hyphal, hyphac 2-6 μm broad, hyaline to pigmented Clamp connections present in the stipe hyphae.

Chemical colour reaction: Schaeffer's reaction negative

Collection examined Punjab plains: Patiala, outside Punjabi University Campus (250 m), growing among grasses, GurjeetKaur, PUN 1593, Aug 29, 1989.

Remarks: The diagnostic characters of the above examined collection resembles fully with the details of *A. cupreo-brunneus* as given by Moller (1950). This species is not known earlier from India hence is a new fungus record.

Culinary properties: Taste mildly acrid with disagreeable odour Edibility is questionable

Agaricus subperonatus (Lange) Sing.C

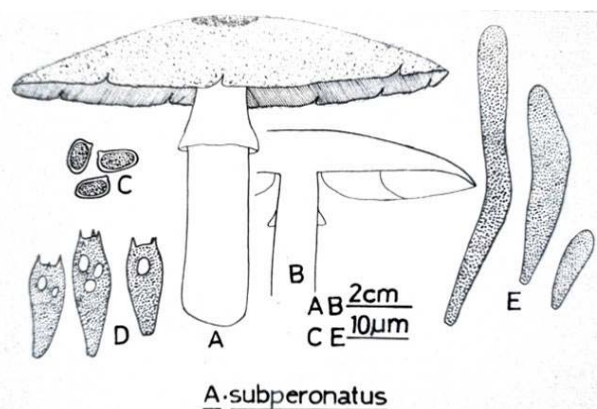


Fig. 5. *A. subperonatus* (Lange) Sing
A. Carpophore; B. V.S. of Carpophore; C. Basidiospores;
D. Basidia; E. Cheilocystidia

Carpophore up to 10 cm in height, campestroid (Fig. 5). Pileus up to 14 cm broad, convex with plane centre, surface dry, orange yellow (71 m.oy) with darker centre and yellowish brown margin, squamulose with appressed squammules covering the entire pileus surface; margin irregular and with

corticalremanants; flesh up to 1.3 cm thick on the disc, white underneath, turns reddish on exposure. Lamellae free, close, broad, unequal, not in series, Red pink (5 m pink), edges serrate Spore deposit orange yellow yellowish brown (81 dgy y.Br.). Stipe up to 8.7×2 cm, obclavate, white, slightly reddish on bruising near the base. fibrillose with floccose recurvedfibrills when young and pruinose at maturity, fleshy, first solid then hollow; annulus ring simple, prominent, white with floccose white fibrills on the lower side, sheathed above, cog wheel present in young carpophores

Spores 6-7×3.5-4.5 μm, ellipsoidal, double walled, outer wall thick and dark. pigmented, apiculate, apiculuspappilate, apical pore absent. Basidia 15-21×5-6 μm, 4-spored, clavate to pyriform, pigmented, sterigmata up to 3.5 μm long Pleurocystidia none Cheilocystidia 13.5-33×4.5-6 μm narrowly clavate, pigmented, some are very long hyphae like (33-64.5×4-6 μm), abundant. rendering the gill edges sterile. Carpophore context homoiomerous. Pilcus cuticle formed of slightly Interwoven 2-10 μm broad pigmented hyphae. Pileustrama composed of tangled 1.18 μm broad pigmented hyphae. Sub-hymenium cellular. formed of 3-9 μm broad pigmented cells. Gill trama irregular, made up of 3-22.5 μm broad pigmented hyphae. Stipe context composed of compactly arranged parallel, 2-18 μm broad pigmented hyphae Universal veil tissue cellular (few hyphae also seen), cells up to 16 μm broad inflated, pigmented. Annulus ring hyphae 2-20 μm broad, pigmented. Clamp connections absent throughout.

Chemical colour reactions: Schaeffer's reaction negative. Pileus surface turns reddish brown with Aniline

Collection examined: Himachal Pradesh Mohan, Banra (1450 m), growing gregariously on humicolous soil under *Quercusincana* N.S. Atri. PUN 2133, 2134, July 12. 1990 (Duplicate at BR)

Remarks: The macroscopic, microscopic and chemical colour reaction details ofthe above examined

collection are in conformity with those given for *A. subperonatus* by Moller (1950) and Pila't (1951). This species constitutes anew fungus record for India.

Culinary properties: Taste and odour mild. Edibility is unknown.

Agaricus campester L Synt.*Mycol* 1:281, 1821.

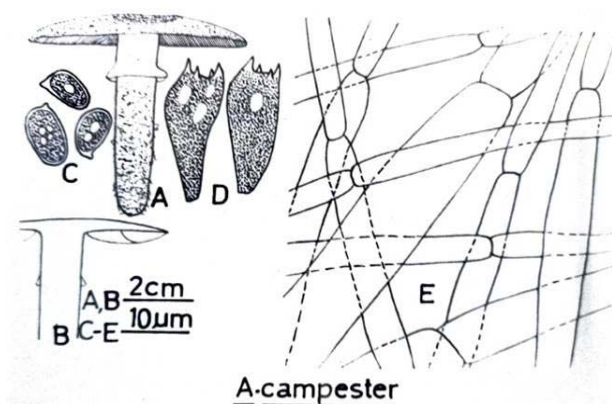


Fig. 6. *A. campester* L.

A. Carpophore; B. V.S. of Carpophore; C. Basidiospores; D. Basidia; E. Universal veil tissue

Carpophore up to 6.2 cm in height, campestroid (Fig. 6). Pileus up to 6.5 cm broad. convexly flattened; surface moist, shiny, yellowish white (4A2) with brownish orange (5C4) patches in the centre, scaly, scales fibrillose, more in the centre, margin regular; flesh up to 4 mm thick in the centre, unchanging on exposure. Lamellae free, crowded, broad, unequal, not in series, reddish brown (9DS), edges serrate. Spore deposit greyish brown (8F4). Stipe 5.8×13 cm, clavate, yellowish white (4A2) in the upper half and pale orange (5A3) in the lower half, pruinose fibrillose, fleshy, solid; annulus ring simple, white, sheathed above, superior.

Spores 7-10×4.5-6 μm, broadly ellipsoidal double walled, outer wall thick and dark, pigmented apiculus indiscernible, guttulate with 1-4 guttae, apical, pore absent. Basidia 18-22.5×7-10 μm, 4-spored. pyriform, pigmented, sterigmata up to 3 μm long. Pleurocystidia absent Gill edges fertile, cheilocystidia not striking in mature gills. Carpophore context homolomerous.

Pileus cuticle formed of loosely interwoven 3-6 µm broad pigmented hyphae. Pileustrama composed of tangled 3-15 µm broad weakly pigmented hyphae. Sub-hymenium cellular, gill trama irregular, made up of 6-19.5 µm broad pigmented hyphae. Stipe hyphae compact and parallel, 3-16 µm broad. Universal veil tissuehyphal, hyphae 3-16.5 µm broad, hyaline. Clamp connection absent throughout.

Chemical colour reactions: Schaeffer's reaction negative. Pileus surface and flesh turns yellowish in conc. HNO₃, brown to reddish brown in conc. H₂SO₄.

Collection examined: Punjab plains: Patiala (250 m), growing solitary along the road side under *Dalbergialatifolia*, Anil Gupta, PUN 1364, July 6, 1988.

Remarks: The present collection resemble in its features with *A. campester* as described by Pila't (1951). Its first report was by Mcrae (1910) from Pusa (Bihar) and later on it was reported from Pangri in Chamba district of Himachal Pradesh by Bose (1921) and from Calcutta in West Bengal by Banerjee (1947). Here it has been collected and described for the first time from Punjab plains.

Culinary properties: Mild flesh and fragrant odour. It is a common edible fungus.

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