

**FLORISTIC STUDIES ON SOME DARK-SPORED
AGARICS OF KERALA**

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for the Degree of*

DOCTOR OF PHILOSOPHY

by

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CERTIFICATE

This is to certify that the thesis entitled "**Floristic studies on some dark-spored agarics of Kerala**" submitted to the University of Calicut by **K. Agretious Thomas**, for the Degree of **Doctor of Philosophy in Botany**, embodies the results of bonafide research work carried out by him under my supervision and guidance and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title or recognition.

Manimohan. P
14-11-2000

P. Manimohan

DECLARATION

I hereby declare that the work presented in this thesis entitled "**Floristic studies on some dark-spored agarics of Kerala**" is original and carried out by me in the Department of Botany, University of Calicut, and has not been submitted earlier either in part or in full for any degree or diploma of any university.



K. Agretious Thomas

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INTRODUCTION

INTRODUCTION

In spite of exploratory studies spanning several centuries, we have not been able to unravel the entire fungal biodiversity of our planet. In fact, we know less than we thought we knew about the diversity of fungi around us. Although fungi are the second largest group of organisms in the world after insects, only 5 % of the world's fungi, 70,000 out of an estimated number of 1.5 million, are currently known (Hawksworth, 1991, Hawksworth & Rossman, 1997). Tropics are considered to be the largest repository of these unknown fungi as they encompass the largest range of climates and habitats on earth.

It is a sad reflection on Indian mycologists that, at a time when many countries are preparing red-data lists of endangered fungi (Arnolds, 1989, 1997; Ing, 1992, 1993; Courtecuisse, 1997), most parts of India, a major tropical country, still remain mycologically unexplored.

A bird's eye view of the literature on mycological research in India reveals that agarics (Agaricales, Basidiomycota) are one of the least-studied groups of fungi. In her updated list of agaricoid and boletoid basidiomycetes reported from India and Nepal, Manjula (1983) listed only 538 species of agarics. According to Watling and Gregory (1980), the British Isles with a landmass almost hundred times lesser than that of India, supported two thousand and five hundred species of mushrooms. The abysmally low figure of agaric species recorded from India, compared to that of the British Isles, very well depicts the present magnitude of ignorance about the diversity and distribution of this group of fungi in India.

Although Professors Natarajan, Sathe and Leelavathy and their students started systematic studies on the agarics of South India more than two decades back more or less simultaneously, the task of preparing a preliminary inventory of agarics of this region is far from complete. For example, Natarajan and Raman's (1983) landmark treatise on the dark-spored agarics of South India mentions only very few dark-spored mushrooms of Kerala, floristically the richest State.

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Though the white-spored mushrooms of Kerala have been comparatively well-documented by various workers, the dark-spored species, except for a few sporadic reports (Sathe & Sasangan, 1977; Sathe & Daniel, 1979, 1980; Bhavanidevi & Nair, 1987; Natarajan & Raman, 1983; Manimohan & Leelavathy, 1986; Watling, Little Flower & Leelavathy, 1988; Joseph, Abraham, Vrinda & Pradeep, 1995; Vrinda, Pradeep, Joseph & Abraham, 1996; Vrinda, Pradeep & Abraham, 1997 and Vrinda, Pradeep, Mathew & Abraham, 1997) remained neglected. This lacuna in our knowledge of dark-spored agarics of Kerala prompted the author to take up the present work.

This treatise presents the results of a preliminary floristic study of four dark-spored agaric families *viz.*, Bolbitiaceae, Strophariaceae, Cortinariaceae and Crepidotaceae of Kerala State. The author is acutely aware that this contribution is a feeble attempt to fill up an immense knowledge-gap.

MATERIALS AND METHODS

The agaric specimens for the present study were collected during a four-year period starting from 1996 by the present author, from different parts of Kerala. These collections were made mainly during the two monsoon seasons of each year.

Basidiomata of all stages were collected, whenever possible, as the morphological features like form, colour, velar characters and gill attachment will change during maturation. A field-note indicating the habit, habitat and date of collection of the mushroom was prepared for each collection. The odour and taste of the basidiomata were also recorded along with informations on the presence or absence of basal mycelium and basal bulb. In most cases, colour photographs of the specimens were also taken in the field.

After field study, collections were wrapped in paper and brought to the laboratory as early as possible. In the laboratory, macroscopic characters such as colour, size, and shape of the pileus, stipe, and lamellae were examined. Certain other characters like presence or absence of striations and scales on pileus and stipe surfaces, and mode of attachment and spacing of lamellae were also noted. All the observations were recorded in a systematic way.

Spore-prints, which are important for identification, were taken from fresh specimens on glass slides. For this, the stipe of the basidioma was cut off and the pileus placed on the slide with the lamellae facing downwards. It was then covered with a petri-dish to protect it from desiccation. After a few hours, the pileus was removed and the spore-print was air-dried. After recording the colour of the air-dried spore-print, it was stored in a refrigerator for further studies.

After studying the macroscopic features, the specimens were dried in a hot-air oven at 60°C. The properly dried specimens, along with a label indicating the date of collection and collection number, were kept in paper bags and stored in a refrigerator to avoid attack of insects and moulds.

Dried specimens were later used to study the microscopic details. Very thin free-

hand sections of the pileus and stipe cuticle and lamellae of the dried materials were made under a stereomicroscope using a razor blade. These dry sections were then revived in 3 % aqueous KOH and stained with 1 % aqueous solutions of phloxine and congo red. The stained sections were then mounted in 3 % aqueous KOH solution. Some of the dry sections were mounted in water to study colour of the various microscopical structures. Spores were examined in 3 % aqueous KOH, water, cotton blue and Melzer's reagent. All measurements and illustrations of microscopic structures were made from materials mounted in 3% aqueous KOH solution.

Basidiospores from spore-prints were measured to study the size range of spores. Rarely, in the absence of spore deposits, spores from the mature hymenium were measured. While expressing the spore measurements, the length is given first and the width second, and if the spores are lenticular, the depth (width in side view) is given following the width. Spore size ranges given are based on the measurements of 20 spores. The arithmetic mean of length and breadth was calculated by the formula $M_m = \frac{M_o}{n}$ where 'M_o' is the sum of observations and 'n' is the number of observations. The root mean square deviation was calculated by the formula, $\delta = \sqrt{\frac{\Sigma(M_m - M_o)^2}{n-1}}$. The ratio of the spore length to its width (Q) was calculated separately for each of the 20 spores and the average of these values was calculated and represented as 'Q_m'.

In the measurement of microscopic structures such as basidia, cystidia and epithelial cells, the entire range of the length is given first, then the range of width of the broadest part. In the case of hyphae of both hymenophoral and pileal trama, the range of width of the individual hyphae is given. Measurements of spores and other microscopical structures have been rounded up to the nearest 0.5 μm.

All the observations and measurements of the microscopic structures were made under an oil-immersion objective. Drawings of these structures were made with a mirror-type camera lucida.

The colour codes used in the description of the species are taken from Kornerup and Wanscher (1978).

Only the morphological species concepts have been adopted for species recognition in this work. Further, as Kuyper (1988) suggested, differences in at least two independent morphological characters were considered for recognition of species as new. The concepts of families and genera adopted in this treatise are those of Singer (1986).

In the systematic account, the name of author is given for all taxa when they are first mentioned. In all other parts of this treatise, however, names of taxa are not followed by names of authors except in titles and subtitles.

Owing to some error in film processing, over which the author had no control, the colour reproduction in some photographs is not 100% accurate.

All the collections mentioned in this treatise are deposited in the herbarium of Calicut University (CALI).

3A



PHYSIOGRAPHY, CLIMATE,
AND VEGETATION OF KERALA

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PHYSIOGRAPHY, CLIMATE, AND VEGETATION OF KERALA

Kerala lies in the extreme south-west corner of the Indian subcontinent, bordered by Karnataka State on the north, Tamil Nadu on the south and east and the Arabian Sea on the west. It lies between 8.2° and 12.8° north latitudes and 74.8° and 77.5° east longitudes. Kerala has an area of 38,864 Km² representing 1.18 % of the total area of India.

The Western Ghats form a mountain barrier in the east extending from north to south with a few breaks. The average height of these mountain ranges is about 900 m with some peaks reaching up to 2680 m. Based on the topography, Kerala is divisible into three geographical regions: Highlands, Midlands and lowlands. The highlands slope down westward from the Western Ghats with numerous valleys and gorges clothed with dense evergreen forest tracts. The midlands, lying between the mountains and lowlands, are made up of undulating hills and valleys. The lowlands or the coastal belt is composed of the river deltas, backwaters and the shore of the Arabian Sea. Both the midlands and lowlands are densely populated and are intensely cultivated.

There are 41 west-flowing rivers and three east-flowing rivers which pass across Kerala with their innumerable tributaries and branches. These rivers are Monsoon-fed and hence, may turn into rivulets in summer.

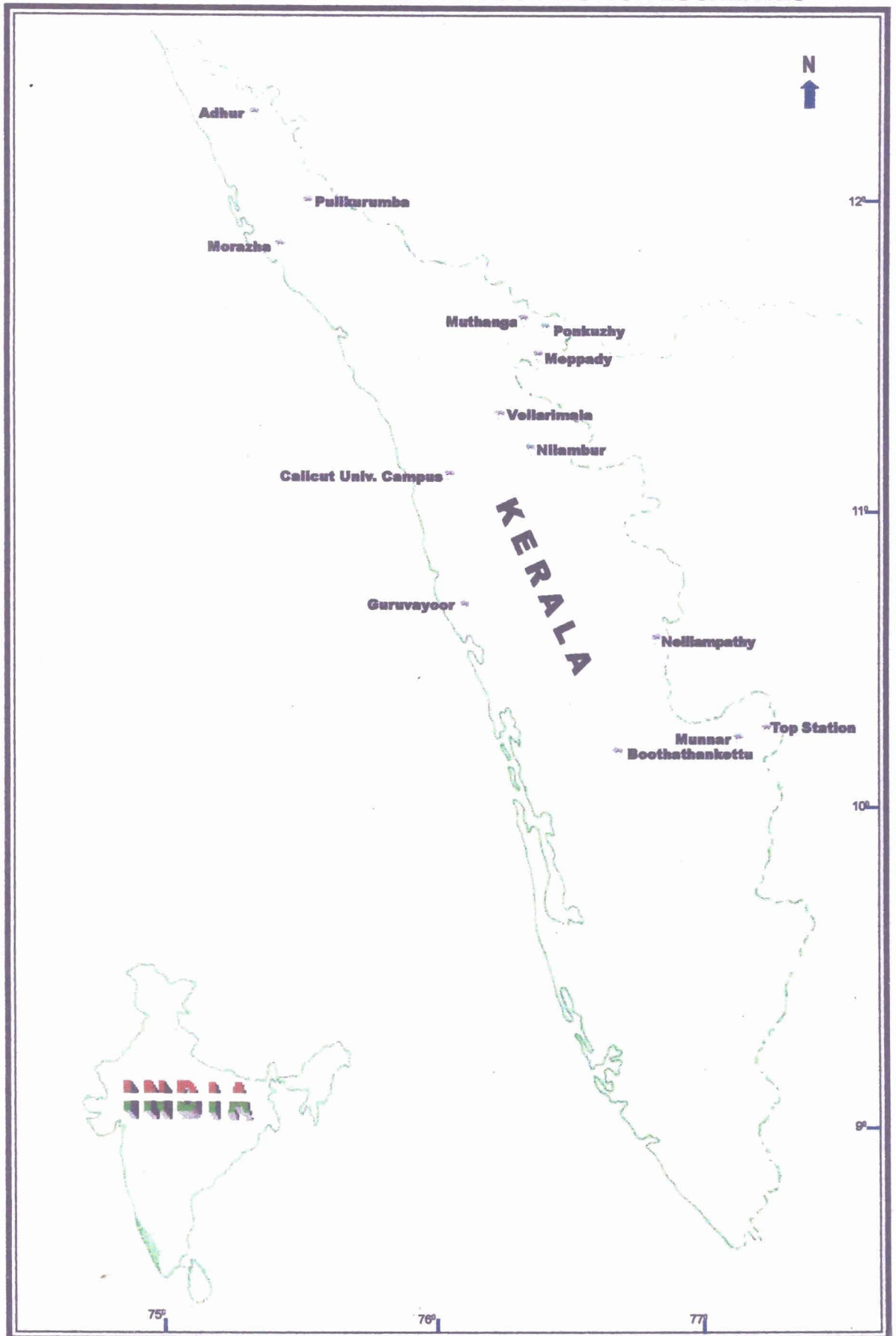
The tropical humid climate of Kerala with intermittent wet and dry periods is associated with two types of Monsoons, viz., South-west Monsoon and North-east Monsoon. The rainfall is distributed in these two Monsoons and generally extends from early June to middle of December with a comparatively less rainy interval in September and October. These Monsoon rains are generally abundant or sometimes torrential and may continue for a few days without a break. The South-west Monsoon first hits Kerala coast during June and continue showering till the end of August. These three months are the wettest period in Kerala. The North-east Monsoon, also called the Retreating Monsoon, extending from the October to the middle of December, brings comparatively less rain in Kerala. The mean

annual rainfall in Kerala is 300 cm. It varies from 100 cm in some parts of the plains to over 760 cm in the hills. The highest relative humidity varies from 100 in June to 80 in December and lowest from 78 in July to 48 in January. The temperature ranges between 24°C and 37.5°C in the plains and between 10°C and 32°C in the hills. The dry weather starts from middle of December and extends to early June.

Based on geographical and vegetational features, India is divided into a number of phytogeographic regions and Kerala falls in the Malabar region, which extends from southern Gujarat to Kanyakumari along the western side of the peninsula. The main distinctive characteristics of the Malabar flora are the presence of taxa belonging to families such as Clusiaceae, Dipterocarpaceae and Myristicaceae, presence of many species of bamboos and palms, and the abundance of species of Malayan type, especially taxa belonging to Sterculiaceae, Myrtaceae, Melastomataceae, Gesneriaceae, Piperaceae, Marantaceae, Cannaceae, Zingiberaceae, Musaceae, Orchidaceae and Araceae (Chandrasekharan, 1962).

About 10,000 Km² land area of Kerala State is under forest cover. All the major types of forests such as wet evergreen and semi-evergreen forests, tropical moist deciduous forests, tropical dry deciduous forests, montane subtropical and temperate shola forests and grasslands are found in Kerala (Manoharan, Uniyal, Sathish Kumar, 1997). Of these, dry type of forest is of limited occurrence in Kerala. Presently, 24 % of the total forest area is protected as conserved areas.

MAP OF KERALA SHOWING MAIN COLLECTION LOCALITIES



map?



REVIEW OF LITERATURE

REVIEW OF LITERATURE

BOLBITIACEAE Singer

The Bolbitiaceae was first recognized in the literature as a distinct group of fungi by Heim (1931). Singer (1936) at first gave a subfamily rank to it and later he (Singer, 1948) elevated it to the family level. It is generally considered as a well-defined, natural group of agarics. There are about 300 taxa in this family and they are found in all the continents except Antarctica (Watling, 1989). Many of the present members of the family Bolbitiaceae were earlier placed under the classical genera like *Pholiota*, *Naucoria*, *Galera* and *Inocybe*.

According to Singer (1986), the main characteristics of the family Bolbitiaceae are the following: lamellate hymenophore; epicutis of piriform or globose cells; hygrophorous pileus which often glistens when dry; bright (orange-) rusty, more rarely ochraceous (*Descolea*) or ferruginous-fuscous to tobacco brown (*Agrocybe* and some *Bolbitius*) or deep fuscous brown to blackish brown (*Agrocybe*) spore-print; smooth or rarely ornamented spores, usually with a broad truncate germ-pore except in some species of *Agrocybe* where the germ-pore is either narrow and often weakly or not truncate or entirely absent (*A. erebia* - group) and in *Descolea* where the germ-pore is replaced by a conspicuous, hyaline, snout-like callus; comparatively broader, 1 to 4-spored basidia; presence of cheilocystidia and occasional occurrence of pleurocystidia; fleshy to fragile stipe often having caulocystidia; and frequent occurrence of clamp-connexions, which is rarely absent in some species of *Bolbitius*, *Pholiotina* and *Agrocybe*.

The Bolbitiaceae is considered as a distinct family conspicuously differing from other dark-spored families like Coprinaceae, Strophariaceae and Cortinariaceae. The pileipellis in Bolbitiaceae is hymeniform and is quite different from the structure of pileipellis in Strophariaceae and Cortinariaceae. Further, majority of the members of the Bolbitiaceae are ephemeral, unlike the members of the two later families. The spore-print colour of some *Agrocybe* and *Conocybe* is dark or dusky as in some members of Coprinaceae like

Psathyrella and *Panaeolina*. But in *Psathyrella*, the spore pigment is partially soluble in H_2SO_4 as against the insoluble spore pigment in Bolbitiaceae. The genus *Panaeolina* differs from Bolbitiaceae in having ornamented spores.

Kühner (1980) reduced the family Bolbitiaceae to a tribe within the family Strophariaceae after incorporating *Panaeolus* therein, an extrapolation from Kühner and Romagnesi (1953) where *Panaeolus* was placed within *Conocybe* and its allies. Bas (1988) and Watling (1989) disagreed with Kühner's opinion and considered Bolbitiaceae as a natural and homogenous group of genera which deserves the rank of a family.

Watling (1965) included three agaric genera *Bolbitius*, *Agrocybe* and *Conocybe*, along with two gasteroid genera namely *Cyrtarophyllum* and *Gastrocybe* under this family. However, Singer (1986) accepted only the lamellate members representing six genera namely *Bolbitius*, *Galerella*, *Conocybe*, *Pholiotina*, *Agrocybe* and *Descolea* in this family.

Watling (1965, 1977a, 1982, 1989, 1992, 1994) adopted the genus *Conocybe* in its broad sense following Kühner (1935) and Orton (1960) and included the two genera, *Galerella* and *Pholiotina* as subgenera of *Conocybe*. However, the genus *Conocybe*, as accepted in this study, includes only *Conocybe sensu stricto*, and following Singer (1986), *Galerella* and *Pholiotina* are considered as autonomous entities having generic status.

Horak (1971b) and Watling (1977a) regarded *Descolea* as a distant relative of Bolbitiaceae after studying ornamentations and non-porous conditions of spores and considered it as closest to the genus *Rozites*. But Singer (1975, 1986) disagreed with their views, mainly because of the presence of hymeniform pileipellis and often non-mycorrhizal basidiomata in the genus *Descolea* in contrast to the non-hymeniform pileipellis and presence of ectotrophical mycorrhizal association in *Rozites* group of Cortinariaceae. Moreover, the spore ornamentation in *Descolea* is the same as that found in some species of *Pholiotina* and *Conocybe*. Further, absence of a germ-pore, as in *Descolea*, is known in some other members of Bolbitiaceae.

During the present study, Singer's (1986) concept of the family has been followed and species belonging to all the six genera recognized by him, i.e., *Descolea*, *Bolbitius*,

Agrocybe, *Pholiotina*, *Galerella* and *Conocybe* could be collected from various parts of Kerala.

Descolea Singer

Genus-concept

The genus *Descolea* was erected by Singer (1951b) based on *D. antarctica*. According to him the major characteristics of the genus are *Pholiotina*-like basidiomata; annuliform veil; frequent presence of universal veil on pileus and stipe; adnexed to emarginate lamellae; ellipsoid to amygdaliform or lemon-shaped spores with verruculose to verrucose exosporial ornamentation; absence of a broad truncate germ-pore in the spore and presence of an apical, often snout like mucro and an indistinct germ-pore or more commonly a callus; complex spore wall and well-developed perisporium; ochraceous or golden ochraceous spore-print; ocher-brown or melleous brown encrusting pigments; presence of mostly numerous or rarely sparse cheilocystidia; and hyphae with clamp-connexions.

Descolea shows similarity with a number of genera of other dark-spored families like Strophariaceae, Cortinariaceae and Crepidotaceae. However, a combination of three characters like hymeniform pileipellis, well-developed annulus and ochraceous spore-print separate *Descolea* from members of other families. *Descolea* is also strikingly similar to *Pholiotina* in several characters like presence of well-developed annulus, pileal striations and hymeniform pileipellis. However, in the genus *Pholiotina* (except *P. verrucispora*), spores are smooth and have an obvious germ-pore and there is no double veil as in *Descolea*.

Singer (1951b) initially placed *Descolea* between the two cortinariaceous genera *Leucocortinarius* and *Gymnopilus*, though there is no evident relationships between the former and the two later genera. Later, he (Singer, 1969, 1975, 1986) incorporated *Descolea* in the Bolbitiaceae close to *Pholiotina* after considering the typical hymeniform pileipellis, which is encountered in the Bolbitiaceae and interpreting the apical discontinuity of the spores as a narrow pore inserted in a protruding apex.

However, Horak (1971b) and Watling and Gregory (1981) retained the genus *Descolea* under Cortinariaceae and considered it as very different from the members of Bolbitiaceae

in spore characters. Within Cortinariaceae, they proposed to insert *Descolea* near *Rozites* as these two genera share some similar characters. At least some species of *Descolea* like *D. recedens* are considered to be mycorrhizal, in contrast to the purely saprophytic non-mycorrhizal agarics of Bolbitiaceae. Further, the spore structure and the basidioma development are also very different in *Descolea* compared to those found in Bolbitiaceae (Watling, 1989). Bas (1988) also agreed with this view and advocated placement of *Descolea* in the Cortinariaceae near *Rozites*. However, as Singer (1986) documented, in the *Rozites* group of the Cortinariaceae, species with hymeniform pileipellis are totally absent and all the species are ectotrophically mycorrhizal as against the occurrence of hymeniform pileipellis and mostly non-mycorrhizal basidiomata in *Descolea*.

Characters used in taxonomy

The major characters which are of taxonomic value in species delimitation in the genus *Descolea* are size and shape of the basidiomata; colour and viscosity of the pileus surface; nature of velar remnants; presence or absence and nature of scales or veil remnants at the stipe base; size of the spores; and presence or absence of associations with trees (Horak, 1971b).

Infrageneric classification

So far nobody has proposed any system of infrageneric classification in the genus *Descolea*.

Ecology

Members of the genus *Descolea* are generally found on the ground among fallen leaves, woody particles or mosses or on naked earth or rarely on dead wood. They occur mostly in the forests or at least near the trees (Singer, 1986). Singer (1951b, 1955, 1969) and other authors (Horak, 1971b, 1980b, 1983; Yokoyama *et al.*, 1979) reported possible mycorrhizal association of the genus *Descolea* with trees. According to Horak (1971b) most species of the *Descolea* show at least facultative ectotrophic associations with trees belonging to Fagaceae, Myrtaceae and Pinaceae. Later, Singer (1975, 1986) altered his previous opinion and considered *Descolea* as not ectotrophically mycorrhizal. However,

Bougher and Malajczuk (1985) confirmed the ability of *D. maculata* to initiate ectomycorrhizal associations with *Eucalyptus* spp. under both sterile and non-sterile conditions.

World distribution

Most species of the genus *Descolea* are mainly known from South temperate zone and East Asia. They are believed to have migrated from their endemic habitats in the Southern Hemisphere to the Northern Hemisphere.

Horak (1971b) revised the genus *Descolea* and gave a key for the determination of the species known. As it is a very small genus, only very few accounts are available on the distribution of the species: **South America:** Argentina (Singer, 1969; Horak, 1971b), Chile (Singer, 1969; Horak, 1971b); **Europe:** Denmark (Bougher & Malajczuk, 1985); **Australia and Pacific Islands** (Singer, 1955, 1969; Horak, 1971b; Bougher & Malajczuk, 1985); New Zealand (Horak, 1971b, 1980b); Papua New Guinea (Horak, 1980b); **Asia:** Japan (Horak, 1971b); Korea (Yokoyama *et al.*, 1979); Siberia (Horak, 1971b).

The only known species of *Descolea* from India is *D. pretiosa*, reported by Horak (1971b) from the foothills of the Himalayas of the State of Himachal Pradesh.

Economic importance

Some species of *Descolea* like *D. maculata* are considered to be ectomycorrhizal (Bougher & Malajczuk, 1985).

***Bolbitius* Fries**

Genus-concept

The genus *Bolbitius* was erected by Fries (1838) with six species. The distinctive features of this genus are the delicate, mostly somewhat deliquescent, coprinoid basidiomata, viscid pileus surface, plicate-sulcate or pectinate pileus margin, brightly coloured vacuolar pigmentation of the pileus, weakly deliquescent lamellae, mostly white or whitish stipe surface, absence of an annulus, bright ferruginous (as in *Conocybe*) or more brown (as in *Agrocybe*) spore-print, smooth, truncate spores with broad germ-pore, absence of lecythiform cheilocystidia and regular hymenophoral trama (Singer, 1986).

Although the genus *Bolbitius* shows close resemblances with *Conocybe*, *Galerella*

and *Pholiotina*, this genus differs from latter genera in having viscid and, as in some coprini, plicate-sulcate pileus and usually white or whitish stipe even near the base. Further, *Bolbitius* can be easily distinguished, as it possesses regular hymenophoral trama, not-abruptly-capitate cheilocystidia, and often slightly deliquescent lamellae.

Characters used in taxonomy

The major characters which are used in the species segregation in the genus *Bolbitius* are the colour of the pileus and the habitat preferences (Watling, 1982). The size of the basidiomata is usually variable but can be critical in taxonomic delimitation as in the separation of *B. lacteus* and *B. pluteoides*. Shape of the pileus varies from companulate, cylindrical to ellipsoid and finally becoming convex or fully expanded. Spores are thick-walled with a broad germ-pore. The spore-size is also valuable in the species delimitation. Spores in the subgenus *Pluteolus* are smaller compared to those in the subgenus *Bolbitius*. The pleuro- and cheilocystidia are not well differentiated in the genus *Bolbitius*. In some species pleurocystidia are totally absent (Watling, 1982). The nature of pileipellis is also useful in the separation of the groups and species. In the subgenus *Bolbitius*, the pileipellis is strictly cellular where as in the *Pluteolus* some cells swell to form articulated chains resembling 'Opuntia-pads' (Watling, 1982). Caulocystidia are found to be present in some species.

Infrageneric classification

Watling (1982) considered two subgenera under the genus *Bolbitius viz.*, *Bolbitius* and *Pluteolus*. In the subgenus *Bolbitius*, the fruit bodies are with shades of yellow, pink, cream or rarely white and they inhabit straw, dung, wood, heaths or sand dunes. In contrast, in the subgenus *Pluteolus*, the pileal surface is pale grey, lilaceous, violaceous, grey lilaceous or livid vinaceous and the basidiomata occur on woody debris or on soil under dense shade.

Singer (1986) studied 13 species of this genus and he placed all the species under two stirps namely *Reticulatus* and *Vitellinus*. According to him, the stirps *Reticulatus* is characterized by bright ochraceous rusty spore-print and absence of yellow or pink pigment on the basidiomata, where as the stirps *Vitellinus* represents ochraceous rusty or dull argillaceous-brown spore-print and often white, yellow or pink basidiomata. Members of the

Reticulatus are generally found on wood and those of the *Vitellinus* are found in pastures, on dung or sawdust.

Ecology

All the members of the genus *Bolbitius* are saprophytic and occur on dung, humus, rotten trunks of trees, sawdust, and earth, preferably on swampy and sandy soils (Singer, 1986). They are usually found inside and outside the woods and forests.

World distribution

Species of *Bolbitius* are considered to be cosmopolitan in distribution (Singer, 1986), but it is comparatively little known from various parts of the world. Singer (1978) published a key to many of the widespread species of *Bolbitius*. Watling and Gregory (1981) listed 30 species of *Bolbitius* in their census catalogue of world members of the *Bolbitiaceae*. Their geographical distribution covers areas such as **North America** (Watling, 1977b); U S A (Watling, 1975a; Watling & Bigelow, 1983); **Central America and West Indies**: Lesser Antilles Pegler, 1983); **South America** (Singer, 1969); Brazil (Watling, 1992); **Europe** (Phillips, 1981); Denmark (Watling, 1983b); Hungary (Babos, 1976); Switzerland (Brietenbach & Kränzlin, 1995); **Africa**: East Africa (Pegler, 1977); **Australia and Pacific Islands** (May & Wood, 1997); New Zealand (Watling & Taylor, 1987) and **Asia**: Japan (Imazeki, Otani & Hongo, 1988); Malaysia (Watling, 1994); Sri Lanka (Pegler, 1986).

Manjula (1983) listed two species of *Bolbitius* viz., *B. flavellus* and *B. vitellinus* from India. Of these, the former species was reported from the State of Uttar Pradesh by Singh and Tewari (1976). Natarajan and Raman (1983) reported a species, *B. aleuriatus* (which according to Watling, Little Flower and Leelavathy, 1988, is *B. reticulatus*) from Tamil Nadu State. Watling *et al.* (1988) reported probable occurrence of two more species in India viz., *B. acer* and *B. variicolor*. So far none of the species of *Bolbitius* is known from the State of Kerala.

Economic importance

Economic utility of this genus is not known.

Agrocybe Fayod

Genus-concept

The genus-name *Agrocybe* was introduced by Fayod (1889). Many of the species currently included in the genus *Agrocybe* were originally placed as species of genera *Pholiotina* and *Naucoria*. The distinctive characters of the genus are: collyboid or sometimes tricholomatoid, non-deliquestent, dull coloured, and fleshy basidiomata; humid, tacky or dry and smooth or slightly wrinkled, non-sulcate-plicate pileus surface; presence of long, white mycelial cords attached to the stipe base; snuff, hazel or brown spore-print; presence of either broad and truncate or narrow and non-truncate germ-pore on the spores; and presence of vacuolar sap in the hymeniform cells of the pileipellis (Watling, 1982).

Agrocybe shows some resemblances to some species of Strophariaceae but the hymeniform pileipellis in *Agrocybe* is quite different from the pileipellis in such members of Strophariaceae, although the hymeniform pileipellis is often distorted in some members of *Agrocybe*. Species of *Agrocybe* which lack a distinct germ-pore have both a strictly hymeniform pileipellis and pleurocystidia and hence it is not difficult to distinguish them from *Simocybe*, *Pholiota* or *Phaeomarasmius*.

In a few species of *Agrocybe*, the spore-print is dark or dusky enough to make one think of Coprinaceae-members like *Psathyrella* and *Panaeolina*. But, the species of *Psathyrella* can be easily excluded as the spore pigment in them are partially soluble in H_2SO_4 , and in *Panaeolina*, the spores are strictly ornamented compared to the smooth spore wall in *Agrocybe*.

Characters used in taxonomy

The size of the fruit body in *Agrocybe* ranges from medium to large and is often variable in a single species although it has restricted application in distinguishing some species like *A. pusilla* and *A. subpediata*. The pileus is usually semiglobate or convex which often expands. The presence or absence of a veil in the form of an annular ring is an important character in species segregation (Watling, 1982). The presence or absence of a distinct apical germ-pore in the spore is another valuable character used in species

segregation. The germ-pore is either broad and truncate or narrow and non-truncate. In some species, majority of the spores are without pores and in some others, spores with 2-3 germ-pores are occasionally found (Singer, 1986). Usually basidia are 4-spored, but when 2-spored basidia are encountered, it is considered to be significant as in *A. erebia* (Watling, 1982). The cheilocystidia are always present in *Agrocybe* and are vesiculose to lageniform or cylindric. The presence or absence of pleurocystidia is also useful in the delimitation of the species (Watling, 1982). The pileus cuticle in *Agrocybe* consists of a single easily disorganising layer of pyriform to sphaeropedunculate cells, sometimes intermixed with cystidia like cells or thin flexuose hairs. Caulocystidia are also observed in some species of *Agrocybe*. In the annulate species, these caulocystidia are only found above the annulus (Watling, 1982). The habitat preferences of the *Agrocybe* members also play some role in the delimitation of the species.

Infrageneric classification

Singer (1975, 1986) subdivided the genus into two subgenera: *Agrocybe* and *Aporus*. The subgenus *Agrocybe* represents species with spores either distinctly truncate and with a broad germ-pore or scarcely truncate and with a very narrow germ-pore, paravelangiocarposly developing basidiomata, presence or absence of veil, mostly non-lignicolous habitat, and clamp-connexions. The subgenus *Aporus* is characterized by the presence or absence of a narrow or exceptionally broad germ-pore of spores, bivelangiocarposly developing basidiomata, annuliform veil, presence of conspicuous pleurocystidia, presence or absence of clamp-connexions and growth on earth, humus or wood. He further subdivided the subgenus *Agrocybe* into five sections namely, *Pediadeae*, *Agrocybe*, *Microspora*, *Allocystides* and *Evelatae* and the subgenus *Aporus* into two sections viz., *Velatae* and *Aporus*. A distinct veil is absent (but sometimes with a fugacious veil) in all the sections except in the section *Agrocybe* of the subgenus *Agrocybe*. In the section *Pediadeae* pleurocystidia are sparse or absent, or if present then basidiospores are >11.5 µm long with a prominent germ-pore whereas in the section *Evelatae* plurocystidia are usually present and basidiospores are = 10 µm long, with a narrow, incomplete or non-

truncate germ-pore which may even be absent in some. The section *Allocystides* is characterized by often early disintegrating pileipellis, capitate, thick-walled pleurocystidia, spores with broad truncate germ-pore and growth on dung and the section *Microsporae* possess conspicuous pleurocystidia and less than 13 μm long (usually smaller than 10 μm) spores which are truncated by a broad germ-pore. In the section *Agrocybe*, the veil leaves either a ring on the stipe or appendiculate velar remnants on the pileus margin, the basidiospores are with a broad truncate germ-pore and pleurocystidia are usually numerous and often large. In the sections *Velatae* and *Aporus* of the subgenus *Aporus*, veil forms either a ring on the stipe or an appendiculate remnants on the pileus margin. *Velatae* is further characterized by sepia or cigar-brown colour of fresh basidiomata, elongate, subfusiform basidiospores, presence of a reduced germ-pore or absence of a germ-pore, and terrestrial habitat. In the section *Aporus*, pileus surface is fulvous to brick-coloured or ochraceous when fresh, basidiospores are ellipsoid, and the basidiomata usually inhabit living or dead trees. Watling (1982) and Watling and Taylor (1987) followed the above system of classification.

Ecology

Agrocybe species are generally found on the ground or manured soil in woods, pastures or heaths and sometimes on dung and plant remains or wood (Watling, 1982). *Agrocybe cylindrica* and its allies are truly lignicolous and have a strong ability to utilize woody substrates (Watling, 1989). The development of *A. parasitica* on wounds of an array of trees in New Zealand suggests its affinity for living materials (Watling, 1989).

World distribution

The genus *Agrocybe* is known from various parts of the world. Singer (1978) and several other authors published keys to the species of *Agrocybe* known to them. Watling and Gregory (1981) reported 84 species of *Agrocybe* for the whole world. The worldwide distributional data on *Agrocybe* includes the following reports: **North America** (Watling, 1975b, 1977b; Phillips, 1991); U S A (Watling & Bigelow, 1983); **Central America and West Indies**: Lesser Antilles (Pegler, 1983); **South America** (Singer, 1969); Argentina (Watling,

1992); Brazil (Watling, 1992); **Europe** (Phillips, 1981); Denmark (Watling, 1983b); Italy (Contu, 1987b); Netherlands (Bas, 1958; Nauta, 1986); Norway (Watling, 1988a); Switzerland (Breitenbach & Kranzlin, 1995); **Africa**: East Africa (Pegler, 1977); **Australia and Pacific Islands** (May & Wood, 1997); New Zealand (Watling & Taylor, 1987); **Asia**: China (Yang, Zang & Liu, 1993); Japan (Imazeki, Otani & Hongo, 1988); Malaysia (Watling, 1994); Sri Lanka (Pegler, 1986).

Manjula (1983) in her revised list of agaricoid and boletoid basidiomycetes from India and Nepal keyed out eight Indian species of *Agrocybe* known from various states. These include *A. molesta*, *A. cylindracea* (or as *A. cylindrica* in later reports), *A. broadwayii*, *A. holophlebia*, *A. manihotis*, *A. pediades*, *A. praecox* and *A. semiorbicularis*. Sathe and Kulkarni (1980) and Saini and Atri (1982) reported two more species *A. karnatakensis* and *A. cubensis* respectively from the Indian subcontinent. Natarajan and Raman (1983) added two additional species, *A. fimicola* and *A. retigera*, to the Indian records from the State of Tamil Nadu. Later, Watling and Abraham (1986) studied Bolbitiaceae of Jammu and Kashmir State and they added four more species viz. *A. aporata*, *A. indica*, *A. subamara* and *A. vervati* to the Indian records, of these the first two species were new to science. The only species previously known from Kerala State is *A. manihotis* (Natarajan & Raman, 1983).

Economic importance

Several species of *Agrocybe* are good edible mushrooms (Singer, 1986). Species like *A. cylindrica*, *A. praecox* and *A. molesta* are excellent edible mushrooms with the first quoted probably being the first edible agaric ever domesticated (Abraham & Nair, 1987). *A. aegerita* is available in the markets, especially in Italy and Chile (Singer, 1986). *A. dura* and probably *A. vermiflua* contain an antibiotic, agrocybin (Singer, 1986).

Pholiotina Fayod

Genus-concept

It was Fayod (1889) who erected the genus *Pholiotina*. He treated *Conocybe* and *Pholiotina* as independent genera. The main characteristic features of this genus are typically robust basidiomata with a fairly fleshy pileus and sturdy stipe; frequent presence of veil

which often forms a thick, deeply sulcate, free annulus; cocoa-brown or even brighter ferruginous (more or less rusty) spore-print; presence of smooth spores (except in two ornamented species, *P. subnuda* and *P. verrucispora*); absence of not abruptly capitate cheilocystidia (except in the section *Intermediae*); presence of a well-developed mediostratum consisting of inflated cells in the hymenophoral trama; and the presence or occasional absence of clamp-connexions (Singer, 1986).

The genus *Pholiotina* shows close affinity with *Conocybe*. But in *Pholiotina*, the hymenophoral trama is with a broad mediostratum consisting of inflated cells and flanked on either side by narrow hyphae whereas in *Conocybe*, the mediostratum is almost obliterated with broader hyphae on both the sides. Moreover, in *Pholiotina*, veil is much more developed than in all species of *Conocybe* (except in a few species of *Conocybe* like *C. subvelate*), and the cheilocystidia are non-capitate. Kühner (1935), Orton (1960), Romagnesi (1968), Kits van Waveren (1970) and Watling (1965, 1971, 1982, 1992, 1994) and some others treated *Pholiotina* as a subgenus of the genus *Conocybe*, as the differences between these two groups are rather insufficient to consider them as separate entities. However, Singer (1936, 1951a, 1962, 1975, 1986), Moser (1983) and many other authors disagreed with this view and treated *Conocybe* and *Pholiotina* as independent genera following Fayod's (1889) original concept.

Characters used in taxonomy

In *Pholiotina*, size, colour and viscosity of the basidiomata are considered as valuable characters of taxonomic significance (Singer, 1986). Pilei are generally moist when young and are often dark reddish brown, which soon disappears and form some shade of brown and eventually pale brown, when the process of drying out is over. Remoistening of the pileus brings back some of the brown colour but never the reddish colour. This process of remoistening will never give back original shade of brown in *Conocybe* (Kits van Waveren, 1970).

Moist pileus of all species of *Pholiotina* is striate, mostly beyond half way to the centre. The extent to which pileus is striate depends largely on the degree of drying out and

varies greatly even within the same species. Therefore the degree of striation cannot be considered as a character of any taxonomic significance, even though Kühner (1935) used this character in his key to the subgenus *Pholiotina*. In certain specimens of species like *P. filaris*, *P. arrhenii* and *P. aporos*, the pileus surface is definitely veined and rugulose, but this feature has no taxonomic significance (Kits van Waveren, 1970).

Members of *Pholiotina* are either annulate or exannulate with white remnants of the veil on the pileus margin. But the dividing line between these two groups is not sharp (Kits van Waveren, 1970). However, Singer (1986) used the presence or absence of annulus and the degree of development and nature of veil as important characters in taxonomic segregation.

In his key to the annulate species of *Conocybe*, Orton (1960) gave some emphasis on the presence or absence of floccose scales on the stipe surface below the annulus. However, Kits van Waveren (1970) gave least importance to this character in species delimitation. Smell of the basidiomata is also useful in some species like *P. aporos* which has a distinct smell of pelargonium.

Spores are generally ellipsoid or slightly amygdaliform in shape and are yellow with a trace of red in water (Kits van Waveren, 1970). The spore-size and presence or absence of ornamentations of spores is often useful in species delimitation (Singer, 1986). The apiculus is usually small but distinct. Although spores in most species are with a distinct germ-pore, *P. aporos* is without a germ-pore and in *P. arrhenii*, germ-pore is very inconspicuous. Basidia are mostly 4-spored. However, basidia in *P. teneroides* are 2-spored. In some species like *P. filaris* and *P. arrhenii*, 4-spored and 2-spored basidia occur adjacent to each other (Kits van Waveren, 1970).

The size, morphology and distribution of cheilo-, pileo- and caulocystidia are very useful in the segregation of groups in the genus *Pholiotina* (Singer, 1986). The shape of the cheilocystidia is considered to be highly specific for each of the annulate species of *Pholiotina* and hence, is a major character for the delimitation of the species. The cystidia are generally colourless, thin-walled and in some, apices are with a thin layer of mucus (Kits van Waveren, 1970).

In *Pholiotina*, the hymenophoral trama is with a broad mediostratum consisting of inflated cells and flanked on both sides with filiform hyphae. The shape and size of the cells constituting the pileipellis vary considerably and are arrayed in a palisade-like manner. They are generally globose or sphaeropedunculate and in many species, base of these cells are thick-walled and brown whereas in others these are thin walled and hyaline. In some, small encrustations are found towards base. In fact, age of the specimens seems to be responsible for these differences, particularly in size and colour and thickness of walls of these cells and are considered to have least importance in species demarcation (Kits van Waveren, 1970).

Infrageneric classification

Singer (1986) placed the species of the genus *Pholiotina* under five sections *viz.*, *Piliferae*, *Cyanopodae*, *Intermediae*, *Verrucisporae* and *Pholiotina*. The species of section *Piliferae* are almost similar to *Conocybe* but they lack any abruptly capitate cheilocystidia and their hymenophoral trama are not *Conocybe*-type. In *Piliferae* the pileus is viscid to subviscid at times, veil is very indistinct, dermatocystidia are generally present and projecting as filiform elements beyond the hymeniform layer, spores are smooth walled and clamp-connexions are often absent. Species of the section *Cyanopodae* are psilocybin-producing and stain blue with age or when bruised. Further, in *Cyanopodae*, cheilocystidia are not abruptly capitate and the veil is poorly developed or absent. In the section *Intermediae*, veil is present and is often annuliform and the cheilo- and pileocystidia are capitate as in *Conocybe*. Species of the section *Verrucisporae* possess ornamented spores, cheilo- and dermatocystidia that are not abruptly capitate, and clamp-connexions. Finally, the section *Pholiotina* is characterized by non-viscid and non-bluing pileus; occurrence of veil which is often annuliform (then the annulus is deeply sulcate and eventually separating from the stipe) or appendiculate; cheilo- and dermatocystidia that are not abruptly capitate; smooth spores with homogenous wall; and frequent absence of pileocystidia.

Ecology

All the members of the genus *Pholiotina* are saprophytic and are found in and outside

of woods and forests. They grow on foliage or decayed wood, humus or earth (Singer, 1986).

World distribution

The genus *Pholiotina* is cosmopolitan in distribution. Singer (1986) enumerated 24 species of *Pholiotina* known to him. Reports on its geographical distribution include: **North America** (Watling, 1971; Phillips, 1991); U S A (Watling & Bigelow, 1983); **South America** (Singer, 1969; Watling, 1992); **Europe** (Kits van Waveren, 1970; Watling, 1971; Phillips, 1981; Hausknecht, 1993; Meusers, 1996); Austria (Hausknecht, Zuccherelli & Cetto, 1998); France (Watling, 1980a); Germany (Enderle, 1985, 1991b, 1996, 1997); Great Britain (Watling, 1980b); Norway (Watling, 1988a); Switzerland (Breitenbach & Kranzlin, 1995); **Australia and Pacific Islands** (May & Wood, 1997); New Zealand (Watling & Taylor, 1987); **Asia:** Malaysia (Watling, 1994).

Manjula (1983) listed only a single species, *Pholiotina filaris*, as known from India. This species was reported by Horak (1980b) from the state of Sikkim. In addition to the above species, Natarajan and Raman reported two more species, *P. teneroides* and *P. arrhenii* from Tamil Nadu. Species of this genus were not known from Kerala State prior to the present study.

Economic importance

The species *Pholiotina cyanopoda* contains psilocybin and hence, is considered to be hallucinogenic. The notorious species *P. filaris* contains amatoxins and is deadly poisonous (Benjamin, 1995; Stamets, 1996).

***Galerella* Earle**

Genus-concept

It was Earle (1909) who established the genus *Galerella*. This genus name is not widely used and its species are sometimes placed in the genus *Conocybe sensu lato*. Watling (1977a, 1982, 1992), a world authority on Bolbitiaceae, adopted a broad genus concept of *Conocybe* and included *Galerella* as a subgenus in the genus *Conocybe* following Kühner (1935) and Orton (1960). However, Moser (1983), Pegler (1977, 1983, 1986), and

Singer (1986) treat it as an autonomous genus.

The main characteristic features of this genus are conic to campanulate, dry plicate-sulcate pileus; thin, brittle stipe; rust-brown spore deposit; smooth spores with germ-pore; and non-capitate cheilocystidia (Moser, 1983).

The genus *Galerella* is very close to *Conocybe* and *Bolbitius*. However, it differs from *Conocybe* in the plicate-sulcate pileus and the non-capitate cheilocystidia and from *Bolbitius* in the non-viscid pileus and the smaller spores (Singer, 1986).

Characters used in taxonomy

Size, form, colour and surface features of the pileus, colour of the lamellae, size and surface characters of the stipe, size of the spores and characters of the cystidia are of taxonomic value in the genus *Galerella* (Moser, 1983).

Infrageneric classification

Presently, no system of infrageneric classification is available in the genus *Galerella*.

Ecology

All the species of *Galerella* known today are terrestrial. Generally, they prefer to inhabit meadows, parks and forests, especially after summer rains.

World distribution

Galerella occurs in temperate and subtropical regions of Northern and Southern Hemisphere (Singer, 1986). The genus is represented by only very few species. Their distributional areas include: **South America:** Brazil (Watling, 1992); **Europe** (Moser, 1983); Bavaria (Hausknecht, 1995c); Great Britain (Watling, 1982); Spain (Esteve-Raventos, 1988); **Australia and Pacific Islands** (May & Wood, 1997) and **Asia:** Sri Lanka (Pegler, 1986).

There are no previous reports on the occurrence of *Galerella* from Indian subcontinent.

Economic importance

Any economic utility of *Galerella* is unknown.

Conocybe Fayod

Genus-concept

The genus *Conocybe* was erected by Fayod (1889). This is the largest genus within the family Bolbitiaceae. The major characteristics of this genus are the slender, delicate, mycenoid, non-deliquestent and uniformly brown basidioma; cinnamon or rusty spore-print; and the presence of usually thick, smooth spore wall with distinct central germ-pore (Watling, 1982). Always the cheilocystidia are lecythiform and the mediostratum of the hymenophoral trama is highly reduced.

Conocybe is close to the genera *Galerella* and *Pholiotina*. But, the small genus *Galerella* can be easily distinguished from *Conocybe* as the former possesses pectinate pileus margin and non-capitate cheilocystidia. The genus *Pholiotina* also can be separated as they have a well-developed veil either on the stem or at the pileus margin, non-lecythiform cheilocystidia, and a well-developed mediostratum in the hymenophoral trama.

Authors like Kühner (1935), Orton (1960), Watling (1965, 1977a, 1982, 1989, 1992, 1994), Watling & Taylor (1987) and some others treated the genera *Pholiotina* and *Galerella* under the genus *Conocybe* as its subgenera. However, Singer, (1986) and several others like Moser (1983) and Pegler (1986) gave an independent generic status to these groups.

Characters used in taxonomy

The basidiomata in the genus *Conocybe* vary from small to medium in size. Although their size is variable even within the same species it can be critical in the separation of some species. The form of the pileus can be companulate, cylindrical, ellipsoid, convex or rarely plano-convex. The colour of the pileus is an important feature used in the segregation of species (Watling, 1982). The pileus surface is smooth, wrinkled or pubescent and often striate to somewhat sulcate when moist. Pileus is hygrophorous and often glistening when dry. The veil is absent or slight on the margin of the pileus and none on the stipe. The stipe is central, elongate, thin and rarely thick-fleshy. Stipe surface is often villous, pubescent or pruinose from hairs or dermatocystidia and is white or coloured.

Spore-print varies from cinnamon to rust. The spores are smooth or faintly verrucose

or verruculose and vary in shape from limoniform, lentiform to ellipsoid. The difference in the spore-size is an important character used in the segregation of species (Watling, 1982). In the subgenus *Ochromarasmius* spores are ornamented (Watling, 1982; Singer, 1986). Basidia are generally broad and short and are variable in the number of sterigmata. Two spored members are frequent in *Conocybe* (Singer, 1986). The cheilocystidia are very characteristic and are lecythiform. The gross morphology and other details of the cheilocystidia are useful in the separation of the groups and species (Watling, 1982). The lamellae of the members of the *Tenera*-group, except *C. dunensis*, sometimes contain a substance that crystallizes in ammoniacal medium forming long, colourless, needle-like structures. Hymenophoral trama consists of a central narrow mediostratum formed of a few filamentous hyphae, which are flanked by the enormously developed hymenopodium consisting of voluminous elements, at least in the narrower lamellae and the outer one third of the normal hyphae. The pileipellis is cellular consisting of a layer of pyriform to subglobose cells sometimes intermixed with cystidia-like cells and frequently with long, flexuous, hyaline hairs as in *C. pubescens* and *C. pilosella* (Watling, 1982). The stipe cortical tissue produces cystidia in all species of the genus at the stipe apex and in subgenus *Conocybe* these extends to the stipe base. These sterile cells are either similar in morphology to the cheilocystidia or have a rather different morphology (Watling, 1982). In the subgenus *Conocybe* details of the caulocystidia are very essential in the segregation of the species (Watling, 1982). Usually all the hyphae are with clamp-connexions.

Infrageneric classification

Watling (1982) subdivided the genus into five subgenera namely *Conocybe*, *Ochromarasmius*, *Galerella*, *Piliferae* and *Pholiotina*. According to him all the subgenera except *Pholiotina* lack velar remains on the stipe or at pileus margin. In the subgenera *Ochromarasmius* and *Conocybe* cheilocystidia are lecythiform, but the spores are distinctly roughened in the former and perfectly smooth in the latter. But, in the subgenera *Galerella* and *Piliferae* cheilocystidia are never lecythiform and are variously shaped. In *Galerella* the pileus is plicate-striate and the cheilocystidia possess a long flexuous neck, whereas in

Piliferae pileus is never plicate and its cheilocystidia lack a long neck. He (Watling, 1982) further subdivided the subgenus *Conocybe* into six sections: *Giganteae*, *Candidae*, *Pilosellae*, *Conocybe*, *Nodulosporae* and *Singerella*. According to him, the section *Giganteae* is characterized by large, *Cortinarius*-like *basidiomata* which reach up to 60 mm diameter and lentiform to maize-seed shaped spores. Members of the section *Candidae* have white or cream coloured deliquescent *basidiomata*. The section *Pilosellae* is characterized by distinctly coloured *basidiomata* and a stipe vesture composed of a mixture of ellipsoid, lageniform or ovoid cells with or without long flexuous cells. In the sections *Conocybe* and *Nodulosporae* caulocystidia are either lecythiform or a mixture of lecythiform and long flexuous cells. Spores are nodulose, lobed or irregular in outline in *Nodulosporae* in contrast to regular outline in *Conocybe*. Members of the section *Singerella* have *basidiomata* with volvate stipe base.

Singer (1986) considered two subgenera namely *Conocybe* and *Ochromarasmius* under the genus *Conocybe*. In the subgenus *Conocybe*, the spores are smooth and larger than 6 μm and the stipe is fragile and rather soft. In the subgenus *Ochromarasmius* spores are distinctly warty or punctate from an exoporsorial ornamentation and small, sometimes reaching less than 6 μm and the stipe is thin and sometimes rather firm and is generally covered with numerous capitate dermatocystidia. He further subdivided the subgenus *Conocybe* into sections like *Conocybe*, *Nodulosporae*, *Mixtae*, *Pilosellae*, *Candidae* and *Giganteae*. In the section *Conocybe*, the stipe surface is entirely covered with lecythiform caulocystidia and the spores are always smooth-walled. The stipe surface in both the sections *Nodulosporae* and *Mixtae* are covered with lecythiform caulocystidia intermixed with non-capitate caulocystidia and long, hyaline hairs. In *Nodulosporae* spores are nodulose in comparison with smooth spores in *Mixtae*. In the section *Pilosellae*, stipe surface is not entirely white and is strongly pubescent with numerous hair-like hyphal elements and are devoid of lecythiform caulocystidia. As in the section *Pilosellae*, the stipe surface of the species of *Candidae* is strongly pubescent but in the latter section the stipe surface is white coloured. The section *Giganteae* is characterized by very stout, white coloured stipe and a stipe vesture composed of lecythiform caulocystidia with or without hairs.

Ecology

All the members of the genus *Conocybe* are saprophytic. They are found on the ground in woods, pastures, green houses, gardens, etc. and on dung. Rarely, they seem to be directly attached to plant remains or vegetable refuse (Watling, 1982).

World distribution

The genus *Conocybe* is considered to be cosmopolitan in distribution (Singer, 1986). Kühner's (1935) annotated account 'Le genre *Galera*' laid down the foundation of modern studies in the genus *Conocybe*. Singer (1986) admitted 54 species in this genus. Watling and Gregory (1981) listed all the species of *Conocybe* known from the whole world. Several monographic keys representing regional or world members of *Conocybe* are available (Moser, 1983; Enderle, 1991a; Hausknecht, 1996; Meusers, 1996). Various floristic accounts available on this genus include: **North America** (Watling, 1975b, 1977b, 1977c; Phillips, 1991); Greenland (Watling, 1977d); U S A (Watling & Bigelow, 1983); **Central America and West Indies**: Lesser Antilles (Pegler, 1983); **South America** (Singer, 1969); Brazil (Watling, 1992); **Europe** (Watling, 1977c, 1980a, 1983a, 1986; Phillips, 1981; Singer & Hausknecht, 1992; Meusers, 1996; Hausknecht, 1993, 1995c, 1996, 1998a, 1998b, 1999); Austria (Singer & Hausknecht, 1988, 1989; Hausknecht & Krisai-Greilhuber, 1992; Hausknecht, 1995a, 1995b; 1995d; Hausknecht, Zuccherelli & Cetto, 1998); Bavaria (Hausknecht, 1995b); Denmark (Watling, 1983b); Finland (Harmaja, 1979); Germany (Enderle, 1985, 1991a, 1991b, 1996, 1997); Great Britain (Watling, 1980b); Italy (Hausknecht & Enderle, 1992; Hausknecht, 1995d); Norway (Watling, 1988b); Spain (Watling, Esteve-Raventos & Moreno, 1986; Esteve-Raventos, 1988); Switzerland (Brittenbach & Kranzlin, 1995); **Africa**: East Africa (Pegler, 1977); Mauritius (Watling & Hausknecht, 1997); Tanzania (Hausknecht & Krisai-Greilhuber, 1998); **Australia and Pacific Islands** (May & Wood, 1997); New Zealand (Watling & Taylor, 1987); **Asia**: Japan (Imazek, Otani & Hongo, 1988); Malaysia (Watling, 1994); Sri Lanka (Pegler, 1986).

Many species of *Conocybe* are known from India. Manjula (1983) listed six species viz., *C. zeylanica*, *C. lactea*, *C. tenera*, *C. siennophylla*, *C. magnicapitata* and *C. khasiensis*

from various states of India. Sathe and Deshpande (1980a) described another species *C. pubescens* from Maharashtra State. Watling and Abraham (1986) added five species viz., *C. glabra*, *C. magnispora*, *C. moseri*, *C. subpubescens* and *C. cf. Tetraspora* to the Indian records from the state of Jammu and Kashmir. Natarajan and Raman (1983) reported eight species of *Conocybe* namely *C. pilosella*, *C. aurea*, *C. ambigua*, *C. semiglobata*, *C. rickenii*, *C. fragilis*, *C. plumbeitincta* and *C. ochracea* from southern India of which *C. pilosella* was collected from Kerala State. Watling, Little Flower and Leelavathy (1988) studied *Conocybe* species of Kerala State and reported occurrence of a number of species like *C. magnicapitata*, *C. mesospora*, *C. pseudopilosella*, *C. pubescens*, *C. semiglobata*, *C. kuehneriana*, *Conocybe* sp. (sect. *Conocybe*), *C. magnispora*, *C. siennophylla*, *C. zeylanica* and *Conocybe* spp. (sect. *Pilosellae*).

Economic importance

Some members of the *Conocybe* like *C. cyanopus*, *C. smithii*, *C. siligineoides* and *C. kuehneriana* are psilocybin-active (Stamets, 1996). *Conocybe rugosa* and other related species are considered to contain amatoxins (Benjamin, 1995).

STROPHARIACEAE Singer & Smith

It was Singer and Smith (1946b) who established the family Strophariaceae. The main characteristic features of the Strophariaceae are the following: pileipellis either a cutis, ixocutis or a trichodermium, or with hyphal strands bundled together to form scales, or of sphaerocyst-chains with strong pigment encrustations; lamellar attachment never truly free; spore-print deep lilac, lilac, violet brown, tobacco brown, clay or ferruginous brown; spores constantly quite smooth with even outline under the oil immersion objective of light microscope, never verrucose, usually with more or less broad and often distinctly truncate germ-pore; hilum of open pore type; spore walls always bi- or tristratous and homogenous; cheilocystidia always present and pleurocystidia frequently belong to chrysocystidioid type; clamp-connexions are constantly seen; and none are ectomycorrhizal (Singer, 1986).

Dark-spored families like Cortinariaceae, Coprinaceae and Bobitiaceae show some

resemblances to Strophariaceae. But Cortinariaceae differs from the Strophariaceae by being ectomycorrhizal with smooth or ornamented spores or non-ectomycorrhizal with usually ornamented spores. Coprinaceae and the Bolbitiaceae are easily distinguishable from Strophariaceae by their cellular or hymeniform pileipellis in contrast to the hyphoid cuticle in the Strophariaceae. The family Galeropsidaceae also shows similarity with Strophariaceae but differ as they possess apobasidia and not producing spore-print (Singer, 1986).

Singer (1975, 1986) subdivided the family into two subfamilies, Stropharioideae and Pholiotoideae, based purely on spore-print colour. He placed those with spore-print colour ranging from violet to chocolate-brown under the subgenus Stropharioideae and those with dull cinnamon to clay-colour under Pholiotoideae. He considered these subfamilies as natural units. However, Smith (1979) questioned the reliableness of this separation as he could study a large number of species having intermediate colour range. Singer (1986) included four genera, viz. *Stropharia*, *Naematoloma*, *Psilocybe* and *Melanotus* under the subfamily *Stropharioideae* and five genera namely, *Pleuroflammula*, *Pachylepyrium*, *Kuehneromyces*, *Phaeomarasmius* and *Pholiota* under *Pholiotoideae*.

Kühner (1980) transferred the cortinariacean genera *Gymnopilus*, *Galerina* and *Phaeocollybia* to the Strophariaceae. He made such a transfer mainly based on the occurrence of styrylpyrones in *Gymnopilus*. Styrylpyrones are a type of pigment which are common among different species of Strophariaceae and probably absent in other genera of Cortinariaceae. He took *Galerina* along with *Gymnopilus* only because of some similarities between the spores of *Gymnopilus* and *Galerina*, and *Phaeocollybia* as it shares some spore characters with *Galerina*. Bas (1988) disagreed with Kühner's concept and considered this transfer as undesirable due to various reasons.

Kühner (1980) reduced the family Bolbitiaceae to a tribe under Strophariaceae and also included members of the subfamily Panaeoloideae along with Strophariaceae. In addition, he shifted three crepidotacean genera viz., *Crepidotus*, *Simocybe* and *Tubaria* to Cortinariaceae without mentioning anything about the genera, *Melanomphalia* and *Pleurotellus*.

The different genera of the family Strophariaceae are afflicted with a number of taxonomical and nomenclatural problems and are treated differently by different authors. Smith (1979) and Kühner (1980) questioned the validity of using pleurocystidial and hypodermial features as the primary characters at generic level and they proposed the merging of closely related genera, which will finally leave a bigeneric Strophariaceae, represented by *Pholiota* and *Psilocybe sensu lato*. Noordeloos (1995) accepted the generic concepts conceived by them and recognized two genera *Psilocybe* (comprising *Psilocybe sensu stricto*, *Stropharia*, *Hypholoma* and *Melanotus*) and *Pholiota* within the family Strophariaceae.

In the present study, Singer's (1980) concepts of the family and genera are followed and species belonging to five genera of the Strophariaceae viz., *Pholiota*, *Stropharia*, *Hypholoma*, *Psilocybe* and *Melanotus* were collected from various parts of Kerala State during the present study.

Pholiota (Fries) Kummer

Genus-concept

The name *Pholiota*, etymologically originated from the Greek word 'pholis' which means scale, was coined by Fries (1821) in his 'Systema Mycologicum' for a tribe of the genus *Agaricus*. He included 16 species, all having rusty spore-print and annulate veil, under the tribe. In the same publication he erected another tribe, *Flammula*, for 15 species having fagacious veil and smooth pileus.

Kummer (1871) assigned generic ranks to the Fresian tribes *Pholiota* and *Flammula*. Quélet (1886), combined the two genera, proposed a new epithet, *Dryophila*, for the genus, and maintained *Pholiota* and *Flammula* as subgenera under this genus. Ricken (1915), Rea (1922), Bresadola (1930) and Lange (1938), however, maintained these two genera as distinct and in their original sense.

When agaricologists began to give emphasis to microscopical characters of these two genera it became clear that they could no longer maintain them as separate. Singer and Smith (1946a) expressed the view that generic differences between the *Pholiota* and

Flammula were too small to justify their separation as distinct genera. They proposed a new genus *Kuehneromyces* for *Pholiota mutabilis* as it had spores with broad germ-pore, and hygrophanous basidiomata (Singer and Smith, 1946b). However, Smith and Hesler (1968) in their monograph treated it as a species of *Pholiota* under the section *Mutabiles* of subgenus *Hemipholiota*. Clemençon (1974) studied the wall-structure of the spores of both *Pholiota* and *Kuehneromyces* and concluded that the two genera are different, but closely related. Kühner (1980), however, proposed to reunite *Kuehneromyces* with *Pholiota*, as according to him there is no significant hiatus between these two genera. After culturing different species, Jacobsson (1989) concluded that there is no justification in treating *Kuehneromyces* as an independent taxon. Recently, Watling and Gregory (1993) transferred *Kuehneromyces* to the genus *Galerina* as a subgenus, as, according to them, the Spore-print colour and correlated characters do not agree their placement in Strophariaceae.

Smith and Hesler (1968) adopted a broad genus concept and incorporated all those species having rust-brown to yellow-brown spore deposit, smooth spores (except *P. aurea*) with at least a minute germ-pore and inner veil under *Pholiota*, which led to the addition of several species usually placed in other genera such as *Hypholoma*, *Phaeolepiota*, *Phaeomarasmius*, *Tubaria*, *Pachylepyrium* and *Kuehneromyces*.

The genus *Pholiota* is currently characterized by the following features: brown spores that are smooth under the light microscope and frequently with the germ-pore; frequent occurrence of chrysocystidia; styrylpyrone pigments; and yellow to brown basidiomata that are more or less scaly and often glutinous. Almost all species are reported to grow on wood and wood debris and no species form mycorrhiza (Jacobsson, 1990)

Because many of the characters used in the circumscription of *Pholiota* are shared by many other genera, the limits of *Pholiota* are still slightly vague and hazy. *Pholiota*, which belongs to Strophariaceae, is very close to *Stropharia*, *Psilocybe*, and *Hypholoma*. In fact, Kühner (1980) has discussed a possible fusion of *Hypholoma*, *Pholiota* and *Psilocybe* into one genus. But in these latter genera the spores are darker with violet to chocolate brown shades, in contrast to rusty-brown to yellow-brown spore-print in *Pholiota*. Also, *Pholiota*

spores are non truncate with a narrow germ-pore. In addition, Jacobsson (1990) reported the presence of some kind of ornamentation in spore walls of many species of *Pholiota* when observed under the scanning electron microscope.

The genus *Gymnopilus*, which is traditionally considered as belonging to Cortinariaceae because of the distinctly rough spores without germ-pore, is now considered related to *Pholiota* because of similar pigments and ecology (Kühner, 1980). Chrysocystidia, however, are not found in *Gymnopilus*.

Characters used in taxonomy

For species segregation in *Pholiota*, characters like colour of the basidiomata, texture of pileus, presence or absence of annular veil, variation in size, shape and pore-size of the spores, presence or absence, frequency and other features of pleuro- and chrysocystidia and degree of gelatinization are considered to be of value (Jacobsson, 1990).

Breitenbach and Kranzlin (1995) utilized the taste of the flesh (mild or bitter) and presence or absence of chrysocystidia and its distribution on lamellae for species delimitation.

The colour of the basidiomata in *Pholiota* varies from yellow to brown. These colour differences are of diagnostic value, though a gradual change in colour can be seen in most basidiomata with age. Various degrees of scale development, their nature, and orientation are characteristic in some species (Jacobsson, 1990).

The colour of the young lamellae are often considered as a useful taxonomic character. Usually young lamellae are pale-coloured with some shades of yellow or olive and soon become darker with age (Jacobsson, 1990).

There is a wide variation in size and shape of the spores in the genus *Pholiota* and are of considerable diagnostic value. Often the spores are medium to small in size and ovoid to ellipsoid in shape. Slight differences in size and shape of the spores can be seen in different collections of the same species or even within the same collection. A wide range of pore size, extending from very broad (*P. mutabilis*, *P. lignicola*) to apparently none as in *P. tuberculosa*, is noted (Jacobsson, 1990). All the species of *Pholiota*, except *P. aurea*, have smooth spores as seen under the light microscope (Smith & Hesler, 1968).

But, later, using electron microscopy Pegler and Young (1971), Clemencon (1974), Farr (1985) and some others proved the occurrence of distinct ornamentations in species like *P. mutabilis* and *P. populicola*. Jacobsson (1990) studied spores of several species under the scanning electron microscope and noticed a wide range of ornamentation pattern in different species.

Different types of cystidia are seen in the genus *Pholiota* and are of some taxonomic significance. The lageniform or clavate chrysocystidia with or without a mucronate apex are found in most species. Often, they contain some amorphous, refractive inclusion, which stains yellow in alkaline solutions. The cheilocystidia are usually hyaline but in several cases these become yellowish brown from necropigments. In the subgenus *Lubricula*, a special type of large, projecting, lageniform to fusoid-ventricose cystidia with often tapering neck and yellow contents are observed at the edges and sides of the lamellae.

The presence of gelatinized hyphae in the pileipellis is of taxonomic value. But, often the environmental conditions like habitat, humidity, and temperature may directly influence the gelatinization of the basidiocarp. As a result viscid and non-viscid pileus may be observed in the same species occurring in different conditions and this can cause much trouble in the classification, especially in the section *Adiposae* as noted by Jacobsson (1987).

Infrageneric classification

Singer (1962) divided the amended genus *Pholiota* into three subgenera; *Hemipholiota*, *Pholiota*, and *Flammula*. Singer (1986) added two more subgenera *Phaeonematoloma* and *Plocoloma* along with the three earlier subgenera. Smith and Hesler (1968) who monographed *Pholiota* in North America divided the genus into seven subgenera *Flavidula*, *Hygrotrama*, *Hemipholiota*, *Phaeonematoloma*, *Flammula*, *Pholiota* and *Flammuloides*.

Kühner (1980) put forth a different system of classification giving emphasis to pigments and nature of spore wall. He divided *Pholiota* into five subgenera; *Kuehneromyces*, *Hemipholiota*, *Flavidula*, *Pholiota* and *Lubricula*. The most important feature of this classification is the recognition of *Kuehneromyces* as a subgenus of *Pholiota*.

Jacobsson (1986, 1987, 1990) studied the European species of the genus *Pholiota*

thoroughly and he utilized scanning electron microscopic studies of spore surfaces, cultural characters and interfertility tests (1989) for the better understanding of the systematic relationships within the genus. Based on these studies, he (Jacobsson, 1990) proposed a system of classification within the genus *Pholiota* that includes six subgenera: *Pholiota*, *Flavidula*, *Hemipholiota*, *Flammula*, *Kuehneromyces* and *Lubricula*.

Ecology

Most species of *Pholiota* are saprobes that grow well on decaying wood. Some are reported to prefer charcoal and ashes (*P. highlandensis*) or moss (*P. henningsii*). Some species like *P. squarrosa*, *P. aurivella* and *P. albocrenulata* are parasitic and may attack living trees (Jacobsson, 1990). *Pholiota jahnii* and *P. gummosa* prefer wood buried in soil. Though most pholiotas which inhabit soil are generally independent of pH gradient, *P. subochracea* and *P. astragalina* show affinity for low pH in soil (Jacobsson, 1990). Any kind of mycorrhizal association is not known in the genus *Pholiota* (Singer, 1986).

World distribution

Pholiota is comparatively well represented from various parts of the world: **North America** (Smith, 1944b; Smith & Hesler, 1968; Phillips, 1991); U S A (Farr & Farr, 1976; Farr, Miller & Farr, 1977; Horak, Desjardin & Hemmes, 1996); **Central America and West Indies**: Lesser Antilles (Pegler, 1983); Mexico (Chio, 1992); **South America** (Singer, 1969); **Europe** (Lange & Hora, 1965; Phillips, 1981; Jacobsson, 1986, 1987, 1990); Great Britain (Orton, 1977); Netherlands (Tjallingii-Beukers, 1976b, 1987; Kuyper & Tjallingii-Beukers, 1986; Tjallingii-Beukers, 1987); Switzerland (Breitenbach & Kranzlin, 1995); **Africa**: East Africa (Pegler, 1977); **Australia and Pacific Islands**(May & Wood, 1997); **Asia**: Japan (Imazeki, Otani and Hogo, 1988); Sri Lanka (Pegler, 1986).

Manjula (1983) listed thirteen species of *Pholiota* known from India which included *P. destruens*, *P. highlandensis* and *P. squarrosa*, reported by Watling and Gregory (1980) and *P. mahabaleshwarensis*, a new species from Maharashtra State reported by Sathe & Deshpande (1980b). Natarajan and Raman (1983) reported four species from Tamil Nadu State, which included a new species *P. truncata*. Joseph, Abraham, Vrinda & Pradeep (1995) reported a species of *Pholiota*, *P. ealaensis*, the only one known from Kerala State.

Economic importance

Pholiota destruens, *P. aurivella* and *P. squarrosadispora* are considered to be active parasites and wood destroyers (Singer, 1986). A few pholiotas are edible, but the only species that have some market value is *P. nameko*, and it is commercially cultivated (Singer, 1986). Lincoff and Mitchel (1977) reported mild poisoning effect of *P. squarrosa*. *Pholiota spectabilis* has been considered as a hallucinogenic mushroom (Walters, 1965).

Stropharia (Fries) Quélet

Genus-concept

Fries (1849) established the tribe *Stropharia* under the genus *Agaricus*. It was Quélet (1872), who gave generic status to the tribe. The genus *Stropharia*, according to Singer (1986), is characterized by centrally stipitate basidiomata having annulus (except in coprophilous species); humid or viscid pileus; lilac to fuliginous lilac to purplish fuscous spore-print; smooth, thick-walled spores with often distinctly truncate germ-pore; chrysocystidia which are only rarely absent; a non-subcellular hypodermium; regular to interwoven hymenophoral trama; and acanthocytes in the basal mycelium (except section *Stercophila*).

Stropharia shows close resemblance to *Hypholoma* and *Psilocybe*. A well-developed annulus is seen in most species of *Stropharia* and is absent in almost all species of *Hypholoma* (Smith, 1951; Singer, 1986). Though chrysocystidia are common in most species of *Stropharia* and *Hypholoma*, the latter genus can be easily separated by its cellular hypodermium (Singer, 1975, 1986). Generally, hypholomas prefer to inhabit wood or woody debris, peat or wet organic acidic soils. The genus *Psilocybe* can be distinguished from *Stropharia* by the absence of chrysocystidia (except in the section *Chrysocystidiatae* Singer) in the former.

The genus *Pholiota* is also very close to *Stropharia* in almost all characters. But they differ in spore-print colour, which is dull cinnamon brown to clay in *Pholiota* in contrast to violet to chocolate brown in *Stropharia*.

Smith (1979) and Kühner (1980) found it very difficult to delimit various genera under the two subfamilies, *Stropharioideae* and *Pholiotoideae* of Strophariaceae. Smith (1979) proposed to unite various subgenera under each subfamily so as to form a single genus in each subfamily. Later, Noordeloos (1995) recognized only two genera under the whole Strophariaceae: genus *Psilocybe*, including the *Psilocybe sensu stricto*, *Stropharia*, *Hypholoma* and *Melanotus* and the genus *Pholiota*, after considering the proposal of Smith (1979) and Kühner (1980).

Characters used in taxonomy

Major characters, which are used in the species segregation of the genus *Stropharia* are size and colour of the pileus, viscosity of the basidiomata, and size of the spores (Watling & Gregory, 1987). The nature of annulus and habitat preferences are also of some taxonomic value.

Infrageneric classification

Singer (1986) subdivided the genus *Stropharia* into three sections viz., *Mundae*, *Stropharia* and *Stercophila*. According to him the section *Mundae* is characterized by subviscid or merely humid pileus and deeply grooved annulus and the section *Stropharia* represents species with subviscid or glutinous pileus. Members of the section *Mundae* mostly inhabit soil in and outside the forests, where as those of the section *Stropharia* are found in the woods, on debris and in shady places. In the section *Stercophila* both pileus and stipe are viscid or glutinous and the spores are often enormously large. Members of this section are subannulate, and sometimes without chrysocystidia and are found on dung, manured field or meadows. Watling and Gregory (1987) followed the same system in their account of the British species.

Ecology

All members of the genus *Stropharia* are saprobic, which inhabit soil in the forests, heaths and pastures or dung and plant debris (Watling & Gregory, 1987). They are reported to be found frequently on highly nitrogenous soils.

World distribution

The genus *Stropharia* is very poorly studied in many parts of the world. Miller and Farr (1975) listed 16 common species of *Stropharia* from the U S A. Watling and Gregory (1987) described eleven species from Great Britain. Some other reports from various parts of the world include: **North America** (Phillips, 1991); U S A (Smith, 1938, 1939b, 1941a; Mitchel & Smith, 1978); **South America** (Singer, 1969); **Europe** (Lange & Hora, 1965; Kibby, 1979; Phillips, 1981); Great Britain (Pearson, 1946, 1948; Orton, 1976; Bigelow, 1978; Watling & Gregory, 1987); Italy (Jahnke, Hoffmann & Pacioni, 1988); Poland (Guminska, 1974); Switzerland (Breitenbach & Kranzlin, 1995); **Africa**: East Africa (Pegler, 1977); South Africa (Pegler, 1996); **Australia and Pacific Islands** (May & Wood, 1997); **Asia**: Japan (Imazeki, Otani & Hongo, 1988).

Manjula (1983) listed six species of *Stropharia* as known from India: *S. semiglobata*, *S. aureofulva*, *S. psathyroides*, *S. pygmaea*, *S. gollani* and *S. mephistopheles*. Natarajan and Raman (1983) reported another species, *S. aurantiaca*, from Tamil Nadu State. No previous reports are available on the occurrence of *Stropharia* in Kerala State.

Economic importance

Some species of the *Stropharia* are edible. *Stropharia rugosoannulata*, a popular edible species (Lincoff & Mitchel, 1977) is being cultivated in many countries, including India (Pathak, Yadav & Gaur, 1998). Lincoff and Mitchel (1977) reported the hallucinating and poisoning effect of *S. coronilla*. *Stropharia aeruginosa* and *S. caerulea* are considered to be poisonous (Harding, Lyon & Tomblin, 1996).

Hypholoma (Fries) Kummer

Genus-concept

It was Fries (1821) who established the tribe *Hypholoma* under the genus *Agaricus* and later, Kummer (1871) elevated this tribe to generic level. Karsten (1879) separated purple-brown-spored, *Flammula*-like agarics from the genus *Hypholoma* and placed them under a new genus *Naematoloma* with *Agaricus sublateritius* as the type species. In this new genus he included *Naematoloma sublateritium*, *N. capnoides*, *N. epixanthum*, *N.*

fasciculare, *N. aelopus*, *N. dispersum* and *N. udum*. According to him the genus *Hypholoma* represents 'fragile type' agarics and *Naematoloma* stands for 'Flammula-like' group. Many subsequent workers treated these two generic names as synonyms and adopted one or the other.

Singer (1986) considered the genus name *Hypholoma* as nomenclaturally untenable and he continued to use the name *Naematoloma*. According to Watling and Gregory (1987) and some others, this name should be correctly spelt *Nematoloma* and not *Naematoloma*. Singer (1986) also emphasized the need for conserving the name *Hypholoma* by some botanical congress, if it is to be maintained.

Romagnesi (1936) regarded *Hypholoma* as a constituent part of *Psathyrella*. Farr and Farr (1981) proposed to conserve one of the three alternative generic names *viz.*, *Hypholoma*, *Nematoloma* and *Psathyrella* to solve the problems in the use of these confused generic names. Considering this proposal, the Committee for Fungi and Lichens of International Botanical Congress unanimously decided to conserve the genus name *Hypholoma* with type species *Agaricus fascicularis* and rejected the other two alternatives (Korf, 1986). As the first known lectotypification of *Nematoloma* is with the proposed type species of *Hypholoma*, the genus name *Nematoloma* is considered as a synonym. Therefore, in this treatise instead of the name *Nematoloma*, the name *Hypholoma* is adopted.

According to Singer (1986) this genus is characterized by centrally stipitate basidiomata with partially or non-hygrophanous pileus, growing in fascicles on wood and often without or rarely with an annulus; subcellular hypodermium formed of short cells organized into parallel, horizontal chains; occurrence of chrysocystidia (except in the section *Stropholoma*); and hymenophoral trama of parallel hyphae which are often somewhat inflated in the mediostratum.

The genus *Hypholoma* is very closely related to *Stropharia* and *Psilocybe*, and in many aspects, it is similar to *Pholiota*. In *Hypholoma* the spore-print is violet or cocoa-coloured where as in *Pholiota* it is dull cinnamon-brown to clay-coloured.

Species of *Hypholoma* can be distinguished from *Stropharia* by the presence of a

subcellular hypodermium in the former. A well-developed annulus is seen in most of the stropharias. Majority of the members of the *Stropharia* have viscid or subviscid pileus and are usually found on dung or soils rich in nitrogenous contents. Contrary to this, hypholomas are dry-capped and are usually lignicolous or seen associated with woody debris or peaty soils.

Singer (1975) regarded absence of subcellular hypodermium in *Psilocybe* as a basic character to distinguish it from *Hypholoma*. Guzmán (1980, 1983) disagreed with this view as he could study some *Psilocybe* having subcellular hypodermium and he considered presence or absence of chrysocystidia as a valid character to distinguish these two genera. According to Guzmán (1983, 1995) the genus *Psilocybe* is totally devoid of chrysocystidia, though Singer (1975, 1986) maintained the section *Chrysocystidiatae* representing chrysocystidiate members along with *Psilocybe*. Smith (1951, 1979) also questioned the validity of subcellular hypodermium as a primary character to separate *Hypholoma* from *Psilocybe* and *Stropharia* and he also recognized that there is no fundamental set of characters to distinguish these three genera.

Some earlier workers treated the genera *Psilocybe*, *Hypholoma* and *Stropharia* as a single broad genus *Geophila* Quélet but this latter generic name could not be maintained for nomenclatural reasons. Smith (1979) proposed to combine these three genera and to form a macrogenus *Psilocybe sensu lato*. Kühner (1980) also discussed a possible fusion of three genera, *Hypholoma*, *Pholiota* and *Psilocybe* into a single large genus. Noordeloos (1995) emended the genus-concept of *Psilocybe* so that it now comprises genera *Psilocybe sensu stricto*, *Stropharia*, *Hypholoma* and *Melanotus*.

Characters used in taxonomy

According to Watling and Gregory (1987), the key characters that can be used in species segregation in *Hypholoma* are habitat preferences, size of the fruit body, colour of lamellae, size of the spores and presence or absence of a germ-pore. Singer (1986) used a few more attributes like presence or absence of annulus, frequency of chrysocystidia and nature of pileipellis for the delimitation of species.

Infrageneric classification

Smith (1951) in his monograph on the genus *Hypholoma*, subdivided the genus into two sections: *Tenacia* and *Fascicularia*. He placed all the species having gregarious habit and terrestrial habitat under the section *Tenacia* and caespitose members with lignicolous habitat under *Fascicularia*.

Singer (1975, 1986) considered four sections under this genus namely, *Cyanoloma*, *Stropholoma*, *Hypholoma* and *Psilocyboides*. The section *Cyanoloma* is characterized by medium-sized spores (up to 12 μm), well-developed annulus, numerous cheilocystidia, gelatinized epicutis, blue staining of pileal surface and context, and terrestrial habitat. The section *Stropholoma* represents species with medium or larger spores (often > 10 μm), well-developed annulus and mostly terrestrial habitat. In the section *Hypholoma*, spores are smaller (<10 μm), veil typically appendiculate, and annulus inconstant and rarely developed, where as in *Psilocyboides* spores are often larger than 10 μm , annulus none or rarely inconstantly and weakly developed and the stipe somewhat thin and elongate. In section *Hypholoma* basidiomata usually develop in dense fascicles on wood and in *Psilocyboides* they are usually solitary or gregarious.

Guzmán (1980) considered six sections under the genus *Hypholoma*, viz., *Hypholoma*, *Cyanoloma*, *Psilocyboides*, *Neocaledoniae*, *Rhombisporae* and *Cokeriana*. Of these, the first three sections were adopted from Singer (1975) and the last three sections were created by him to accommodate chrysocystidiate members of the genus *Psilocybe*. According to him (Guzmán, 1980) the section *Neocaledoniae* is characterized by subcellular or hyphoid hypodermium, rhombic spores and bluing of basidiomata. The sections *Rhombisporae* and *Cokeriana* are without subcellular hypodermium and their basidiomata are non-bluing. In the section *Rhombisporae* spores are rhombic and in *Cokeriana* they are subellipsoid.

Ecology

Hypholomas prefer to inhabit decaying wood or woody debris or humus-rich soil and thus hastening the process of decomposition. Any kind of mycorrhizal association with

flowering plants is not known so far. Redhead and Kroeger (1987) reported a sclerotium-producing *Hypholoma*, *H. tuberosum*, from British Columbia.

World distribution

In his monographic study on the genus *Hypholoma*, Smith (1951) included 21 species from North America. Singer (1986) admitted 23 species under the genus. Floristic reports on the genus from various parts of the world consist: **North America** (Smith, 1941b, 1948, 1951; Phillips, 1991); **Central America and West Indies**: Lesser Antilles (Pegler, 1983); **South America** (Singer, 1969); **Europe** (Kühner, 1936; Kibby, 1979; Phillips, 1981; Moser, 1983); Great Britain (Orton, 1984; Watling & Gregory, 1987); Switzerland (Breitenabach & Kränzlin, 1995); **Africa**: East Africa (Pegler, 1977); **Australia and Pacific Islands** (May & Wood, 1997); **Asia**: Japan (Imazeki, Otani & Hongo, 1988); Sri Lanka (Pegler, 1986).

Ghosh, Pathak and Tewari (1967) reported *Hypholoma fasciculare* from Assam. Watling and Gregory (1980) also reported occurrence of *H. fasciculare* and an additional species *H. capnoides* on conifer stumps at Kashmir. In addition to these two species, Manjula (1983) listed *H. sublateritium* as known from West Bengal. Natarajan and Raman (1983) reported another species *H. subviride* along with *H. fasciculare* from Tamil Nadu State. *H. munnarensis* was the only species of *Hypholoma* known from Kerala State (Sathe & Daniel, 1980) prior to this study.

Economic importance

The wood-inhabiting hypholomas like *H. fasciculare* are occasional wood destroyers which may even contribute to the death of trees in forests and plantations (Singer, 1986). Lincoff and Mitchel (1977) reported fatal poisoning from the specimens of sulfur tuft, *H. fasciculare*. Biologically-active substances like naematolin, muscarine and epimuscarine, and fasciculol D have been isolated from this species. A biologically-active alkaloid of the psilocybin group is present in *H. popperianum*. Styrylpyrone pigments are reported from several species of *Hypholoma*. Some species like, *H. sublateritium* are used as food, especially in Italy, after a special preparation (Singer, 1986).

Psilocybe (Fries) Kummer

Genus-concept

The name *Psilocybe* was initially used as the name of a tribe under the genus *Agaricus* by Fries (1821). It was Kummer (1871) who gave a generic status to *Psilocybe*. When Kummer gave generic status to *Psilocybe*, he did not indicate a type specimen. Smith (1870) recognized a subgenus *Deconica* within the genus *Agaricus*. Karsten's (1879) elevation of *Deconica* to genus level resulted in the removal of the most typical species of *Psilocybe* to that genus. Until very recently, many authors treated *Deconica* as an autonomous genus having remarkable similarity with *Psilocybe*. However, later studies on extra-European species weakened the hiatus between *Psilocybe* and *Deconica* (Pegler & Young, 1971) and the delimitation between the two genera became impossible. Presently, *Deconica* is considered as a synonym of the genus *Psilocybe* by most authors. Donk (1962) argued convincingly for the adoption of *Agaricus montanus* Persoon ex Fries (= *Psilocybe montana* (Persoon ex Fries) Kummer) as the type species of *Psilocybe* which would make *Deconica* a synonym of *Psilocybe*. Guzmán (1983) and Singer (1986) followed this suggestion.

The genus *Psilocybe* and other members of the family Strophariaceae, such as *Pholiota*, *Kuehneromyces*, *Hypholoma*, *Stropharia*, and *Melanotus* are remarkably similar in several features. *Psilocybe* differs from *Pholiota* mainly in the colour of the Spore-print. But spores of the members of the section *Chrysocystidiatae* (Singer, 1973a) of *Psilocybe* and section *Subsiccae* of *Pholiota* are very similar in colour. However, section *Chrysocystidiatae* differ from section *Subsiccae* in having truncate germ-pore in the spores, hygrophanous pileus, non-gelatinized hymenopodium, and the typical habit of smaller psilocybes.

Though *Psilocybe* is close to *Kuehneromyces* in some aspects, the latter genus has a different spore-print colour. In addition, the spores of *Kuehneromyces* are distinctly ornamented (Pegler & Young, 1971).

In the genus *Melanotus* stipe is short, eccentric or completely absent, where as in *Psilocybe* it is central and well-developed. According to Singer (1975, 1986) hypodermium

in *Hypholoma* is subcellular where as such a hypodermium is totally absent in *Psilocybe*. But, Guzmán (1980, 1983) reported the occurrence of subcellular hypodermium in some species of *Psilocybe* and stressed the non-validity of using this character in separating *Hypholoma* from *Psilocybe*. Guzmán (1980, 1983) excluded all the chrysocystidiate members from the genus *Psilocybe* and considered the genus as totally lacking chrysocystidia. However, Singer (1986) in his classification, retained the section *Chrysocystidiatae* representing chrysocystidiate members under the genus *Psilocybe*. Guzmán (1980, 1983) adopted presence of chrysocystidia as a taxonomically good character to separate *Hypholoma* and *Stropharia* from *Psilocybe*, without considering simultaneous occurrence of chryso- and pleurocystidia in some intermediate taxa.

Smith (1979) mentioned the non-reliableness of using the chrysocystidia and hypodermial characters as a genus character and he proposed a broad genus *Psilocybe sensu lato* to include *Psilocybe sensu stricto*, *Hypholoma* and *Stropharia*, which are strikingly similar and naturally allied. Following this proposal, Noordeloos (1995) took the radical decision to emend the generic concepts within the family Strophariaceae and included four genera viz., *Psilocybe sensu stricto*, *Stropharia*, *Hypholoma* and *Melanotus* in *Psilocybe sensu lato*.

Characters used in taxonomy

In *Psilocybe*, the species delimitation is mainly based on characters like habitat preferences; form and texture of the pileus; position of lamellae; presence or absence of annulus; size, shape and colour and thickness of wall of the spores; colour and size of pleuro- and cheilocystidia; presence or absence of blueing reaction; and the structure of subhymenium and hypodermium.

Psilocybes are generally habitat-specific (Smith, 1977; Stamets, 1996). The shape of the pileus in *Psilocybe* is important in species delimitation. Their habit varies from mycenoid to collybioid. In many a clear acute umbo is noticed. Some species like *P. zapotecorum* exhibit a strong variation in the form of pileus. A wide range in the size of the pileus is also noticed in some. A gelatinized pellicle on the pileus is observed in many

species such as *P. pelliculosa*, *P. semilanceata*, *P. baeocystis*, *P. subviscida*, etc. and this feature is of much taxonomic value. In others, surface may be dry, moist or lubricous.

The type of the attachment of the lamellae to the stipe is considered to be an important feature in species segregation and this may range from adnexed to subdecurrent. Lamellae are never fully free or decurrent. The colour of the lamellae in young specimens are almost pale brown or pale grey and usually becomes violaceous brown with age. Sometimes they show mottling. Mostly, lamellar edges are white.

The size and shape of the stipe are not of much value. The stipe surface may be smooth, almost scaly or subfloccose. The presence of rhizomorphs as in *P. cyanescens* or *P. aztecorum* and pseudorhiza as in *P. fagicola* or *P. wassoniorum* are of taxonomic value. A well-developed annulus is noted in species of section *Cubensae*, *Merdariae*, *Squamosae*, and *Stuntzii*, and two members of the section *Psilocybe* (Guzmán, 1983).

The size, shape, and wall-thickness of the spores of *Psilocybe* are considered to be of much taxonomic value. The different types of spores observed are rhomboid, sub-rhomboid, sub-hexagonal, sub-ellipsoid and asymmetrical. The spores may be thick or thin-walled and always with a germ-pore. A considerable increase in size and wall thickness of the spores of *Psilocybe* is noted in temperate regions when compared to tropics. Since the psilocybes of temperate regions are subjected to severe winters and droughts, these thick wall of the spores avoid excessive water loss during dry periods and the excess nutrients available in the large spores increase the chance of survival of mycelium (Guzmán, 1983).

Cheilocystidia are usually present in the genus. Their form and size are of much value in the taxonomic delimitation of species. Usually they are hyaline except in the section *Brunneocystidiatae* where they are brown or brownish. The presence or absence of pleurocystidia is of some taxonomic value. Pleurocystidia can be seen in most members of the section *Cyanescens*. They are usually hyaline but in some they are brownish. According to Guzmán (1983) chrysocystidia are absent in the genus *Psilocybe*.

For a long time it has been considered that *Psilocybe* are devoid of cellular or subcellular hypodermium, but later studies revealed presence of hypodermium in many

species (Guzmán, 1980, 1983). In many species of the sections *Psilocybe* and *Cordisporae*, the subhymenium is subcellular, thick-walled and strongly encrusted with brownish orange or yellowish pigment.

Infrageneric classification

In his monograph Guzmán (1983) divided the genus into eighteen sections by considering features of spores, cystidia and veil. The sections recognized by him are *Brunneocystidiatae*, *Blattariopsidae*, *Subaeruginosae*, *Cordisporae*, *Psilocybe*, *Mexicanae*, *Stuntzii*, *Coprophilae*, *Merdariae*, *Cubensae*, *Zapotecorum*, *Singerianae*, *Pratensae*, *Atrobrunneae*, *Squamosae*, *Aztecorum*, *Cyanescens*, and *Semilanceatae*.

In the supplement to his monograph, Guzmán (1995) reduced section *Cyanescens* as a synonym of section *Semilanceata* and revised the circumscriptions of sections *Psilocybe* and *Pratensae*.

Singer (1986) subdivided the whole genus into seven sections viz., *Merdariae*, *Caerulescentes*, *Tenaces*, *Atrobrunneae*, *Septembres*, *Psilocybe* and *Chrysocystidiatae*. Guzmán (1983) did not include members of *Chrysocystidiatae* under the genus *Psilocybe*. But Singer (1986) maintained the section *Chrysocystidiatae* in *Psilocybe* as he thinks "the section *Chrysocystidiatae* is closely allied to section 6 *Psilocybe*, so the exclusion of the species with *Chrysocystidia*-relegating them to *Naematoloma* or *Pholiota* is extremely artificial".

Biology and ecology

Majority of the psilocybes so far unravelled contains indolic substances like psilocybin and psilocin, which can induce hallucinations in human beings. These substances can act as antimetabolite for serotonin in the human brain. The neurotransmitter serotonin is intended to keep the nervous system in a normal state and any substitution of serotonin with psilocybin makes it abnormal and leads to a transitory stage of hallucination. In some, these psilocybin mushrooms may induce feeling of glorious visions of colour and sounds of music, alteration of perception of time and space, or a feeling of joy and bliss or in others, they may evoke anxiety and depression. Usually, the finale is a deep unconsciousness (Subramanian, 1995).

Hofmann, Heim, Brack and Kobel (1958) isolated these active principles, psilocybin and psilocin from *Psilocybe mexicana*. Later, Heim and Hofmann (1958), Heim, Genest, Hughes and Belec (1966), Guzmán and Ott (1976), Høiland (1978), Margot and Watling (1981) and Christiansen, Rasmussen and Høiland (1981), demonstrated their presence in many psilocybes. Leung and Paul (1968) isolated some other indolic substances, baeocystin and nor-baeocystin from *Psilocybe baeocystis*. These active principles are known in various other species of *Psilocybe* (Høiland, 1978; Guzmán, 1983). A major characteristic feature of these hallucinogenic species is the development of a blue colour on the basidiomata either with age or when they are injured. According to Stamets (1996), "the bluing reaction is obvious in more potent species, especially those high in psilocin". All the members of the section *Caerulescentes* are considered to be psilocybin producing.

The bluing reaction is a phenomenon paralleling the degradation of unstable psilocin or dephosphorylated psilocybin to unknown compounds by some enzymes within the mushroom cells (Stamets, 1996). It is also reported that the more the mushrooms are bruised the less potent they become. The chemical structure of blueing compound still remains elusive.

In his identification guide to the psilocybin mushroom of the world, Stamets (1996) argues that psilocybes have progressed themselves to the forefront of evolutionary race precisely because of the psilocybin content and thus the production of psilocybin is considered to have desirable evolutionary advantage.

Psilocybes are saprophytes that thrive well in a wide range of habitats like dung, moss, soil, grassland or decaying wood debris (Guzmán, 1983). Key and Brown (1990) noted a weak invasion of the root tissue, particularly moribund cells of the outer cortex of some grasses, by *P. semilanceata* in co-culture. They grow well in different kinds of soils like humus, clay, and sandy soil. Guzmán recognized that psilocybes prefer to grow in acidic pH ranging from 4-6.5. Stamets (1996) very well depicted their affection for disturbed habitats, especially the interface environments where humans, forests and grasslands struggle to co-exist. Smith (1977) recognized habitat specificity of the psilocybes.

Stamets (1996) has pinpointed six classic habitats viz., grasslands; dung deposits; riparian zones, disturbed habitats and gardens; woodlands; mosslands; and burned lands, preferred by species of *Psilocybe*.

World distribution

Psilocybe is a cosmopolitan genus known from almost all parts of the world. This genus is extensively studied mainly due to their ability to cause cerebral mycetism, thanks especially to Wasson (1958, 1959, 1961, 1962) who brought psilocybes and their potential recreational use to the world attention.

Presently, around 200 valid species of *Psilocybe* are known from the world. The largest number of hallucinogenic species is reported from Mexico. In addition to the monographic works (Singer & Smith, 1958; Guzmán, 1983, 1995; Stamets, 1996), a large number of sporadic reports are available since 1950's covering the whole world. They comprise: **North America** (Smith, 1948; Phillips, 1991); **U S A** (Guzmán & Ott, 1976; Guzmán, Ott, Boydston & Pollock, 1976; Guzmán, Tapia & Stamets, 1997); **Central America and West Indies**: Lesser Antilles (Pegler, 1983); Mexico (Heim & Hofmann, 1958; Singer, 1958); Cifuentes & Guzmán, 1981; Guzmán, 1978a, 1979, 1982, 1998; Guzmán, Montoya-Bello & Bandala-Munoz, 1988); Puerto Rico (Guzmán, Tapia, Nieves-Rivera & Betancourt, 1997); **South America** (Singer, 1969; Guzmán, 1978b); Argentina (Singer, 1959); Columbia (Guzmán, Saldarriaga, Pineda, Garcia, & Velazquez, 1994); Peru (Singer, 1959, 1969); **Europe**: (Phillips, 1981); Austria (Hausknecht & Singer, 1986); Great Britain (Bigelow, 1978; Watling & Gregory, 1987); Netherlands (Tjallingii-Beukers, 1976a; Guzmán & Bas, 1977; Bas & Noordeloos, 1996; Noordeloos, 1995, 1998); Switzerland (Breitenbach & Kranzlin, 1995); **Africa**: East Africa (Pegler, 1977); South Africa (Reid & Eicker, 1999); **Australia and Pacific Islands** (May & wood, 1977; Guzmán & Watling, 1978; Margot & Watling, 1981); New Zealand (Guzmán & Horak, 1978; Guzmán, Bandala & King, 1991, 1993; Johnston & Buchanan, 1995); Papua New Guinea (Guzmán & Horak, 1978); **Asia**: Japan (Yokoyama, 1973, 1976; Imazeki, Otani & Hongo, 1988); Sri Lanka (Pegler, 1986); Thailand (Guzmán, Bandala & Allen, 1993).

Manjula (1983) listed 5 *Psilocybe* viz., *P. tristis*, *P. coprophila*, *P. merdaria*, *P. caespiticia*, and *P. montana* from India. A number of subsequent reports indicate occurrence of some more *Psilocybe* species in India: *P. indica* (Sathe & Daniel, 1980), *P. cubensis*, *P. aztecorum* var. *bonetii*, *P. crobula*, *P. muscorum*, *P. argentina*, *P. squarrosipes* (Natarajan & Raman, 1983), *P. pseudoaztecorum* (Natarajan & Raman, 1985), *P. kashmeriensis* (Abraham, 1995) and *P. semilanceata* (Stamets, 1996). The only species of *Psilocybe* previously known from Kerala State is *P. indica* (Sathe & Daniel, 1980).

Economic importance

Many species of *Psilocybe*, particularly the members of the section *Caerulescentes* are reported to be hallucinogenic. According to Stamets (1996), of the 180 *Psilocybe* species reported so far, about 95 are psilocybin-active. These psilocybin-active, hallucinogenic species are of great ethnological, physiological and medicinal interest. In Mexico and Guatemala, several groups of Indians use these hallucinogenic mushrooms in their religious rites (Guzmán, 1983; Singer, 1986). These psychotropic mushrooms are much valuable in neuropsychiatric research (Guzmán, 1983). Yokoyama (1973) and Singer (1986) considered some species like *P. subcaerulipes* and *P. argentipes* as poisonous. *Psilocybe cubensis*, a psilocybin-active mushroom, is widely cultivated in the world (Stamets, 1996).

Melanotus Patouillard

Genus-concept

The genus *Melanotus* was first described by Patouillard (1900). This genus is characterized by rather small, inconspicuous, mostly pleurotoid basidiomata occurring on rotting organic debris; absence of veil; brown spore-print mostly with a purplish tint; ovate, lentiform or limoniform spores with a complex but homogenous, smooth, brown or opaque wall and with a distinct apical germ-pore; lanceolate to fusoid cheilocystidia; and a cutis-type pileipellis with clamp-connexions and encrusting pigment.

Earlier workers described most species of *Melanotus* under the genera *Crepidotus* or *Claudopus* owing to the striking similarities in habit and habitat though the latter genera

are taxonomically unrelated to *Melanotus* in microscopical characters. The genus *Crepidotus* can be easily distinguished as it lacks germ pore. *Claudopus* is characterized by pink spore-print and angular spores.

Macroscopically *Melanotus* is very similar to *Pleuroflammula* Sing.apud and *Pyrrhoglossum*. The purplish fuscous or lilac spore-print of *Melanotus* can be used to distinguish it from *Pleuroflammula* having brown to brighter ferruginous spore-print. Usually, the hyphae of most *Pleuroflammula* carry a yellow soluble pigment. Moreover in *Pleuroflammula* spores are more intensely coloured, never lentiform, mostly without a truncate germ-pore and cheilocystidia have a different shape. *Pyrrhoglossum* can be easily separated by noting its verrucose spores.

The genus *Melanotus* is very close to *Psilocybe*. In fact, there are no differences existing between the two genera in microscopical structures like spores, basidia, cystidia, cuticle, etc. The pleurotoid habit is the only feature by which *Melanotus* differs from *Psilocybe* (Horak, 1977b; Singer, 1986). Noordeloos (1995) emended the generic concepts within the family Strophariaceae, which resulted in the formation of a single macrogenus *Psilocybe* comprising the genera *Psilocybe sensu stricto*, *Stropharia*, *Hypholoma* and *Melanotus* under the subfamily *Stropharioideae*.

Characters used in taxonomy

According to Watling and Gregory (1987) the species of *Melanotus* can be separated mainly by considering their substrate, size and shape of the spores, colour of the spore-print and the structure of the pileipellis. In some species of *Melanotus* a more or less gelatinized layer is reported on the pileal tissue by various authors (Kits van Waveren, 1979; Horak, 1977b; Watling & Gregory, 1987) and this feature seems to be of taxonomic value. Presence of pleurocystidia also seems to be useful in delimiting species (Ammirati, Traquair, Martin, Gillon & Ginns, 1979; Sime & Petersen, 1999).

Infrageneric classification

So far, no one has proposed a system of infrageneric classification in the genus *Melanotus*.

Ecology

According to Horak (1977b) all known species of *Melanotus* grow saprophytically on decomposing organic materials and since most of the species described are known only from the type collections, our knowledge about the ecology of the species is very poor. Majorities of the species are restricted to the tropical and subtropical regions (Horak, 1977b; Singer, 1986). However, some taxa also occur in the temperate zones.

World distribution

Horak (1977b) in his monograph on *Melanotus* described 21 species known from different parts of the world. Apart from this monographic work, there are a few other scattered reports from various parts of the world. These include **North America**: Canada (Ammirati *et al.*, 1979; Redhead & Malloch, 1980; Redhead and Kroeger, 1984); USA (Horak, Desjardin & Petersen, 1990); **Central America and West Indies**: Lesser Antilles (Pegler, 1983); **South America** (Singer, 1969); Brazil (Pegler, 1988); Venezuela (Dennis, 1970); **Europe**: Great Britain (Orton, 1984; Watling & Gregory, 1987); Switzerland (Breitenbach, 1980), Netherlands (Kits van Waveren, 1979); **Africa**: East Africa (Pegler, 1977); Kenya (Pegler & Rayner, 1969); **Australia and Pacific Islands**: (May & Wood, 1997) and **Asia**: Sri Lanka (Pegler, 1986).

Two species of *Melanotus* are known from India. *Natarajan* and Raman (1983) reported *Melanotus bambusinus* from Tamil Nadu. Sathe and Daniel (1980) reported *M. cuneiformis*, inhabiting coconut palm, from Kerala State.

Economic importance

Two species of *Melanotus*, *M. musaecola* and *M. textiles*, are reported to be active destroyers of fabrics (Singer, 1986; Redhead & Kroeger, 1984).

CORTINARIACEAE Roze

The Cortinariaceae is a very large and comparatively well-defined family. It comprises many obligatorily endo- or ectomycorrhizal agarics. According to Singer (1986), the main characteristic features of this family are: the centrally stipitate (rarely eccentrically or laterally stipitate) basidiomata; a veil which, when present, is frequently cortinoid; a pileipellis which

is either a trichodermium or a cutis (with some exceptions); brownish argillaceous to ferruginous spore-print; spores that are always with a compound wall, often ornamented and then marbled to punctate or warty from an exosporial layer, and sometimes with a persistent perisporium, mostly without a germ-pore with hilum of open-pore type and often with a callus; and regular hymenophoral trama.

The Cortinariaceae shows some similarity with Strophariaceae and Crepidotaceae in some features. The Strophariaceae, however, differs from Cortinariaceae in characters like the absence of mycorrhizal associations, the absence of ornamentations and the presence of germ-pore on the spore wall under the light microscope, and the presence of chrysocystidia and clamp-connexions. The Crepidotaceae also differs from Cortinariaceae by being either smooth-spored or having ornamentations of a different kind under a light microscope. In the electron microscopic sections of spores of Crepidotaceae, the immersed and sometimes confluent columns of the spore surface appear as free, very narrow and quite isolated, hollow cones. In cortinariacean genera, the spore surface appears rugose-verrucose with irregular ornamentations consisting of broad warts, which show irregular cavities. The Spore-print colour in Crepidotaceae is never bright rusty, a feature which also facilitates their easy separation from Cortinariaceae (Singer, 1986).

Although, the genera *Ripartites* and *Neopaxillus* show some similarity with Cortinariaceae, they can be distinguished by their clitocyboid habit and anatomical, chemical and cytological characters.

Kühner (1980) proposed to transfer three Cortinariacean genera *Gymnopilus*, *Galerina* and *Phaeocollybia* to the Strophariaceae. According to him the genus *Gymnopilus* is closer to *Pholiota* and other genera of Strophariaceae than to Cortinariaceae. The yellow styrylpyrone pigment of *Gymnopilus* is common in many species of Strophariaceae and is supposed to be absent in other genera of Cortinariaceae. In addition, the saprobic nature and the absence of mycorrhizal associations make them closer to Strophariaceae. He transferred *Galerina* along with *Gymnopilus* mainly due to certain similarities existing between the spores of the two genera. He brought *Phaeocollybia* along with *Galerina* and *Gymnopilus*

mainly because of the similarity of the ornamented spores of the former with those of *Galerina*.

Bas (1988) rejected Kühner's proposal and maintained these three genera under Cortinariaceae due to the following reasons. (i) In *Gymnopilus* and *Galerina*, the inner spore wall is dextrinoid as in many species of *Hebeloma* kept in the Cortinariaceae. Further, this reaction is rare or absent in the family Strophariaceae. (ii) Styrylpyrones generally occur in lignicolous fungi. Hence, presence of styrylpyrone in the genus *Gymnopilus* is quite natural, as it is mostly lignicolous. Moreover, styrylpyrones are also known from a few species of *Cortinarius* like *C. flammuloides* and *C. renidens*. (iii) Kühner argued that his rearrangement of taxa could make Cortinariaceae and Strophariaceae strictly mycorrhizal and non-mycorrhizal respectively and he considered it as an added advantage of his classification. But the presence of both mycorrhizal and non-mycorrhizal species are known in some families and even in some genera. (iv) Kühner transferred taxa with preponderance of ornamented spores to the family Strophariaceae in which ornamented spores are very rare. (v) Members of the brown-spored genera, particularly *Galerina* show strong resemblances with species of *Cortinarius* subgenus *Telamonia*. In addition, Bas (1988) abolished the family Crepidotaceae and included all the lamellate members of that family under the Cortinariaceae. Further, he added another genus, *Flammulaster*, a member traditionally considered as belonging to the Strophariaceae, to the Cortinariaceae.

Singer (1986) subdivided the family into three tribes viz., *Inocybeae*, *Hebelomateae* and *Cortinarieae* mainly based on features of the spore-surface and spore-print colour. He included one genus *Inocybe* under the tribe *Inocybeae*, three genera viz., *Hebelomina*, *Hebeloma* and *Alnicola* in *Hebelomateae* and ten genera viz., *Leucocortinarius*, *Rozites*, *Dermocybe*, *Stephanopus*, *Cuphocybe*, *Cortinarius*, *Phaeocollybia*, *Galerina*, *Gymnopilus* and *Pyrrhoglossum* under the tribe *Cortinarieae*.

In the present treatise, Singer's (1986) concept of the family is followed. During the period of this study species belonging to three genera of this family, viz., *Inocybe*, *Cortinarius* and *Gymnopilus* were collected from Kerala.

Inocybe (Fries) Fries**Genus-concept**

Fries (1821) used the term *Inocybe* for the first time to represent a tribe under the genus *Agaricus*, which was later elevated by him (Fries, 1863) to generic level. He based the circumscription of the genus *Inocybe* mostly on macroscopical characters and remarkably, the generic concept remained almost unchanged to this day. The genus can often be recognized by macroscopical characters alone.

Massee (1904) was the first to publish a world-monograph of the genus. Kuyper (1986) published a revision of the genus *Inocybe* in Europe. Recently, Bon (1997a, 1997b, 1998) prepared a monographic key on this genus. Regional monographic treatments of the genus have been carried out by Heim (1931) and Kühner (in Kühner & Romagnesi, 1953) in France; Alessio (1980) in Italy; Enderle and Stangl (1981), Stangl and Enderle (1983) and Stangl (1989) in Germany; Kauffman (1924), Stuntz (1947, 1954), Grund and Stuntz (1968, 1970, 1975, 1977, 1980, 1981, 1983, 1984) in North America and Horak (1977a, 1979, 1980a, 1981) in Asia and Australia. The numerous species described in the genus are traditionally grouped into two subgenera viz., *Inocybium* Earle (for smooth-spored species) and *Clypeus* Britzelmayr (for gibbous-spored species) (Massee, 1904; Heim, 1931; Kühner & Boursier, 1932; Kühner & Romagnesi, 1953; Fries, 1863; Singer, 1975; Moser, 1983). In 1889, Schroeter introduced a new genus name *Astrosporina* (equivalent to the subgenus *Clypeus*) to include *Inocybe*-like species having convex, umbonate or acutely papillate pileus; central, equal or basally marginate-bulbous stipe; brown spore-print; nodulose, gibbous, stellate or spinose spores; often metuloidal and crystal encrusted cystidia; and frequently, a characteristic odour.

Following Schroeter's concept, Horak (1971a, 1977a, 1979, 1980a) also considered *Astrosporina* as distinct from *Inocybe*, based solely on the morphology of spores and treated *Astrosporina* as an independent genus, though the two genera are linked here and there by intermediate species.

But most modern mycologists like Singer (1986), Kuyper (1986) and

Bon (1997a, 1997b, 1998) consider the separation of *Astrosporina* from *Inocybe* as taxonomically unnecessary and meaningless. The cladistic analysis done by Kuyper (1986) supports this latter viewpoint.

According to Singer (1986), the main characteristics of the genus *Inocybe* are the presence of ectomycorrhizal association; tobacco-brown to argillaceous brown spore-prints; non-ornamented, smooth, nodulose-gibbous to nodulose-subangular or stellate spore surface; short, broad cheilocystidia with broadly rounded apex and frequent occurrence of metuloids.

The genus *Inocybe* is placed under the monogeneric tribe *Inocybeae* within the family Cortinariaceae by Singer (1986). Though, there exists some macromorphological similarities between *Inocybe* and other members of the Cortinariaceae like *Hebeloma*, *Hebelomina*, and *Alnicola*, a close relationship between *Inocybe* and other members of Cortinariaceae are non-existing. In *Hebloma*, and generally, in other genera of the Cortinariaceae, spores are ornamented, and this ornamentation originates in the epitunica (Clemencon, 1977) where as in *Inocybe* the spores are smooth walled, though Pegler and Young (1972a) reported minute irregularities of coriotunical origin on the spore surface. Some species of the genus *Galerina* are smooth spored, with a well-developed layer of epitunica, but this layer is completely absent in *Inocybe* (Kuyper, 1986).

Several species of *Inocybe* show strong resemblance to the genus *Phaeomarasmius* of the family Strophariaceae. But, all the members of the genus *Phaeomarasmius* are saprophytes. In addition, the structure of pileipellis is far more complex in *Phaeomarasmius* when compared to the rather simple cutis in *Inocybe*. The spores of *Cystoagaricus*, *Crucispora*, *Horakia* and *Conocybe* section *Nodulosporae* also show similarity to the nodulose, subangular or stellate spores of the subgenus *Inocybe*. But they can be easily distinguished from the inocybes by their hymeniform pileipellis and non-mycorrhizal nature.

Characters used in taxonomy

In *Inocybe*, basidiomata vary from tricholomatoid, collybioid to mycenoid in habit and are considered to have very limited value in species delimitation. The size and form of

the pileus are also of limited value as a taxonomic character. Usually, the young specimens are more or less conical or companulate and mature ones are convex, plano-convex or applanate. An umbo is of common occurrence, but is often absent when the velipellis is well-developed (Kuyper, 1986). The surface texture of the pileus ranges from smooth to radially fibrillose, squamulose or squarrose and is taxonomically important at species level. Some species of *Inocybe* are viscid or glutinous. Species like *I. impexa*, *I. hygrophana* and *I. ionochlora* are reported to be hygrophanous. The colour of the context is of not much use in species segregation. A strong reddening of the context is reported in several unrelated species. The smell is, generally, useful in species recognition (Kuyper, 1986).

Lamellar attachment varies from broadly adnate to almost free. The young lamellae are often white or sometimes with yellow, grey or violaceous tints, which turn brown with maturity. The lamella-edge is almost white and varies from coarsely flocculose to minutely fimbriate (Kuyper, 1986).

A basal bulb, which is either marginate or not, is observed in the stipe of many species and is considered to have less taxonomic relevance as it is variable in occurrence. In several species the marginate bulb is visible in primordial stage, although it disappears on further development. In the smooth spored species *I. amblyspora*, marginate bulb is considered to be a constant and easily recognizable character (Kuyper, 1986). Earlier workers like Kühner gave much attention to the colour of the stipe, especially at the apical part, in the separation of different groups. However, modern authors like Kuyper (1986) do not consider it as a reliable character.

In many young primordia, the hyphae of the universal veil and those of pileipellis proper grow intricately through one another and therefore in older stages it is very difficult to determine which hyphae originated from the pileipellis proper and which from the universal veil (velipellis). The hyphae of the velipellis are usually colourless and without any encrustations in their wall. In some cases, the intermingling does not occur and the hyphae of the velipellis develop thickened walls without any encrustations. Sometimes, the velipellis may become viscid (Kuyper, 1986).

Spores of the genus *Inocybe* are either smooth or nodulose, gibbous, stellate or spinose. There is no clear separating line between smooth spored species and the later group. In many, spores are intermediate between these two types. In the genus *Inocybe*, spore forms are very useful in species delimitation.

A true germ-pore is absent in *Inocybe* except in some species like *I. luteipes* and *I. subporospora*. However, a thinning of the spore wall near the apex is reported in several species of the subgenus *Inocybe*. As the spore measurements are often more variable than mentioned in descriptions, the species separation by this character is quite difficult. Occurrence of albinistic spores are reported in the albinistic variants of *I. flocculosa*, *I. lacera*, *I. sindonia*, *I. lanuginosa* and *I. asterospora* (Kuyper, 1986).

In most species of *Inocybe* basidia are clavate, but in some they are swollen towards apex and are considered to have some use in circumscribing natural taxa. A unique brown necropigment is reported in the basidia of the members of subgenus *Mallocybe*. In several species of *Inocybe*, occasional occurrence of crassobasidia are also reported (Kuyper, 1986).

Different types of cystidia are known in the genus *Inocybe*. These sterile elements may differ in their origin and structure in different species. The cheilocystidia in subgenus *Mallocybe* arise as terminal elements of the hyphae of the hymenophoral trama, but those in subgenus *Inosperma* and subgenus *Inocybe* are hymenial in origin.

Usually mature cheilo- and pleurocystidia are similar in *Inocybe*. The wall thickness of Cheilo- and pleurocystidia ranges from less than 0.5 μm to more than 5 μm and they usually possess crystalline apical encrustations formed of calcium oxalate crystals. The thick-walled cystidia having encrustations are referred to as metuloids. Generally, the wall thickness increases with age. There exists some correlation between lime content in the soil and the thickness of the cystidial wall and frequency of apical crystals (Kuyper, 1986). The form of cheilo- and pleurocystidia is considered as a constant feature that has some value in species delimitation.

In the subgenus *Inosperma* cheilocystidia are thin-walled and their form ranges from

slenderly cylindrical to broadly clavate or pyriform and are considered as species specific. In addition to the true cheilocystidia, the lamella-edge shows thin-walled, colourless, clavate or pyriform elements called the paracystidia (Kuyper, 1986). They are almost thick-walled and brown encrusted in *I. phaeocomis*, *I. muricellata* and *I. vulpinella*. In many species a transition between these two types of cystidia can be seen. The paracystidia also have some value in infrageneric taxonomy.

The occurrence of pileocystidia in *Inocybe* is inconstant and is considered to have no value from a taxonomic point of view. Examination of the pruinosity of the stipe and microscopic study of the distribution of caulocystidia and caulocystidioid hairs are very important in defining natural groups (Kuyper, 1986).

Mostly, the pileipellis is an undifferentiated cutis but sometimes it becomes disrupted with scattered bundles of ascending hyphae. In the genus *Inocybe* the formation of a true trichodermium as in *I. squarrosa* is rare. Clamp-connexions are known in all species of *Inocybe*.

Infrageneric classification

In his revisionary work on the genus *Inocybe*, Kuyper (1986) recognized three subgenera under the genus *Inocybe* viz., *Mallocybe*, *Inosperma* and *Inocybe*. The subgenus *Mallocybe* is characterized by necropigmented basidia, broadly adnate or almost subdecurrent lamellae, comparatively short stipe, and tramal origin of cheilocystidia. The subgenus *Inosperma* is characterized by longer stipe and phaseoliform spores, basidia without necropigment and cheilocystidia of hymenial origin. It consists of two sections, *Cervicolores* and *Rimosae*. The subgenus *Inocybe* is characterized by thick-walled pleurocystidia (metuloids) and the rather long hilar appendix of the spores. In this subgenus, he recognized two groups *Cortinatae* and *Marginatae* and gave the informal rank of super section to these groups.

Singer (1986) subdivided the genus into three subgenera: *Inosperma*, *Inocybium* and *Inocybe*. He placed all the smooth spored species under two subgenera viz., *Inosperma* and *Inocybium* and all the angulate- to echinulate-spored members having either metuloids

or thin-walled cystidia under the subgenus *Inocybe*. The subgenus *Inocybium* differs from subgenus *Inosperma* in the presence of metuloids. Singer included three sections viz. *Depauperatae*, *Rimosae* and *Cervicolores* under *Inosperma*, five sections namely *Lactiferae*, *Lacerae*, *Hystrices*, *Splendentes* and an unnamed section under *Inocybium* and six sections namely *Rubellae*, *Inocybe*, *Calosporae*, *Petiginosae*, *Marginatae* and an unnamed section under *Inocybe*.

Kobayashi (1993) proposed a new subgenus, *Leptocybe*, as suggested by Singer (1986), to accommodate members having thin-walled cystidia and gibbose spores. The main distinguishing characters of this subgenus are the angulate, nodulose, echinulate or stellate spores and the absence of metuloids. He included two *Inocybe* species from Japan under this subgenus.

Recently, Bon (1997a) recognized three subgenera under the genus *Inocybe*, namely *Inosperma*, *Inocybe*, and *Clypeus*. He placed all the members having gibbous, nodulose, spinose or stellate spores under the subgenus *Clypeus* and all those having smooth-spores under the subgenera *Inosperma* and *Inocybe*. The subgenus *Inosperma* is characterized by thin-walled, clavate or differently shaped cheilocystidia having no crystalloid cap, absence of pleurocystidia (metuloids) and ovo-ellipsoid to cylindrico-phaseoliform spores. In the subgenus *Inocybe*, cystidia are metuloidal with a crystalloid cap and the spores are often ovoid to cylindrico-conic. He subdivided the genus *Inosperma* into three sections viz., *Depauperatae*, *Cervicolores* and *Rimosae* and the subgenus *Inocybe* into five sections namely *Lactiferae*, *Lilacinae*, *Inocybe*, *Tardae*, and *Splendentes*. He considered three sections such as *Cortinatae*, *Petiginosae* and *Marginatae* under the subgenus *Clypeus*.

Ecology

All species of the genus *Inocybe* are considered to be mycorrhizal with conifers or members of Fagaceae, Tiliaceae, Casuarinaceae, Dipterocarpaceae, Myrtaceae and some other families. Only a rather loose association is observed between inocybes and their hosts. Generally, the individual species in the genus *Inocybe* are considered as euryoecious. For example *Inocybe geophylla* and *I. rimosa* are reported to have associated with eight

and fourteen different genera of trees respectively (Kuyper, 1986).

Most species of the genus *Inocybe* prefer somewhat disturbed vegetations. A few reports on their occurrence in sand dunes without any nearby vegetation suggests their probable saprophytic mode of life. Almost all species of *Inocybe* prefer to grow on calcareous or nutrient-rich soils and then, with a less obligate mycorrhizal association. *Inocybe sambucina* and *I. lacera* are commonly found in acid, nutrient-poor soil. Some species of *Inocybe* also occur in xeric conditions (Kuyper, 1986).

World distribution

The genus *Inocybe* is worldwide in distribution. Majority of the species is reported from temperate regions. Tropics are, generally, considered as poorer in species of *Inocybe* (Pegler & Young, 1972; Kuyper, 1986). From the very beginning of the last century, agaricologists, Masee, Kühner, Heim, and Lange from Europe, Peck, Atkinson, Kauffmann, Smith, and Murrill from North America and several others from various parts of the world described many species of *Inocybe*. Unfortunately, many of these earlier works suffer from inadequate descriptions of the species. Pegler and Young (1972) studied spores of European species of *Inocybe* using scanning electron microscopy and they keyed out various species based on the form of the spores. Kostyra (1993) studied the cystidial crystals in the genus *Inocybe* using chemical and crystal-optical analysis. Recently, there appeared a few monographic works (Alessio, 1980; Kuyper, 1986; Stangl, 1989; Bon, 1997a, 1997b, 1998) on the genus *Inocybe*, representing European members. Various other floristic works include: **North America** (Phillips, 1991); **Canada** (Vauras, 1994b); **U S A** (Stuntz, 1947, 1954; Grund & Stuntz, 1968, 1970, 1975, 1977, 1980, 1981, 1983, 1984; Arora, 1979; Nishida, 1988, 1989; Bessette & Fatto, 1998); **Central America and West Indies**: Jamaica (Dennis, 1968); Lesser Antilles (Pegler, 1983); **South America** (Singer, 1969); **Europe** (Høiland, 1977; Phillips, 1981, Kuyper, 1986; Vauras, 1994b); Finland (Stangl & Vauras, 1988; Jacobsson & Vauras, 1989; Vauras, 1989, 1994a); France (Bon, 1979, 1984; Bon & Chevassut, 1988); Germany (Einhellinger & Stangl, 1979); Great Britain (Pearson, 1946); Hungary (Babos & Stangl, 1985); Italy (Alessio, 1983, 1998); Netherlands (Huijsman, 1978);

Keizer & Arnolds, 1995); Spain (Jacobsson & Vauras, 1989; Heykoop & Esteve-Raventós, 1994; Esteve-Raventós & Orlega, 1995; Esteve-Raventós, 1997); **Africa**: East Africa (Pegler, 1977); South Africa (Pegler, 1996); **Australia and Pacific Islands** (Horak, 1979, 1980a; May & Wood, 1997) and **Asia** (Horak, 1979, 1980a); Japan (Kobayasi, 1952; Imazeki *et al.*, 1988; Kobayashi, 1993, 1994, 1995; Kobayashi & Courtecuisse, 1993; Kobayashi & Hongo, 1993); Sri Lanka (Pegler, 1986).

In her revised list of agaricoid and boletoid basidiomycetes from India and Nepal, Manjula (1983) listed eight species of *Inocybe*. Horak (1981) reported four species, *Astrosporina shoreae*, *A. calospora*, *Inocybe calamistrata* and *I. claviger* from the southern slopes of Himalayas. Natarajan and Raman (1983) reported another species, *I. microspora*, from Tamil Nadu.

Presently, a number of *Inocybe* are known from various regions of Kerala State. These include *Inocybe bongardii* (Sathe & Sasangan, 1977), *I. virosa* (Vrinda, Pradeep, Joseph & Abraham, 1996), *I. purpureoflavida* (Vrinda, Pradeep & Abraham, 1997), *I. acuta*, *I. ionides*, *I. lasserii*, and *I. umbrina* (Vrinda, Pradeep, Mathew & Abraham, 1997). Manimohan and Leelavathy (1986) reported two species viz., *I. cutifracta* and *I. petchi* from the Calicut University Campus.

Economic importance

Inocybe cutifracta of tropical Asia and the European species *I. jura* are considered to be edible (Singer, 1986). Some species of *Inocybe*, like *I. patouillardii*, *I. fastigiata*, *I. geophylla*, *I. mixtilis*, *I. pudica*, *I. sororia*, and *I. subdstricta* have the potentiality to cause severe muscarine-type of poisoning (Singer, 1986; Yam, Helfer & Watling, 1994; Benjamin, 1995). *Inocybe aeruginascens*, *I. corydalina*, *I. haemacta* and *I. tricolor* are regarded as hallucinogenic and they contain alkaloids like psilocybin and muscarine (Besl & Mack, 1985; Stamets, 1996). *Inocybes* are important in forestry and forest ecology as probably all of them are mycorrhiza-forming. They can play some significant role in regeneration, growth, health and distribution of their host plants (Horak, 1980a).

Cortinarius Fries

Genus-concept

Cortinarius is the largest agaric genus with more than 2,000 species (Moser, McKnight & Sigl, 1994). *Cortinarius* was initially regarded as a series within the genus *Agaricus* by Fries (1821). Later, he (Fries, 1836) gave generic status to this series.

The main characters of the genus *Cortinarius* are terrestrial habitat; presence of ectotrophic mycorrhizal associations with forest trees; cortinoid veil of basidioma; rust-brown or ochraceous-tawny spore-print; presence of exosporial ornamentations on spore surface; and absence of a suprahilar plage.

Some of the smaller cortinariii show similarities with *Dermocybe*, *Galerina* and *Melanomphalia*. Although, *Cortinarius* and *Dermocybe* are closely-allied genera, species of the latter can be easily distinguished by small to medium-sized basidiomata with yellow, green, orange, yellow-brown or red lamellae and presence of certain anthraquinonic pigments like endocrocin. The other two genera are non-mycorrhizal and they are distinguishable from *Cortinarius* by their cystidial characters also. Additionally, in *Galerina*, the stipe of the basidiomata is narrow and fragile, the spores are normally with a distinct suprahilar plage and the cheilocystidia are often abundant and typically fusoid-ventricose or with a swollen rounded apex.

Some of the cortinariii may also be confused with *Gymnopilus*, *Tubaria* and *Inocybe*. *Gymnopilus* however, differs from the *Cortinarius* in cystidial characters and in the total absence of ectotrophic mycorrhiza formation. *Tubaria* can be easily distinguished from *Cortinarius* as the former has smooth spores, which are thin-walled and easily collapsible when mounted in alkaline solution. The genus *Inocybe* can be easily delimited, as they possess smooth or nodulose spores when compared to the ornamented spores in *Cortinarius*.

Characters used in taxonomy

The size and shape of the basidiomata in the genus *Cortinarius* are highly variable and are useful in the segregation of certain species. Generally, the size of the basidiomata

ranges from very small (1 cm) to very large (20 cm). The habit may be mycenoid, collybioid, clitocyboid, tricholomatoid or nearly pleurotoid (Moser, in Singer, 1986). The colour and surface features of the pileus are also very valuable from a taxonomic point of view. The pileal colour in *Cortinarius* is often unusual or bright such as bright yellow, red, violet, lilac or purple (Largent & Thiers, 1977). Basidiomata are either hygrophanous or non-hygrophanous. The pileus surface is often squamose, squamulose, rimose, fibrillose, tomentose, silky or glabrous. The viscosity of the pileus surface is also very important in the delimitation of the groups and species.

The lamellar attachment on the stipe varies from sinuate to subdecurrent. A wide variation in colour of the lamellae is observed in young specimens of different groups and species (Moser, in singer, 1986). With maturity the lamellae become richly coloured in the shades of the spore-print.

The cortinariii are centrally stipitate. Usually the size and colour of the stipe varies with the species. The stipe surface may be glabrous or fibrillose, viscid or dry according to the species. A basal bulb, sometimes a marginate one, is known in some species. Basidiomata are usually with an inner and an outer veil. The inner veil often forms a cortina when young or sometimes a membranous ring. The outer veil forms a fugacious to persistently belt-like (annular to peronate) structure on the lower portion of the stipe and in some groups, a distinct membranous volva. In species of the subgenus *Telamonia* the outer veil forms several belts on the stipe surface and in some other groups like *Myxacium* it becomes mucilaginous. Velar remnants are totally absent in some species (Moser, in Singer, 1986). Many species of *Cortinarius* have characteristic odours (Largent & Thiers, 1977). The taste of the basidiomata is also distinct in some species. The mycorrhizal specializations of the cortinariii with woody plants are also useful for the species differentiation (Moser, in Singer, 1986).

Various chemical reactions also appear to be of great significance in the identification and classification of cortinariii. The reactions of alkalies like NH_3 with flesh and pileus of the basidiomata is often useful in the separation of the taxa, especially at the subgeneric level.

A careful study of the various kinds of pigments in certain subgenera such as *Telamonia* appear to be useful in taxonomy. Moser *et al.* (1994) used styrylpyrone pigments in the generic delimitation and also in defining species. The presence or absence of luminous reaction under ultraviolet light and the nature of fluorescence are often useful in the taxonomic studies of *Cortinarius*. Gruber (1969) studied occurrence of different fluorescent substances specific for the different sections of the subgenus *Leprocybe*. Moser *et al.* (1994) determined fluorescence of fresh and dried specimens under ultraviolet light (255 & 354 nm) to differentiate taxa otherwise difficult to separate. They (Moser *et al.*, 1994) also used anthraquinonic pigment patterns which appeared in thin layer chromatography to distinguish species in subgenera *Phlegmacium*, *Leprocybe* and *Telamonia*.

The colour of the spore-print is generally rust brown. The shape of the spores may be rounded, elliptical, amygdaliform, spindle-shaped, or limoniform and are often useful in the species delimitation (Moser, 1983). Spores are mostly warty or rarely almost smooth. Basidia are 4- or rarely 2-spored. Cheilocystidia are present in some members of this genus. The size and shape of the cheilocystidia are very useful in the taxonomic segregation in subgenus *Telamonia* (Moser, in Singer, 1986). Pleurocystidia are rare and if present, are with coarsely granular contents or yellow granular encrustations. Usually, the hymenophoral trama is regular. In *Cortinarius*, the pileipellis is a cutis composed of repent filamentous hyphae. A detailed study of the cortical layers of both pileus and stipe and the other anatomical characters are also useful in the segregation of species in some groups of *Cortinarius* (Moser, in Singer, 1986).

Infrageneric classification

The genus *Cortinarius* is considered as one of the most taxonomically complicated genera in the Agaricales. Moser (1983) subdivided the genus into six subgenera, namely *Myxacium*, *Phlegmacium*, *Sericeocybe*, *Cortinarius*, *Leprocybe* and *Telamonia*.

In the subgenus *Myxacium* both pileus and stipe are sticky from glutinous universal veil and the pileus cuticle is often bitter in taste, where as in subgenus *Phlegmacium* only the pileus is sticky and the stipe frequently has a bulb which often forms a marginate base.

In *Sericeocybe* pileus is often silky or satiny (with or without a cellular hypoderm) or scaly (and then lamellae bluish and spores rounded) and is not sticky or hygrophanous. In the subgenus *Cortinarius* the basidiomata are large, dark violet, and tomentose-scaly with large cheilo- and pleurocystidia. The subgenus *Leprocybe* is characterized by olive green, brownish olive, yellowish brown, orange-brown, or rarely red colours; fibrous, scaly, tomentose or smooth and silky pileus surface; round to broadly elliptical or rarely elliptical spores; and 6–10 μm or often more wide, pigment encrusted, interwoven, relatively loose pileipellis hyphae. They may give a luminous reaction under ultraviolet light. Species of the subgenus *Telamonia* are mostly hygrophanous and contains most of the small, brown members. Moser, further subdivided most of these subgenera into a number of sections.

Later, Moser (in Singer, 1986) included two more subgenera, namely *Paramyxacium* and *Cystogenes* under the genus *Cortinarius*. The habit and colours of basidiomata in *Paramyxacium* are similar to some species of *Myxacium*. However, in *Paramyxacium* only the pileus is glutinous and the stipe remains dry. The partial veil in *Paramyxacium* is cobweb like or frequently forming a membranous annulus. The subgenus *Cystogenes* is characterized by orange, rufous or brown pileus, yellow, olive green, or more rarely brown to whitish brown stipe, ocher, yellow, green, ferruginous or fuscous universal veil; mostly differentiated pleuro- and cheilocystidia; and absence of fluorescent substances under ultraviolet light.

Ecology

All the members of the genus *Cortinarius* are regarded as obligate ectomycorrhizal symbionts with one or two exceptions from Southern Hemisphere (Moser *et al.*, 1994). They are seen mostly associated with members of Pinaceae, Fagales, Salicales, Tiliaceae, Caesalpinaceae, Myrtaceae, Rhamnaceae, Sapotaceae and Ericaceae (Moser, in Singer, 1986). The enormous species diversity and the ecological amplitude suggest their prominent role in forest ecosystems, mainly as symbionts and as decomposers.

A certain degree of host specificity is reported in some species of *Cortinarius*. For example, the species *C. fusco-peronatus* is always seen associated with *Abies* spp. (Moser *et al.*, 1994).

Habitats derived from calcareous materials with pH values close to neutral are considered as favourable for cortinariid, especially for the members of the subgenus *Phlegmacium*. Species such as *C. orichalceus* are regarded as typical indicators for neutral pH (Moser *et al.*, 1994).

World distribution

The cortinariid are widely distributed in the temperate zones of North America, Europe and Asia and in the mountains of subtropical and tropical areas where various mycorrhizal partners co-exist with them (Moser, in Singer, 1986). Several accounts are available on their wide geographical distribution: **North America** (Smith, 1939a, 1944a; Phillips, 1991; Moser, 1993; Thorn & Malloch, 1994; Moser, McKnight & Ammirati, 1995; Moser & Ammirati, 1996, 1999, 2000); U S A (Thiers & Smith, 1969; Cripps & Miller, Jr. 1994); **South America**: Chile (Valenzuela & Esteve-Raventos, 1994); Venezuela (Dennis, 1970); **Europe**: Austria (Bendiksen, Brandrud, Bendiksen & Lindström, 1993; Moser, 1995); France (Henry, 1982; Bon, 1985; Moser, 1996); Germany (Kärcher & Seibt, 1988, 1990, 1991, 1993); Great Britain (Orton, 1960, 1977, 1987; Phillips, 1981); Hungary (Bohus, 1970, 1976, 1979); Italy (Henry & Contu, 1985, 1986, 1987, 1989; Contu, 1987a, 1992; Ballero, Contu & Poli, 1995); Norway (Høiland, 1980; Bendiksen & Bendiksen, 1992, 1993; Bendiksen, Brandrud, Bendiksen & Lindström, 1993); Sweden (Moser, 1989; Bendiksen, Brandrud, Bendiksen & Lindström, 1993); **Australia and Pacific Islands** (Bougher & Hilton, 1989; Høiland & Watling, 1990; May & Wood, 1997); **Asia** (Hongo, 1969, 1973; Imazeki, Otani & Hongo, 1988); Papua New Guinea (Horak, 1995).

Comparatively very little information is available on the cortinariid of India. Manjula (1983) listed eleven species of *Cortinarius* as known from India, of which, five species, namely *C. argutus*, *C. aff. cyanopus*, *C. subfulgens*, *C. decipiens* and *C. kashmiriensis* were reported from the State of Jammu and Kashmir (Watling, 1980c; Watling & Gregory, 1980). The list also includes *C. gringlingii* collected from Uttar Pradesh by Moser (1960). Remaining species include *C. vinosus*, *C. violaceus*, *C. flammeus*, *C. saniosus*, and *C. deceptivus*. Sathe and Deshpande (1980a) reported a species, *C. graminicolus* from

Maharashtra State. Two species of this genus viz., *C. cinnabarinus* (Bhavanidevi & Nair, 1987) and *C. palmicolus* (Sathe and Daniel, 1980) are known from Kerala State.

Economic importance

Many species of the subgenera *Phlegmacium*, *Myxacium*, *Sericeocybe* and *Telamonia* are considered to be edible (Moser, in Singer, 1986). Some species, especially of the subgenus *Leprocybe*, are regarded as poisonous. *Cortinarius orellanus*, *C. splendens*, *C. speciosissimus* and several other species contain the renal toxins, orellanin and cortinarin and hence, are deadly poisonous (Høiland, 1980; Moser, in Singer, 1986; Michelot & Tebbett, 1990; Thorn & Malloch, 1994; Benjamin, 1995). Almost all species of the genus *Cortinarius* are ectomycorrhiza-forming and thus, have important role in forest ecology. In forestry, many species of the subgenus *Phlegmacium* are used for the artificial development of mycorrhiza (Moser, in Singer, 1986).

***Gymnopilus* Karsten**

Genus-concept

In the first volume of *Systema Mycologicum*, under the broad genus *Agaricus*, subgenus *Cortinarius* and tribe *Dermocybe*, Fries (1821) established subtribe *Lignatiles* comprising two species, *Agaricus sapineus* and *A. picreus*, both of which are now placed in the genus *Gymnopilus*. In the same volume he erected tribes *Pholiota* and *Flammula* also.

In his *Epicrisis Systematics Mycologici*, Fries (1838) upgraded the status of *Flammula* from tribe to subgenus and transferred the two species attached to the subtribe *Lignatiles* to the subgenus *Flammula*. Moreover, he added six more species: *A. stabilis*, *A. penetrans*, *A. hybridus*, *A. harmoge*, *A. liquiritiae* and *A. limulatus* to the subgenus *Flammula*. Kummer (1871) gave generic status to both *Pholiota* and *Flammula*. But, as there was already a genus *Flammula* representing some flowering plants, the generic name *Flammula* could not be used for fungi (Watling & Gregory, 1993).

Quélet (1886) established the genus *Dryophila*, with *Pholiota* and *Flammula* as

subgenera. Under the subgenus *Flammula*, section III. *Sapineae*, Quélet briefly described six species, which are now placed under the genus *Gymnopilus*. Finally, Karsten (1879) proposed the genus *Gymnopilus*, based on *Flammula liquiritiae* and *F. picreus*.

Under the genus *Gymnopilus*, Hesler (1969) placed those species which have lignicolous habitat, non-gelatinous hyphal systems, frequent occurrence of partial veil, ferruginous to brownish clay spore deposits, ornamented spores without germ-pore and gymnopiloid cheilocystidia. Most of the species currently included in the genus *Gymnopilus* were originally described as species of *Flammula*, *Pholiota*, *Naucoria* and *Cortinarius*.

According to Singer (1986), the genus *Gymnopilus* is characterized by the absence of ectotrophic mycorrhiza formation, central or somewhat eccentric stipe, rusty Spore-prints, spores with exosporial ornamentation and without suprahilar plage, tramal hyphae with clamp-connexions and brown to black staining on the pileus surface when KOH is added.

The genus *Gymnopilus* is related to other members of the family Cortinariaceae and to some other genera like *Pholiota*, *Pleuroflammula* and *Phaeomarasmius*. The genus *Cortinarius* is considered as the nearest relative of *Gymnopilus*. The cystidial characters and the total absence of ectotrophic mycorrhiza formation make *Gymnopilus* distinct from *Cortinarius*. In addition, *Cortinarius* can be distinguished from *Gymnopilus* by noting the former's terrestrial habitat, the gelatinous to viscid pileus in many species, frequently well-developed universal veil, and the brownish to clay-coloured spores (Hesler, 1969). At least some species of the genus *Gymnopilus* share some characters with *Cortinarius*. A few species of *Gymnopilus* are terrestrial and in some, spores are subamygdaliform and coarsely warty (*G. fulgens* and *G. ventricosus*), which show their natural relationships with *Cortinarius* (Hesler, 1969).

Gymnopilus can be separated from *Galerina* by the former's almost non-striate, non-hygrophanous, fleshy cap and the thick-walled, more strongly ornamented spores which lack a hilar depression.

The genus *Gymnopilus* is also close to *Pyrrhoglossum*, but in *Pyrrhoglossum* the basidiomata are consistently pleurotoid at maturity and mostly the spores are smaller

(Singer, 1986). *Gymnopilus* is considered related to the genus *Pholiota* by some authors, but the members of the genus *Pholiota* are generally smooth spored and are usually with distinct chrysocystidia. The genera *Phaeomarasmius* and *Pleuroflammula* also have smooth-walled spores and can easily be distinguished from *Gymnopilus*.

Kühner (1980) regarded the genus *Gymnopilus* as a member of the family Strophariaceae as, according to him, the styrylpyrone pigments and ecology (true saprophytism and absence of ectomycorrhizal associations) suggest its position among strophariacean genera rather than in Cortinariaceae. Høiland (1990) agreed with this view. Bas (1988) disagreed with Kühner in placing *Gymnopilus* outside the family Cortinariaceae for several reasons. Høiland (1984) proposed the idea that *Gymnopilus* may be related to a hypothetical, primitive, saprophytic ancestor of both Strophariaceae and Cortinariaceae.

Characters used in taxonomy

In *Gymnopilus*, the size, shape, colour and surface characters of the pileus are useful in distinguishing species and groups. Similarly, colour, odour, and taste of pileal context are valuable. Size, shape, and ornamentation of spores, and their reaction to certain chemicals are also useful in taxonomy (Hesler, 1969).

The size of the pileus varies from small to large and is useful when coupled with other characters. The form of the pileus is of limited use. A considerable range of pileus colour is reported and is important in species diagnosis, especially when used in contrasting extremes (Hesler, 1969; Rees, Orlovich & Marks, 1999). The texture of the pileus surface is an important feature for making species distinctions. In a large number of species, the pileus surface is fibrillose or scaly and the arrangement and distribution of these scale are also valuable. In some, the pileus is glabrous or becoming so at maturity. Rarely, short pileocystidia are clustered together to appear as mounds as in *G. melleus*. In a few species namely *G. parvulus*, *G. fulgens*, and *G. chrysopellus* the pileus margin is striate or even sulcate. Generally, *Gymnopilus* species are considered as non-hygrophanous. Various features of the context like colour or change of colour on bruising, odour, and taste have some supplementary value in species recognition.

The attachment of lamellae to the stipe varies from adnexed to decurrent. The spacing of the lamellae is also distinct in some species. The lamellae are initially with a shade of yellow and becoming ferruginous or tawny later. But in some species like *G. braendlei* and *G. pulchrifolius* they are initially white. Colour changes on bruising are also reported in the lamellae of some species like *G. melleus*, *G. humicola*, and *G. punctifolius*. All these features are useful in taxonomy in combination with other characters (Hesler, 1969).

The size and colour of the stipe vary with the species. The stipe surface may be glabrous, glabrescent, silky, fibrillose, or scaly according to the species. The presence or absence of partial veil and its nature and behaviour, if present, are of great taxonomic value in *Gymnopilus*. These characters are used in the separation of the two subgenera, *Annulati* and *Gymnopilus* (Hesler, 1969).

The spores range in size from small to large. In the subgenus *Gymnopilus*, spores are smaller in the section *Microspori* and larger in the section *Gymnopilus*. Spore dimensions are useful in taxonomy at the sectional level, and at times in the separation of species and groups of species (Hesler, 1969). In most of the species, spores are ellipsoid in face-view, and often inequilateral in profile. In a few species the spores are subglobose to ovoid and rarely amygdaliform or almost pip-shaped. The spore shape is considered only as a supplementary character. Spores always lack germ-pore and are not truncate. The epispore ornamentation is without any loosening and is rough. Small variations in spore ornamentations are considered to have greater value in *Gymnopilus* (Rees *et al.*, 1999). In majority of the spores the ornamentation consists of a wrinkling. However, in *Gymnopilus fulgens* and *G. imperialis* the roughness is exaggerated and appears as conspicuous warts. An intermediate condition of these wrinkles and coarse warts occur in many species. Usually the spore wall is moderately thick. Rees *et al.* (1999) reported the presence of suprahilar discs in many species of Australian *Gymnopilus*.

A positive or negative reaction in Melzer's reagent is valuable to separate groups of species (Hesler, 1969, Rees *et al.*, 1999). Hesler (1969) observed dextrinoid reaction in

three forth of all the species studied by him. The basidial characters are considered to have limited value in this genus. Several clavate to cylindric basidioles with brown contents, usually buried in the hymenium, are often encountered in the genus *Gymnopilus*, but they are considered to have limited use in the species determination (Hesler, 1969)

In *Gymnopilus* one or more kinds of cystidia are of common occurrence. Cheilocystidia are mostly capitate, sometimes subcapitate or even non-capitate. Slight variations in the shape of cheilocystidia assume greater importance in species segregation (Rees *et al.*, 1999). They are usually longer and more conspicuous than pleurocystidia. The presence or absence of a capitellum on the cheilocystidia is not of value as it varies even in the same specimen.

The pleurocystidia are typically colourless, ventricose and more or less nine-pin shaped. In a few species they are fusoid, clavate, obclavate or spathulate and are rarely capitate. In some species they are very rare and inconspicuous or totally absent. The pileocystidia, when occur in distinct tufts on the pileus surface, may be of some value when used along with other characters. The caulocystidia are also useful, especially when they occur in tufts or palisades, in separating species and groups and they are ventricose, clavate, or cylindric and colourless or brown (Hesler, 1969).

Though the hyphal arrangement of the hymenophoral trama is of no value in taxonomy, that of pileus trama is of some use in species identification. The hyphae of pileus trama are either radial or interwoven in arrangement. The pileipellis surface in *Gymnopilus* varies from an undifferentiated cutis to a well-differentiated repent cutis having thick-walled and often encrusted hyphae, which are more or less erect at times. The nature of the pileipellis has only limited value in species determinations (Hesler, 1969). Presently, the styrylpyrone pigments present in the genus are widely used in taxonomic determination (Høiland, 1990; Rees *et al.*, 1999).

Infrageneric classification

Singer (1951) assigned all the species of *Gymnopilus* to two sections, *Annulati* and *Sapinei*. The section *Annulati* is characterized by persistent membranous, annulus and the

section *Sapinei* by the presence of a slight fugacious cortina or often absence of a cortina. Later, Singer (1962) replaced the name *Sapinei* with *Gymnopilus*. Hesler (1969) elevated the taxonomic rank of section *Annulati* and *Gymnopilus* to subgeneric level and splitted the subgenus *Gymnopilus* into two sections, *Microspori* and *Gymnopilus* based on spore length. Guzmán-Davalos (1995) added a new section *Macrospori* to the subgenus *Gymnopilus*, also by considering spore length. Singer (1986) however, still maintains only two sections, *Annulati* and *Gymnopilus*, within the genus.

Ecology

Almost all the species of *Gymnopilus* are lignicolous. However, *Gymnopilus terrestris*, *G. angustifolius*, *G. arenicola*, and *G. humicola* are terrestrial or humicolous (Hesler, 1969). *Gymnopilus fulgens* is mostly reported as growing on peaty or burned soil. Unlike most other members of the family Cortinariaceae, the members of the genus *Gymnopilus* do not form any ectomycorrhizal associations with plants.

World distribution

Gymnopilus is considered to be cosmopolitan in distribution (Singer, 1986), though it is very poorly studied in many parts of the world. The total number of species is estimated to be less than 150 from the whole world (Stamets, 1996). The major floristic works on *Gymnopilus* are the following: **North America** (Hesler, 1969; Phillips, 1991; Guzmán-Davalos, 1996a); U S A (Seidl, 1989; Horak, 1989); **Central America and West Indies**: Guatemala (Guzmán-Davalos, 1996a); Lesser Antilles (Pegler, 1983); Mexico (Guzmán-Davalos & Guzmán, 1986, 1991, 1995; Guzmán-Davalos, 1994, 1995, 1996b); **South America**: Chile (Singer, 1969); **Europe** (Phillips, 1981; Moser, 1983; Horak, 1989); Great Britain (Watling & Gregory, 1993); Norway (Høiland, 1990); **Africa** (Pegler, 1966); East Africa (Pegler, 1977); Zimbabwe (Høiland, 1998); **Australia and Pacific Islands** (May & wood, 1997; Rees *et al.*, 1999); **Asia** (Horak, 1989); China (Zhishu, 1991); Sri Lanka (Pegler, 1986).

Manjula (1983) listed eight species of *Gymnopilus* as already known from various parts of India. Natarajan and Raman (1983) added seven species to the Indian reports, of which *G. giganteus* and *G. minutosporus* were new to science. The only species of

Gymnopilus known from Kerala is *G. minutosporus* (Natarajan & Raman, 1983).

Economic importance

Many species of *Gymnopilus* are wood destroyers. Some may form orchid endomycorrhiza and hence are used in horticulture. Styrylpyrones, the soluble yellow pigments present in many species, are used as dyeing material for cytological studies (Singer, 1986). Several species of *Gymnopilus* including *G. aeruginosus*, *G. braendleii*, *G. intermedius*, *G. luteoviridis*, *G. liquiritiae*, *G. luteus*, *G. purpuratus*, *G. spectabilis*, *G. validipes*, and *G. viridans* are psilocybin-active (Singer, 1986; Watling & Gregory, 1993; Stamets, 1996). Some species like *G. spectabilis* and *G. depressus* are eaten in certain regions, though they are somewhat bitter in taste (Singer, 1986). A number of species like *G. junonius* are considered poisonous (Singer, 1986; Watling & Gregory, 1993).

CREPIDOTACEAE (Imai) Singer

According to Singer (1986), the family Crepidotaceae is characterized by non-mycorrhizal basidiomata having central, eccentric, or lateral stipe or having no stipe. Spore-prints are in all shades of brown but not in bright or orangy ferruginous colour, sometimes reaching olive black, yellow ochraceous, tobacco brown or ochraceous cinnamon shade, or very rarely some kind of cream. Spores are either quite smooth and with a distinctly pigmented wall, or ornamented by an unevenness of the wall, punctate, or rarely more strongly verrucose with an ornamentation which in electron microscopic sections differs from the 'cortinarius-type' as it shows individualized or paired, fully erect, hollow columns. Under oil-immersion objective of the light microscope, these spores appear to have deeper-coloured or denser shorter column perforating the episporium or arising from it. Spores do not have a true plage when they are ornamented. Clamp-connexions are present in centrally stipitate forms.

Crepidotaceae is considered as intermediate between Cortinariaceae and Entolomataceae and is also close to Paxillaceae (Singer, 1986). In Cortinariaceae the spore ornamentations are rugose-verrucose and irregular consisting of broad warts which show irregular cavities. Many of the members in Cortinariaceae and Paxillaceae are

ectomycorrhizal, but no ectomycorrhizal species is known in Crepidotaceae. The family Paxillaceae is further characterized by a greater reactivity of the carpophores and their pigments with FeSO_4 , KOH and NH_4OH , strongly developed bilateral trama, and absence of the type of ornamentation seen in Crepidotaceae (Singer, 1986). In Entolomataceae, the hilum of the spores is nodulose type when compared to open-pore type hilum in Crepidotaceae (Pegler & Young, 1971).

Although Singer (1986) still maintains Crepidotaceae as a distinct family, there is a trend to abolish this family and to transfer the genera to other families. Kühner (1980) referred *Crepidotus*, *Tubaria*, and *Simocybe* to the Strophariaceae but nothing was mentioned about *Pleurotellus* and *Melanomphalia*, the remaining lamellate forms of the family. Bas (1988) also did not recognize Crepidotaceae as a distinct family and all genera considered as belonging to this family by Singer (1986), were transferred to Cortinariaceae. This decision was based primarily on the demonstration by Pegler and Young (1972b) that the ornamentation of the spores in this family was not fundamentally different from that of Cortinariaceae. In this treatise, however, Singer's concept of the family Crepidotaceae is followed. Singer (1986) included nine genera under this family viz., *Tubaria*, *Simocybe*, *Melanomphalia*, *Crepidotus*, *Pleurotellus*, *Pellidiscus*, *Chromocyphella*, *Phaeosolenia*, and *Episphaeria*. During the present study, only species belonging to the genus *Crepidotus* could be collected from Kerala.

Crepidotus (Fries) Staude

Genus-concept

The name *Crepidotus* was first used by Fries (1821) as the name of a tribe of his broadly conceived genus *Agaricus*. In this tribe he included more or less pleurotoid species with ferruginous or pale argillaceous spores and ephemeral fibrillose veil. Though he included fourteen species under the tribe, only three of them are presently included in the genus *Crepidotus*. Staude (1857) was the first to ascribe generic rank to *Crepidotus*. Staude treated only one species, *C. mollis* in the genus and hence it became the type species of *Crepidotus*. Kummer (1871) considered ten species in this genus, which included *C. violaceo-fulvus*, which has white spores. Quélet (1872) without any reference to Staude's

or Kummer's works, treated *Crepidotus* as a genus and transferred additional species to it. Pilát (1948) restricted the name *Crepidotus* to species with brown to yellow brown spores in his monograph of the European species. Singer (1947, 1973b) recognized the significance of presence or absence of clamp-connexions, fine structure of spore wall, pigmentation of the epicuticular hyphae and the gelatinization of pileus trama in *Crepidotus*.

Singer (1986) included under the genus *Crepidotus* those agarics having pluerotoid basidiomata that are either sessile or with a reduced pseudostipe; a not highly differentiated, cutis-type pileipellis; spore deposits ranging from clay colour to almost cinnamon or brownish melleous; and often rather pale spores with a rusty tinge under the microscope, mostly ornamented and without a germ-pore.

The genus *Crepidotus* is closely related to all other genera of the Crepidotaceae, especially to the genera *Pleurotellus* and *Simocybe*. The genus *Pleurotellus* can be distinguished from *Crepidotus* as it shows pale spore-print and spore colour, homogenous spore wall and absence of clamp-connexions (Singer, 1973b). *Simocybe* is also distinct from *Crepidotus* since it possesses smooth spores, better developed stipe, pileipellis with subhymeniform to hymeniform fragments or bunches of dermatocystidia, non-gelatinous trama and clamp-connexions (Singer, 1973b).

A few authors have used the term *Dochmiopus* as a genus name to incorporate those species of *Crepidotus* having ornamented spores. But, presently it is considered as a synonym of the genus *Crepidotus* (Singer, 1973b; Watling & Gregory, 1989) or as a subgenus of *Crepidotus* (Hesler & Smith, 1965, Senn-Irlet, 1995).

The crepidoti may, sometimes, be confused with certain other genera such as *Pleuroflammula*, *Melanotus*, and *Pyrrhoglossum*, though they are not closely related, because of the pleurotoid habit and dark spores. The spore-prints in *Pleuroflammula* and *Melanotus* are deep fuscous to rusty and are never so in *Crepidotus*. In addition, the spores in *Melanotus* are truncate with a broad germ-pore. In *Pyrrhoglossum* the spores are richly coloured and warty and darken in alkali.

Characters used in taxonomy

The major characters which are of taxonomic value in species delimitation in *Crepidotus* include size, shape, colour, nature of pigmentation, and texture of pileus, size, shape, and ornamentation of spores, colour of spore deposit, morphology of the cheilocystidia and, if present, pleurocystidia and presence or absence of clamp-connexions (Hesler & Smith, 1965).

The basidiomata in *Crepidotus* are pleurotoid and relatively small. Usually, the pileus is attached laterally, sometimes dorsally or rarely even centrally, to the substratum. The pileus can be fan-shaped, semi-orbicular, reniform or spathulate. The basidiomata may be scattered, gregarious or in imbricate clusters. The colour of the pileus surface is important in species delimitation. Generally, colour of the pileus and lamellae changes with maturity. The nature of pigmentation whether it is plasmatic, non-encrusting, encrusting or absent is of some value. The pileal surface may be glabrous, fibrillose or tomentose. In some, pileus surface may be viscid or slippery due to the gelatinous cuticular hyphae and is considered to have taxonomic implications (Hesler & Smith, 1965).

The taste of raw flesh in some species is bitter to disagreeable and is important in species delimitation (Hesler & Smith, 1965).

The colour of the spore deposit ranges from yellow to earth-brown and is considered to have taxonomic value (Hesler & Smith, 1965; Senn-Irlet, 1995). The spore form can be globose, subglobose, ellipsoid, ovoid, fusoid, or rarely lanceolate. Spore surface may be either smooth or ornamented. The ornamentation pattern is an important feature, though, often it is indistinct under a light microscope. These ornamentation types may be punctate, echinulate, rugulose or verrucose. The spore-shape and ornamentation patterns are more decisive than spore-size in species delimitation in *Crepidotus* (Hesler & Smith, 1965; Senn-Irlet, 1995).

Cheilocystidia are usually found in *Crepidotus* except in some species like *C. albidus* and *C. aquosus* (Hesler & Smith, 1965). The cheilocystidia are usually diverse in form, and may show a number of features like crooked to contorted condition and development of

secondary septa, which are useful in species segregation. Pleurocystidia are reported from a number of species and have some use in infrageneric delimitation. But, as the morphological difference among pleurocystidia of various species is meager, it is considered to have minor use.

There is not much taxonomic significance in the organization of lamellar- and pileal trama in *Crepidotus* (Hesler & Smith, 1965). However, Senn-Irlet (1995) emphasized the significance of construction of hymenophoral trama in the separation of two subgenera, *Crepidotus* and *Dochmiopus*. The difference in the organization of the pileus cuticle is of great value. The pileipellis may be a differentiated or non-differentiated cutis, a trichodermium or a gelatinous cuticle. Hesler and Smith (1965) also reported the taxonomic value of elements of trichodermium in species delimitation. The occurrence of pileocystidia on the surface is valuable from a taxonomic point of view.

The presence or absence of clamp-connexions on the hyphae of the basidiomata is of prime importance in the taxonomy of *Crepidotus* (Singer, 1947; Hesler & Smith, 1965), although Horak (1964) disagreed with this view. Usually, the clamps are readily observable in cuticular hyphae as these hyphae are not inflated much.

Infrageneric classification

In his work on the genus *Crepidotus*, particularly from the Western Hemisphere, Singer (1947) recognized two sections in the genus *Crepidotus* namely, *Echinosporae*, representing taxa with punctate spore-wall, and *Laevisporae*, taxa bearing smooth spores. He recognized two subsections *Porpophorini* and *Aporpini* under the section *Echinosporae* and subsections *Fibulatini* and *Defibulatini* under *Laevisporae*. Later, Singer (1962) changed the name of section *Laevisporae* to section *Crepidotus* for nomenclatural reasons. Singer (1986) maintained this classification, though he replaced the name of subsection *Defibulatini* with *Crepidotus*.

Pilát (1948) included those species with brown to yellow brown spore deposits under the genus *Crepidotus*. In this genus he considered 12 subgenera: *Tapinella*, *Paxillina*, *Gelocutis*, *Sphaerocrepidotus*, *Naucoriopsis*, *Stipitina*, *Geophila*, *Nebulosi*, *Dochmiopus*, *Muscicola*, *Colorati* and *Pearsonomyces*.

Hesler and Smith (1965) proposed a system of classification in which they considered the presence or absence of clamp-connexions and the shape of spores as the most useful characters in subgeneric delimitation. They included three subgenera *Crepidotus*, *Sphaerula*, and *Dochmiopus* under the genus. They considered six sections viz. *Cinnabarini*, *Tubariopsis*, *Stratosi*, *Parvuli*, *Crepidotus* and *Versuti* under subgenus *Crepidotus*, two sections viz., *Nyssicolae* and *Sphaerula* under subgenus *Sphaerula*, and seven sections viz., *Cystidios*, *Fulvidi*, *Phaseoli*, *Fusisporae*, *Betulae*, *Dochmiopus* and *Crepidotella* in *Dochmiopus*.

Ecology

Crepidoti are saprophytes, which grow on wood, wood debris or small twigs of herbaceous plants, or sometimes attached to mosses and ferns. Two species of *Crepidotus*, *C. autochthonus* and *C. versutus* are reported to inhabit soil, probably in association with litter or wood (Senn-Irlet, 1995).

World distribution

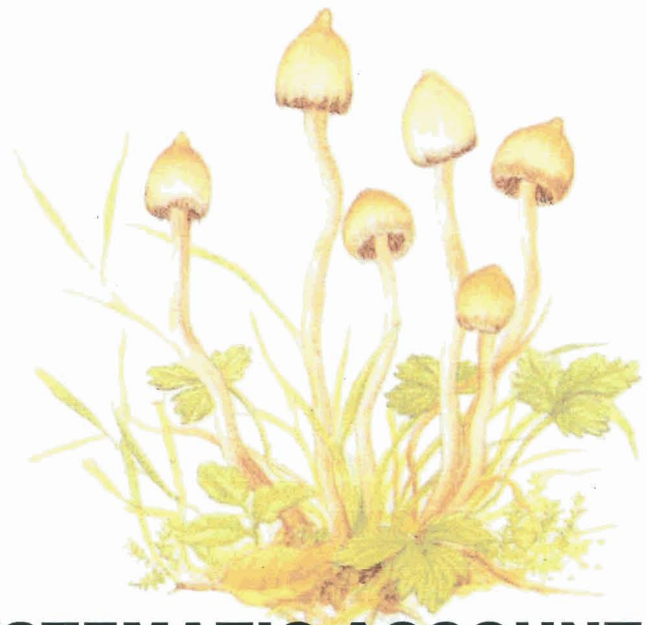
The genus *Crepidotus* is worldwide in distribution and is comparatively well studied mainly in Europe, North America and South America. The genus had been studied only superficially until the appearance of Singer's (1947) revisionary work on the genus representing mainly the species of the Western Hemisphere. A year later, Pilát (1948) published a monograph of the European species and this was followed by a type-analysis of the extra-European species (Pilát, 1950). Singer and Digilio (1952) published an extensive work on the genus *Crepidotus* of Argentina. Based on the concepts proposed by the foregoing workers, Orton (1960) conducted a further study of the British species. Hesler and Smith (1965) published a comprehensive monographic work on the North American species of the genus *Crepidotus*. Singer (1969) prepared a floristic account of the species from South America. Pegler and Young (1972) revised British species of *Crepidotus* after studying the spore surface with scanning electron microscope. Further, Singer (1973) published a monographic work describing the neotropical species. Apart from these major works, studies on the genus *Crepidotus* include a number of regional monographs and other works:

North America: (Phillips, 1991); **USA** (Ueki & Smith, 1973; Singer, 1988); **Central America and West Indies:** Lesser Antilles (Pegler, 1983); Mexico (Cifuentes Perez-Ramirez & Villegas, 1989; Bandala, Montoya & Moreno, 1999); **South America:** (Singer, 1973b); Argentina (Horak, 1964); Brazil (Singer, 1989a; Senn-Irlet & Meijer, 1998); Venezuela (Dennis, 1970); **Europe:** (Phillips, 1981; Seen-Irlet, 1992b, 1993, 1995); Austria (Hausknecht & Krisai-Greilhuber, 1988); Britain (Orton, 1984; Watling & Gregory, 1989); Denmark (Senn-Irlet, 1991); France (Courtecuisse, 1994); Germany (Senn-Irlet & Krieglsteiner, 1996); Italy (Poder & Ferrari, 1984); Netherlands (Senn-Irlet, 1992a); Norway (Norstein, 1990); Spain (Ortega & Buendia, 1989); **Africa:** East Africa (Pegler, 1977); **Australia and Pacific Islands** (Singer, 1989b; May & Wood, 1997); **Asia:** Japan (Imazeki, Otani & Hongo, 1988); Sri Lanka (Pegler 1986).

Manjula (1983) listed five species of *Crepidotus* viz., *C. cystidiosus*, *C. eucalypticola*, *C. uber*, *C. applanatus*, and *C. alveolus* as known from India. Of these, the first three were collected from Tamil Nadu State by Natarajan and Raman (1981), and later they (Natarajan & Raman, 1983) added two more species *C. applanatus* and *C. nephrodes* to the South Indian records. There are no previous reports on the occurrence of *Crepidotus* in Kerala.

Economic importance

Some of the members of the genus *Crepidotus* are harmless wood destroyers and some others are edible (Singer, 1986). A kind of rot is reported in shaded branches of Citrus by *C. citricolor* (Singer, 1986).



SYSTEMATIC ACCOUNT

SYSTEMATIC ACCOUNT

Key to the families

1. Pileipellis a hymeniform layer or rarely an epithelium; spore-print argillaceous brown, ochraceous brown or rust-brown; spores mostly with a truncate germ-pore; basidia short and often pyriform **BOLBITIACEAE**
1. Pileipellis neither a hymeniform layer nor an epithelium, but mostly a cutis, sometimes an ixocutis or a trichodermium; spore-print cinnamon-brown, fuscous, or lilaceous black; spores with or without a truncate germ-pore; basidia not pyriform 2
2. Spores constantly smooth under a light microscope; usually truncated by a germ-pore; chrysocystidia sometimes present; never forms ectomycorrhizal associations with trees **STROPHARIACEAE**
2. Spores usually ornamented, sometimes smooth-walled; usually without a germ-pore; chrysocystidia absent; ectomycorrhizal or not 3
3. Stipe usually central and well-developed; spore-print ferruginous brown to bright ferruginous or orange-ferruginous; spores mostly ornamented, frequently rugose-verrucose, sometimes with nodulose-gibbous to nodulose-subangular or stellate surface, occasionally smooth-walled, sometimes with an apical callus; mostly forming ectomycorrhizal associations with trees **CORTINARIACEAE**
3. Stipe usually poorly developed, eccentric or lateral in many; spore-print pale cinnamon-brown; spores either smooth, or ornamented by a general unevenness of wall or punctate or echinulate, apical callus absent; not forming, mycorrhizal associations..... **CREPIDOTACEAE**

BOLBITIACEAE Singer

in Pap. Mich. Acad. Sci., Arts & Lett. 32:147 (1948).

Basidiomata small to large; coprinoid, mycenoid, collybioid or tricholomatoid. Pileus conical, conico-companulate, convex or applanate. Context thin to thick, never gelatinized.

Lamellae free, adnexed or adnate, rust-brown to ferruginous. Stipe central, cylindrical or attenuated towards apex. Veil absent or sometimes present as a membranous annulus. Spore-print argillaceous brown, ochraceous brown or rust-brown. Spores ovoid, ellipsoid or rarely amygdaliform, sometimes lenticular, smooth, occasionally rugulose to verrucose, thick-walled, frequently truncated by an apical germ-pore. Basidia 2- or 4-spored. Lamella-edge mostly sterile with cheilocystidia. Pleurocystidia occasional or absent. Hymenophoral trama regular, sometimes with a mediostratum and flanking, broad hymenopodia. Pileipellis hymeniform; sometimes with pileocystidia. Caulocystidia often present. Clamp-connexions present or absent. Terricolous, humicolous, lignicolous or coprophilous. Cosmopolitan in distribution. Type genus: *Bolbitius* Fries

Key to the genera

1. Spores with a protracted callus and without a distinct germ-pore *Descolea*
1. Spores without a protracted callus and with a distinct germ-pore 2
2. Pileus viscid and soon putrescent; lamellae free or becoming so *Bolbitius*
2. Pileus not viscid and putrescent; lamellae not free 3
3. Basidiomata medium to large, often fleshy; spore-print tobacco brown..... *Agrocybe*
3. Basidiomata small to medium, usually fragile; spore-print ochraceous rust to rust-brown 4
4. Basidiomata with distinct velar remnants on stipe or at pileal margin.....*Pholiotina*
4. Basidiomata without velar remnants 5
5. Pileus plicate-striate; cheilocystidia not lecythiform but with long flexuous neck *Galerella*
5. Pileus not plicate-striate; cheilocystidia lecythiform *Conocybe*

Descolea Singer
in Lilloa 23:256. 1950 (1951).

Basidiomata small to medium-sized. Pileus convex to plane, dry or viscid. Lamellae adnexed to adnate. Stipe central, cylindrical or slightly tapering apically. Partial veil forming

a persistent, striate annulus; universal veil often leaves remnants on the lower part of the stipe and near the pileus margin. Spore-print ochraceous. Spores ellipsoid-amygdaliform or lemon shaped, never smooth but with verruculose to verrucose exosporial ornamentation, with a protracted mucro-like callus and without a distinct germ-pore. Cheilocystidia numerous to sparse. Pleurocystidia absent. Hymenophoral trama regular to subregular. Pileipellis hymeniform. Clamp-connexions present. On the ground, sometimes among fallen leaves and woody particles, rarely on dead wood. Ectotrophically mycorrhizal or not. Distributed in the South temperate zone, East Asia, the Himalayas and possibly in North Africa. Type species: *Descolea antarctica* Singer

Only a single species of *Descolea* was recorded from Kerala during the present study.

Descolea maculata Bougher
in Aust. J. Bot. 33:620 (1985).

Fig. 1 A-E; Plate 1 A

Pileus 20–40 mm diam., initially conico-convex, turning to convex, eventually plano-convex, usually with a distinct or indistinct obtuse umbo, at times with a small depression at the disc; surface uniformly dark brown (7F4, 7F5) when young, when mature, dark brown (7F8) towards the disc, fading to brown (6E7, 7E7) towards margin, hygrophanous and becoming uniformly light orange (5A4, 6A4), moist, sometimes with fine radial wrinkles, translucent-striate towards margin, with powdery velar remnants; margin decurved to plane, sometimes slightly upturned, entire or at times fissile or eroded. Context up to 3 mm wide at the centre, whitish. Lamellae adnexed to almost free, light orange (5A4) or greyish orange (5B6), frequently with a brown tint, close, up to 5 mm wide, with lamellulae of 3–4 lengths; edge pale, entire to slightly eroded, finely pruinose under a lens. Stipe 25–65 x 3.5–8 mm, central, terete, sometimes slightly compressed, slightly attenuated towards apex, hollow; surface pale orange (5A3), sometimes brownish towards base, glabrous, at times fibrillose towards base, annulate; annulus central to almost superior, pendant, radially grooved. Odour not distinctive. Spore-print not obtained.

Spores 9–14 x 5–8.5 (10.88±1.45 x 6.77±0.85) μm , Q=1.44–1.80, Qm=1.62,

amygdaliform to subamygdaliform, faintly verruculose, yellowish brown, slightly thick-walled, with an apical callus, lacking germ-pore. Basidia 29–50 x 9–14.5 μm , clavate, mostly with hyaline to yellowish brown granular contents, 1-, 2-, or 4-spored; sterigmata very long, up to 14.5 μm long. Lamella-edge heteromorphous with crowded cheilocystidia. Cheilocystidia 12.5–60 x 5–20.5 μm , clavate or flexuous, thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama subregular with a mediostratum of 3–27 μm wide, inflated, thin-walled, light brown hyphae, flanked on either side by 2–10 μm wide, narrow, thin-walled, brown hyphae. Pileal trama parallel-interwoven; hyphae 2–26.5 μm wide, thin-walled, with brown encrusting pigment; hyphae of the hypodermial region bear copious dark brown encrusting pigment. Pileipellis hymeniform; elements 12.5–56.5 x 7.5–25 μm , vesiculose, clavate or pedicellate-clavate, thin-walled, hyaline towards the distal end, brown encrusted towards base. Stipe trama composed of 2–25 μm wide hyphae, parallel, thin-walled, with pale brown pigment. Stipitipellis a cutis; hyphae 2–14 μm wide, thin-walled, coarsely encrusted by a brown pigment. Velar elements 4–20 μm wide, slightly thick-walled, encrusted by a dark brown pigment. Clamp-connexions present in all parts of the basidioma.

On soil, around or attached to buried roots and trunks of *Eucalyptus* trees, scattered, August-October.

Specimens examined: India, Kerala State, Idukki District, Munnar: 29 August 1997, A. Thomas T162; 8 August 1999, A. Thomas T321; 12 October 1999, A. Thomas T321b.

The Kerala collections are indistinguishable from those described from Australia by Bougher and Malajczuk (1985). The Australian collections also were mostly associated with *Eucalyptus* trees and they (Boughere & Malajczuk, 1985) xperimentally proved the ectomycorrhizal association of *Descolea maculata* with *Eucalyptus* trees. The genus *Descolea* is considered to have migrated from its endemic habitat in the Southern hemisphere to the Northern hemisphere. *Descolea pretiosa* Horak, described from the coniferous forest in the State of Himachal Pradesh (Horak, 1971b), is the only previously known species from India.

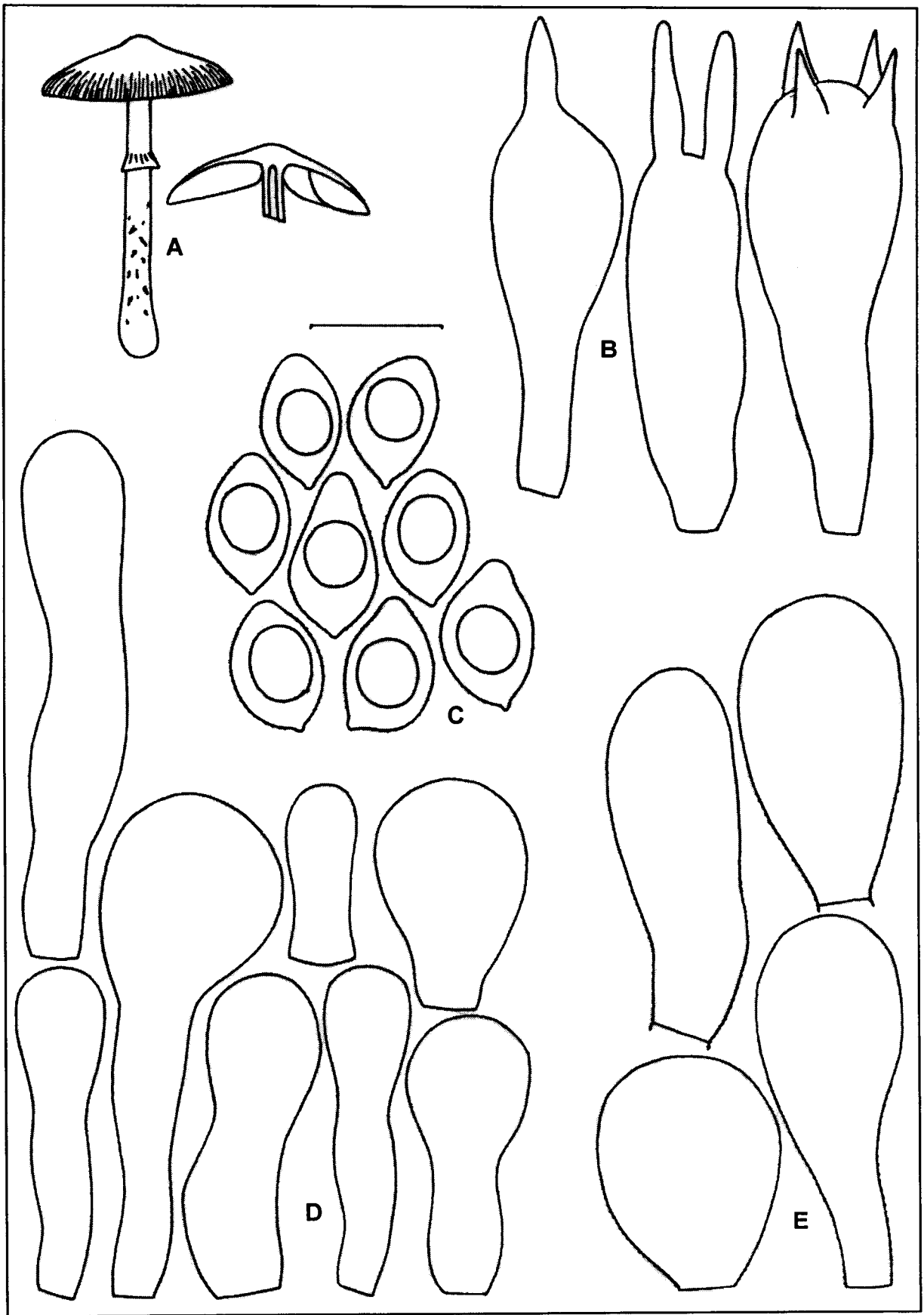


Fig. 1. *Descolea maculata* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Elements of pileipellis. Scale bar = 10 μ m

Bolbitius Fries
in *Epicrisis*:253 (1838)

Pluteolus (Fries) Gillet in *Hymen. Fr.*:549 (1876)

Basidiomata small to medium-sized, coprinoid, ephemeral. Pileus convex to plano-convex, often brightly coloured, viscid, thin, plicate-striate at least towards the margin. Context very thin, papery. Lamellae free or nearly so, close to crowded, rust-brown, mostly deliquescent after spore discharge. Stipe long, central, hollow, fragile, initially whitish. Spore-print rust-brown. Spores ovoid to ellipsoid, yellowish brown, smooth, thick-walled, apically truncated by a germ-pore. Basidia typically pyriform. Lamella-edge sterile to heteromorphous. Cheilocystidia vesiculose and non-capitate. Hymenophoral trama regular, with inflated hyphae. Pileipellis a hymeniform layer. Stipitipellis often with caulocystidia. Humicolous or coprophilous. Worldwide in distribution. Type species: *Bolbitius vitellinus* (Persoon: Fries) Fries

Only a single species of *Bolbitius* was recorded from Kerala during this study.

Bolbitius coprophilus (Peck) Hongo
in *Mem. Fac. Lib. Arts. Educ., Shiga University Nat. Sci.* 9:82 (1959).

Fig. 2 A-F; Plate 1 B

Pluteolus coprophilus Peck in *Report New York Mus. Nat. Hist.* 45:59 (1893).

Pileus 30–65 mm diam., conico-complanate to conico-convex, becoming plane, finally uplifted, with a central obtuse umbo, often on a central shallow depression; surface light orange (6A4) to pastel red (7A4) at the center, fading centrifugally, hygrophanous and becoming greyish orange (6B3) all over, glabrous, sulcate-striate to the center, glutinous when moist especially towards the center; margin appanate to reflexed, entire, becoming fissile or eroded. Context up to 2 mm thick at the center, white. Lamellae adnexed to almost free, initially pinkish (7A2), becoming brownish orange (6C5) to light brown (7D6), close, up to 5 mm wide, with lamellulae of three lengths; edge pale, fimbriate under a lens. Stipe 40–100 x 2.5–9 mm, central, terete, attenuated towards apex, fragile, hollow; surface white or pinkish white (7A2), faintly pruinose; base slightly swollen. Odour unpleasant when mature. Spore-print not obtained.

Spores 9.5–13.5 x 6.5–9 x 6–8 ($11.67 \pm 1.22 \times 7.81 \pm 0.69 \times 6.84 \pm 0.56$) μm , $Q=1.35$ – 1.65 , $Q_m=1.49$, lenticular, ovoid to ovo-ellipsoid in face-view, ellipsoid in side-view, melleous-brown, smooth, thick-walled, truncated by an apical germ-pore. Basidia 20–26.5 x 10.5–14 μm , pyriform, 4-spored; sterigmata up to 3 μm long. Lamella-edge heteromorphous. Cheilocystidia 16.5–49 x 7.5–16.5 μm , lageniform to utriform, scattered, thin-walled, hyaline. Pleurocystidia absent. Hymenophoral trama subregular; hyphae 2–17.5 μm wide, inflated, thin-walled, hyaline. Pileal trama interwoven; hyphae 2–26.5 μm wide, narrower towards upper part, inflated towards lower region, thin to slightly thick-walled, pale yellowish brown. Pileipellis composed of loosely arranged hymeniform elements, 19–57.5 x 8–17 μm , clavate to sphaeropedunculate, dispersed in a gelatinous matrix, thin-walled, hyaline to pale-yellow or pinkish. Stipe trama composed of 2–9 μm wide hyphae, thin-to slightly thick-walled, hyaline. Stipitipellis a cutis; hyphae 2–12.5 μm wide, thin to slightly thick-walled, almost hyaline. Caulocystidia 5.5–12.5 μm wide, arising as modified terminal parts of lateral hyphae, irregularly branched or diverticulate, septate, thin-walled, hyaline, in clusters or scattered. Clamp-connexions not observed.

On elephant dung, scattered, June-September.

Specimens examined: India, Kerala State, Thrissur District, Guruvayoor: 11 June 1999, A. Thomas T312; 17 June 1999, A. Thomas T312b; Kasargod District, Adhoor: 16 September 2000, A. Thomas T312C.

Except for the smaller spores, the present collections are inseparable from *Bolbitius coprophilus* known from north temperate regions. This species is characterized by pinkish basidiomata growing on dung and straw. According to Watling (1982), this species is widely distributed in glasshouses in the Netherlands. Apart from the North temperate regions, *B. coprophilus* is also known from Australia (Hongo, 1959) and Singapore (Watling, 1994). It is very close to *B. vitellinus* (Persoon ex Fries) Fries, a widely distributed species usually associated with dung including elephant dung (Pegler, 1977), but the latter species has bright lemon-chrome basidiomata. Watling (1994) expressed the view that *B. variicolor* Atkinson might be considered conspecific with *B. coprophilus*.

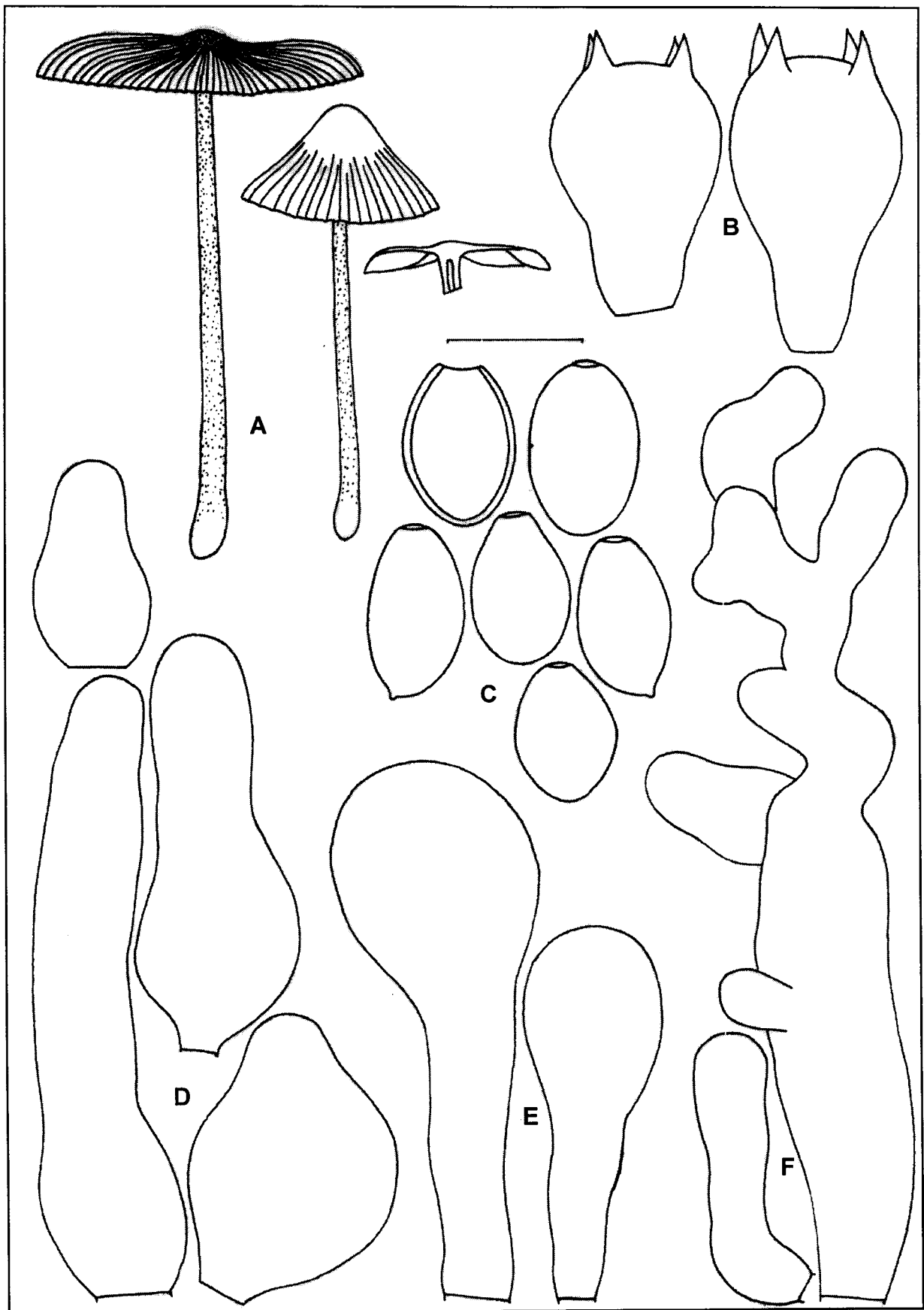


Fig. 2. *Bolbitius coprophilus* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Elements of pileipellis; F. Caulocystidia. Scale bar = 10 μ m

Agrocybe Fayod

in Ann. Sci. Nat., Bot.ser. 7,9:358 (1889).

Cyclopus (Quélet) Barbier in Bulliard Soc. Sci. Nat. Saone-et-Loire 33:131 (1907).

Togaria W. G. Smith in Brit. Basid.:121 (1908).

Bulla Earle in Bulliard New York Bot. Gard. 5: 424 (1909).

Cyclocybe Velenovsky in Op. Bot. Cech. 4:122 (1947).

Basidiomata small to large. Pileus convex to plane, white to dark brown, glabrous. Context usually fleshy. Lamellae adnexed to adnate, snuff brown to fuscous. Stipe central, often arising from basal mycelial cords. Veil present or absent, when present mostly persisting as a membranous annulus. Spore-print rusty brown, tobacco brown, or dark brown. Spores ovoid to ellipsoid, yellowish brown, smooth, thick-walled, with an apical germ-pore which may or may not truncate the apex. Basidia bi- or tetrasporic. Lamella-edge sterile to heteromorphous. Pleurocystidia present or absent. Hymenophoral trama regular. Pileipellis a hymeniform layer composed of inflated, globose, pyriform or clavate elements. Terrestrial, coprophilous or lignicolous. Worldwide in distribution. Type species *Agrocybe praecox* (Persoon: Fries) Fayod

Key to the species

1. Basidiomata with a distinct annulus 5
1. Basidiomata without an annulus 2
2. Pileus surface subviscid; cheilocystidia usually ventricose-fusoid, lageniform or almost tibiiform 3
2. Pileus surface not viscid; cheilocystidia mostly clavate or vesiculose 4
3. Pileus pale- or light orange with long white powdery velar remnants towards margin; spores 9–14.5 µm long; basidia 4-spored *Agrocybe pediades*
3. Pileus brown, without velar remnants; spores 11–19 µm long; basidia mostly 2-spored *Agrocybe semiorbicularis*
4. Basidiomata on decaying grass tufts; pileus translucent-striate when moist; spores 9–2.5 µm long *Agrocybe* sp. 1
4. Basidiomata on soil; not striate when moist; spores 12–18 µm long .. *Agrocybe* sp. 2

5. Basidiomata up to 200 mm diam., robust, on decaying logs; annulus not evanescent; basidia 2-spored; pileocystidia absent ***Agrocybe* sp. 3**
5. Basidiomata less than 60 mm diam., fragile, on elephant dung; annulus evanescent; basidia 4-spored; pileocystidia present ***Agrocybe* sp. 4**

Agrocybe pediades (Fries) Fayod
in Ann. Sci. Nat., Bot. Ser. 7,9:358 (1889).

Fig. 3 A-F; Plate 1 C

Pileus 6–35 mm diam., hemispherical to convex, becoming plano-convex to plane, sometimes with an indistinct umbo or a small depression at the disc; surface pale orange (5A3) or light orange (5A4) at the centre, orange white (5A2) towards margin, glabrous, sometimes with white powdery velar remnants towards margin especially when young, non-hygrophanous, dull, slightly sticky when moist; margin initially incurved, becoming decurved and finally plane, initially entire, at times becoming fissile. Context up to 3 mm thick at the centre, whitish or orange white (5A2). Lamellae adnate to adanto-adnexed, light brown (6D4) to greyish brown (7D3), close to subcrowded, with lamellulae of 3 lengths, up to 8 mm wide; edge pale, finely scalloped. Stipe 25–60 x 1.5–4 mm, central, terete, almost equal or broader towards both ends with a bulbous base, solid, turning to fistulose; surface pale orange (5A3) or orange white (5A2), initially coated with velar remnants, later glabrescent, without an annulus; base with a few rhizoids. Odour not distinctive. Spore-print dark brown (6F8).

Spores 9–14.5 x 7–9 x 6.5–8 ($12.28 \pm 1.49 \times 7.97 \pm 0.62 \times 7.03 \pm 0.45$) μm , $Q=1.27-1.68$, $Q_m=1.52$, lenticular, ovoid in face-view, ellipsoid in side-view, cinnamon brown, smooth, thick-walled, apically truncated by a germ-pore. Basidia 24–39 x 8.5–12.5 μm , cylindric-clavate, frequently with a slight medium constriction, 4-spored; sterigmata up to 6 μm long. Lamella-edge sterile to heteromorphous. Cheilocystidia 13–34.5 x 5–10.5 μm , lageniform or rarely somewhat tibiiform, sometimes distal end capped with a resinous substance, thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama regular; hyphae 2–19 μm wide, thin-walled, hyaline. Pileal trama loosely interwoven; hyphae 2–17.5 μm wide, thin-walled, hyaline to yellowish. Pileipellis hymeniform, sometimes covered with a poorly developed

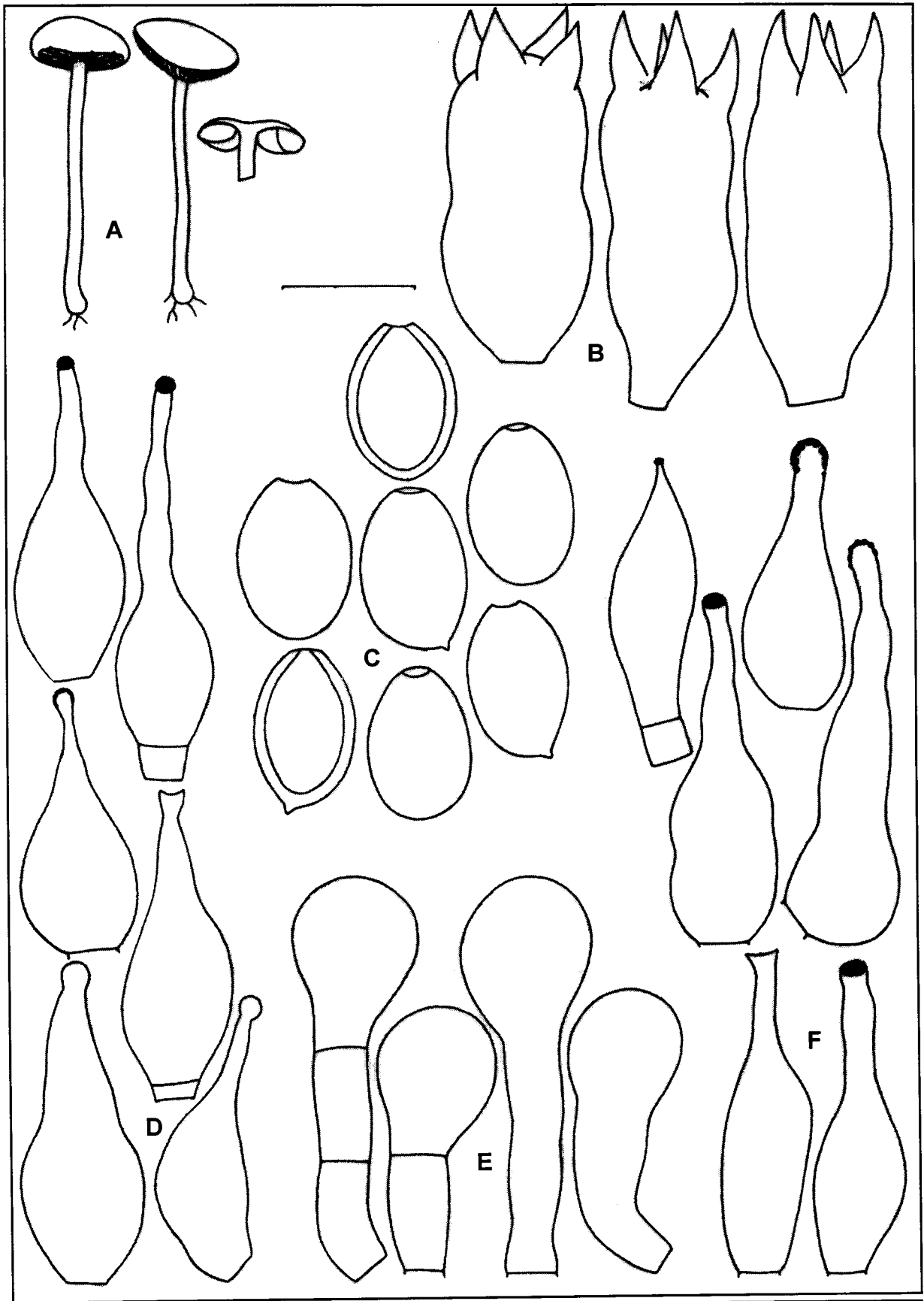


Fig. 3. *Agrocybe pediades* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Elements of pileipellis; F. Caulocystidia. Scale bar = 10 μ m

gelatinous layer; elements 8–35.5 x 6–13 μm , pedicellate-clavate, disrupted in most specimens, thin-walled, hyaline towards distal end, yellowish towards base. Hypodermium composed of 2–7 μm wide, thin walled hyphae with light yellowish brown encrustation. Stipe trama composed of 2–15.5 μm wide hyphae, thin-walled, hyaline or with a pale yellow wall pigment. Stipitipellis a cutis; hyphae 1.5–5 μm wide, thin to slightly thick-walled, yellowish to light yellowish brown. Caulocystidia 15–40 x 5–10 μm , narrowly lageniform to almost tibiiform, apex capped with a resinous substance, thin-walled, hyaline, restricted to upper part of the stipe. Clamp-connexions present.

On sandy roadside, sometimes attached to grass roots and other plant debris, gregarious to scattered, May-August.

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 10 June 1998, A. Thomas T268; 16 June 1998, A. Thomas T268b; 30 June 1998, A. Thomas T268c; 16 August 1998, A. Thomas T268d; 11 May 1999, A Thomas T268e; 25 May 1999, A. Thomas T268f.

The Kerala collections are indistinguishable from *Agrocybe pediades* described from other parts of the world (e.g., Watling, 1982; Watling & Taylor, 1987). This species is characterized by pale coloured, convex pileus with white powdery velar remnants towards margin when young, non-annulate stipe, large spores with truncate germ-pores, 4-spored basidia, lageniform to somewhat tibiiform cystidia and clamped hyphae. *Agrocybe semiorbicularis* (Bulliard) Fayod is extremely close and it is considered as the same as *A. pediades* by some authors (e.g., Nauta, 1986; Breitenbach & Kranzlin, 1995), but that species is predominantly bisporic, and has yellowish brown, subviscid pileus and larger spores. *Agrocybe pediades* seems to prefer sandy soil as is evident from the Kerala collections, British records (Watling, 1982) and New Zealand collections (Watling & Taylor, 1987).

Agrocybe semiorbicularis (Bulliard) Fayod
in Ann. Sci. Nat., Bot. ser. 7,9:358 (1889).

Fig. 4 A-G; Plate 2 A

Agaricus semiorbicularis Bulliard in Herb. Fries: Pl. 422/1 (1789).

Naucoria semiorbicularis (Bulliard) Gillet in Champ. Fries:439 (1874).

Simocybe semiorbicularis (Bulliard) Karsten in Hattsv.:427 (1879).

Hyalophila semiorbicularis (Bulliard) Quélet in Fl. Mycol. Fries:88 (1888).

Pseudodeconica semiorbicularis (Bulliard) Overeem in Bull. Jard. Bot., Buitenz. 9:19 (1927).

Agrocybe pediades (Fries) Fayod var. *bispora* Singer in Acta Inst. Bot. Kom. Acad. Sci. URSS ser. 2,6:457 (1950).

Basidiomata robust. Pileus 10–45 mm diam., hemispherical, becoming convex to broadly convex, sometimes with a small central depression when fully mature; surface brown (6D7), slightly fading towards margin or orange (5A6) with brown tint at the centre and light orange towards the margin, smooth, glabrous, slightly lubricous; margin incurved, becoming decurved, entire, sometimes becoming fissile. Context up to 2 mm thick at the centre, whitish or with an orange tint. Lamellae adnate, greyish orange (5B3, 5B4) when young, becoming light brown (6D5, 6D6) on maturity, subcrowded to close, up to 7 mm wide, with lamellulae of 3 lengths; edge pale, almost entire or eroded under a lens. Stipe 25–60 x 2–4 mm, central, terete, almost equal or sometimes with a slightly enlarged base, fistulose; surface pale orange (5A3) or light orange (5A4), faintly longitudinally striate. Odour not distinctive. Spore-print brown (6E7).

Spores 11–19 x 7.5–12 x 7–11 ($15.20 \pm 2.19 \times 9.79 \pm 1.27 \times 9.22 \pm 1.07$) μm , $Q=1.41$ – 1.68 , $Q_m=1.56$, ovo-ellipsoid in face-view, ellipsoid in side-view, melleous brown, thick-walled, with a prominent apical germ-pore, rarely biporate. Basidia 24–35 x 7.5–11.5 μm , clavate, sometimes with a median constriction, mostly 2-spored, rarely 4-spored; sterigmata up to 9 μm long. Lamella-edge sterile. Cheilocystidia 16.5–44 x 5–14 μm , mostly ventricose-fusoid with a globose capitellum, rarely clavate or lageniform, occasionally with an apical resinous cap, thin-walled, hyaline. Pleurocystidia rare, similar to cheilocystidia in all aspects. Hymenophoral trama regular to subregular; hyphae 2–14 μm wide, thin-walled, hyaline to pale yellow. Pileal trama loosely interwoven; hyphae 2–15.5 μm wide, thin-walled, light yellowish brown, sometimes faintly encrusted. Pileipellis a hymeniform layer covered with a poorly developed gelatinous layer; elements 12–25 x 4.5–12 μm , inflated-clavate to

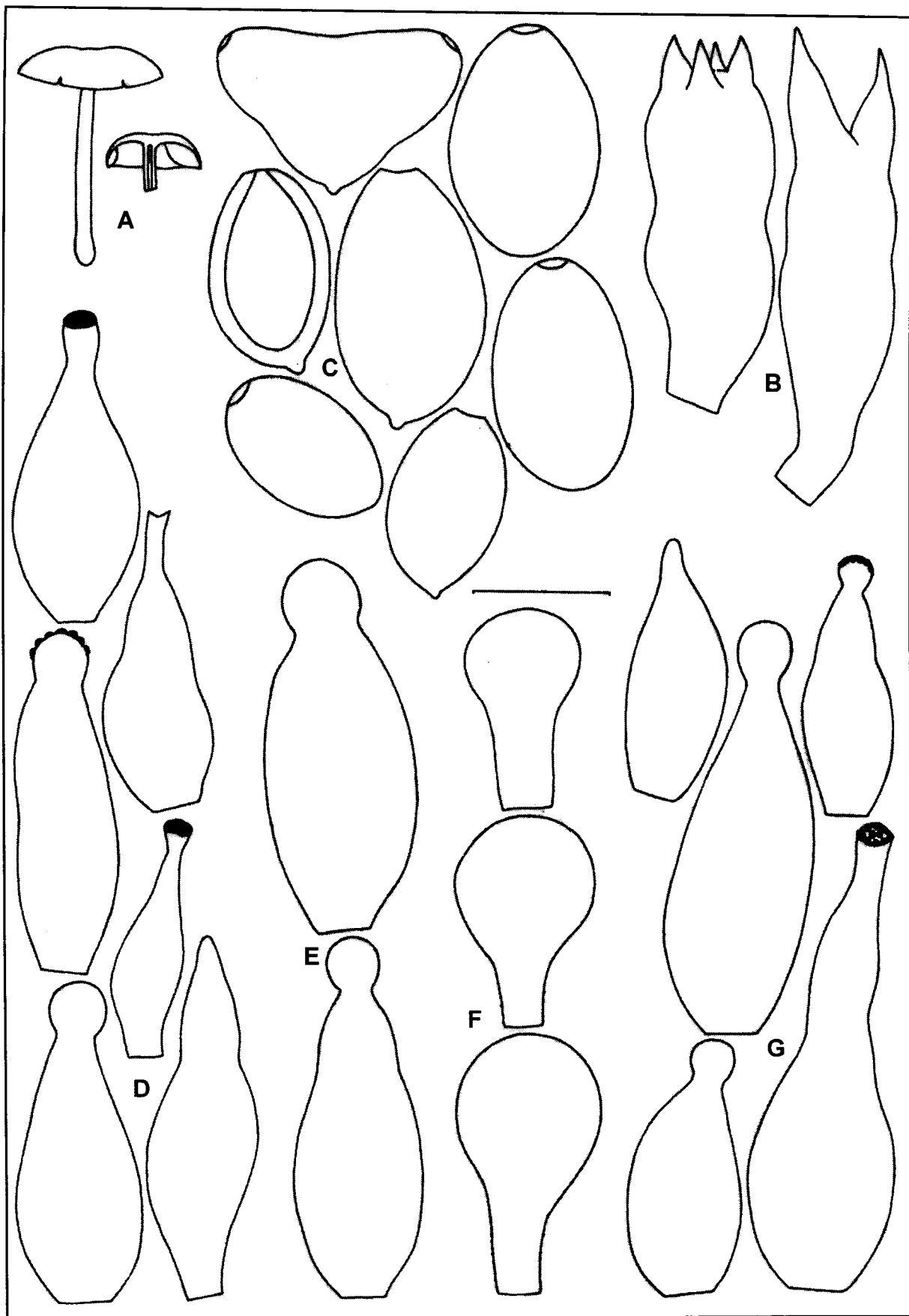


Fig. 4. *Agropybe semiorbicularis* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. Elements of pileipellis; G. Caulocystidia. Scale bar = 10 μ m

vesiculose, thin-walled, pale yellow towards apex, light yellowish brown and sometimes faintly encrusted towards base, overlying a hypodermium of 2–6.5 μm wide, yellowish brown, and faintly encrusted hyphae. Stipe trama composed of 1.5–15 μm wide, thin-walled, pale yellowish hyphae. Stipitipellis a cutis; hyphae 1.5–7.5 μm wide, thin-walled, light yellowish brown, faintly encrusted. Caulocystidia similar to cheilocystidia in size and morphology, in clusters or scattered, towards the upper part of the stipe. Clamp-connexions present in all parts of the basidioma.

On sandy soil, amongst grass, gregarious to scattered, October.

Specimens examined: India, Kerala State, Idukki District, Munnar: 11 October 1999, A. Thomas T334; 12 October 1999, A. Thomas T334b.

The present collections are remarkably similar to the Sri Lankan material of *Agrocybe semiorbicularis* described by Pegler (1986). The only deviation is the broader size range of the spores of the present collections. As indicated earlier, this species is very close to *A. pediades* (Fries) Fayod and some workers (Nauta, 1986; Breitenbach & Kranzlin, 1995) treat these two species as synonymous. The Kerala collections of these two species, however, can be distinguished on the basis of colour of the pileus, size of spores and predominance of bisporic basidia.

***Agrocybe* sp. 1**

Fig 5 A-G; Plate 2 B

Pileus 12–30 mm diam., convex to plano-convex, without umbo; surface greyish orange (5B3), rarely brown (6E4), strongly hygrophanous and becoming light yellow (4A4) or light orange (5A4), smooth, glabrous, translucent-striate when moist; margin decurved to almost plane, entire, sometimes becoming fissile. Context up to 1 mm thick at the centre, whitish. Lamellae adnate, becoming adnexed, initially greyish orange (5B3), later light brown (6D6), brown (6E7) or dark brown (7F7, 7F8), close to subclose, up to 5 mm wide, with lamellulae of 3–4 lengths; edge slightly paler than sides, entire. Stipe 28–45 x 2–2.5 mm, central, terete to slightly compressed, almost equal, fistulose, becoming hollow; surface greyish

orange (5B3), faintly pruinose, especially towards apex under a lens; base slightly swollen. Odour not distinctive. Spore-print brown (6E7).

Spores 9–12.5 x 6–8.5 x 5.5–7 (10.63±1.23 x 7.09±0.64 x 6.37±0.50) μm , Q=1.36–1.65, Qm=1.49, lenticular, ovo-ellipsoid to ellipsoid in face-view, ellipsoid in side-view, brown, thick-walled, truncated with an apical germ-pore. Basidia 20–29 x 7–9 μm , clavate, 4-spored, occasionally 2-spored; sterigmata up to 7.5 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 10–32.5 x 7–18 μm , mostly clavate or vesiculose rarely lageniform or lecythiform, thin-walled, hyaline. Pleurocystidia 29–71.5 x 9.5–21.5 μm , not frequent, mostly narrowly utriform rarely clavate, containing some hyaline inclusions, thin-walled, hyaline. Hymenophoral trama regular to subregular; hyphae 2–15 μm wide, thin-walled, light yellow to light greyish brown; subhymenium conspicuous, composed of pseudoparenchymatous cells. Pileal trama interwoven; hyphae 2–15.5 μm wide, thin-walled, pale yellow to yellow. Pileipellis hymeniform, composed of pyriform, sphaeropedunculate or clavate elements of 15.5–44 x 12.5–27.5 μm , thin-walled, pale yellow. Stipe trama composed of 2–24 μm wide, thin-walled, yellowish hyphae. Caulocystidia 15–54 x 5.5–18 μm , versiform: pedicellate-clavate, cylindric-flexuous or ventricose-fusoid, occurring towards the upper part of the stipe, in clusters, thin-walled, hyaline. Clamp-connexions present on all hyphae.

On decaying grass tufts, scattered, October.

Specimens examined: India, Kerala State, Idukki District, Munnar: 11 October 1999, A. Thomas T331; 12 October 1999, A. Thomas T331b.

This species is characterized by thin, highly hygrophanous and pellucid-striate pileus; total absence of velar remnants; large (mostly > 10 μm) spores with truncate germ-pores, versiform cheilocystidia; utriform pleurocystidia; and versiform caulocystidia. It seems to belong to the section *Pediadeae* (Fries) Singer. Microscopically it is very similar to *Agrocybe earlei* (Murrill) Watling, but that species is not hygrophanous and not pellucid-striate and it grows on humus. *Agrocybe cubensis* (Murrill) Singer has similar spores and habitat but it has a chestnut brown pileus with floccose velar remnants and lacks pleurocystidia.

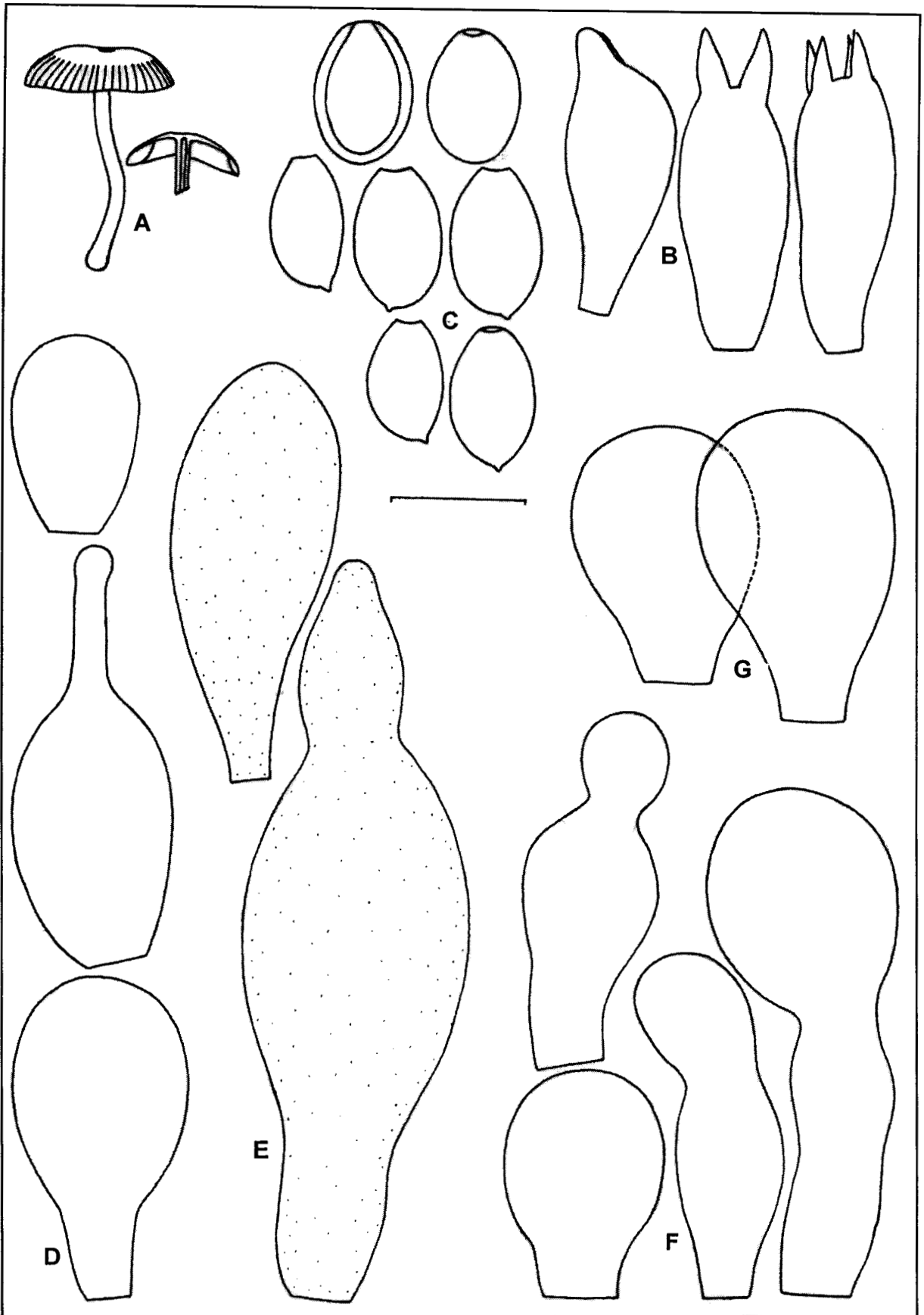


Fig. 5. *Agrocybe* sp. 1. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. Caulocystidia; G. Elements of pileipellis. Scale bar = 10 μ m

Agrocybe sororia (Peck) Watling is similar in many characters including the spore-size but cystidial shapes are different. The author considers it as an undescribed species.

***Agrocybe* sp. 2**

Fig. 6 A-G; Plate 2 C

Pileus 10–30 mm diam., convex becoming applanate with or without a broad umbo; surface light yellow (4A4) to pale orange (5A3) at the centre, yellowish white (4A2) or pale yellow (4A3) towards margin, irregularly pitted at periphery, glabrous; margin decurved to plane, finally slightly upturned, almost entire, becoming crenate to eroded or fissile. Context up to 4 mm thick at the centre, yellowish white (4A2). Lamellae narrowly adnate to adnexed, pale yellow (4A3) to pale orange (5A3), subcrowded to close, up to 4mm wide, with lamellulae of 3-4 lengths; edge pale, finely pruinose under a lens. Stipe 20–55 x 2–6 mm, central, terete, tapering towards apex, solid, turning to fistulose; surface pale yellow (4A3) to orange white (5A2), glabrous; base slightly swollen, sometimes with a few rhizoids attached. Odour not distinctive. Spore-print not obtained.

Spores 12–18 x 8–11.5 x 7.5–9.5 ($14.58 \pm 1.52 \times 9.20 \pm 1.08 \times 8.08 \pm 0.67$) μm , $Q=1.43$ – 1.77 , $Q_m=1.58$, lenticular, ovo-ellipsoid, yellowish brown, smooth, thick-walled, apically truncated by a small germ-pore. Basidia 24–45 x 10–15.5 μm , clavate or pedicellate-clavate, 4-spored; sterigmata up to 7.5 μm long. Lamella-edge sterile to heteromorphous. Cheilocystidia 16–65 x 7–27.5 μm , versiform: pedicellate-clavate, sphaeropedunculate, ventricose-fusoid, utriform or flexuous, thin-walled, hyaline. Pleurocystidia occasionally present in some collections, similar to cheilocystidia in size and shape, rarely with small apical resinous encrustations. Hymenophoral trama regular; hyphae 2–11.5 μm wide, thin-walled, hyaline. Pileal trama interwoven; hyphae 2–16.5 μm wide, long, filamentous, thin-walled, hyaline. Pileipellis hymeniform; cells 15–49 x 12.5–29 μm , subspherical to pyriform, sometimes sphaeropedunculate, thin-walled, hyaline, pale yellowish towards base. Stipe trama composed of 1.5–17.5 μm wide hyphae, thin-walled, hyaline. Stipitipellis a repent cutis, hyphae 2–7 μm wide, thin-walled, hyaline to pale yellow. Caulocystidia 12.5–70 x 7.5–24 μm , similar to cheilo- and pleurocystidia in morphology, distal ends rarely encrusted with

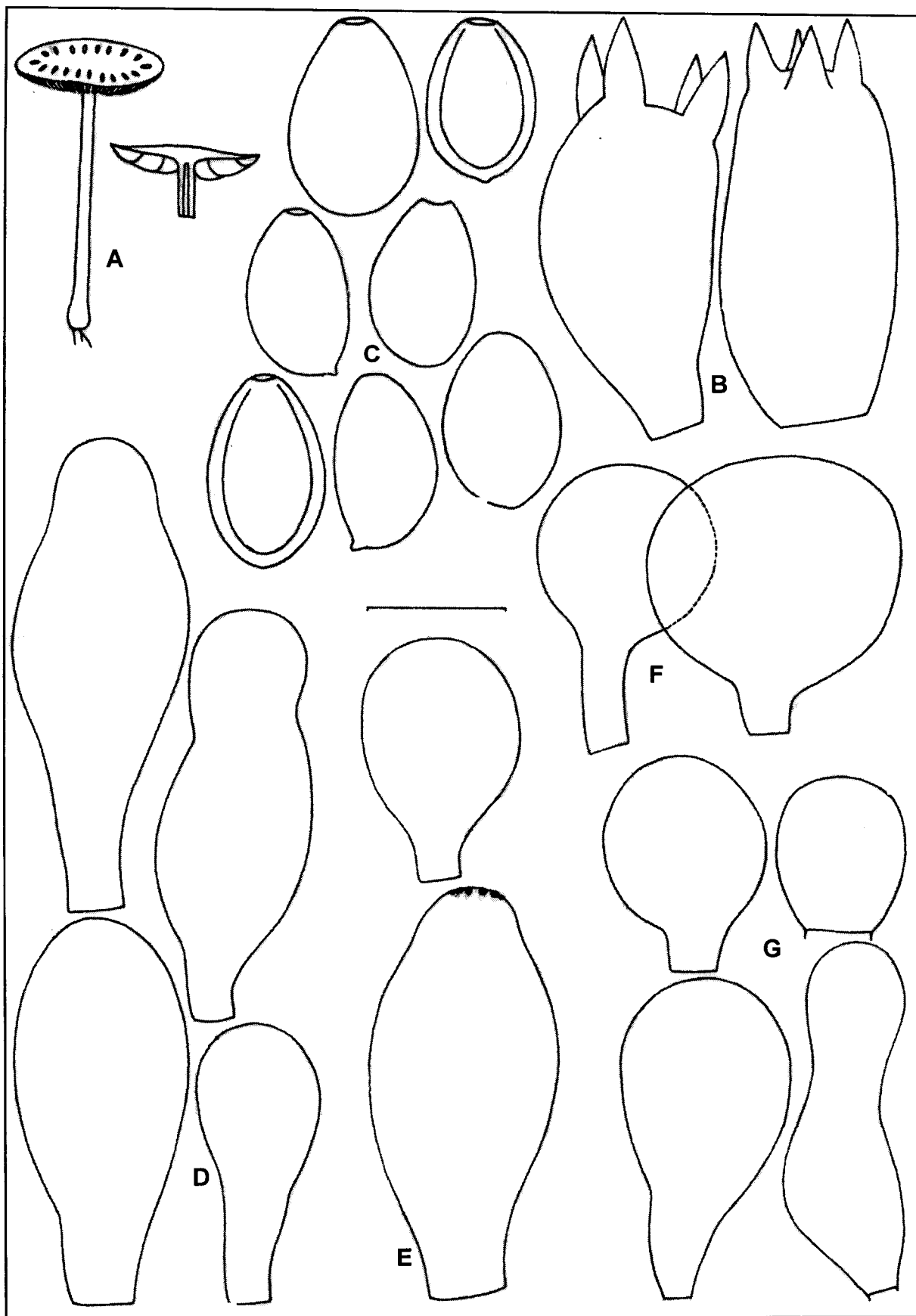


Fig. 6. *Agrocybe* sp. 2. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. Elements of pileipellis; G. Caulocystidia. Scale bar = 10 μ m

resinous material, occurring towards the upper part of the stipe, in groups or scattered. Clamp-connexions present in all hyphae.

On the ground, frequently near casuarina trees, scattered, May-June.

Specimens examined: India, Kerala State, Malappuram District, Calicut University Campus: 7 June 1998, A. Thomas T255; 11 June 1998, A. Thomas T255b; 8 June 1998, A. Thomas T257; 9 June 1998, A. Thomas T257b; 10 June 1988, A. Thomas T257c; 12 May 1999, A. Thomas T257d.

This species has the following diagnostic features: (1) yellow colour to all parts of the basidiomata; (2) total absence of velar remnants; (3) broad size-range (12–18 μm long) and truncate germ-pore of the spores; (4) 4-spored basidia; (5) versiform cheilocystidia; (6) occasional presence of pleurocystidia; and (7) caulocystidia restricted to the upper part of the stipe. It belongs to the section *Pediadeae* of subgenus *Agrocybe* where it seems to be very close to several species such as *Agrocybe pediades* (Fries) Fayod, *A. arenaria* (Peck) Singer, *A. arenicola* (Berkeley) Singer, *A. broadwayii* (Murrill) Dennis, *A. semiorbicularis* (Bulliard) Fayod and *A. malesiana* Watling. It is very difficult to delimit species in this group owing to overlapping of characters but the author is convinced that the Kerala collections represent an as yet undescribed species, owing to the combination of features outlined above. *Agrocybe broadwayii* and *A. arenaria* have viscid pileus and lack pleurocystidia. *Agrocybe malesiana* has conico-companulate, clay-coloured pileus with appendiculate margin showing cortinoid veil. *Agrocybe pediades* has viscid pileus and smaller spores. *Agrocybe semiorbicularis* has viscid pileus, 2-spored basidia and smaller spores. *Agrocybe arenicola* (*sensu* Singer) appears to be the closest differing in the arenicolous habit and cystidial morphology.

***Agrocybe* sp. 3**

Fig. 7 A-G; Plate 3 A

Basidiomata robust, medium-sized to very large. Pileus 40–200 mm diam., convex to applanate, frequently becoming depressed at the centre; surface light orange (5A3), pale

orange (5A4) or greyish orange (5B3) at the centre, fading towards margin to orange white (5A2), not striate, moist, glabrous, smooth or sometimes irregularly pitted; margin incurved when young, turning to plane and finally becoming slightly upturned, almost entire to slightly eroded. Context fleshy, whitish, up to 18 mm thick at the centre. Lamellae adnate to slightly adnexed, greyish orange (5B3), orange grey (5B2) or light brown (6D5), subcrowded, up to 12 mm wide, with lamellulae of 3 lengths; edge pale, almost entire, serrate or slightly eroded under a lens. Stipe 40–110 x 3.5–20 mm, central, terete, almost equal or broad at the base, solid, with a well-developed, persistent, striate, superior annulus. Surface pale orange (5A3) to orange white (5A2); fibrillose-striate; base deeply immersed in the woody substratum. A colourless liquid oozing out from fresh stipes when wounded. Odour not distinctive. Spore-print brown (6E7).

Spores 9–16.5 x 5.5–8 (12.23±2.04 x 6.55±0.76) μm, Q=1.47–2.17, Qm=1.85, ellipsoid, ellipsoid-oblong, subreniform or somewhat cylindric, occasionally with a constriction, smooth, with a thickened yellowish brown wall and indistinct germ-pore. Basidia 24–39 x 6–9 μm, cylindric, sometimes with a median constriction, 2-spored (rarely 1-spored); sterigmata up to 7 μm long. Lamella-edge sterile. Cheilocystidia 12.5–60 x 6.5–12.5 μm, versiform: clavate, fusoid cylindric or utriform, sometimes mucronate or with a subcapitate apex, crowded, hyaline to pale yellowish brown pigmented wall. Pleurocystidia 32.5–57.5 x 9–14.5 μm, clavato-mucronate, scattered, thin-walled, hyaline. Hymenophoral trama regular; hyphae 2.5–20 μm wide, thin-walled, hyaline to pale yellowish brown. Pileal trama loosely interwoven; hyphae 2–19 μm wide, thin-walled, hyaline to pale yellowish brown. Pileipellis hymeniform; elements 17.5–47 x 12.5–35 μm, difficult to separate, hyaline to pale yellowish brown. Pileocystidia 15–49 x 8–17.5 μm, similar to cheilocystidia in shape, scattered, hyaline. Stipe trama composed of 25–30 μm wide, parallel, thin- to slightly thick-walled hyphae with a yellowish brown wall. Stipitipellis a cutis; hyphae 2–12 μm wide, thin to slightly thick-walled, with a yellowish brown wall, faintly encrusted. Caulocystidia 15–77.5 x 5–15 μm, similar to cheilocystidia in shape, thin-walled, hyaline to yellowish brown. All hyphae with clamp-connexions.

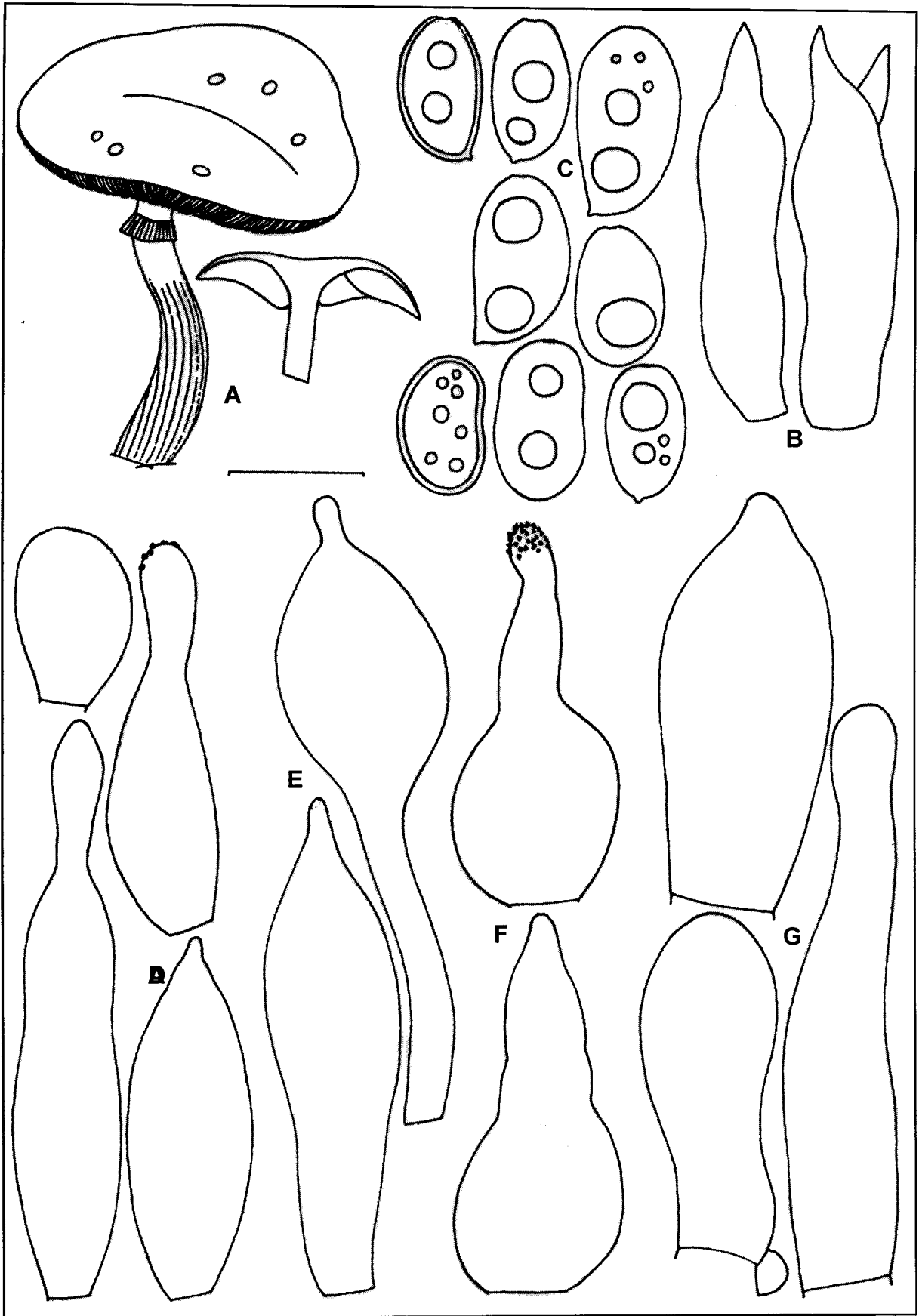


Fig. 7. *Agrocybe* sp. 3. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. Pileocystidia; G. Caulocystidia. Scale bar = 10 μ m

On decaying logs, scattered or in caespitose groups, June-October.

Specimens examined: India, Kerala State, Wayanad District, Muthanga Forest: 25 June 1997, A. Thomas T87; 26 October 1998, A. Thomas T87b; 27 October 1998, A. Thomas T87c.

This species is characterized by (1) medium to very large, pale coloured basidiomata growing in clusters on decaying wood; (2) stipe with a well-developed superior annulus; (3) exudation of a colourless liquid when stipe is cut; (4) large spores with an indistinct germ pore; (5) exclusively 2-spored basidia; (6) versiform cheilocystidia and clavato-mucronate pleurocystidia; (7) presence of both pileocystidia and caulocystidia; and (8) presence of clamp connexions in all parts of the basidiomata. The large, fleshy, pale coloured, lignicolous basidiomata with annulate stipe and the spores with small, indistinct germ-pores suggest that it belongs in section *Aporus* (Singer) Singer of the subgenus *Aporus* Singer where it is reminiscent of *Agrocybe cylindrica* (De Candolle ex Fries) Maire in most of the macroscopic features. This species, however, is distinct from *A. cylindrica* in several microscopic characters. The spores of the present collections are distinctly larger and the basidia are constantly bisporic. The cheilo- and pleurocystidia are of the same shape in *A. cylindrica* whereas the constantly clavato-mucronate pleurocystidia is distinctly different from the cheilocystidia of the present collections. Finally, pileocystidia are unknown in *A. cylindrica*. Size and shape of the basidiomata and spore size of our collections are strikingly similar to those of the Sri Lankan species *A. badia* (Petch) Pegler, but again, the constantly bisporic basidia, the constantly clavato-mucronate pleurocystidia and the presence of pileocystidia make our collections quite distinct.

***Agrocybe* sp. 4**

Fig. 8 A-G; Plate 3 B

Basidiomata fragile. Pileus 15–60 mm diam., convex becoming plano-convex or plane; surface light yellow (4A4), pale orange (5A3) or light orange (5A4) towards disc, yellowish white (4A2) or pale yellow (4A3) towards margin, glabrous, sometimes with scattered, shallow

pits, faintly translucent-striate towards margin when moist; margin decurved, becoming plane, entire when young, turning fissile with maturity. Context up to 3.5 mm thick at the centre, white or with a tint of yellowish white (4A2). Lamellae adnexed, light brown (6D4, 6D5) or brown (6E6, 7E6), subcrowded to close, up to 7 mm wide, with lamellulae of different lengths; edge pale, scalloped under a lens. Stipe 30–140 x 2–8 mm, fragile, central, terete, tapering towards apex, hollow; surface yellowish white (4A2, 4A3) or orange white (5A2), pruinose towards apex, elsewhere glabrous, with faint longitudinal striations, with a median annulus, concolorous with the stipe, up to 4 mm wide, evanescent. Odour not distinctive. Spore-print dark brown (7F5, 7F6).

Spores 9–13.5 x 6.5–9 x 6–8 ($11.25 \pm 1.26 \times 7.47 \pm 0.55 \times 6.97 \pm 0.47$) μm , $Q=1.33\text{--}1.68$, $Q_m=1.50$, lenticular, ovoid to ovo-ellipsoid in face-view, ellipsoid in side-view, melleous brown, smooth, thick-walled, apically truncated by a germ-pore. Basidia 22–28 x 8.5–12 μm , clavate, 4-spored; sterigmata up to 4 μm long. Lamella-edge sterile. Cheilocystidia 11.5–60 x 9–27.5 μm , subglobose, sphaeropedunculate, utriform or clavate, thin-walled, hyaline. Pleurocystidia very infrequent, similar to cheilocystidia. Hymenophoral trama regular; hyphae 2–22.5 μm wide, thin-walled, hyaline. Pileal trama interwoven; hyphae 1.5–24 μm wide, thin-walled, hyaline to pale yellow. Pileipellis hymeniform; elements 20–57.5 x 17.5–40 μm , sphaeropedunculate, thin-walled, hyaline to pale yellow. Stipe trama parallel; hyphae 2–27.5 μm wide, thin- to slightly thick-walled, hyaline to pale yellow. Stipitipellis a cutis; hyphae 2–17 μm wide, thin- to slightly thick-walled, pale yellow to hyaline. Caulocystidia 14–52.5 x 7.5–25 μm , variable: utriform, oblong, subglobose, clavate or fusoid, frequently with a subcapitate apex. In clusters or scattered, thin-walled, hyaline, restricted to the upper part of the stipe. Clamp-connexions present.

On elephant dung, scattered, July–October.

Specimens examined: India, Kerala State, Thrissur District, Guruvayoor: 14 July 1999, A. Thomas T316; 16 July, A. Thomas T316b; 21 July 1999, A. Thomas T316c; 18 October 1999, A. Thomas T316d.

Pale yellow pileus, stipe with an evanescent but distinct median annulus, spores that

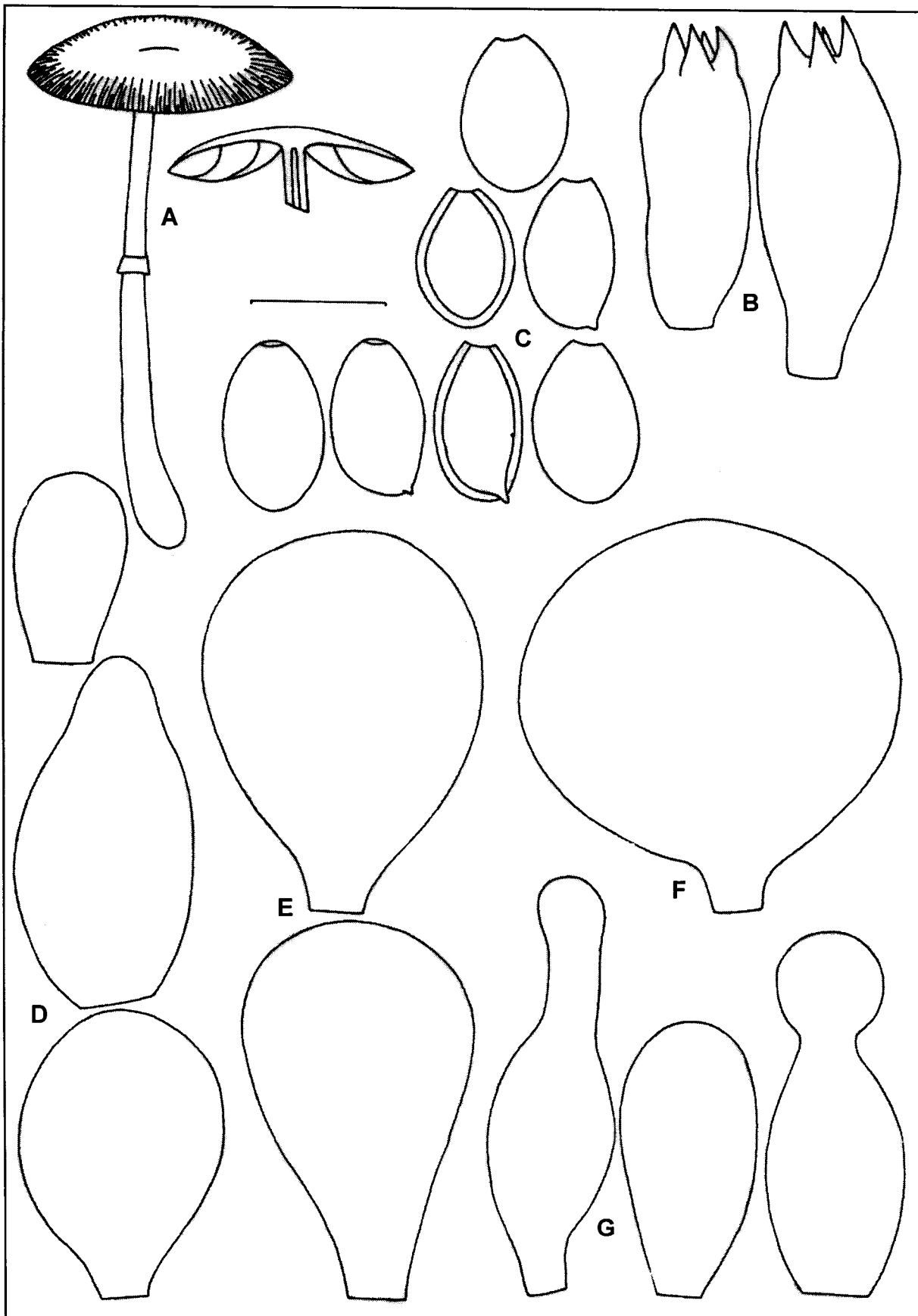


Fig. 8 *Agrocybe* sp. 4. **A.** Habit x 1; **B.** Basidia; **C.** Spores; **D.** Cheilocystidia; **E.** Pleurocystidia; **F.** Element of pileipellis; **G.** Caulocystidia. Scale bar = 10 μ m

are 9–13.5 μm long and with a truncate germ-pore, sphaeropedunculate to vesiculose cheilocystidia, infrequent pleurocystidia that are similar to cheilocystidia, and caulocystidia restricted to the upper part of stipe are the characteristic features of this species which belongs to the subgenus *Agrocybe*, section *Agrocybe*. It is very close to *Agrocybe molesta* (Lasch) Singer, and *A. howeana* (Peck) Singer because of several shared characters. *Agrocybe molesta*, however, has cracking pileal surface, veil forming an appendiculate margin to the pileus or forming cottony ring-zones on the stipe and different cystidial morphology. *Agrocybe howeana* has a disagreeable odour and smaller spores.

Pholiotina Fayod
in Ann. Sci. Nat. VII, 9:359 (1889).

Basidiomata small to medium. Pileus convex, initially conic or companulate, becoming plano-convex, mostly ochre, reddish brown or brown, hygrophanous, glabrous, margin striate. Lamellae adnate to adnexed, ochraceous to fulvous. Stipe central, whitish, yellowish, ochraceous or greyish brown, paler towards upper region. Veil present either as membranous annulus or as distinct remnants on the pileal margin. Spore-print rusty brown. Spores ellipsoid to smooth, verrucose in a few species, thick-walled, with an apical germ-pore. Lamella-edge sterile. Cheilocystidia always present and non-capitate. Pleurocystidia present or absent. Hymenophoral trama regular with a well-developed mediostratum. Pileipellis a hymeniform layer of globose to pyriform elements. Mostly with clamp-connexions. Terrestrial, lignicolous or coprophilous. Type species: *Pholiotina blattaria* (Fries) Fayod

Key to the species

1. Basidiomata on soil amongst grass; spores usually longer than 9.5 μm ; cheilocystidia utriform ***Pholiotina* sp. 1**
1. Basidiomata exclusively on elephant dung; spores less than 9.5 μm long; cheilocystidia versiform ***Pholiotina* sp. 2**

***Pholiotina* sp. 1**

Fig. 9 A-F; Plate 3 C

Pileus 7–27 mm diam., convex becoming plano-convex; surface brown (7E8, 7E7, 7E6) or reddish brown (8E6) towards centre, fading towards margin to light brown (6D6, 7D6), rapidly hygrophanous, turning to pale orange (5A3), smooth, glabrous, faintly pellucid-striate towards margin when moist; margin straight, entire. Context up to 1.5 mm thick at the centre, off-white with a brown tint. Lamellae adnate to adnexed, light brown (7D6) to brown (7E7), crowded to subcrowded, up to 4.5 mm wide, with lamellulae of 3 lengths; edge whitish, entire. Stipe 30–55 x 1–3.5 mm, central, terete, equal or slightly tapering towards apex, fistulose; surface concolorous with the pileus, sometimes becoming darker especially towards base, pruinose at apex, glabrescent below, annulate; annulus superior, movable. Odour none. Spore-print light brown (6D6).

Spores 9.5–12 x 5.5–6.5 x 4.5–6 ($10.70 \pm 0.65 \times 6.02 \pm 0.38 \times 5.33 \pm 0.34$) μm , $Q=1.52$ – 2.00 , $Q_m=1.78$, slightly lenticular, ellipsoid to oblong-ellipsoid, melleous brown, darkening in alkali, thick-walled, truncated by an apical germ-pore. Basidia 20–25.5 x 7–10 μm , clavate, 4-spored; sterigmata up to 3.5 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 14–45 x 5–15 μm , mostly utriform, occasionally clavate, thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama regular; hyphae 2–15.5 μm wide, with a well-developed mediostratum consisting of short, comparatively more inflated cells. Pileal trama interwoven; hyphae 2–12.5 μm wide, thin-walled, with a brownish yellow wall pigment, encrusted. Pileipellis a hymeniform layer; elements 20–60 x 14–22 μm , sphaeropedunculate or inflated-clavate, thin-walled, with brownish yellow wall pigment towards base, hyaline. Stipe trama composed of 2–17 μm wide hyphae, thin-walled, with a light yellow wall pigment. Stipitipellis a cutis; hyphae 2–10 μm wide, with a thin, yellow-pigmented wall. Caulocystidia 16.5–47.5 x 7.5–15 μm , mostly similar to cheilocystidia in shape, but occasionally capitate or subcapitate, seen towards the upper part of the stipe, in clusters, thin-walled, hyaline. Clamp-connexions present in all tissues.

On the ground, amongst grass, scattered, August.

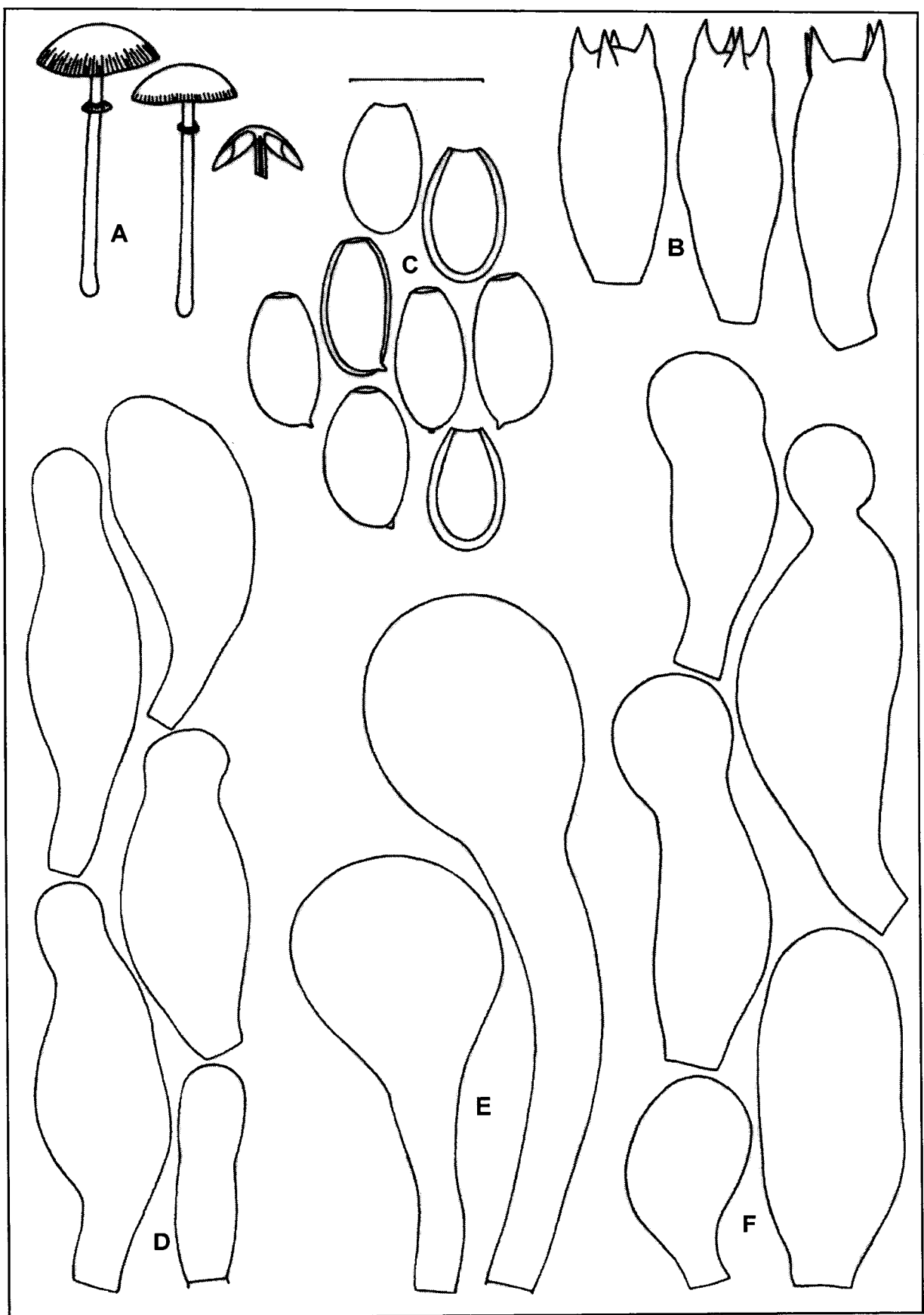


Fig. 9. *Pholiotina* sp. 1. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Elements of Pileipellis; F. Caulocystidia. Scale bar = 10 μ m

Specimens examined: India, Kerala State, Idukki District, Munnar: 29 August 1997, A. Thomas T158; 30 August 1997, A. Thomas T158b.

A highly hygrophanous pileus that quickly turns from brown to pale orange; stipe with a distinct movable annulus; spores that are mostly longer than 10 μm and with a germ-pore; utriform cheilocystidia; and the occasionally subcapitate to capitate caulocystidia are the diagnostic features of this species which belongs to section *Pholiotina*. It can be placed somewhere around *Pholiotina arrhenii* (Fries) Singer and related species, but it is not fitting into any of the available species descriptions.

***Pholiotina* sp. 2**

Fig. 10 A-F; Plate 4 A

Basidiomata small. Pileus 7–30 mm diam., convex to plano-convex; surface orange (6B7), reddish golden (6C7) or light brown (6D7, 7D6, 7D7) when moist, later fading to light orange (5A4, 5A5, 6A4, 6A5), greyish orange (5B4, 5B5) or pale orange (5A3) on drying, smooth, glabrous, occasionally with fine wrinkles, faintly striate towards margin when moist; margin decurved, entire. Context up to 2.5 mm thick at the centre, pale orange (5A3) or off-white with a brown tint. Lamellae adnexed, initially pale orange (5B3) or light orange (5B4), later brownish orange (6C6, 6C7), light brown (7D6) or brown (6D8, 7D7, 7E6), crowded to subcrowded, up to 4 mm wide, with lamellulae of 3-5 lengths; edge whitish, finely torn under a lens. Stipe 15–50 x 1.5–7 mm, central, terete, almost equal or slightly tapering apically with a slightly swollen base, fistulose; surface concolorous with the pileus, pale orange (5A3) or greyish orange (5B4), usually paler towards apex, becoming brownish towards base, finely pruinose with fine longitudinal striations, annulate; annulus central to superior, movable, with fine striations, not evanescent. Spore-print dark brown (7F5).

Spores 7–9 x 4.5–6 x 4–5.5 ($8.22 \pm 0.44 \times 5.30 \pm 0.37 \times 4.73 \pm 0.32$) μm , $Q=1.42-1.75$, $Q_m=1.55$, slightly lenticular, ellipsoid, melleous brown, darkening in alkali, smooth, thick-walled, truncated by an apical germ-pore. Basidia 19–25 x 8–10 μm , clavate, 4-spored; sterigmata up to 3 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 14–36.5 x 8–17 μm , versiform: utriform, clavate, oblong, ventricose-fusoid or vesiculose,

thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama regular, with a broad mediostratum composed of short, comparatively more inflated cells; hyphae 2–12 μm wide, thin-walled, hyaline. Pileal trama interwoven; hyphae 2–10.5 μm , thin-walled, with a yellowish brown wall pigment, encrusted. Pileipellis a hymeniform layer; cells 21.5–60 x 10–26.5 μm , sphaeropedunculate, thin-walled, with an yellowish brown encrusting pigment towards base. Stipe trama composed of 2–21.5 μm wide hyphae, thin-walled, with or without a light yellow wall pigment. Stipitipellis a repent cutis; hyphae 2–10.5 μm wide, thin-walled, encrusted with a light brownish yellow pigment. Caulocystidia 14–40 x 5.5–16.5 μm , either in clusters, or scattered as recurved peripheral hyphal tips of the stipitipellis, similar to cheilocystidia in shape, thin-walled, hyaline. Clamp-connexions present.

On elephant dung, scattered, June–November.

Specimens examined: India, Kerala State, Wayanad District, Muthanga: 1 October 1997, A. Thomas T179; 30 June 1998, A. Thomas T179b; 9 June 1999, A. Thomas T179f; 4 July 1997, A. Thomas T96; 18 August 1997, A. Thomas T96c; Ponkuzhy: 13 October 1998, A. Thomas T179c; 27 October 1998, A. Thomas T179d; 19 November 1998, A. Thomas T179e; Idukki District, Munnar: 11 October 1999, A. Thomas T179h; 12 October 1999, A. Thomas T179i.

This species is characterized by the following combination of features: (1) basidiomata that are always associated with elephant dung; (2) reddish brown to pale orange pileus; (3) stipe with a distinct, movable annulus; (4) spores that are less than 10 μm long and with a distinct germ-pore; and (5) versiform cheilocystidia and caulocystidia that are never capitate. This combination of features makes it distinct from all other previously described species of the section *Pholiotina*. Macroscopically, it is very similar to the unnamed *Pholiotina* species described and photographically illustrated by Enderle (1997:30) but spore size and cystidial morphology makes the latter distinct.

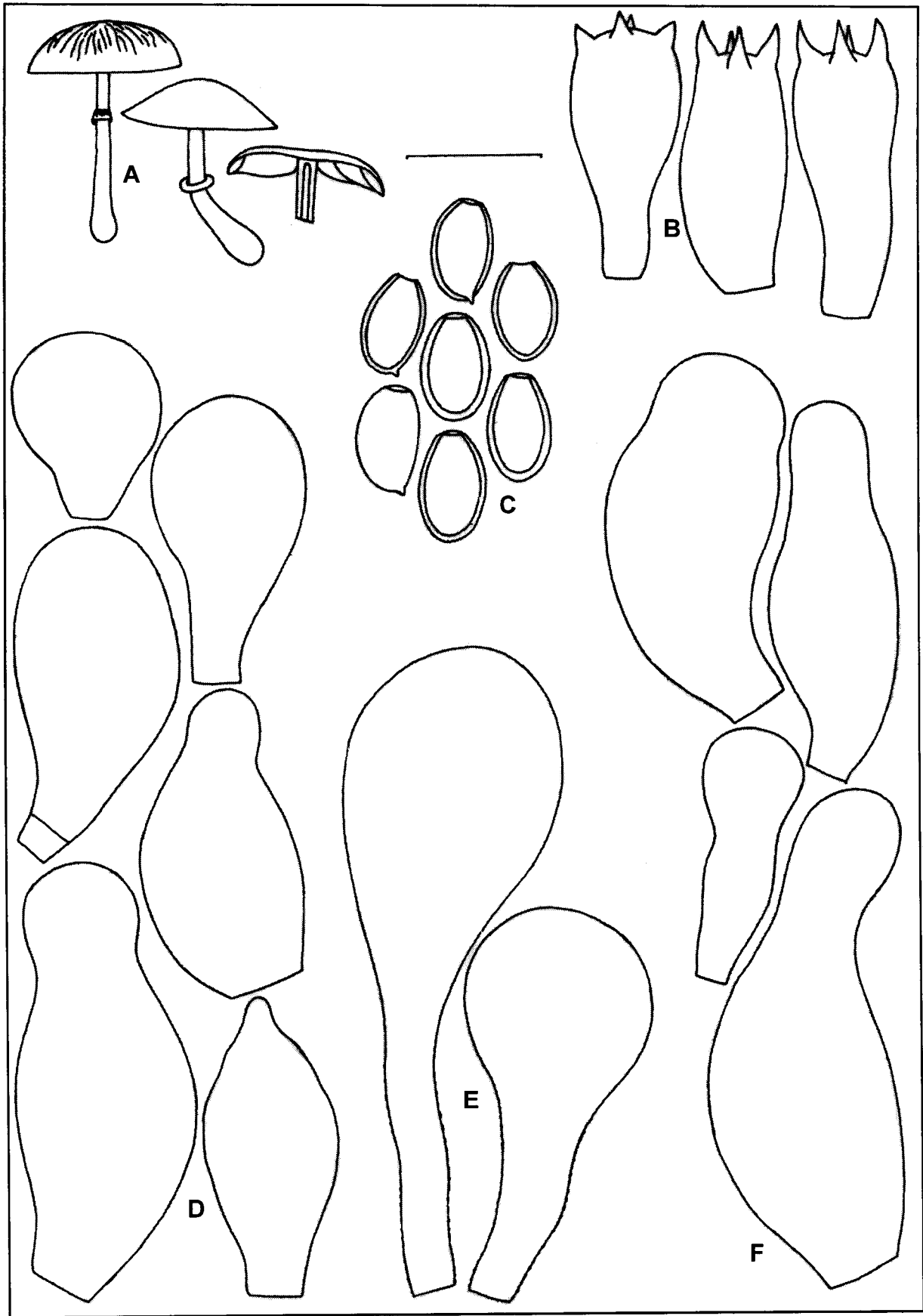


Fig. 10. *Pholiotina* sp. 2. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Elements of pileipellis; F. Caulocystidia. Scale bar = 10 μ m

Galerella Earle

in Bull. New York Bot. Gard. 5:422 (1909).

Basidiomata small, delicate. Pileus conic to conico-convex, thin, plicate-striate, yellowish brown or whitish. Lamellae adnato-adnexed, rust-brown, close or distant. Stipe central, thin, hollow. Veil absent. Spore-print rust-brown. Spores ovoid to ellipsoid, smooth, rust-brown, thick-walled, apically truncated by a germ-pore. Basidia sphaeropedunculate. Cheilocystidia non-capitate, fusoid to lageniform. Pleurocystidia absent. Hymenophoral trama regular with a comparatively narrow mediostratum. Pileipellis a hymeniform layer. Terrestrial. Distributed in temperate and tropical regions. Type species: *Galerella plicatella* (Peck) Singer.

Only a single species of *Galerella* was recorded from Kerala during the present study.

Galerella plicatella (Peck) Singer
in Lilloa 22: 490 (1949), 1951.

Fig. 11 A-F; Plate 4 B

Basidiomata small, delicate. Pileus 4–8 mm diam., convex to plano-convex with a central depression, at times with a small umbo in the depression; surface brown (7E6, 7E7) at centre, fading towards margin as radial, parallel strips, intervening regions pale orange (5A3), becoming brownish on drying, dull, dry, plicate-striate to the centre; margin decurved, crenate. Context up to 0.5 mm thick at the centre. Lamellae adnexed, pale orange (5A3) or light orange (5A4), subclose, with lamellae of 2–3 lengths, up to 1.5 mm wide; edge slightly pale, fimbriate under a lens. Stipe 12–25 x 0.4–0.8 mm, central, terete, slightly tapering apically, hollow, base slightly swollen; surface orange white (5A2), finely pubescent in some specimens, glabrescent. Odour none. Spore-print not obtained.

Spores 6–9.5 x 4.5–7 x 4–5 ($7.44 \pm 0.94 \times 5.34 \pm 0.79 \times 4.23 \pm 0.40$) μm , $Q=1.20-1.58$, $Q_m=1.40$, lenticular, subrhomboid to subhexagonal or occasionally ovo-ellipsoid in face-view, ellipsoid in side-view, smooth, melleous brown, slightly thick-walled, apically truncated by a germ-pore. Basidia 13–19 x 7–10 μm , sphaero-pedunculate, 4-spored; sterigmata up to 2.5 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 16.5–54

x 8–16.5 μm , ventricose or lageniform with a long neck and obtuse apex, thin-walled, pale yellow to hyaline. Pleurocystidia none. Hymenophoral trama almost regular with a mediostratum of comparatively narrow hyphae; hyphae 2–14 μm wide, thin-walled, pale yellow to hyaline. Pileal trama interwoven; hyphae 2–12.5 μm wide, thin-walled narrower and encrusted with yellowish brown pigment towards hypodermial region, slightly inflated and pale yellow or hyaline towards lower region of the trama. Pileipellis a hymeniform layer; elements 12–34 x 9–21.5 μm , subglobose, pyriform or clavate, thin-walled, pale yellow to hyaline towards apex, yellowish brown towards base. Pileal rim with numerous cystidia, 17.5–81.5 x 7.5–17.5 μm , similar to cheilocystidia. Stipe trama composed of 1.5–21.5 μm wide hyphae, thin-walled, pale yellow to hyaline. Stipitipellis a repent cutis; hyphae 1.5–9.5 μm wide, thin-walled, sometimes faintly encrusted, pale yellow to hyaline. Caulocystidia 17.5–85 x 5–13 μm , narrowly lageniform with long neck, scattered, thin-walled, pale-yellow to hyaline. Clamp-connexions present in all the tissues.

On the ground, scattered, June.

Specimens examined: India, Kerala State, Malappuram District, Calicut University Campus: 22 June 1997, A. Thomas T82; 23 June 1997, A. Thomas T82b.

Except for the subrhomboid to subhexagonal shape of the majority of spores, the Kerala collections are indistinguishable from the north temperate species, *Galerella plicatella*. In fact, there are quite a few spores with the typical ovo-ellipsoid shape (in face-view) of the spores of *G. plicatella*. Still, as spore shape is recognized as a very fundamental feature, the author considers that the Kerala collections represent a new variety within this species. According to singer (1986), *G. plicatella* is so variable in some secondary characteristics, especially in South America, that it is possible that it will eventually be split into several microspecies or at least varieties. The Sri Lankan species *G. microphues* (Berkeley & Broome) Pegler resemble our collections in some characters but differs in the colour of the pileus, shape of the spores, size of the cheilocystidia and in the absence of caulocystidia.

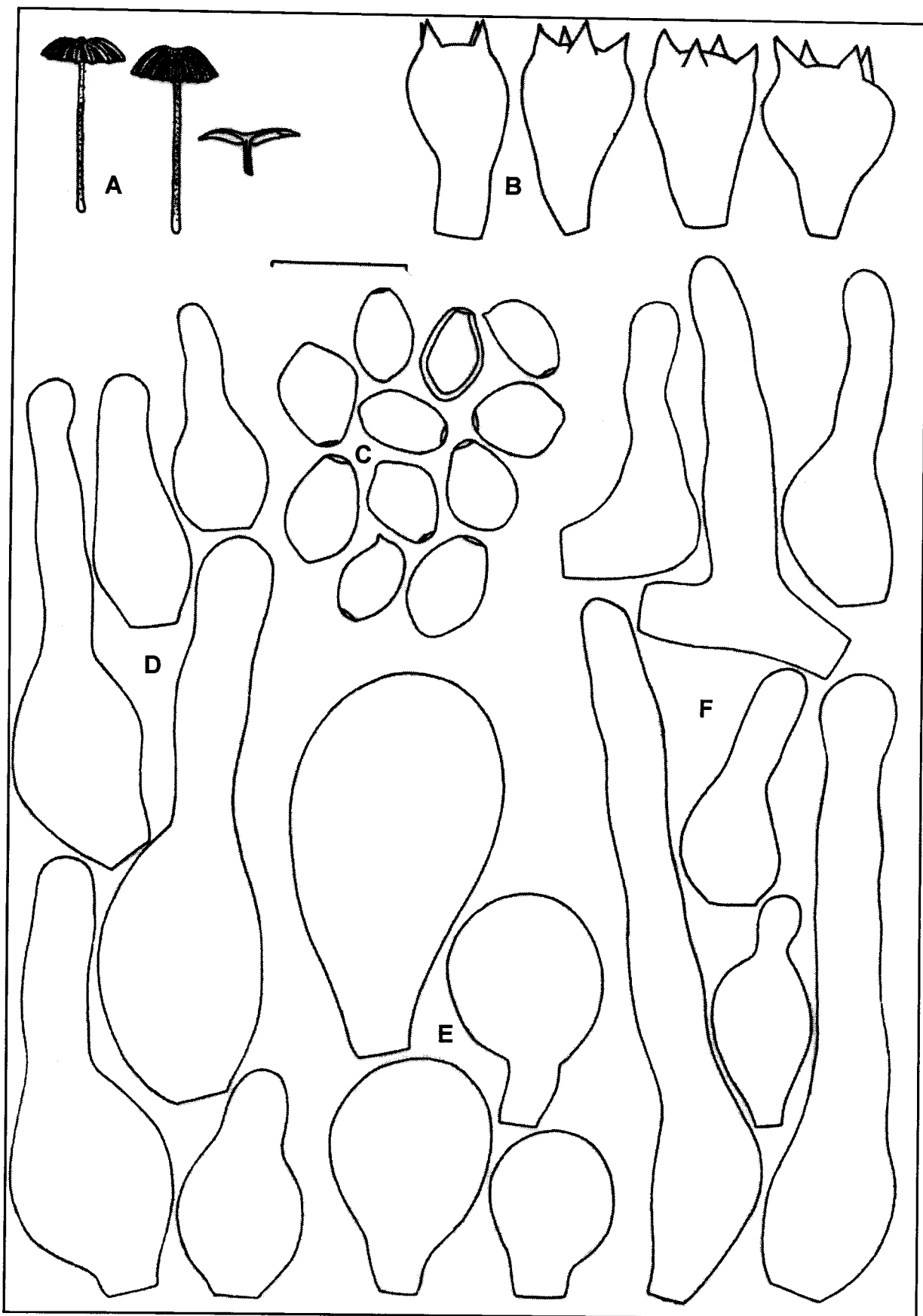


Fig. 11. *Galerella plicatella* A. Habit x 2; B. Basidia; C. Spores; D. Cheilocystidia; E. Elements of pileipellis; F. Caulocystidia. Scale bar = 10 μ m

Conocybe Fayod

in Ann. Sci. Nat., Bot. ser. 7,9:357 (1889).

Basidiomata small to medium-sized, mycenoid, fragile. Pileus campanulate, conico-convex to convex, rarely expanding, often cream-coloured, tawny, rust-brown, ochraceous brown or dark brown, hygrophanous, glabrous or rarely pubescent. Context thin. Lamellae adnate to adnexed or occasionally almost free, ferruginous brown. Stipe long, central, often pubescent. Veil usually absent. Spore-print rust-brown to yellowish brown. Spores small to large, ovoid to ellipsoid, rarely subangular, mostly smooth, rarely verrucose to rugulose, yellowish brown, with a truncated apical germ-pore. Basidia typically sphaeropedunculate, 2- or 4-spored. Cheilocystidia always present, typically lecythiform. Pleurocystidia usually absent. Hymenophoral trama regular, reduced to a narrow mediostratum flanked on either side by inflated subhymenial hyphae. Pileipellis a hymeniform layer. Clamp-connexions present on all hyphae. Terrestrial, humicolous or rarely coprophilous or lignicolous. Worldwide in distribution. Type species: *Conocybe tenera* (Shaeffer: Fries) Fayod

Key to the species

1. Basidiomata volvate; stipe base with reddish brown tint **Conocybe sp. 1**
1. Basidiomata never volvate; stipe base lacking a reddish brown tint 2
2. Stipe surface with at least a few lecythiform cystidia 3
2. Stipe surface without any lecythiform cystidia 4
3. Pileus up to 40 mm diam.; stipe radicating; spores ellipsoid, ovo-ellipsoid or subhexagonal in face-view and ellipsoid in side-view; lecythiform caulocystidia frequent **Conocybe sp. 2**
3. Pileus less than 20 mm diam.; stipe never radicating; spores ovo-ellipsoid in face-view, sybamygdaliform in side-view; lecythiform caulocystidia very rare **Conocybe sp. 3**

4. Pileocystidia present 5
4. Pileocystidia absent 6
5. Pileus conical, pale yellow, with fine longitudinal subsulcate striations; spores occasionally subhexagonal in face-view; on dried cow dung **Conocybe sp. 4**
5. Pileus companulate, pale- or light orange, with fine translucent-striations; spores not subhexagonal in face-view; on decaying stem of palm **Conocybe sp. 5**
6. Spores 6.5–11 μm long **Conocybe sp. 6**
6. Spores mostly more than 11 μm long 7
7. Stipe radicating; caulocystidia mostly lageniform **Conocybe sp. 7**
7. Stipe never radicating; caulocystidia of different shape 8
8. Spores ellipsoid to faintly subhexagonal in face-view; on dung-manured soil **Conocybe sp. 8**
8. Spores ovo-ellipsoid to oblong ellipsoid in face-view; on elephant dung **Conocybe sp. 9**

Conocybe sp. 1

Fig. 12 A-F; Plate 4 C

Pileus 15–55 mm diam., membranous, companulate to conical to conico-convex, sometimes with an obtuse umbo; surface, in most specimens, brown (7D7, 7E8) or reddish brown (8E7, 9E6) towards disc and light brown (7D5, 7D6) towards margin, sometimes light brown (7D5, 7D6) or brown (7E6) all over, hygrophanous and becoming greyish orange (6B3), glabrous, smooth, finely translucent-striate when moist; margin decurved, entire or finely crisped. Context up to 1.5 mm thick at the centre, brownish white. Lamellae adnexed to narrowly adnate, light brown (7D5, 7D6) or sometimes brown (6D7), close to subcrowded to crowded, up to 3.5 mm wide, with lamellulae of different lengths; edge pale when young, later concolorous with the sides, entire. Stipe 50–140 x 1.5–6 mm, central, terete, attenuated towards apex, hollow; surface white towards apex, greyish red (7B3, 8B3) or reddish brown (8E4, 9E5) towards base, finely longitudinally striate, faintly pruinose towards apex under a lens; base volvate; volva bifid, whitish, firmly appressed, with a cottony interior and exterior.

Odour not distinctive. Spore-print not obtained.

Spores 9.5–14.5 x 7–9 x 6–8 ($11.53 \pm 1.10 \times 7.98 \pm 0.60 \times 6.84 \pm 0.46$) μm , $Q=1.28\text{--}1.64$, $Q_m=1.44$, ovo-ellipsoid to ellipsoid or frequently subhexagonal in face-view, ellipsoid in side-view, smooth, melleous brown, thick-walled, apically truncated by a broad germ-pore. Basidia 19–26.5 x 11.5–15.5 μm , inflated-clavate or pedicellate-clavate, 4-spored; sterigmata up to 3 μm long. Ammonia-reaction negative. Lamella-edge sterile. Cheilocystidia 18–29 x 7.5–14 μm , lecythiform, with a capitellum of 6 μm diam., thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama regular, with a mediostratum of comparatively narrow hyphae and lateral strata of inflated hyphae; hyphae 3.5–17 μm wide, thin-walled, hyaline. Pileal trama composed of 1.5–17.5 μm wide hyphae, thin-walled, hyaline to pale yellow, with a hypodermial region of narrow, pale yellowish brown and sometimes faintly encrusted hyphae. Pileipellis hymeniform; elements 27.5–60 x 19–37.5 μm , thin-walled, hyaline towards distal end, pale yellowish brown and sometimes inconspicuously encrusted towards base. Stipe trama formed of 2–29 μm wide hyphae, thin-walled, hyaline. Stipitipellis a cutis; hyphae 2–15 μm wide, thin-walled, hyaline to pale yellowish brown. Caulocystidia seen towards the upper part of the stipe, in small clusters, 9–31.5 x 6.5–13 μm , variable: clavate, oblong, lageniform, obclavate, or irregular, thin-walled, hyaline. Clamp-connexions present on all hyphae.

On elephant dung, scattered, May–August.

Specimens examined: India, Kerala State, Thrissur District, Guruvayoor: 11 June 1999, A. Thomas T302b; 17 June 1999, A. Thomas T302c; 14 July 1999, A. Thomas T302d, 21 August 2000, A. Thomas T302e.

Only five species of *Conocybe* with volvate stipe base are known to this date. Watling (1979) proposed a new section, *Singerella*, for species with volva. The present Kerala collections do not agree with any known species and hence they are considered as belonging to a new species. The characteristic features of this species include large basidiomata, large spores that are frequently subhexagonal in face-view, lecythiform cheilocystidia, variously shaped caulocystidia that are never lecythiform and growth on elephant dung.

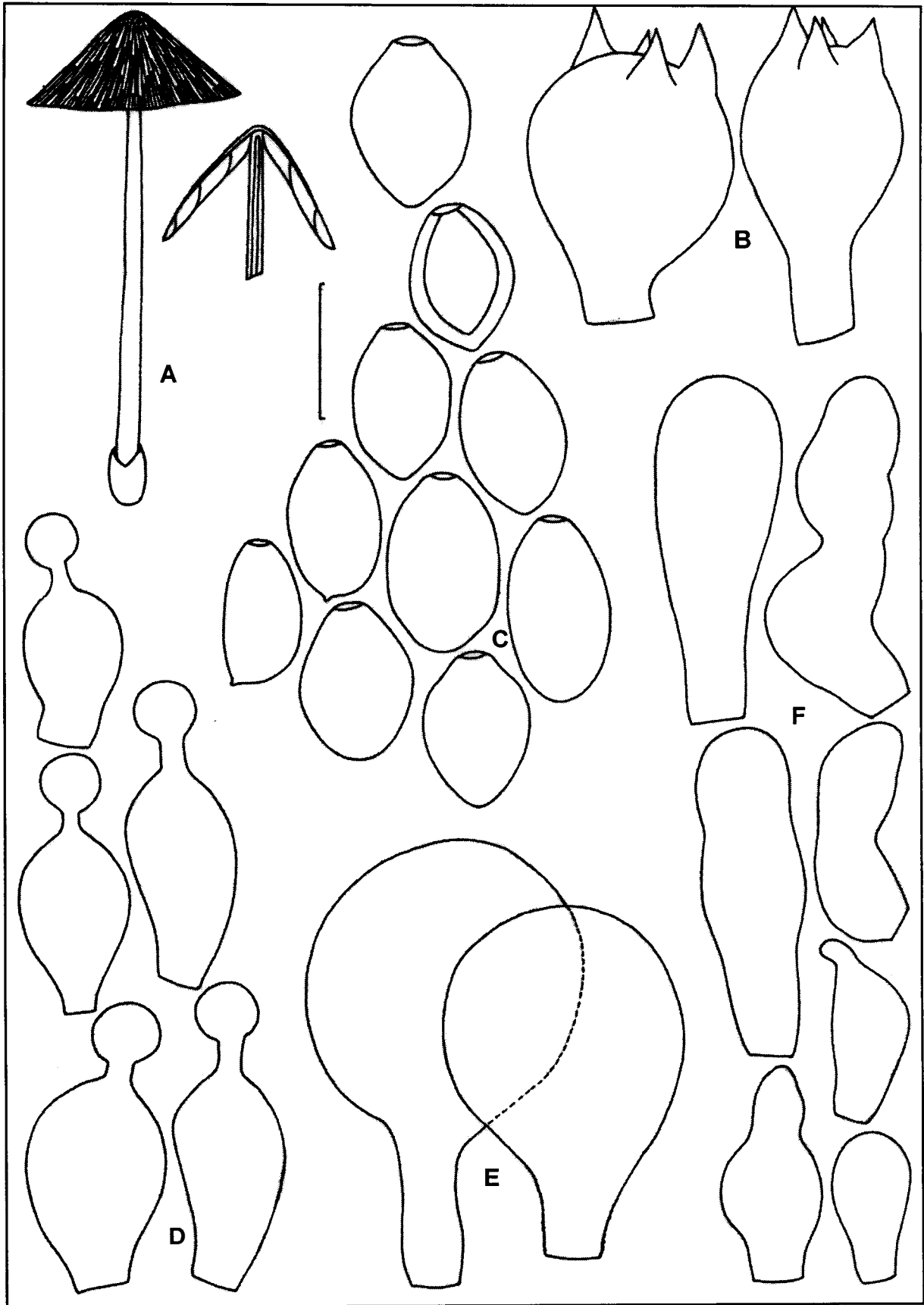


Fig. 12. *Conocybe* sp. 1. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Elements of pileipellis; F. Caulocystidia. Scale bar = 10 μ m

The large basidiomata, vinaceous colour and growth on elephant dung suggest closeness to *C. comerii* Watling described from Malaysia and New Guinea, but that species has smaller spores and capitate caulocystidia

***Conocybe* sp. 2**

Fig. 13 A-F; Plate 5 A

Pileus 12–40 mm diam., conico-convex to companulate, hardly expanding; surface pale orange (5A3) light orange (5A4) or greyish orange (5B4, 5B5), with small, shallow, scattered pits, glabrous with faint radial striations towards margin when moist; margin decurved, entire, at times turning fissile. Context up to 2 mm thick at the centre, white to orange white (5A2). Lamellae adnexed, pale orange (5A3) turning to brown (6E7), subcrowded, up to 5.5 mm wide with lamellulae of 4–5 lengths; edge slightly pale or concolorous with the sides, entire. Stipe 60–140 x 2–3.5 mm, central, cylindric, equal or slightly tapering apically, solid, becoming fistulose; surface pale yellow (4A3) or pale orange (5A3) towards apex and underground portion, brownish orange (6C4) elsewhere, sometimes yellowish white (4A2) all over, fimbriate towards apex, rest faintly pruinose, sometimes minutely longitudinally-fibrillose; base distinctly radicating. Odour not distinctive. Spore-print brown (6D7).

Spores 8.5–13 x 5.5–8 x 5–7 (10.36 ± 1.11 x 6.95 ± 0.56 x 6.0 ± 0.46) μm , $Q=1.30$ – 1.75 , $Q_m=1.51$, lenticular, ovo-ellipsoid, ellipsoid or subhexagonal in face-view, ellipsoid in side-view, melleous brown, smooth, thick-walled with a truncate apical germ-pore. Basidia 21.5–29 x 7.5–11 μm , clavate, sometimes with a median constriction, 4-spored; sterigmata up to 4.5 μm long. Needle-like crystals not formed but small, sand-grain like crystals observed in plenty with Ammonia solution. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 14–26.5 x 4–10 μm , lecythiform, with a capitellum of 3–4.5 μm diam., thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama regular to subregular, with a mediostratum of comparatively narrow hyphae and broad lateral strata of inflated hyphae; hyphae 2–31.5 μm wide, thin-walled, pale yellow. Pileal trama interwoven; hyphae 1.5–35

μm wide, thin-walled, pale yellow to hyaline, those towards hypodermial region narrow, yellowish and encrusted, and those towards lower region inflated and non-encrusted. Pileipellis hymeniform; elements $16.5\text{--}54 \times 11.5\text{--}30 \mu\text{m}$, sphaeropedunculate to vesiculose, thin-walled, pale yellow, faintly encrusted. Stipe trama composed of $2\text{--}24 \mu\text{m}$ wide hyphae, thin-walled, pale yellow to yellowish brown. Stipitipellis a cutis; hyphae $1.5\text{--}9.5 \mu\text{m}$ wide, thin-walled, pale yellow. Caulocystidia $10\text{--}28 \times 4.5\text{--}8 \mu\text{m}$, mostly lecythiform, at times the neck becoming much elongated and filamentous without developing a capitellum, at the upper part of the stipe, in clusters or scattered as modified peripheral hyphal tips, hyaline. Clamp-connexions present.

On the ground, amongst grass, scattered or mostly solitary, July-October.

Specimens examined: India, Kerala State, Malappuram District, Calicut University Campus: 12 July 1996, A. Thomas T28; 11 August 1999, A. Thomas T28b; 30 October 1999, A. Thomas T28c.

Large basidiomata, distinctly radicating stipe, total absence of velar remnants, occasional presence of subhexagonal spores amongst ellipsoid ones, and a stipe-vesture composed of both lecythiform and filiform elements are the characteristic features of this species. It can be placed in subgenus *Conocybe*, section *Mixtae* (Kühner) Singer owing to this combination of features. The radicating stipe, a diagnostic feature of the present collections, is known in quite a few species of *Conocybe* (Hausknecht, 1996), of which *C. cettoiana* Hausknecht & Enderle seems to be the nearest one in the section *Mixtae*. *Conocybe cettoiana*, however, has lecythiform pileocystidia, exclusively ellipsoidal spores and much shorter stipe. *Conocybe antipus* (Lasch) Fayod another species with radicating stipe, differs in having consistently subhexagonal to strongly hexagonal spores, a stipe-vesture composed entirely of lecythiform cells and smaller stature of the basidiomata. The large and robust basidiomata and the large spores of the present collections invite comparison with *C. zeylanica* (Petch) Boedijn originally described from Sri Lanka, but that species has subbulbous, non-radicating stipe base, and fusoid-ventricose caulocystidia. In the field, at first glance, it is reminiscent of the cosmopolitan *C. tenera* (Shaeffer: Fries) Fayod. In fact

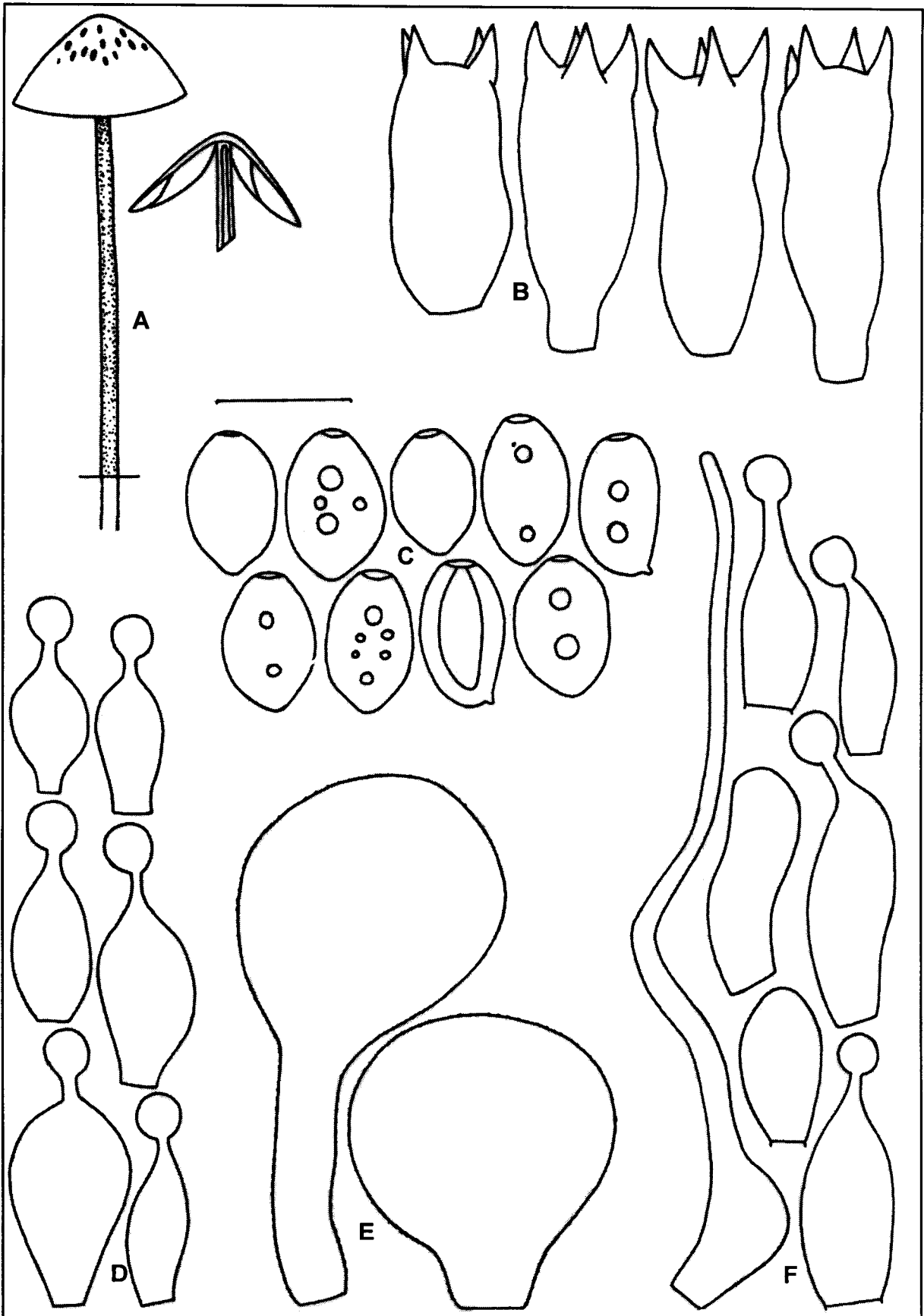


Fig. 13. *Conocybe* sp. 2. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Elements of pileipellis; F. Caulocystidia. Scale bar = 10 μ m

our collections are strikingly similar to the specimen of *C. tenera* photo-illustrated by Breitenbach and Kranzlin (1995), but in that species the stipe is not radicating, lecythiform caulocystidia are not intermixed with filiform cells and ammonia-reaction on the hymenium is positive. *Conocybe subovalis* (Kühner) Kühner & Watling is similar in most macroscopic and microscopic features, but it has non-radically stipe with a marginate bulb at the base and lecythiform pileocystidia.

***Conocybe* sp. 3**

Fig. 14 A-F; Plate 5 B

Pileus 7–20 diam., 4–8 mm high conic, conico-complanate, or conico-convex; surface orange-white (5A2), pale orange (5A3), or light orange (5A4), mostly with a light brown tint, hygrophanous, glabrous, dry, dull, faintly translucent striate when moist; margin decurved, almost entire to slightly undulating. Context up to 1 mm thick at the centre, concolorous with the pileus surface. Lamellae narrowly adnate, pale orange (5A3) or with a brown tint, subclose, up to 3.5 mm wide, with lamellulae of 2-lengths; edge pale, almost entire. Stipe 35–52 x 0.7–1.5 mm, central, cylindric, equal or slightly tapering apically, hollow; surface orange-white (5A2) to greyish orange (5B3), faintly pruinose. Odour none. Spore-print not obtained.

Spores 7.5–11.5 x 5.5–8 x 4.5–7 ($9.60 \pm 1.01 \times 6.50 \pm 0.53 \times 5.92 \pm 0.65$) μm , $Q=1.26$ – 1.70 , $Q_m=1.48$, lenticular, ovo-ellipsoid in face-view, subamygdaliform in side-view, melleous brown, slightly thick-walled, apically truncated by a germ-pore. Basidia 16.5–29 x 9–12.5 μm , short clavate to vesiculose, 4-spored; sterigmata up to 5 μm long. Ammonia-reaction negative. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 15–27 x 6.5–12.5 μm , lecythiform, with a capitellum of 3–5 μm diameter, subtended by a narrow neck, thin-walled, pale yellow to hyaline. Pleurocystidia none. Hymenophoral trama subregular, with a narrow mediostratum having narrow hyphae and broad lateral strata of inflated hyphae; hyphae 2–30 μm wide, thin-walled, pale brownish yellow to hyaline. Pileal trama interwoven; hyphae 2–34 μm wide, thin-walled, narrower and encrusted by a brownish yellow pigment towards hypodermial region, more inflated and pale brownish yellow to almost hyaline without

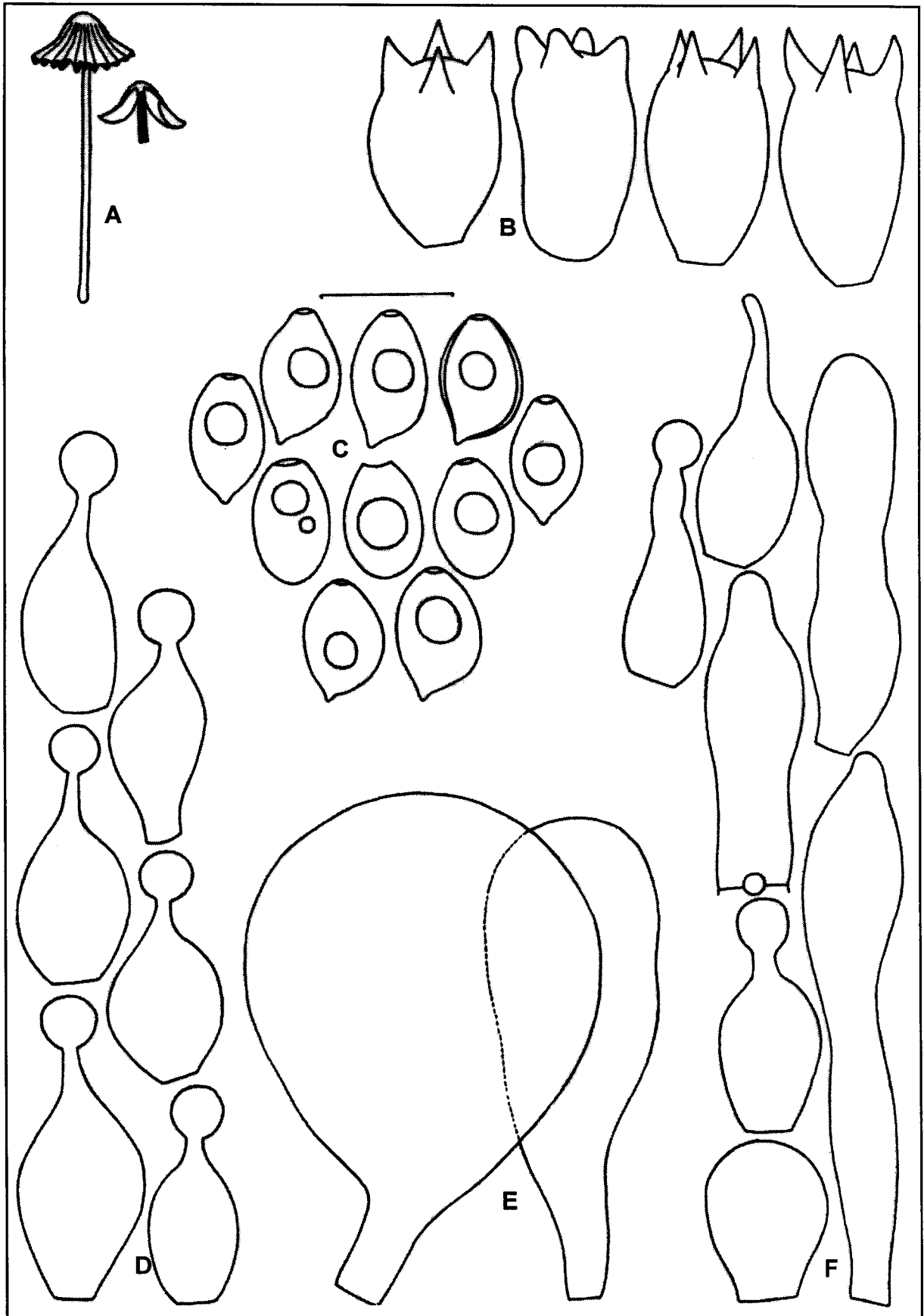


Fig. 14. *Conocybe* sp. 3. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Elements of pileipellis; F. Caulocystidia. Scale bar = 10 μ m

encrustation towards lower region of the trama. Pileipellis a hymeniform layer; elements 17.5–41.5 x 12.5–32.5 μm , sphaeropedunculate, thin-walled, pale yellow to hyaline towards apex, brownish yellow towards base. Pileal margin with numerous cystidia having same size and shape of the cheilocystidia. Stipe trama of 2–26.5 μm wide hyphae, parallel, thin-walled, pale brownish yellow to almost hyaline. Stipitipellis a repent cutis; hyphae 2–9.5 μm wide, thin-walled, pale brownish yellow to almost hyaline. Caulocystidia 7–28 x 4.5–10.5 μm , variable in shape, very rarely lecythiform or with a filiform apical part, thin-walled, pale yellow to hyaline. Clamp-connexions present on all hyphae.

On the ground, scattered, June.

Specimens examined: India, Kerala State, Malappuram District, Calicut University Campus: 15 June 1998, A. Thomas T265.

The distinguishing features of this species are the subamygdaliform spores and the highly variable caulocystidia which are very rarely lecythiform or filiform. It belongs to the subgenus *Conocybe*, section *Conocybe*. Macroscopically it is similar to *Conocybe tenera* (Shaeffer: Fries) Fayod, but the latter species has bigger, ellipsoid spores, exclusively lecythiform caulocystidia and exhibits positive ammonia- reaction. Extensive searches in the literature could not provide a previously published name for this species and hence it is considered as a new species.

***Conocybe* sp. 4**

Fig. 15 A-G; Plate 5 C

Basidioma delicate. Pileus 25–40 mm diam., conical, sometimes with an obtuse umbo; surface brown (6D7, 6E7) towards disc, pale yellow (4A3) or when old light brown (6D4) elsewhere, hygrophorous, glabrous, with fine longitudinal subsulcate striations; margin decurved, entire, sometimes fissile. Context up to 1 mm thick at the centre, concolorous with the pileus surface. Lamellae adnexed to narrowly adnate, yellowish white (4A2) or orange-white (5A2) when young, later turning rust-brown (6E8), close, up to 3.5 mm wide, with lamellulae of 3–4 lengths; edge concolorous with the sides, almost entire. Stipe 100–135 x 3–4.5 mm, fragile, central, terete, tapering apically, hollow; surface yellowish white

(4A2) or orange-white (5A2), densely pubescent, becoming glabrescent. Odour not distinctive. Spore-print not obtained.

Spores 10.5–14.5 x 8–10 x 7–9 ($12.45 \pm 1.10 \times 8.80 \pm 0.62 \times 7.86 \pm 0.61$) μm , $Q=1.25$ – 1.64 , $Q_m=1.42$, lenticular, ovo-ellipsoid or occasionally subhexagonal in face-view, ellipsoid in side-view, smooth, melleous brown, thick-walled, apically truncated by a broad germ-pore. Basidia 25–38 x 12–15.5 μm , pedicellate-clavate, 1-, 2-, or 4-spored; sterigmata up to 4 μm long. Ammonia-reaction negative. Lamella-edge almost sterile. Cheilocystidia 17.5–28 x 7–12.5 μm , lecythiform, with a capitellum of 3–5 μm diam., thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama subregular, with a mediostratum of narrow hyphae and lateral strata of inflated hyphae; hyphae 1.5–19 μm wide, thin-walled, hyaline. Pileal trama interwoven; hyphae 1–21.5 μm wide, thin-walled, densely encrusted by a yellowish brown pigment towards the hypodermial region, mostly without and rarely with encrustation towards lower region, pale yellow to hyaline. Pileipellis hymeniform; elements 24–54 x 15–27.5 μm , sphaeropedunculate, thin-walled, hyaline towards distal end, yellowish brown towards base. Pileocystidia 27–47.5 x 4.5–7.5 μm , scattered, obclavate with a capitellum of 3–5.5 μm diam., thin-walled, yellowish brown or almost hyaline. Stipe trama composed of 1.5–25 μm wide hyphae, thin-walled, hyaline. Stipitipellis a cutis; hyphae 1.5–10 μm wide, thin-walled, hyaline to pale yellow. Caulocystidia 13–46.5 x 4–9 μm , versiform and irregular, rarely subcapitate, mixed with long hairs, all thin-walled and hyaline. Clamp-connexions present in all parts of the basidioma.

On a heap of dried cow dung, scattered, July.

Specimens examined: India, Kerala State, Malappuram District, Calicut University Campus: 9 July 1999, A. Thomas T318; 16 July 1999, A. Thomas T318b.

This species is characterized by delicate, yellowish basidiomata; conical, subumbonate pileus with fine subsulcate striations; large (>10 μm long) spores apically truncated by a broad germ-pore; lecythiform cheilocystidia; obclavate pileocystidia with a capitellum; and versiform caulocystidia that are occasionally subcapitate and mixed with hairs. This combination of characters indicates that it belongs to the subgenus *Conocybe*,

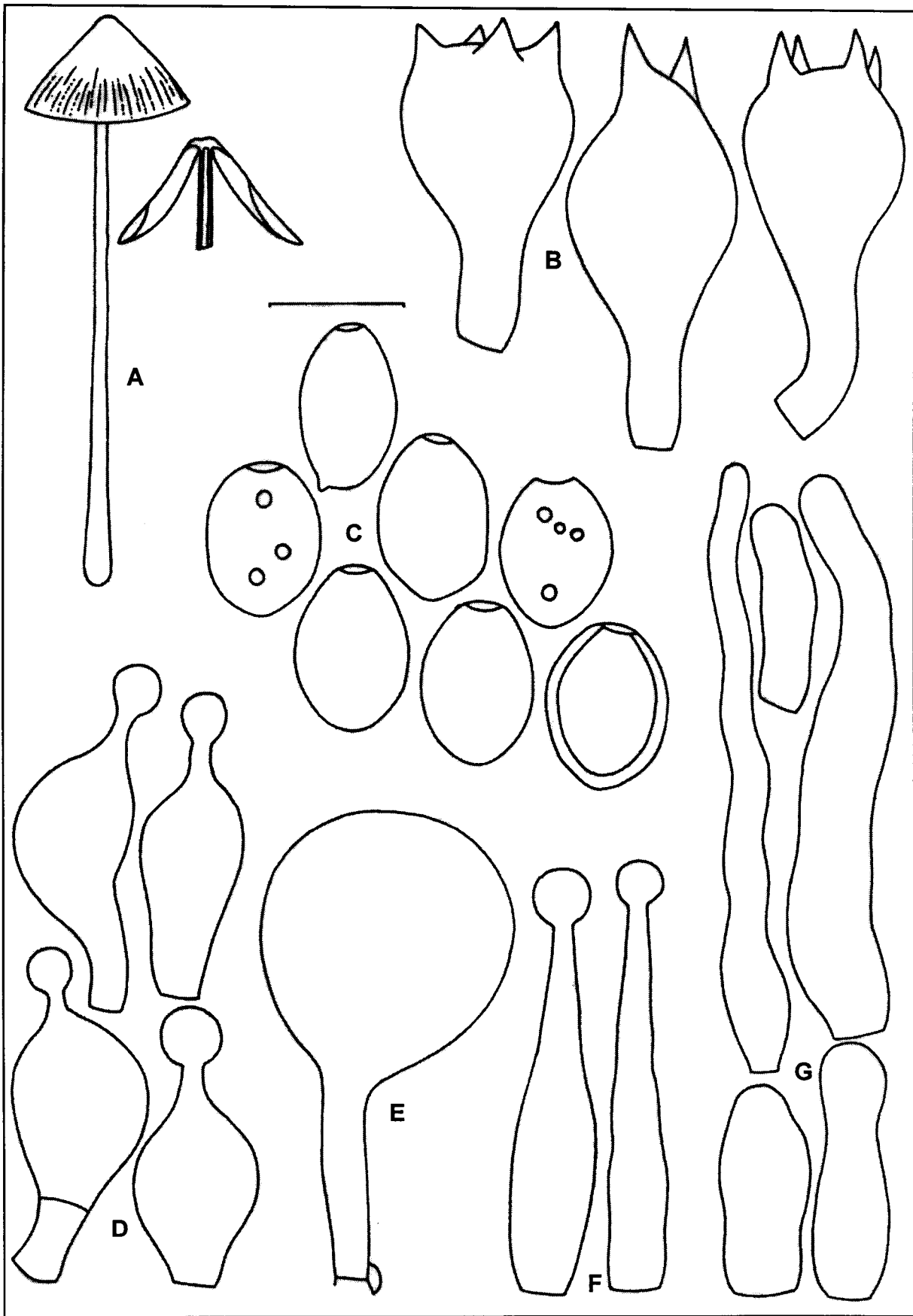


Fig. 15. *Conocybe* sp. 4. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Element of pileipellis; F. Pileocystidia; G. Caulocystidia. Scale bar = 10 μ m

section *Pilosellae* (Kühner) Singer where it is distinct from all the previously published species. It seems to be close to *Conocybe rickenii* (J. Schaeffer) Kühner, *C. siennophylla* (Berkeley & Broome) Singer and *C. huijsmanii* Watling of the *C. siliginea* group. *Conocybe rickenii* shares similar spore-size and coprophilous habit but it has 2-spored basidia, striate pileus and filiform cells on the stipe surface. *Conocybe siennophylla* differs in having relatively small spores, filiform cells on the stipe surface and smaller stature of the basidiomata. *Conocybe huijsmanii* differs in lacking pileocystidia and in possessing filiform elements amongst caulocystidia. *Conocybe crispa*, with which Watling (1983) compared *C. huijsmanii*, is extremely close. Our collections are remarkably similar to the description of *C. crispa* given by Pegler (1977) differing only in the anastomosing gills and foliicolous habit. *Conocybe crispa*, according to Watling (1982) is characterized by deliquescent lamellae, (1-) 2-spored basidia and pavement cells in the hymenium. Microscopically, *Conocybe* sp. 5 described later in this treatise is very close but the latter species has companulate, pellucid-striate pileus, spores that are never subhexagonal and an entirely different habitat..

***Conocybe* sp. 5**

Fig. 16 A-G; Plate 6 A

Pileus 20–45 mm diam., companulate, with a small umbo at the centre; surface brown (6D7) to rust-brown (6E8) at disc, orange white (5A2), pale orange (5A3), or light orange (5A4) elsewhere, hygrophanous, glabrous, finely translucent-striate when moist; margin decurved, entire. Context up to 2 mm thick at the centre, off-white or with an orange tint. Lamellae adnexed to narrowly adnate, brownish orange (6C6), or light brown (6D6), turning brown (7D7, 7E6), close, up to 3 mm wide, with lamellulae of different lengths; edge concolorous with the sides, entire. Stipe 65–130 x 2–6 mm, central, terete, tapering apically, hollow; surface orange white (5A2) or pale orange (5A3), densely pubescent, becoming smooth; base slightly enlarged. Odour not distinctive. Spore-print not obtained.

Spores 10–15.5 x 7.5–11 x 7–9.5 ($12.97 \pm 1.59 \times 9.05 \pm 1.07 \times 8.27 \pm 0.51$) μm , $Q=1.23$ – 1.62 , $Q_m=1.44$, lenticular, ovo-ellipsoid in face-view, ellipsoid in side-view, smooth, melleous

brown, thick-walled, apically truncated by a broad germ-pore. Basidia 17.5–29 x 9.5–14 μm , pedicellate-clavate, 4-spored, sterigmata up to 3.5 μm long. Ammonia-reaction negative. Lamella-edge heteromorphous to sterile. Cheilocystidia 16.5–27.5 x 7–10.5 μm , lecythiform with a capitellum of 2.5–4.5 μm diam., thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama subregular, with a narrow mediostratum comprising narrow, (1.5–9 μm wide) pale yellowish brown hyphae and broad lateral strata of inflated (up to 25 μm wide), thin-walled, hyaline hyphae. Pileal trama loosely interwoven; hyphae 1.5–29 μm wide, narrow and densely encrusted with a yellowish brown pigment towards hypodermial region, inflated and hyaline towards basal region. Pileipellis hymeniform; elements 20.5–56.5 x 11.5–25 μm , inflated-clavate or sphaeropedunculate, thin-walled, hyaline towards distal end, yellowish brown towards base. Pileocystidia 24–48 x 4–6.5 μm , elongated lageniform with a long tapering neck and a capitellum of 3.5–5 μm diam., scattered, thin-walled, hyaline or yellowish brown. Stipe trama composed of 1.5–27.5 μm wide hyphae, thin-walled, hyaline or pale yellowish brown. Stipitipellis a cutis; hyphae 2–9.5 μm wide, thin-walled, hyaline or pale yellowish brown. Caulocystidia present throughout the surface in fascicles, 11.5–45 x 3–9 μm , clavate, cylindrical or lageniform, some with long, filiform apical appendage, all thin-walled and hyaline. Clamp-connexions present in all parts of the basidioma.

On decaying pith of the palm *Corypha umbraculifera* Linnaeus (Arecaceae), scattered, September–October.

Specimens examined, India, Kerala State, Kannur District, Pulikurumba: 14 September 1997, A. Thomas T147; 15 September 1997, A. Thomas T147b; 16 September 1997, A. Thomas T147c; 28 September 1997, A. Thomas T147d; 26 October 1997, A. Thomas T147e.

Large basidiomata, densely pubescent stipe, large spores truncated by a broad germ-pore, lecythiform cheilocystidia, capitate pileocystidia and variable but non-capitate caulocystidia mixed with hairs are the characteristic features of this species. It belongs to the subgenus *Conocybe* section *Pilosellae*. In many features it is very close to *Conocybe zeylanica* (Petch) Boedijn, originally described from Sri Lanka. *Conocybe zeylanica*, however,

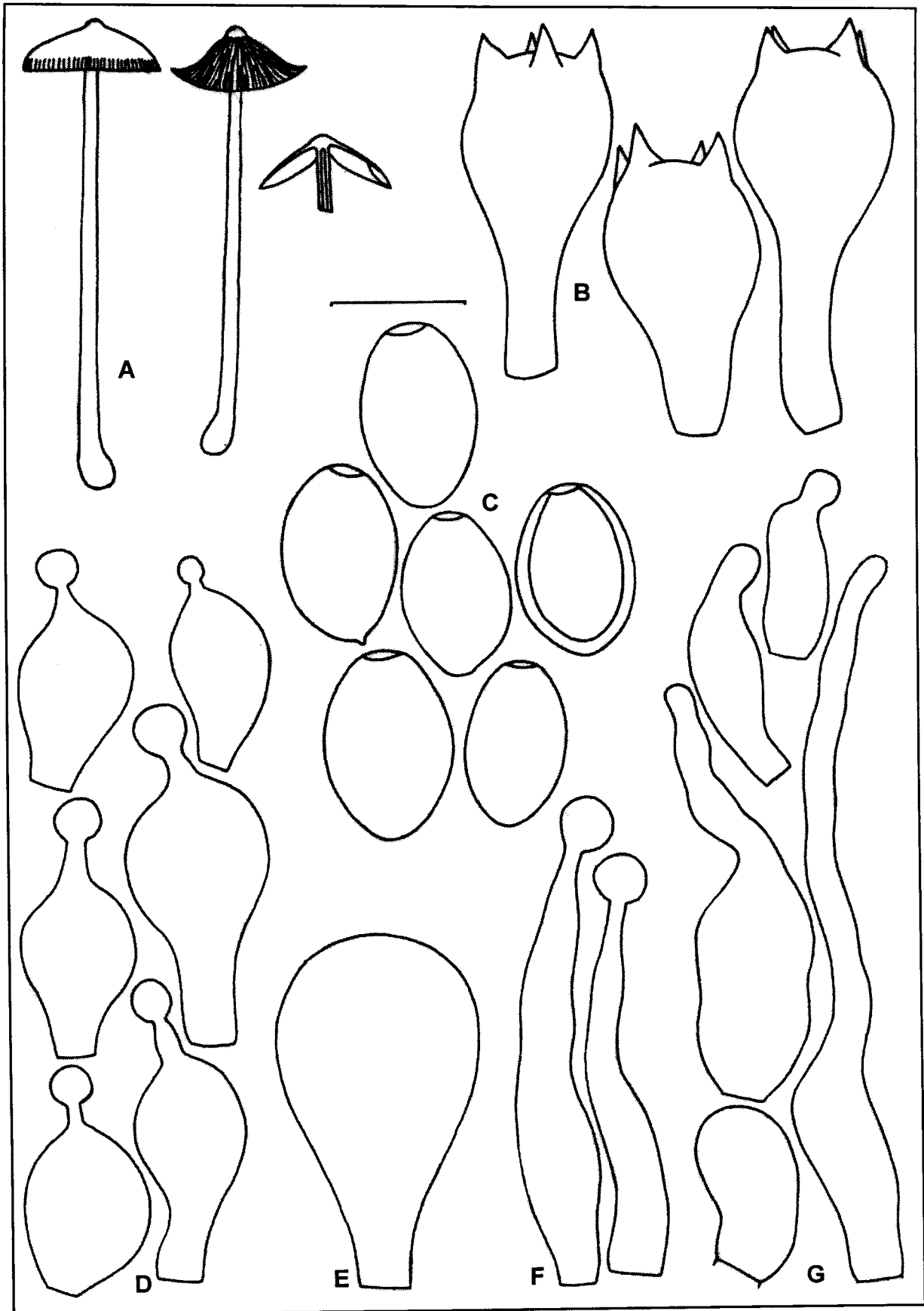


Fig. 16. *Conocybe* sp. 5. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Element of pileipellis; F. Pileocystidia; G. Caulocystidia. Scale bar = 10 μ m

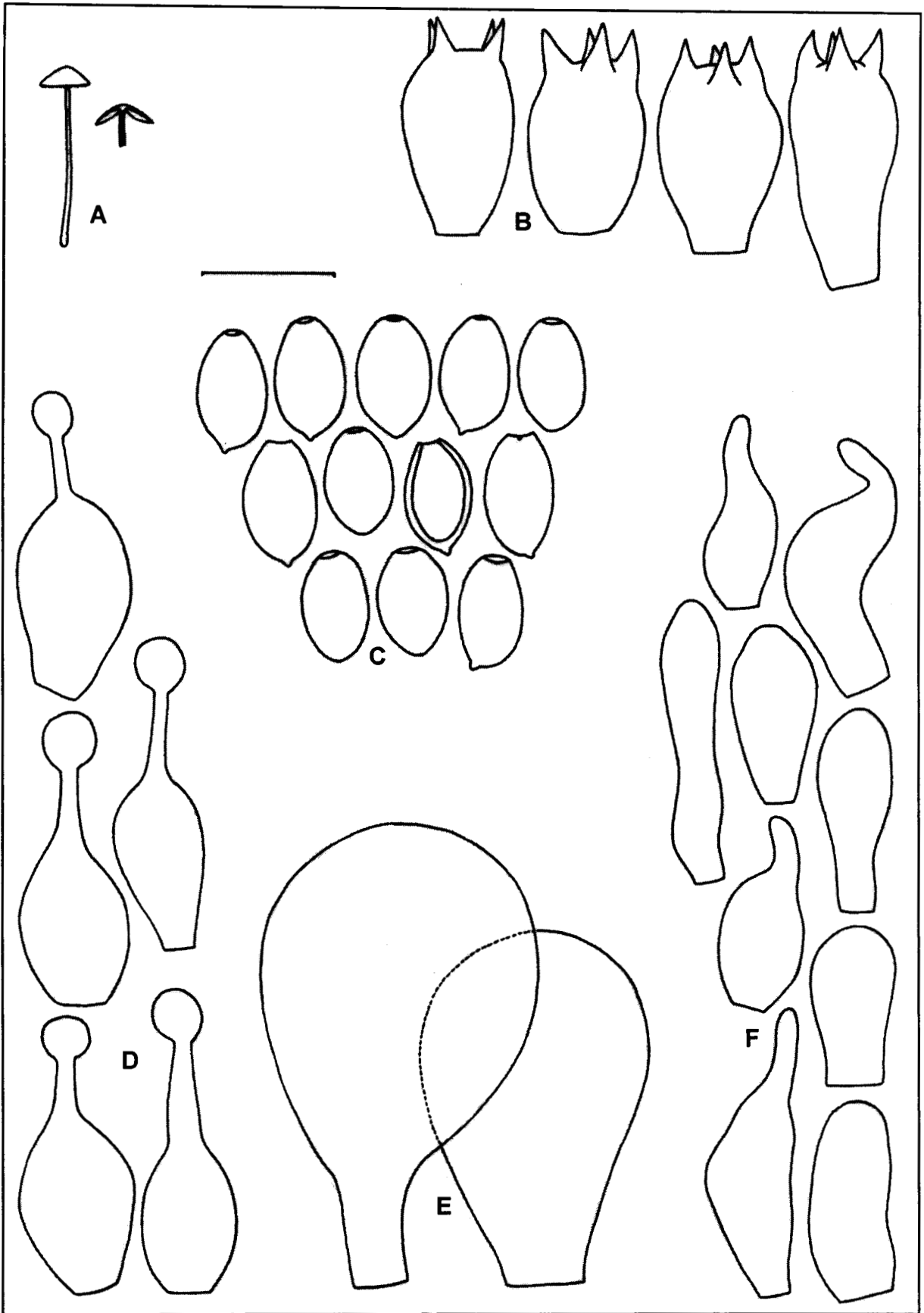


Fig. 17. *Conocybe* sp. 6. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Elements of pileipellis; F. Caulocystidia. Scale bar = 10 μ m

has no pileocystidia and the stipe-surface of that species is not densely pubescent. Also, caulocystidia of *C. zeylanica* are of different morphology and are mixed with hairs. *Conocybe* sp. 4 described earlier in this treatise is microscopically very similar but the conical pileus with distinct subsulcate striations, the presence of occasional subhexagonal spores and the coprophilous habitat make it distinct. A previously published species description to which the present collections can comfortably fit in could not be traced.

***Conocybe* sp. 6**

Fig. 17 A-F; Plate 6 B

Basidiomata small, slender. Pileus 4–8 mm diam., conico-convex, convex or plano-convex, occasionally with an indistinct umbo; surface brownish orange (6C5, 6C6, 7C5, 7C6), unicolorous, hygrophanous, smooth, glabrous, dry; margin decurved, entire. Context up to 0.5 mm at the centre. Lamellae adnexed, brown (6D7, 7D7), close, up to 2 mm wide, with lamellulae of 3 lengths; edge concolorous with the sides, entire. Stipe 20–45 x <1 mm, central, terete, slightly tapering apically, hollow; surface concolorous with the pileus surface, glabrous. Odour none. Spore-print not obtained.

Spores 6.5–11 x 4.5–6.5 (8.58 ± 1.28 x 5.64 ± 0.62) μm , $Q=1.22$ – 1.78 , $Q_m=1.50$, ellipsoid, smooth, melleous brown, thick-walled, apically truncated by a germ-pore. Basidia 14.5–22 x 7.5–10.5 μm , clavate, 4-spored; sterigmata up to 3 μm long. Ammonia-reaction negative. Lamella-edge heteromorphous to almost sterile with sparse or crowded cheilocystidia. Cheilocystidia 18–30 x 6.5–10 μm , lecythiform, with a long slender neck and a capitellum of 3–5 μm diam., thin-walled, hyaline to light brownish yellow. Hymenophoral trama subregular, with a narrow mediostratum of narrow, yellowish brown hyphae and broad lateral strata of inflated, paler hyphae; hyphae 2–24.5 μm wide, thin-walled. Pileal trama interwoven; hyphae 1.5–35 μm wide, narrow and densely brown-encrusted towards hypodermial region, inflated and hyaline or paler towards lower region of the pileal trama, thin-walled. Pileipellis hymeniform; elements 19–41.5 x 11.5–27.5 μm , pear-shaped to sphaeropedunculate, thin-walled, pale brown or hyaline towards apex, brown towards base. Stipe trama composed of 1.5–27.5 μm wide hyphae, parallel, thin-walled, light yellowish brown. Stipitipellis a cutis;

hyphae 2–9.5 μm wide, thin-walled, light yellowish brown. Caulocystidia 10–29 x 4.5–7.5 μm , in fascicles, mostly clavate or cylindric-flexuose; sometimes with a beak-like projection at the apex, thin-walled, hyaline to light yellowish brown. Clamp-connexions present in all tissues.

On decaying twigs and humus-rich soil, scattered, November.

Specimens examined: India, Kerala State, Malappuram District, Nilambur: 14 November 1997, A. Thomas T210. 18 November 1997, A. Thomas T210b.

This species is characterized by small, brownish orange basidiomata; non-striate, hygrophanous pileus; total absence of velar remnants; small, ellipsoid spores truncated by an apical germ-pore; 4-spored basidia, lecythiform cheilocystidia; and caulocystidia that are neither lecythiform nor filiform. It belongs to subgenus *Conocybe*, section *Pilosellae* where owing to the combination of characters listed above, it occupies a rather isolated position. Several features including the bright colour of the pileus and size of spores are suggestive of *C. mesospora* Kühner ex Singer but the latter species has larger basidiomata, lecythiform pileo- and caulocystidia. The small size of the basidiomata, the bright colour of the pileus and the size of the spores are suggestive of *C. minima* Singer & Hausknecht but *C. minima* has very distant lamellae, lecythiform pileo- and caulocystidia and spores without a distinct germ-pore.

***Conocybe* sp. 7**

Fig. 18 A-F; Plate 6 C

Basidiomata small, fragile. Pileus 6–14 mm diam., 6–12 mm high, conico-complanate to conico-convex to convex, sometimes with a small umbo; surface pale orange (5A3) or light orange (5A4, 5A5), hygrophanous, smooth, glabrous, dull, translucent-striate when moist; margin decurved, entire. Context up to 2 mm wide at the centre, concolorous with the pileus surface. Lamellae adnate to adnato-adnexed, light brown (6D6) or brown (6D7), close, up to 3 mm wide, with lamellulae of 3 lengths; edge entire, concolorous with the sides. Stipe 60–90 x 1–2 mm, central, cylindric, slightly tapering apically, hollow; surface

concolorous with the pileus surface, slightly pubescent; base distinctly radicating. Odour not distinctive. Spore-print not obtained.

Spores 11.5–15.5 x 7–9.5 x 6.5–8.5 (13.92±1.02 x 8.73±0.76 x 7.52±0.63) μm , Q=1.42–1.79, Qm=1.6, lenticular, ellipsoid to ovo-ellipsoid, smooth, melleous brown, apically truncated by a germ-pore. Basidia 22.5–36.5 x 11.5–15.5 μm , clavate, 4-spored, rarely 2-spored; sterigmata up to 10 μm long. Ammonia-reaction negative. Lamella-edge heteromorphous to almost sterile. Cheilocystidia 12.5–22.5 x 5.5–11 μm , lecythiform, with a small capitellum of 2.5–5 μm diam., subtended by a short neck, thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama subregular, composed of a narrow mediostratum of narrow hyphae and lateral strata of inflated cells; hyphae 3–37.5 μm wide, thin-walled, light brownish yellow to hyaline. Pileal trama composed of 2–39 μm wide hyphae, inflated, thin-walled, almost hyaline or often with light brownish yellow encrustation. Pileipellis hymeniform; elements 17.5–46.5 x 12.5–36.5 μm , globose to sphaeropedunculate, thin-walled, sometimes faintly encrusted, hyaline towards distal end, light brownish yellow towards base. Stipe trama composed of 2–26.5 μm wide hyphae, thin-walled, hyaline to pale yellow. Stipitipellis a cutis; hyphae 2–11.5 μm wide, thin-walled, pale yellow to hyaline. Caulocystidia 24–122.5 x 4.5–25 μm , variable, mostly somewhat lageniform but never lecythiform, seen at the upper part of the stipe, either in clusters or scattered, thin-walled, hyaline. Clamp-connexions present on all hyphae.

On the ground, amongst grass, scattered, April.

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 29 April 1998, A. Thomas T252.

The most distinctive feature of this species is the strongly radicating base of the stipe. It belongs to the subgenus *Conocybe* section *Pilosellae*. Among the radicating species of *Conocybe* it seems to come close to *C. fiorii* (D. Saccardo) Watling owing to many macro- and microscopic similarities. The latter species, however occur on sand and has more robust basidiomata, cinnamon-brown pileus, and lecythiform caulocystidia. *Conocybe cettoiana* Hausknecht & Enderle differs in having slightly smaller spores, pileocystidia, and

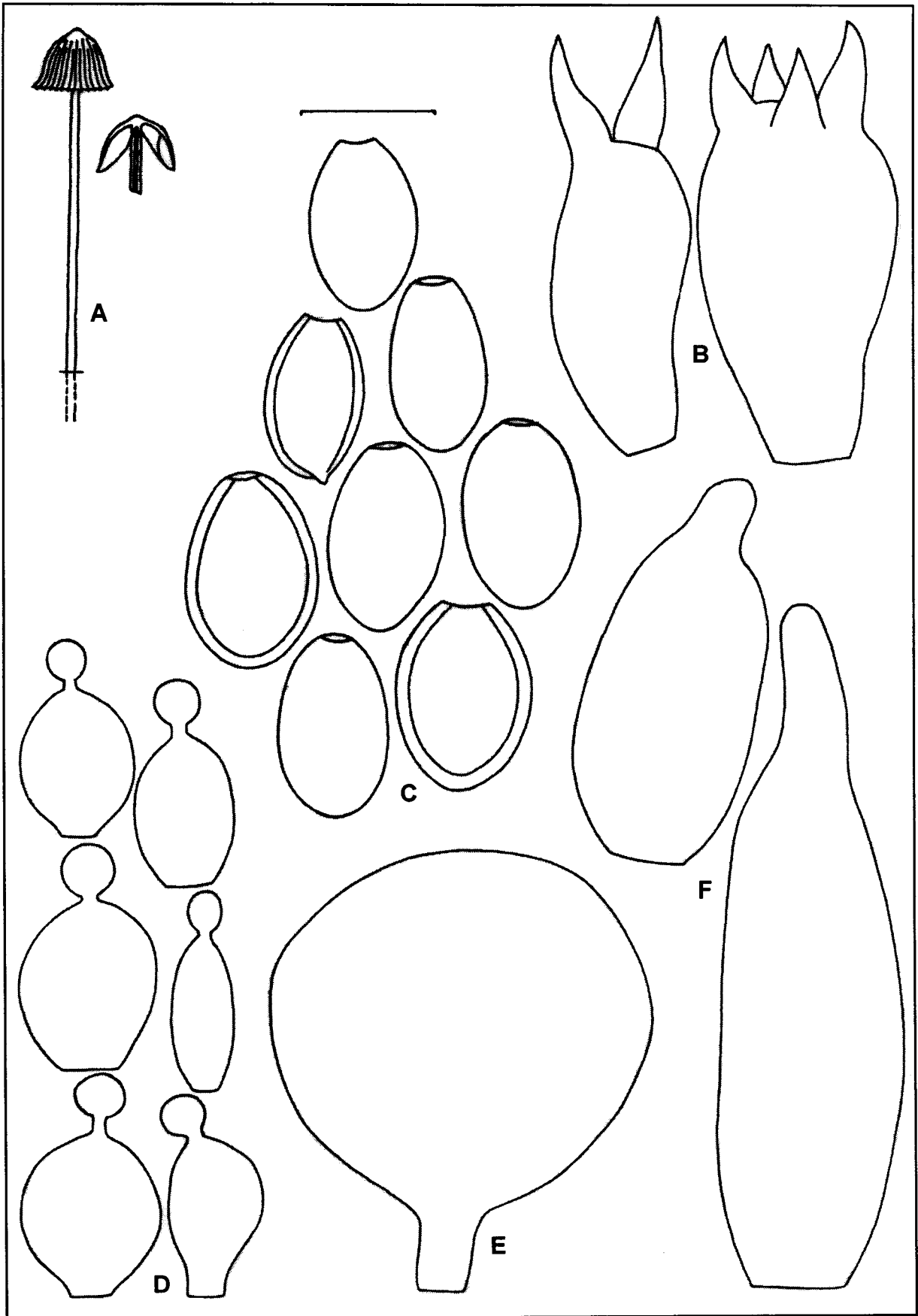


Fig. 18. *Conocybe* sp. 7. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Element of pileipellis; F. Caulocystidia. Scale bar = 10 μ m

filiform elements amongst caulocystidia. It is not fitting into any previously published species description and hence is considered as a new species. *Conocybe* sp. 2 described earlier differs in having subhexagonal spores and lecythiform caulocystidia mixed with filiform elements.

***Conocybe* sp. 8**

Fig. 19 A-F; Plate 7 A

Pileus 4–15 mm diam., convex, conico-convex, or companulate; surface almost pale orange (5A3), greyish orange (5B3) or brownish orange (5C3), hygrophanous and becoming orange white (5A2), smooth, glabrous, dull, atomate, faintly translucent-striate when moist; margin decurved, entire. Context up to 1.5 mm thick at the centre, concolorous with pileus surface. Lamellae narrowly adnate, almost pale orange (5A3) when young, later turning light brown (6D6), close, up to 3 mm wide, with lamellulae of 2–3 lengths; edge slightly lighter than the sides, entire. Stipe 25–65 x 0.7–1.5 mm, central, almost equal, or slightly attenuated towards apex, fistulose; surface concolorous with the pileus surface, initially finely pruinose, becoming glabrous. Odour none. Spore-print rust-brown (6E8) to brownish grey (6F8).

Spores 10–15 x 7–9.5 x 6.5–8.5 ($13.19 \pm 1.26 \times 7.78 \pm 1.91 \times 7.58 \pm 0.52$) μm , $Q=1.39$ – 1.81 , $Q_m=1.60$, slightly lenticular, ellipsoid to faintly subhexagonal in face-view, ellipsoidal in side-view, smooth, melleous brown, thick-walled, with a broad, truncate apical germ-pore. Basidia 20–32.5 x 12.5–17 μm , vesiculose to pedicellate-clavate, 4-spored, sterigmata up to 3.5 μm long. Needle-like crystals not formed but sand-grain like crystals formed with Ammonia solution. Lamella-edge heteromorphous to almost sterile. Cheilocystidia 15–25 x 5.5–12 μm , lecythiform, with a globose capitellum of 2.5–4.5 μm diam., thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama subregular, with a narrow mediostratum of narrow hyphae and broad lateral strata of inflated hyphae; hyphae 2.5–32.5 μm wide, pale yellowish brown. Pileal trama interwoven; hyphae 1.5–30 μm wide, inflated, thin-walled, yellowish brown, sometimes encrusted with yellowish brown pigment especially at hypodermial region. Pileipellis hymeniform; elements 20–45 X 12.5–37.5 μm , sphaeropedunculate, thin-walled,

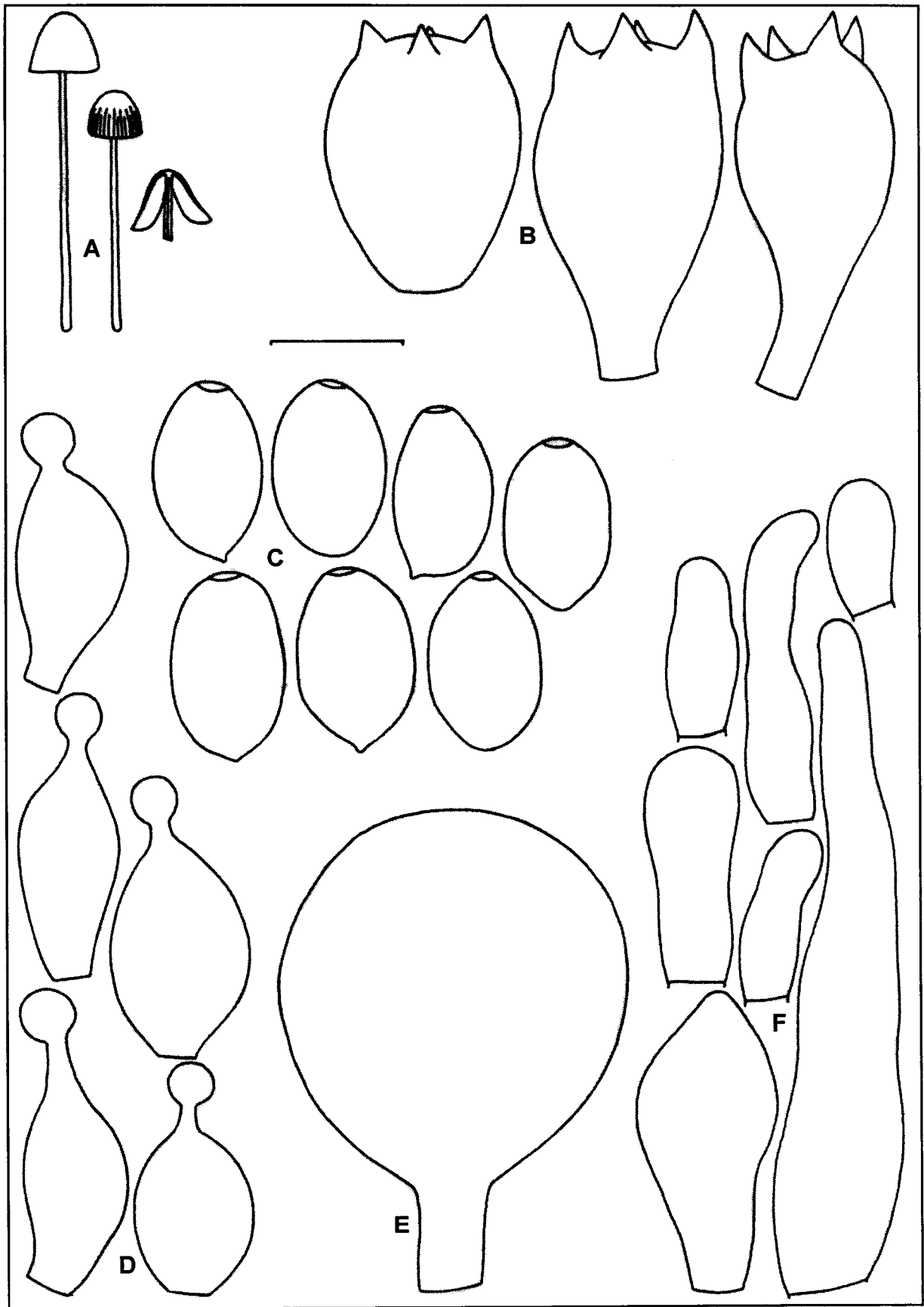


Fig. 19. *Conocybe* sp. 8. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Element of pileipellis; F. Caulocystidia. Scale bar = 10 μ m

hyaline towards distal end, yellowish brown towards base. Stipe trama consists of 2–28 μm wide hyphae, thin-walled, pale yellow. Stipitipellis a repent cutis; hyphae 2–9 μm wide, thin-walled, pale yellow. Caulocystidia 11.5–99 x 4.5–17 μm , very variable in shape but never lecythiform, mostly cylindric-flexuose, in clusters to scattered throughout stipe surface, thin-walled, hyaline. Clamp-connexions present.

On dung-manured pots, scattered, September-October.

Specimens examined: India, Kerala State, Malappuram District, Calicut University Campus: 5 September 1999, A. Thomas T326; 7 September 1999, A. Thomas T326b; 6 October 1999, A. Thomas T326c; 9 October 1997, A. Thomas T183.

This species is characterized by small basidiomata growing on manured soil; small, hygrophanous pellucid-striate pileus; large (>10 μm long) spores that are ellipsoid in side-view and ellipsoid to faintly subhexagonal in face-view; lecythiform cheilocystidia; and caulocystidia that are very variable in shape but never lecythiform. It belongs to the subgenus *Conocybe*, section *Pilosellae*. The faintly subhexagonal spores invite comparison with *C. lenticulospora* Watling which differs in having umber or date brown pileus and smaller spores. Watling, Little Flower and Leelavathy (1988) mention a collection (Little Flower 381) that has not been assigned to a particular species, which in many ways resembles the present collections. They (Watling *et al.*, 1988) compared it (Little Flower 381) to *C. khasiensis* (Berkeley) Watling, described from Assam, India, but in both *C. khasiensis* and Little Flower 381, caulocystidia could not be recovered. The author believes that the present collections represent an undescribed species.

***Conocybe* sp. 9**

Fig. 20 A-F: Plate 7 B

Basidiomata small. Pileus 5–14 mm diam., conico-convex to conico-complanate; surface almost brownish orange (6C5, 6C6), hygrophanous and becoming orange-white (5A2), smooth, glabrous, dull, translucent-striate when moist; margin decurved, entire to slightly eroded. Context less than 1 mm thick at the centre, orange-white. Lamellae narrowly adnate, light brown (7D6), close, up to 2.5 mm wide, with lamellulae of 3 lengths; edge

paler, entire. Stipe 30–60 x 1–2 mm, central, terete, equal or slightly attenuated towards apex, hollow; surface initially concolorous with pileus surface, later pale orange (5A3), faintly pruinose, glabrescent. Odour none. Spore-print not obtained.

Spores 11.5–17.5 x 7.5–12 x 7–10 (14.39±1.79 x 9.44±0.98 x 8.74±0.87) μm , $Q=1.29$ – 1.69 , $Q_m=1.52$, lenticular, ovo-ellipsoid to oblong-ellipsoid in face-view, ellipsoid in side-view, smooth, melleous brown, thick-walled, apically truncated by a broad germ-pore. Basidia 18–30 x 10.5–16.5 μm , clavate or pedicellate-clavate, 4-spored; sterigmata up to 3 μm long. Ammonia-reaction negative. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 12.5–27 x 6.5–12 μm , lecythiform with a capitellum of 2.5–5 μm diam., subtended by a small neck, thin-walled, hyaline to pale brownish yellow. Pleurocystidia none. Hymenophoral trama subregular, with a narrow mediostratum composed of narrow hyphae, and broad lateral strata of inflated hyphae; hyphae 2–27.5 μm wide, thin-walled, pale brownish yellow to almost hyaline. Pileal trama interwoven; hyphae 2–30 μm wide, narrow and with light yellow encrustation towards hypodermial region and inflated, with hyaline to pale yellow pigment towards lower region of the trama, thin-walled. Pileipellis hymeniform; elements 22.5–55 x 17–44 μm , sphaeropedunculate, thin-walled, hyaline towards distal end, light yellow towards base. Stipe trama composed of 2–34 μm wide hyphae, thin-walled, pale yellow or hyaline. Stipitipellis a cutis; hyphae 2–11.5 μm wide, thin-walled, pale yellow to almost hyaline. Caulocystidia 7.5–56.5 x 5–12.5 μm , very variable, never lecythiform, sometimes with a swollen base and a very long, flexuose upper part, in fascicles or scattered, thin-walled, pale yellow to hyaline. Clamp-connexions present in all tissues.

On elephant dung, scattered, May-June.

Specimens examined: India, Kerala State, Wayanad District, Muthanga: 25 June 1997, A. Thomas T84; 25 May 1999, A. Thomas T84b.

Small, coprophilous basidiomata; total absence of velar remnants; brownish, hygrophanous and pellucid-striate pileus; large (>11 μm long) spores with a truncate germ-pore; and very variable caulocystidia that are never lecythiform are the characteristic features of this species which belongs to the subgenus *Conocybe* section *Pilosellae*. While it is not

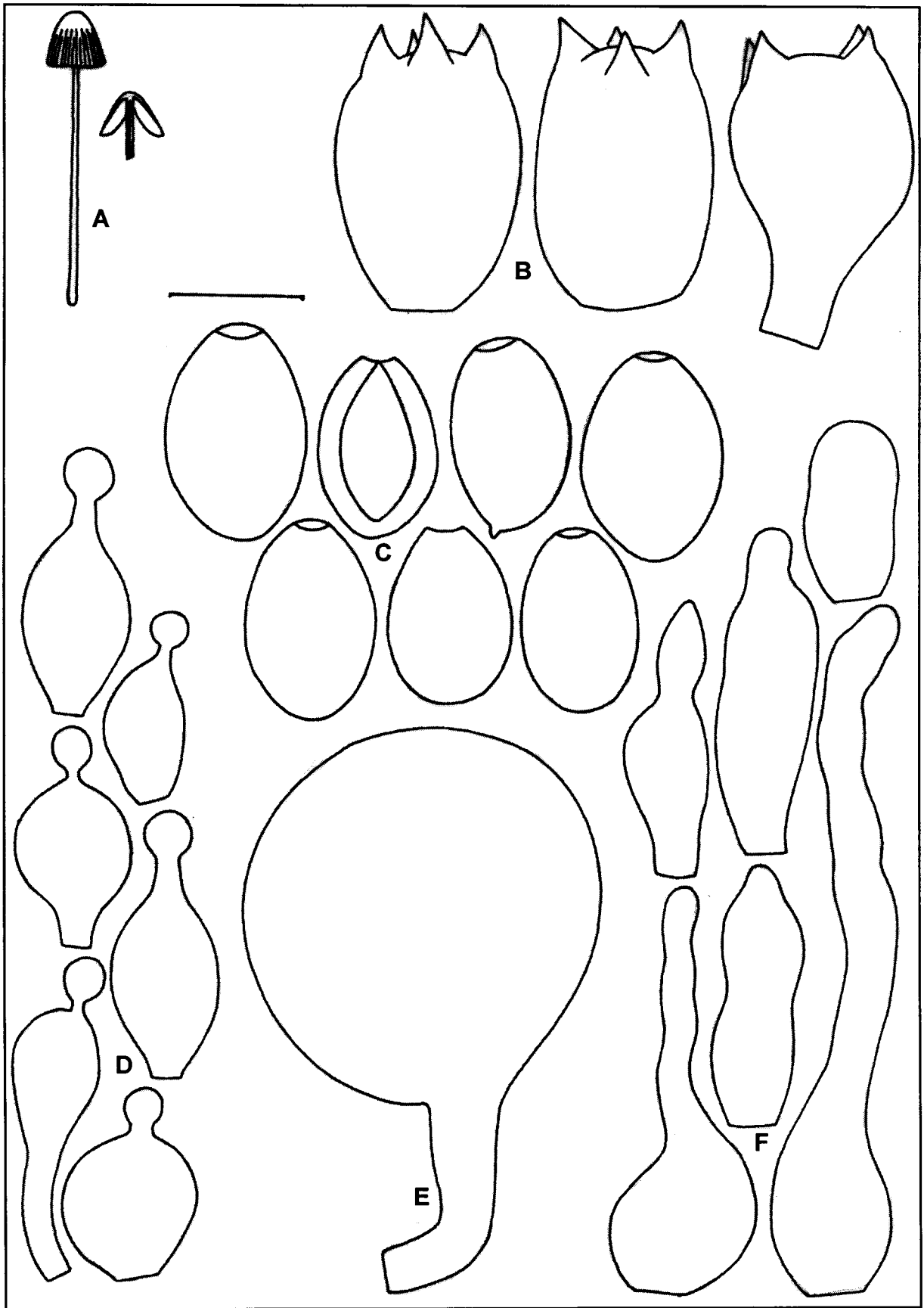


Fig. 20. *Conocybe* sp. 9. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Element of pileipellis; F. Caulocystidia. Scale bar = 10 μ m

agreeing with any species already described in that section, it is remarkably similar to the description of *Conocybe pubescens* (Gillet) Kühner given by Pegler (1977) differing only in the caulocystidial features. In the infrageneric taxonomy of *Conocybe*, however, caulocystidial morphology is used to differentiate sections and *C. pubescens* belongs to section *Conocybe*. The Kerala collections are therefore considered as belonging to a new species.

STROPHARIACEAE Singer & Smith
in *Mycologia* 38:503 (1946).

Strophariaceae Van Overeem in *Bull. Jard. Bot. Buitenzorg* 9:19 (1927) nom. nud.

Strophariaceae Romagnesi in *Rev. Mycol.* 2:243 (1937) nom. nud.

Basidiomata small to large, pholiotoid or crepidotoid. Pileus viscid, moist or dry, often brightly coloured, glabrous or scaly, hygrophanous or not. Lamellae adnexed to adnato-decurrent. Stipe central, sometimes excentric and much reduced. Veil membranous-annulate, cortinoid, evanescent or absent. Spore-print lilaceous black, dark fuscous brown, greyish brown, dark brown, ferruginous or cinnamon-brown. Spores small to large, smooth, thin- to thick-walled, sometimes lenticular, with a germ-pore which mostly truncate the apex. Basidia 2- or 4-spored. Lamella-edge sterile with numerous cheilocystidia. Pleurocystidia present or absent. Chrysocystidia mostly present. Hymenophoral trama often regular. Pileipellis an epicutis of filamentous hyphae, often with a pseudoparenchymatous hypodermium. Terrestrial, humicolous, lignicolous or coprophilous. Not forming mycorrhizal association. Worldwide in distribution. Type genus: *Stropharia* (Fries) Quélet

Key to the genera

1. Spore-print cinnamon-brown to rust-brown; spore-wall melleous brown to cinnamon; spores with or without a germ-pore; basidioma never bluing when bruised; pileus not hygrophanous (subfamily Pholiotoideae) ***Pholiota***
1. Spore-print lilaceous black to dark fuscous brown; spore-wall deeply pigmented; spores always with a distinct germ-pore; basidioma sometimes turning blue when bruised; pileus hygrophanous or not (subfamily Stropharioideae) 2
2. Chrysocystidia typically present; pileus mostly non- or partly hygrophanous; stipe always central 3
2. Chrysocystidia very rare; pileus mostly hygrophanous; stipe central or eccentric 4

3. Pileus variously coloured but rarely with orange or red shades, somewhat viscid; veil often forming a membranous annulus or leaves some velar remnants on the pileal margin as in some coprophilous species; cheilocystidia mostly inflated-clavate; hypodermium not forming a subcellular layer; basidiomata not fascicular; usually not lignicolous ***Stropharia***
3. Pileus mostly brightly coloured with yellow, red or orange shades, non-viscid; veil non-membranous and often cortinoid; hypodermium usually forming a subcellular layer; mostly found in fascicles on wood ***Hypholoma***
4. Basidiomata not crepidotoid, often turn blue on bruising; stipe central, well-developed, rather long in relation to the diameter of the pileus; rarely with chrysocystidia ***Psilocybe***
4. Basidiomata crepidotoid, never turn blue on bruising; stipe poorly developed, short, excentric, mostly curved; chrysocystidia always absent ***Melanotus***

Subfamily **PHOLIOTOIDEAE** (Imai) Singer
in Agar. mod. Tax. 1st ed. p. 511 (1951).

Spore-print cinnamon-brown to rust-brown; spore-wall melleous brown to cinnamon-brown; basidioma never turns blue on bruising. Type genus: *Pholiota* (Fries) Quélet

Pholiota (Fries) Kummer
in Fuhr. Pilzk.:22 (1871).

Agaricus Fries tribe *Pholiota* Fries in Syst. Mycol. 1:240 (1821).

Flammula (Fries) Kummer in Fuhr. Pilzk.:22 (1871).

Dryophila Quélet in Enchiridion:66 (1886).

Flammulopsis Fayod, in Ann. Sci. Nat., Bot. ser. 7,9:356 (1889).

Basidiomata small to large. Pileus convex or conico-convex, glabrous, often scaly or fibrillose, viscid to dry, in many margin appendiculate, frequently yellowish, olivaceous, rusty yellowish or brownish. Context often fleshy. Lamellae adnexed to subdecurrent, initially yellowish. Stipe central, glabrous, fibrillose or scaly, darker towards base, paler at apex.

Partial veil often persistent, at times annulate, arachnoid to membranous, usually leaving velar remnants on the stipe. Spore-print cinnamon-brown to rust-brown. Spores small to medium-sized, ovoid, ellipsoid or phaseoliform, smooth, with an apical germ-pore, often weakly developed and indistinct. Lamella-edge sterile or heteromorphous with cheilocystidia. Pleurocystidia present or absent. Chrysocystidia often present. Hymenophoral trama regular or subregular. Pileipellis a repent cutis or an ixocutis, with or without a differentiated hypodermium. Clamp-connexions present. Lignicolous, humicolous, terrestrial or carbonicolous. Worldwide in distribution. Type species: *Pholiota squarrosa* (Persoon ex Fries) Kummer.

Only a single species of *Pholiota* was recorded from Kerala during this study.

***Pholiota* sp. 1**

Fig. 21 A-F; Plate 7 C

Basidiomata small to medium-sized. Pileus 10–50 mm diam., initially convex, turning infundibuliform; surface greyish yellow (4B3), greyish orange (5B3) or orange grey (5B2), with concentric zones of evenly spaced, appressed, easily removable scales which are reddish brown (8D7, 8E7, 8F7) towards centre and light brown (7D4) towards margin, viscid, inconspicuously striate towards margin when dried; margin straight to reflexed, entire, sometimes undulating. Context yellowish white. Lamellae sinuate or adnexed, orange grey (5B2) or greyish orange (5B3), crowded to subcrowded, up to 5.5 mm wide, with lamellae of 3–5 lengths; edge pale, entire, minutely fimbriate under a lens. Stipe 15–30 mm x 1.5–5 mm, central, terete, almost equal, solid; surface pale yellow (4A3) or light yellow (4A4), glabrous, at times with velar remnants. Odour not distinctive. Slightly bitter in taste. Spore-print yellowish brown (5D6).

Spores 7–9 x 4.5–6.5 (7.97 ± 0.60 x 5.28 ± 0.51) μm , $Q=1.3$ – 1.8 , $Q_m=1.56$, mostly ovo-ellipsoid, occasionally subphaseoliform, yellowish-brown, smooth, thick-walled (about 0.5 μm), with a small apical germ-pore. Basidia 16.5–22.5 x 7–9.5 μm , clavate to cylindrical, 4-spored, rarely 2-spored; sterigmata up to 6 μm long. Lamella-edge sterile or heteromorphous. Cheilocystidia in the form of chrysocystidia, 15.5–60 x 6.5–12.5 μm ,

conspicuously projecting, narrowly utriform or utriform, sometimes with a flexuous upper half, rarely subcapitate, thin-walled, hyaline or sometimes with light yellowish brown amorphous inclusion. Pleurocystidia in the form of chrysocystidia, 20–85 x 7.5–15.5 µm, similar to cheilocystidia in morphology, thin-walled, with yellowish brown amorphous content, rarely hyaline or pale yellowish brown. Hymenophoral trama regular; hyphae 2–22.5 µm wide, formed of short, inflated, hyaline, thin-walled cells, flanked on either side by a subgelatinized subhymenium composed of 1.5–4.5 µm wide hyphae, loosely interwoven, thin-walled, hyaline. Pileal trama interwoven; hyphae composed of 2–21.5 µm wide, short, inflated, hyaline cells towards lower layers and comparatively long and narrow (up to 12.5 µm wide), pale brownish yellow elements towards upper region. Pileipellis an ixocutis; hyphae 1.5–4.5 µm wide, repent, thin-walled, hyaline, embedded in a gelatinous matrix above a hypodermium of non-gelatinized, yellowish hyphae with faint encrustation. Velar remnants on the pileal surface composed of 2–7.5 µm wide hyphae with yellowish brown encrustation, sometimes with cystidioid end cells, 26.5–56.5 x 9–17.5 µm, thin-walled. Stipe trama composed of 2–13 µm wide, thin-walled hyphae with light yellow wall pigment. Stipitipellis a cutis; hyphae 2–7.5 µm, thin-walled, with light yellow wall. Caulocystidia 15–52 x 5–12 µm, clavate, utriform, vesiculose or ventricose-fusoid, thin-walled, hyaline, occasional, occurring towards the stipe apex, in clusters or scattered as recurved hyphal tips. Clamp-connexions present in all parts of the basidioma.

On decaying bamboo logs, gregarious to scattered, November.

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 18 November 1997, A. Thomas T215; 20 November 1997, A. Thomas T215b.

This species is characterized by (1) a viscid pileus with concentric zones of easily removable, appressed scales; (2) absence of an annulus; (3) presence of conspicuous, utriform chrysocystidia on the edge and sides of lamellae; (4) ovo-ellipsoid to subphaseoliform, non-truncate, thick-walled basidiospores which are yellowish brown in print; (5) gelatinized subhymenium and pileipellis; (6) presence of caulocystidia; and (7) occurrence on decaying bamboo logs. Smith and Hesler's (1968) key leads to subgenus *Flammuloides*

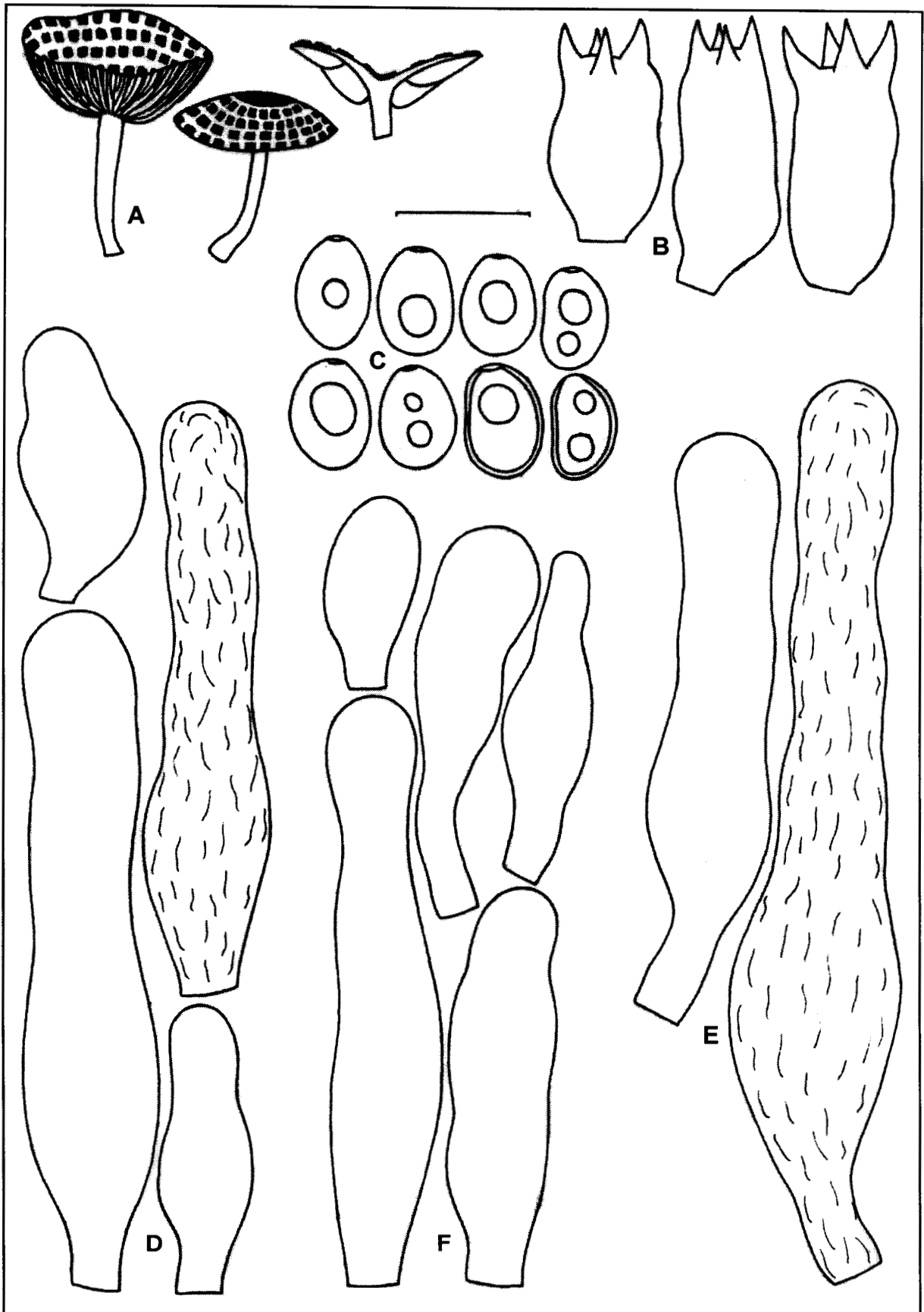


Fig. 21. *Pholiota* sp. 1. A. Habit $\times 1$; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. Caulocystidia. Scale bar = 10 μm

Smith & Hesler, section *Spumosae* Smith & Hesler, stirps *Scamba*. Within the stirps *Scamba*, there are quite a few north temperate species listed by Smith and Hesler (1968) that come close to our species but none of them agrees fully with it. *Pholiota gregariiformis* (Murrill) Smith & Hesler, which seems to be the closest, has similar microscopic features including the size and shape of spores but differs in having pileal surface that is glabrous except for velar remnants on the margin, downwardly tapering stipe, thinner-walled spores and growth on soil. Size and shape of spores are very similar in the present collections and in *P. scamba* (Fries: Fries) Moser but the latter species has silky-fibrillose pileal surface, fragrant odour, thinner-walled basidiospores ($< 0.25 \mu\text{m}$) and growth on conifer logs and debris. *Pholiota pulchella* Smith & Hesler is similar in several characters including the thickness of spore wall, but has slightly shorter and broader basidiospores, cystidia with acute apex, olive to green tones in all parts of the basidiomata and association with conifer debris and humus. In several macro- and microscopic features it is similar to *P. peleae* Horak & Desjardin described from the Hawaiian Islands (Horak, Desjardin & Hemmes, 1996). *Pholiota peleae*, however, differs in the following features: obtusely umbonate pileus, stipe with numerous coarse white rhizomorphs, nongelatinized subhymenium, absence of caulocystidia, and growth on moss-covered branches of dicot trees and tree ferns.

Subfamily **STROPHARIOIDEAE** (Singer) Singer
in Lilloa 22:497 (1951).

Spore-print lilaceous black to dark fuscous brown; spore-wall deeply pigmented; basidiomata sometimes bluing on bruising. Type genus: *Stropharia* (Fries) Quélet

Stropharia (Fries) Quélet
in Champ. Jura Vosges 1:110 (1872).

Basidiomata small to large. Pileus convex, moist to strongly glutinous, often brightly coloured. Lamellae adnate or adnexed, initially whitish, olive brownish or pale greyish becoming darker. Stipe central, viscid or not. Partial veil membranous-annulate to cortinoid or fugacious. Spore-print purplish brown or violaceous grey. Spores medium-sized to

large, ellipsoid to hexagonal, smooth, with a truncate apical germ-pore. Lamella-edge usually sterile with crowded cheilocystidia. Chrysocystidia present, rarely absent. Hymenophoral trama regular to subregular. Pileipellis a repent cutis or an ixocutis; without a subcellular hypodermium. Terrestrial, humicolous or coprophilous. Worldwide in distribution. Type species: *Stropharia aeruginosa* (Curtis ex Fries) Quélet

Key to the species

1. Pileus with a thick layer of gluten; annulus fugacious; spores ovo-ellipsoid, limoniform or subhexagonal in face-view *S. bicolor*
1. Pileus subviscid; annulus thick, fleshy, strongly striate; spores ovo-ellipsoid in face-view *S. rugosoannulata*

Stropharia bicolor Pegler
in Kew Bull. Addl. Ser. 6:463 (1977).

Fig. 22 A-E; Plate 8 A

Pileus 25–60 mm diam., conico-convex, hemispherical or convex, sometimes with an obtuse umbo; surface reddish brown (8E6, 8E7) to dark brown or liver brown (8F6) at the top, fading to brownish orange (6C5, 6C6) or brown (6D6) towards margin, smooth, copiously viscid, frequently with a thick layer of gluten; margin decurved; becoming almost plane, entire, becoming fissile, with white velar remnants along the rim. Context off-white. Lamellae adnate, brownish grey (7E2, 6D2), greyish brown (7E3, 6E3), close, up to 8 mm wide, with lamellulae of different lengths; edge whitish, finely tuberculate-punctate under a lens. Stipe 30–100 x 3–8 mm, central, terete, tapering apically, hollow; surface concolorous with the pileus or greyish orange (6B4) to brownish orange (7C5), sometimes pale orange (5A3) towards apex, glabrous, viscid. Odour not distinctive. Spore-print dark brown (8F5 to 9F5).

Spores 10.5–14.5 x 7.5–10 x 6.5–8.5 ($12.16 \pm 1.10 \times 9.02 \pm 0.81 \times 7.48 \pm 0.51$) μm , $Q=1.25\text{--}1.48$, $Q_m=1.35$, lenticular, ovo-ellipsoid to limoniform, or subhexagonal in face-view, ellipsoid in side-view, violet-brown, smooth, thick-walled, apically truncated by a conspicuous germ-pore. Basidia 22.5–35 x 9–12.5 μm , mostly cylindrical with a median

constriction, occasionally clavate, 4-spored; sterigmata up to 4.5 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 21.5–47.5 x 4.5–10.5 μm , narrowly cylindrical with a clavate to subcapitate apex, thin-walled, hyaline, with some contents. Chrysocystidia 25–50 x 8–13 μm , clavate with a mucronate apex, sometimes the protuberance at the apex furcate or rarely with two such protuberances, thin-walled, containing brownish yellow pigment. Hymenophoral trama regular; hyphae 2.5–15 μm wide, thin-walled, hyaline. Pileipellis an ixocutis; hyphae 2–4 μm wide, loosely arranged, thin-walled, embedded in a gelatinous matrix, overlying a conspicuous hypodermium of 2–7.5 μm wide hyphae, thin-walled, encrusted with an yellowish brown pigment. Stipe trama composed of 2–17.5 μm wide hyphae, thin-walled, hyaline to light yellow. Stipitipellis an ixocutis; with 2–4.5 μm broad, loosely arranged hyphae, embedded in a gelatinous matrix overlying a hypodermium of 2–6.5 μm broad hyphae, thin-walled, encrusted with an yellowish brown pigment. Clamp-connexions present on all hyphae.

On elephant dung, in groups or scattered, August.

Specimens examined: India, Kerala State, Idukki District, Munnar: 29 August 1997, A. Thomas T152; Palakkad District, Nelliampathy: 29 August 1999, A. Thomas T152b; 30 August 1999, A. Thomas T152c.

Stropharia bicolor was described by Pegler (1977) from East Africa where also it is constantly associated with elephant dung. The very thick glutinous covering over both the pileus and stipe is a characteristic feature of this species. The Kerala collections, although agreeing with this species in almost all characters, exhibited some deviations. Pegler (1977) noted a greyish green colour on the pileal surface when fresh which later changed to yellowish brown. Such a greyish green colour was not observed in the Kerala collections. Also, an annulus, which is said to be cortinoid and evanescent in *S. bicolor*, was not observed in the present collections.

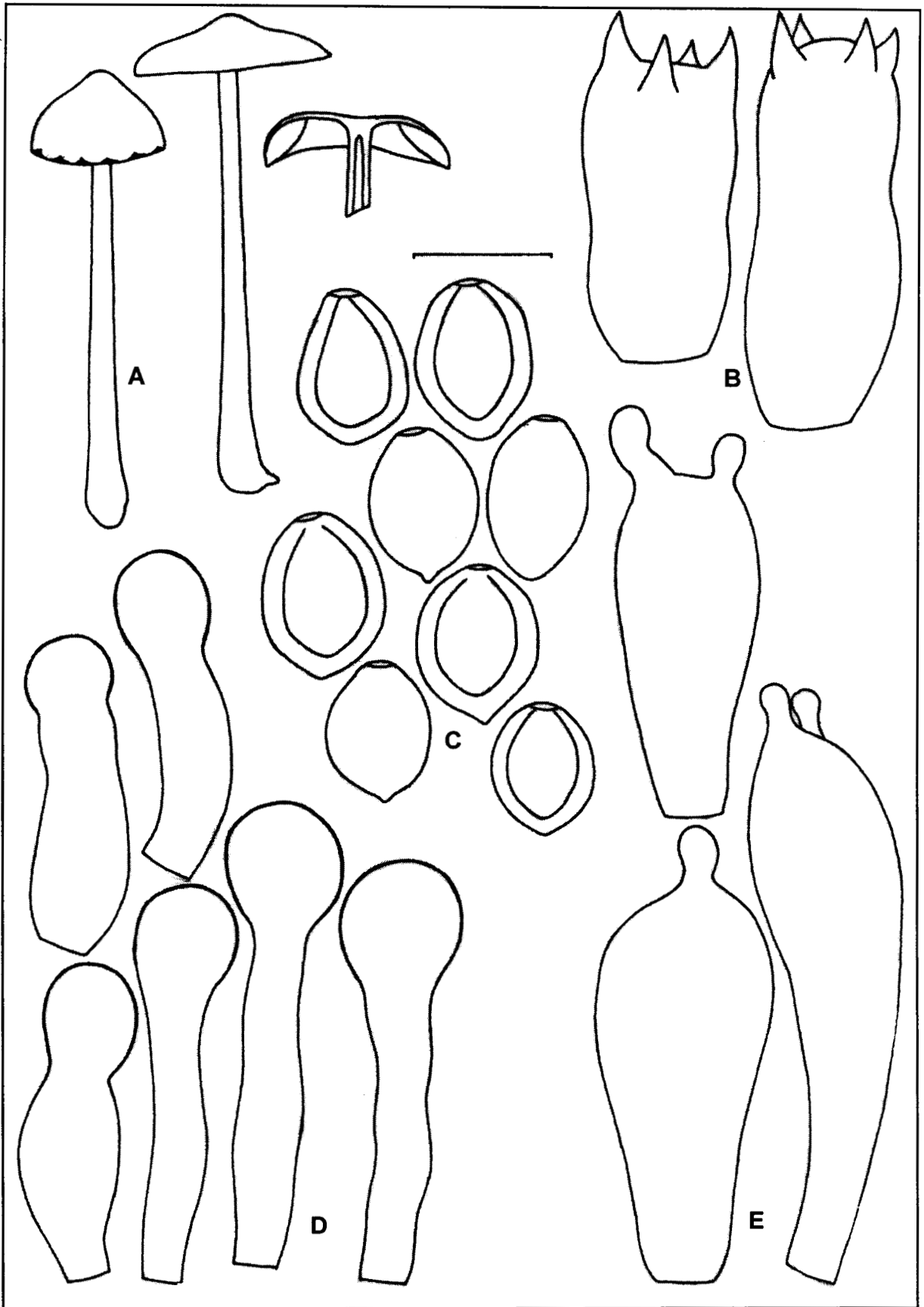


Fig. 22. *Stropharia bicolor* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Chrysocystidia. Scale bar = 10 μ m

Stropharia rugosoannulata Farlow ex Murrill
in *Mycologia* 14:139 (1922).

Fig. 23 A-F; Plate 8 B

Stropharia ferrii Bresadola in *Riv. de Sci. Naturali Nat. Milano* 19:17 (1928).

Naematoloma ferrii (Bresadola) Singer in *Lilloa* 22 (1949):503 (1951).

Basidiomata medium-sized to large. Pileus 35–110 cm diam., subglobose or convex, becoming appanate; surface reddish brown (8E6, 9F6) when young, turning to greyish orange (6B6) or brownish orange (7C5) at disc and orange white (6A2) or greyish orange (6B3) towards margin when mature, smooth or sometimes finely appressed squamulose, dull, subviscid when wet, becoming shiny when dry; margin incurved initially, later becoming straight, entire, becoming fissile, frequently appendiculate. Context up to 7 mm thick at the centre, whitish. Lamellae adnate, becoming slightly adnexed, brownish grey (8C2, 9C2) turning to brownish grey (10E2) or dull violet (15E3), crowded, up to 7 mm wide, with lamellulae of different lengths; edge whitish, entire to finely eroded. Stipe 65–125 x 10–35 mm, central, terete, attenuated towards apex, with a subbulbous base, solid; surface white or orange white (5A2), glabrous, sometimes longitudinally striate, annulate; annulus superior, thick, persistent, concolorous with the stipe surface, deeply sulcate above, smooth below, with triangular segments at margin. Odour not distinctive. Spore-print violet-brown (10F4).

Spores 10–14.5 x 7–9.5 x 6.5–8.5 ($12.08 \pm 0.95 \times 8.28 \pm 0.62 \times 7.45 \pm 0.67$) μm , $Q=1.38$ – 1.56 , $Q_m=1.46$, ovo-ellipsoid slightly lenticular, violaceous brown, smooth, thick-walled, apically truncated by a germ-pore. Basidia 22.5–35 x 8–12.5 μm , clavate, 4-spored; sterigmata up to 4 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 17.5–49 x 7.5–16.5 μm , clavate or ventricose-fusoid, mostly with a mucronate or rostrate apex, rarely capitate or subcapitate, thin-walled, hyaline. Pleurocystidia (chrysocystidia ?) similar to cheilocystidia in size and shape, containing a hyaline amorphous inclusion, not yellowing in alkali. Hymenophoral trama regular; hyphae 2–10 μm , thin-walled, hyaline. Pileal trama interwoven; hyphae 2–15 μm , thin-walled, hyaline. Pileipellis a cutis, frequently disrupted by semi-erect to erect bundles of loosely arranged, branched hyphae; cells 31.5–155 x 6.5–17.5 μm , cylindrical to fusoid, thin-walled, with violaceous brown plasmatic pigment. Stipe

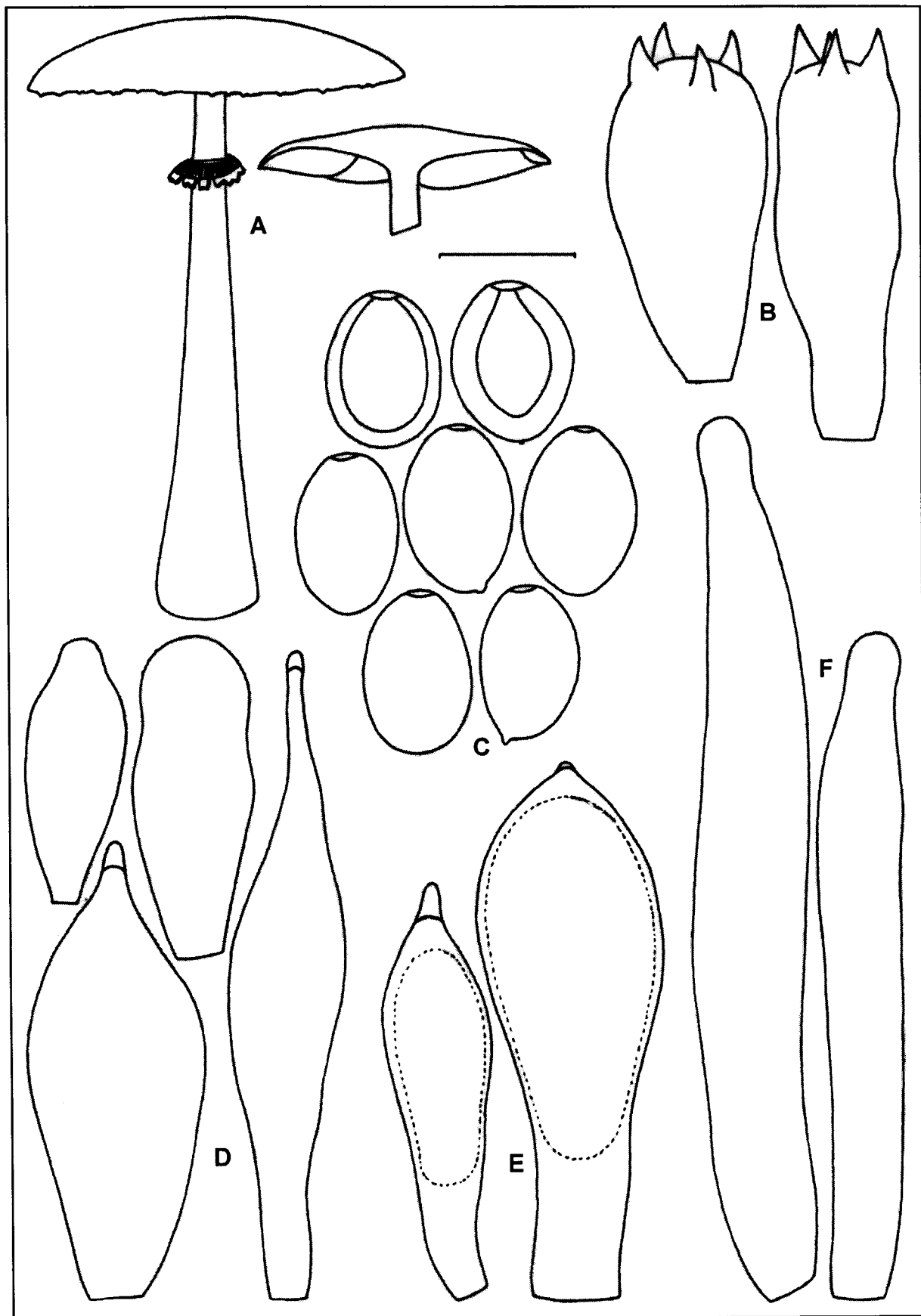


Fig. 23. *Stropharia rugosoannulata* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. End-cells of pileipellis. Scale bar = 10 μ m

trama composed of 2.5–14 μm wide hyphae, filamentous, thin-walled, hyaline. Stipitipellis a repent cutis towards the base; hyphae 2.5–10 μm wide, thin-walled, disrupted to form semi-erect to erect bundles of loosely arranged branched hyphae at the tip of the stipe, thin-walled, with light violaceous brown plasmatic pigment. Clamp-connexions present on all hyphae.

On elephant dung, solitary to scattered, June–August.

Specimens examined: India, Kerala State, Wayanad District, Muthanga: 17 June 1997, A. Thomas T75; 25 June 1997, A. Thomas T75b; 4 July 1997, A. Thomas T75c; 21 July 1999, A. Thomas T75e; 25 July 1999, A. Thomas T75f; Palakkad District, Nelliampathy: 15 August 1997, A. Thomas T75d.

The present collections agree remarkably closely with previously published descriptions of *Stropharia rugosoannulata* (e.g., Watling and Gregory, 1987). Macroscopically the Kerala collections are indistinguishable from those illustrated by Imazeki *et al.* (1988) from Japan. To this date, however, *S. rugosoannulata* was known only from temperate localities growing on rotting straw, mulch, etc. Remarkably, all the present collections were found growing on elephant dung. *Stropharia bicolor* Pegler, an East African species, is known only from elephant dung, but that species has very thick glutinous covering over both pileus and stipe and a cortinoid, fugacious annulus (Pegler, 1977).

Hypholoma (Fries) Kummer
in Fuhr. Pilzk.:21 (1871).

Agaricus Fries tribe *Hypholoma* Fries in Syst. Mycol. 1:11 (1821).

Naematoloma P. Karsten in Medd. Soc. Fauna Fl. fenn. 5:61 (1879).

Basidiomata small to medium-sized. Pileus convex, becoming plane, brightly coloured, often with yellow, olive or orange colours, non-hygrophanous; margin often appendiculate. Lamellae adnexed, adnate or with a decurrent tooth, greenish when young, becoming darker

with maturity. Stipe central, hollow, often caespitose. Partial veil present or absent, silky fibrillose or cortinate, evanescent, never truly annulate. Spore-print violaceous to fuscous brown. Spores small to large, ellipsoid, smooth, thick-walled, with a germ-pore which often truncates the apex. Lamella-edge sterile with cheilocystidia. Chrysocystidia present, clavate-mucronate containing refringent contents. Hymenophoral trama regular. Pileipellis a cutis composed of narrow repent hyphae, subtended by a subcellular hypodermium. Lignicolous or humicolous. Worldwide in distribution. Type species: *Hypholoma fasciculare* (Hudson ex Fries) Kummer

Only a single species of *Hypholoma* was recorded from Kerala during this study.

Hypholoma subviride (Berkeley & Curtis) Dennis
in Kew Bull. 15:134 (1961).

Fig. 24 A-E; Plate 8 C

Agaricus subviridis Berkeley & Curtis in Journ. Linn. Soc., Bot. 10:292 (1869).

Agaricus janus Berkeley & Curtis in Journ. Linn. Soc., Bot. 11:541 (1871).

Flammula janus (Berkeley & Curtis) Saccardo in Syll. Fung. 5:821 (1887).

Psilocybe subviridis (Berkeley & Curtis) Saccardo, *op. cit.*:1051 (1887).

Hypholoma papillatum Patouillard in Bull. Soc. Mycol. Fries 14:54 (1898).

Flammula aureoviridis Patouillard in Duss, Enum. Meth. Champ. Guad. Mart.:265 (1903).

Flammula olivacea Patouillard, *op. cit.*:265 (1903).

Gymnopilus olivaceus (Patouillard) Murrill in Mycologia 5:18 (1913).

Gymnopilus aureoviridis (Patouillard) Murrill, *op. cit.*:19 (1913).

Hypholoma flavovirens Murrill in Mycologia 10:68 (1918).

Hypholoma janum (Berkeley & Curtis) Petch in Ann. Roy. Bot. Grad., Peradeniya 9:125 (1924).

Pholiota aggregata Beeli in Bull Soc, Bot. Belg. 61:85, t. 4/23a-b (1928).

Nematoloma subviride (Berkeley & Curtis) A. H. Smith in Mycologia 43:519 (1951).

Pileus 5-30 mm diam., conico-convex, turning convex to plane with an acute or obtuse umbo, which sometimes is indistinct; surface light yellow (4A4), reddish yellow (4A6) or light orange (5A4, 5A5) at the center, mostly fading towards margin to pastel yellow (3A4) to pale yellow (3A3, 4A3), slightly browning with age, smooth, glabrous, moist; margin

decurved to plane, initially appendiculate, becoming eroded to fissile. Context up to 2 mm wide at the centre, yellowish. Lamellae adnate, sometimes almost subdecurrent or with a decurrent tooth, light yellow (4A4), turning brownish orange (6C5), to light brown (6D5) or brown (6E5), subcrowded, up to 3 mm wide, with lamellulae of different lengths; edge pale, entire to serrate under a lens. Stipe 7–40 x 1–3.5 mm, central, terete to slightly compressed, almost equal, fistulose to hollow; surface reddish yellow (4A6) to light yellow (3A4, 4A4, 4A5), glabrous, rarely with small, evanescent annular remnants; base sometimes slightly broad, inserted in to the decaying wood. Odour not distinctive. Taste bitter. Spore-print greyish brown (7E3) to brownish grey (8E2).

Spores 6–8.5 x 4–5 x 3.5–4.5 ($6.97 \pm 0.68 \times 4.38 \pm 0.38 \times 3.97 \pm 0.39$) μm , $Q=1.33$ – 1.85 , $Q_m=1.59$, ellipsoid, smooth, brownish, slightly thick-walled, apically truncated by a broad germ-pore. Basidia 15–25 x 4.5–7 μm , clavate, to cylindrical, mostly with a median constriction, 4-spored; sterigmata up to 3 μm long. Lamella-edge heteromorphous with crowded cheliocystidia. Cheliocystidia 14–32.5 x 5.5–10 μm , mostly lageniform or utriform, occasionally clavate or flexuous, thin-walled, hyaline, sometimes slightly thick-walled, and with a yellowish brown pigment. Chrysocystidia occurring on edge and sides of the lamellae, 21.5–44.5 x 7.5–13.5 μm , clavate with a mucronate apex, scattered, containing a hyaline to yellowish brown amorphous inclusion. Hymenophoral trama regular; hyphae 2–25 μm wide, inflated, thin-walled, hyaline to pale yellowish brown. Pileal trama interwoven; hyphae 2–20 μm wide, thin-walled, hyaline to pale yellowish brown. Pileipellis a cutis; hyphae 2–10.5 μm wide, thin-walled, with an yellowish brown encrusting pigment, overlying a hypodermium of inflated cells, hyphae 4–33 μm wide, thin-walled, encrusted with yellowish brown pigment. Stipe trama composed of 1.5–18 μm wide hyphae, parallel, thin-walled, hyaline to pale yellowish brown. Stipitipellis a cutis; hyphae 2–10.5 μm wide, thin-walled, with a yellowish brown pigment. Clamp-connexions present in all parts of the basidioma.

On decaying wood, in small caespitose clusters or gregarious, June–November.

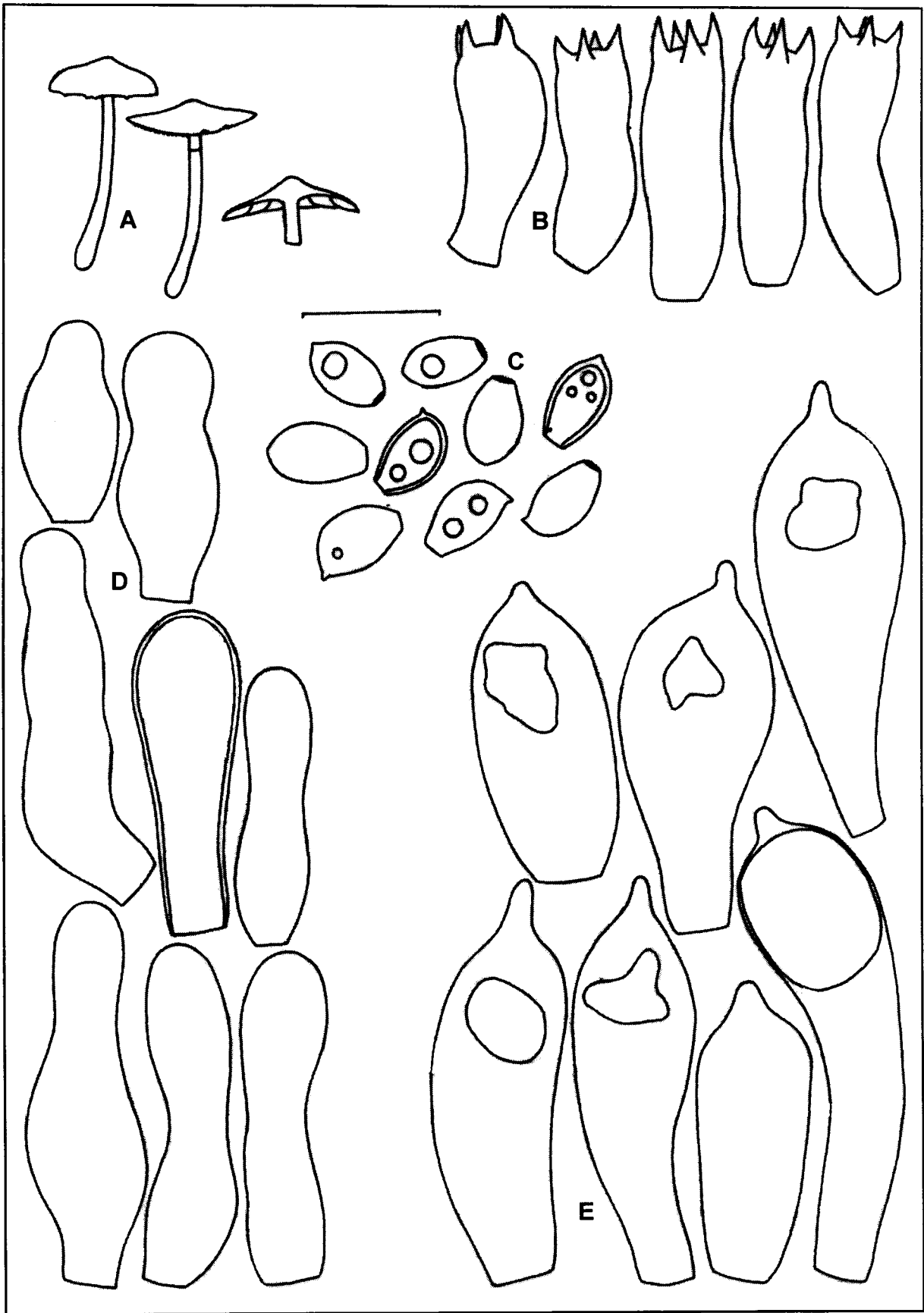


Fig. 24. *Hypholoma subviride* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Chrysocystidia. Scale bar = 10 μ m

Specimens examined: India, Kerala State, Ernakulam District, Boothathankettu: 21 June 1997, A. Thomas T80; Palakkad District, Nelliampathy: 14 August 1997, A. Thomas T80b; 15 August 1997, A. Thomas T80c; Wayanad District, Ponkuzhy: 19 August 1997, A. Thomas T80d; 20 November 1997, A. Thomas T80h; Muthanga: 30 June 1998, A. Thomas T80f; 25 July 1999, A. Thomas T80i; Idukki District, Mattupetty: 29 August 1997, A. Thomas T80e; Pampadumpara: 7 November 1997, A. Thomas T80g.

The present collections exactly match with *Hypholoma sbviride* in all characters. The temperate species *H. fasciculare* (Hudson ex Fries) Kummer is extremely close differing only in the comparatively robust habit.

Psilocybe (Fries) Kummer
in Fuhr. Pilzk.:71 (1871).

Deconica (W. G. Smith) Karsten in Bidr. Kann. Finl. Nat. Folk 32:XXVI (1879).

Pholiotella Spegazzini in Bol. Acad. Cienc. Cordoba 11:412 (1889).

Delitescor Earle in Bull. New York Bot. Gard. 5:434 (1909).

Basidiomata small to medium-sized. Pileus subglobose, convex, conical or conico-companulate, often umbonate or papillate, viscid to dry, hygrophorous or not. Context thin, often becoming blue on exposure or bruising. Lamellae adnexed, adnate or with decurrent tooth. Stipe typically slender, central, hollow, usually rigid and brittle, glabrous or with floccose covering, annulus present or absent. Spore-print violaceous brown to fuscous brown. Spores small to large, smooth, with a truncate apical germ-pore, rhomboid, hexagonal, ovoid, ellipsoid or asymmetrical, often lenticular. Lamella-edge sterile with crowded cheilocystidia. Pleurocystidia present or absent. Chrysocystidia present in one group. Hymenophoral trama regular to subregular. Pileipellis a cutis or an ixocutis. Hypodermium not subcellular. Clamp-connexions present on all hyphae. Terrestrial, lignicolous or coprophilous. Worldwide in distribution. Type species: *Psilocybe montana* (Persoon ex Fries) Kummer

Key to the species

1. Chrysocystidia present *P. alnetorum*
1. Chrysocystidia absent 2
2. Spores rhomboid, subrhomboid, limoniform or ovo-ellipsoid in face-view 3
2. Spores subhexagonal in face-view 8
3. Spores always ovo-ellipsoid in face-view *P. pseudoaztecorum*
3. Spores limoniform or subrhomboid in face-view 4
4. Basidiomata on elephant dung; pileus subviscid *P. subaeruginascens*
4. Basidiomata on soil or plant debris; pileus not viscid 5
5. Stipe more or less radicating; annulus absent; spores sometimes ovo-ellipsoid
in face-view..... *Psilocybe* sp. 1
5. Stipe never radicating; annulus always present 6
6. Pileus not sticky, with a very prominent acuminate umbo; caulocystidia absent
..... *Psilocybe* sp. 2
6. Pileus slightly sticky, with a small, acute umbo; caulocystidia present
..... 7
7. Basidiomata coprophilous; lamellae adnate to subdecurrent; spores 7–9.5 μm long,
distinctly rhomboid *Psilocybe* sp. 3
7. Basidiomata terricolous or lignicolous; lamellae adnexed; spores 8–11 μm long,
subrhomboid in face view *Psilocybe* sp. 4
8. Basidiomata staining blue *P. cubensis*
8. Basidiomata not staining blue 9
9. Annulus present; spores sometimes limoniform in face-view .. *P. pseudobullacea*
9. Annulus absent; spores always subhexagonal in face-view 10
10. Pleurocystidia present; spores 10.5–15.5 μm long *P. coprophila*
10. Pleurocystidia absent; spores 12–17 μm long *P. argentina*

Psilocybe alnetorum (Singer) Singer
in *Mycologia* 51:583 (1959).

Fig. 25 A-G; Plate 9 A

Deconica alnetorum Singer in *Lilloa* 25:332 (1951).

Basidiomata small. Pileus 5–30 mm diam., conico-convex to plano-convex to plane, with a conic to papillate umbo; surface brown (7E7) or reddish brown (8E6, 8E7) or dark brown (8F7) with often darker (8E8, 8F8) disc, hygrophanous and becoming brownish orange (6C5), light orange (5A4, 6A4) or orange white (5A2, 6A2), dull, smooth, glabrous, faintly translucent-striate towards margin when moist, sometimes faintly sulcate-striate up to the middle; margin decurved to plane, appendiculate, initially entire, becoming fissile. Context up to 2 mm thick, white with brown tint. Lamellae adnate to slightly subdecurrent, light brown (7D6) to brown (6E7, 7E7), close, up to 3.5 mm wide, with lamellulae of 3–6 lengths; edge pale, finely torn under a lens. Stipe 10–45 x 1–4.5 mm, central, terete, equal or slightly tapering apically, solid turning to hollow; surface brown (6E7), greyish orange (6B4), pale orange (5A3, 6A3) or orange white (6A2), glabrescent at base, pruinose towards apex; base not insititious. Odour not distinctive, bitter in taste. Spore-print dark brown (8F5).

Spores 6.5–7.5 x 4–4.5 x 3.5–4 ($6.80 \pm 0.47 \times 4.25 \pm 0.29 \times 3.83 \pm 0.77$) μm , $Q=1.42$ – 1.84 , $Q_m=1.61$, slightly lenticular, ovoid to subrhomboid in face-view, ellipsoid in side-view, olive brown, thick-walled, apically truncated by a broad germ-pore. Basidia 17–24 x 5–7 μm , clavate to cylindrical, mostly with a median constriction, 4-spored; sterigmata up to 4 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 11.5–30 x 4–8.5 μm , mostly narrowly utriform, occasionally clavate or fusoid, thin-walled, hyaline. Pleurocystidia 12–27.5 x 3–6.5 μm , similar to cheilocystidia in shape, thin-walled, hyaline. Chrysocystidia 19–37.5 x 7–12 μm , clavate with mucronate apex, thin-walled, containing colourless amorphous inclusions that does not turn yellowish in alkali, frequent on both the edge and sides of the lamellae. Hymenophoral trama regular; hyphae 2–10 μm wide, with a thin, brown encrusted wall. Pileal trama interwoven; hyphae 2.5–14 μm wide, with a thin, brown, encrusted wall. Pileipellis an undifferentiated cutis; hyphae 2–9 μm wide, with a thin, brown encrusted wall. Stipe trama composed of 2–15 μm wide hyphae, with a thin, brownish

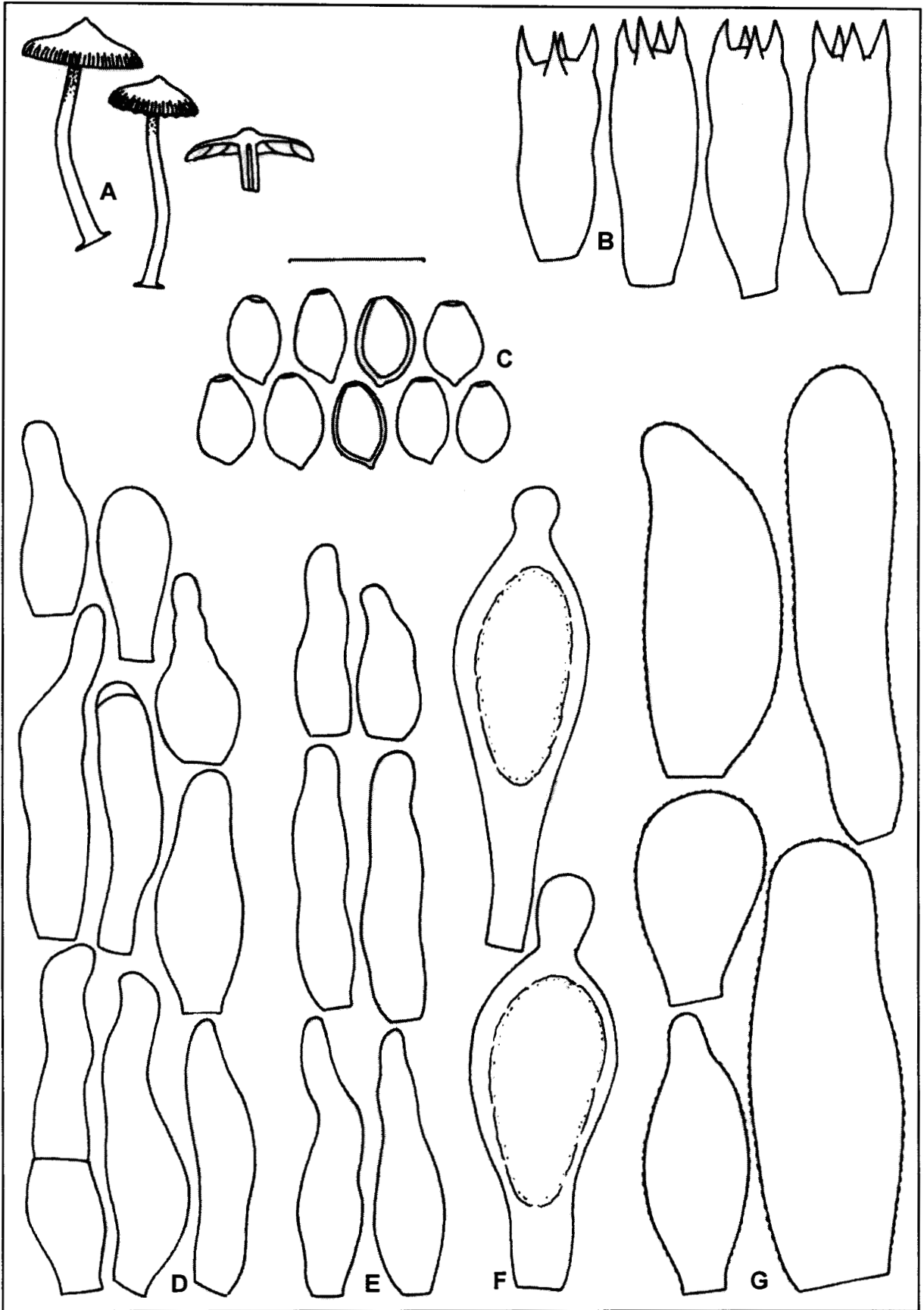


Fig. 25. *Psilocybe alnetorum* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. Chrysocystidia; G. Caulocystidia. Scale bar = 10 μ m

encrusted wall. Stipitipellis a cutis; hyphae 2–8 μm wide, with a thin brownish encrusted wall. Caulocystidia 17–65 x 7–19.5 μm , mostly clavate, sometimes oblong, ovoid, utriform or clavato-mucronate, seen towards the upper part of the stipe, in clusters or scattered as recurved hyphal tips, thin-walled, brown encrusted. Clamp-connexions present in all the tissues.

On decaying bamboo leaves, gregarious to scattered, August-October.

Specimens examined: India, Kerala State, Malappuram District, Calicut University Campus: 25 August 1997, A. Thomas T141; 26 August 1997, A. Thomas T141b; 8 September 1997, A. Thomas T141c; 24 September 1997, A. Thomas T141d; 27 September 1997, A. Thomas T141e; 15 August 1998, A. Thomas T141f; 29 October 1999, A. Thomas T141g.

The dark brown spore-print, the spores that are apically truncated by a broad germ-pore and the chrysocystidia together indicate that this species belongs in the family Strophariaceae and the subfamily Stropharioideae. Following Singer (1986), one can easily place it in section *Chrysocystidiatae* Singer of the genus *Psilocybe*. The hygrophanous pileus without a cellular hypodermium indicates that it is not a *Hypholoma* (= *Nematoloma*) and the non-viscid, exannulate basidiomata rule out *Stropharia*. According to Guzmán (1980, 1983) however, species with chrysocystidia do not belong to *Psilocybe* and he transferred *Psilocybe* species with chrysocystidia to *Hypholoma*. The author prefers to follow Singer (1986).

Except for the characteristic habitat, the Kerala collections are indistinguishable from *Psilocybe alnetorum* described from Argentina. The South American collections grow on dead and fallen branches of *Alnus jorullensis*. The Kerala collections were always found growing on decaying bamboo leaves.

Psilocybe pseudoaztecorum Natarajan & Raman
in *Mycologia* 77(1):158 (1985).

Fig. 26 A-F; Plate 9 B

Psilocybe aztecorum var. *aztecorum sensu* Natarajan & Raman in *Bibliotheca Mycol.* 89:106 (1983); non *Psilocybe aztecorum* var. *aztecorum* R. Heim emend Guzmán.

Pileus 20–60 mm diam., initially conico-convex, becoming convex or plano-convex, sometimes with a small obtuse umbo; surface orange (5A6), light orange (5A4, 5A5) or greyish orange (5B4) at the top, pale yellow (4A3) or pale orange (5A3) or off-white towards margin, hygrophanous and becoming whitish, glabrous, smooth, subviscid when wet, shining; margin slightly incurved when young, turning to decurved at maturity, entire, becoming fissile to eroded. Context up to 5 mm thick at the center, off-white. Lamellae adnate to sinuate, greyish brown (5E3-6F4), crowded to subcrowded, up to 6.5 mm wide, with lamellulae of 3–4 lengths; edge pale, entire. Stipe 30–145 x 2.5–7 mm, central, terete, equal or sometimes slightly attenuated towards apex, solid, turning fistulose; surface pale yellow (4A3) to orange white (5A2), pruinose towards apex, sometimes coated with white patches of velar squamules, rarely annulate; annulus superior, delicate, thin, soon vanishing. Basidiomata turning blue on bruising or aging. Odour not distinctive. Spore-print greyish brown (9F3).

Spores 12.5–17 x 9–11 x 7.5–10 (15.33±1.32 x 9.77±0.56 x 9.02±0.58) μm, Q=1.43–1.72, Qm=1.57, slightly lenticular, ovo-ellipsoid in face-view, ellipsoid in side-view, violet-brown, smooth, thick-walled, apically truncated by a conspicuous germ-pore. Basidia 27.5–36.5 x 9–12.5 μm, cylindrical to clavate, sometimes with a median constriction, 4-spored; sterigmata up to 4.5 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 19–34.5 x 5–11.5 μm, narrowly utriform to lageniform, frequently subcapitate, sometimes apex thick-walled, and containing some granular inclusions, hyaline. Pleurocystidia scattered, similar to cheilocystidia in size and shape. Hymenophoral trama regular; hyphae 2–11.5 μm, thin-walled, hyaline. Pileal trama interwoven; hyphae 2–16.5 μm, thin-walled, hyaline. Pileipellis an ixocutis of 1.5–4 μm wide hyphae, thin-walled, hyaline, embedded in a gelatinous matrix, overlying a hypodermium of 2–8 μm wide hyphae, thin-walled, hyaline. Stipe trama composed of 2.5–16.5 μm wide hyphae, thin-walled, hyaline. Stipitipellis a cutis; hyphae 2–

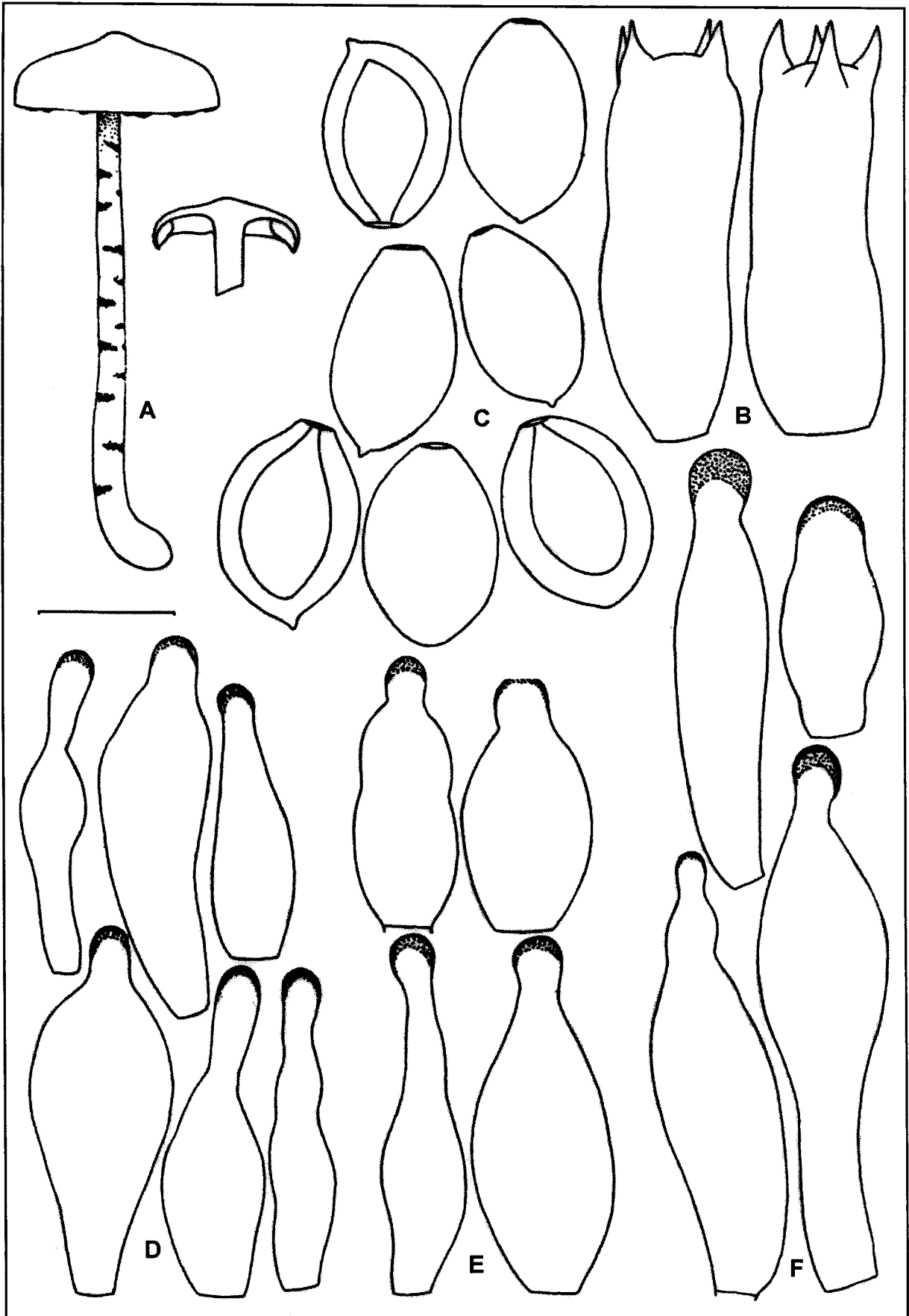


Fig. 26. *Psilocybe pseudoaztecorum* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. Caulocystidia. Scale bar = 10 μ m

10 µm, thin-walled, hyaline. Caulocystidia 14–57.5 x 4.5–10.5 µm, cylindrical, to clavate or fusoid with a capitate apex, at times apex thick-walled and with some granular contents, clustered towards the uppermost part of the stipe, sometimes originate as recurved peripheral hyphal tips, hyaline. Clamp-connexions present in all hyphae.

On the ground, amongst grass, scattered, August.

Specimens examined: India, Kerala State, Idukki District, Munnar: 29 August 1997, A. Thomas T156; 30 August 1997, A. Thomas T156c; 12 October 1999, A. Thomas T156d; Top Station: 30 August 1997, A. Thomas T 156b.

Natarajan and Raman (1983, 1985) reported *P. pseudoaztecorum* from the higher elevations (2100 - 2400 m) of southern India. Our collections of this species were also from higher elevations and they agree very closely with the description given by Natarajan and Raman (1983, 1985). The only differences observed in our collections are the absence of a cortina and the presence of caulocystidia. Our specimens rarely showed a well-developed superior annulus and white, floccose velar remnants beneath it. *Psilocybe natarajanii* Guzmán, another species known only from southern India, seems to be very close differing only in having smaller spores.

Psilocybe subaeruginascens Hohnel
in Sitzungsber. Kaiserl. Akad. Wissen. Wien 123(1):78 (1914).

Fig. 27 A-F; Plate 9 C

Pileus 5–17 mm diam., conic to conico-convex, mostly acutely umbonate; surface olive brown (4F3) to greyish brown (5F3) at the top, fading to olive brown (4D3) to greyish brown (5D3) towards margin, translucent-striate when moist, hygrophanous and becoming orange white (5A2), glabrous, sticky when wet; margin straight, entire to crenate. Context up to 3 mm thick at the centre, whitish. Lamellae adnate to adnato-adnexed, greyish brown (6E3, 7E3) to dark brown (8F4), subcrowded to close, up to 2.5 mm wide, with lamellulae of 3–4 lengths; edge pale, entire. Stipe 20–60 x 1.5–4 mm, central, terete, slightly tapering apically, fistulose; surface orange white (5A2) towards apex, light brown (6D4, 6D5) towards

base, smooth, faintly pruinose towards apex, glabrous towards base, annulate; annulus superior, fragile; base slightly swollen. Basidiomata turning blue on bruising or aging. Odour not distinctive. Spore-print dark brown (9F4).

Spores 8–11 x 6–8.5 x 5–7 ($9.50 \pm 0.87 \times 7.27 \pm 0.75 \times 6.30 \pm 0.71$) μm , $Q=1.19\text{--}1.50$, $Q_m=1.32$, slightly lenticular, limoniform to almost subrhomboid in face-view, ovo-ellipsoid in side-view, violet-brown, smooth, thick-walled, truncated by an apical germ-pore. Basidia 21.5–30 x 6.5–10 μm , clavate, cylindric, or with a median constriction, 4-spored, rarely 2-spored; sterigmata up to 4.5 μm long. Lamella-edge sterile with densely crowded cheilocystidia. Cheilocystidia 15–30 x 3–7.5 μm narrowly lageniform to lageniform, frequently with a flexuous apical part, thin-walled with a cap-like apical thickening, hyaline. Pleurocystidia scattered, similar to cheilocystidia in size and shape. Hymenophoral trama regular; hyphae 2.5–10.5 μm wide, thin-walled, with a yellow wall pigment. Pileal trama interwoven; hyphae 2–14.5 μm wide, thin-walled, with a yellow wall pigment. Pileipellis an ixocutis of 2–5.5 μm wide, thin-walled, hyaline, hyphae embedded in a gelatinous matrix, overlying a hypodermium of 2–8 μm broad, hyphae with a thin yellowish wall. Stipe trama composed of 2–12.5 μm wide, hyphae with a thin yellowish wall. Stipitipellis a cutis; hyphae 2–9 μm wide, with a thin, yellowish wall. Caulocystidia 15–41.5 x 3–8 μm , similar to cheilocystidia in shape, thin-walled, with a cap-like apical thickening, in clusters, or scattered as recurved peripheral hyphal tips. Clamp-connexions present in all tissues.

On elephant dung, gregarious to scattered, September–November.

Specimens examined: India, Kerala State, Calicut District, Vellarimala: 19 September 1997, A. Thomas T170; 20 September 1997, A. Thomas T170b; 8 November 1999, A. Thomas T170c.

Guzmán's (1995) key leads directly to *P. subaeruginascens* and our collections snugly fit into the description of this species given by Guzmán (1983). Guzmán (1983) mentioned about a hyaline, mucilaginous substance at the apex of cystidia. In our collections also we observed a refractile, cap-like formation at the tips of cystidia but

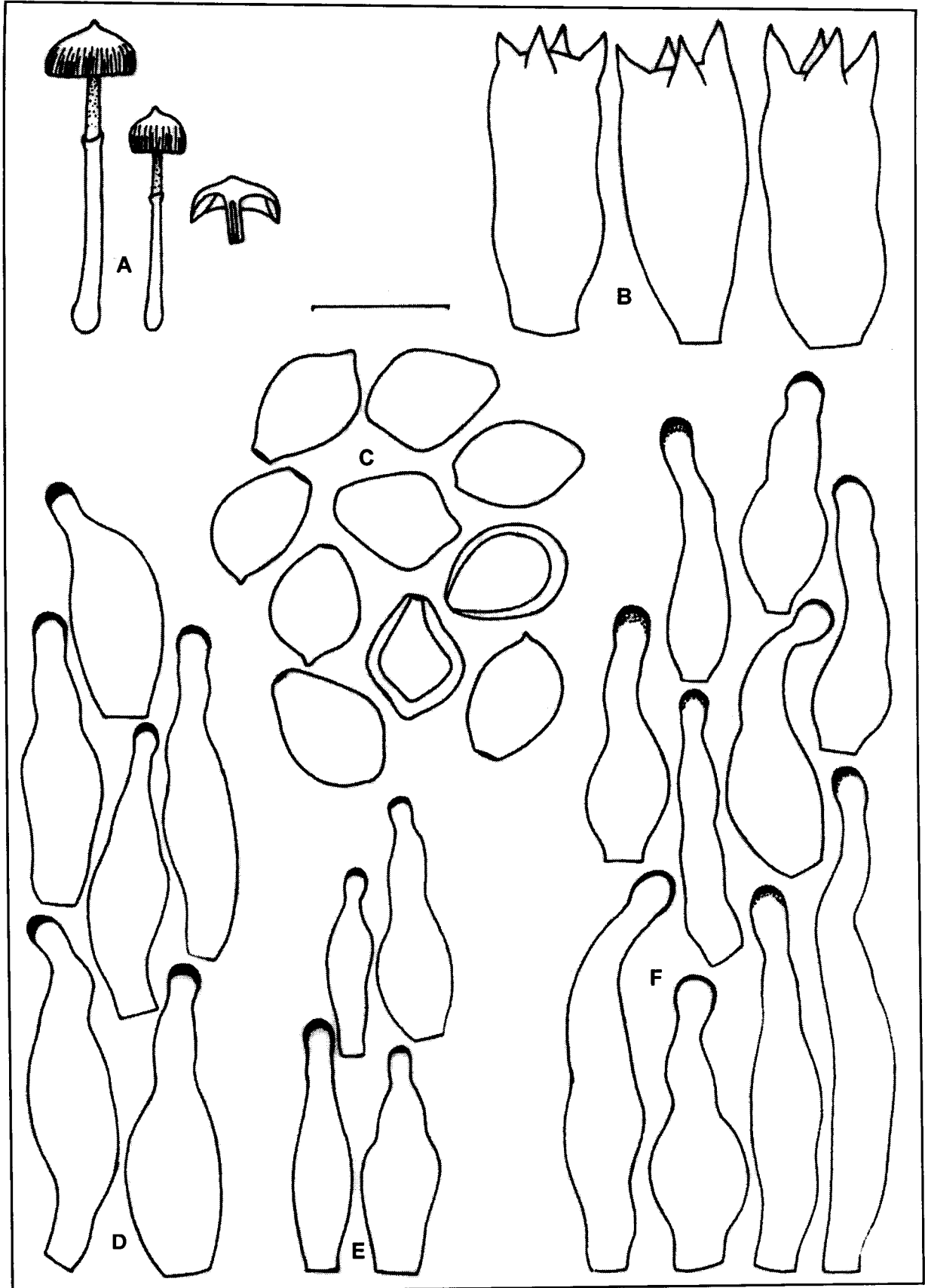


Fig. 27. *Psilocybe subaeruginascens* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. Caulocystidia. Scale bar = 10 μ m

to us they looked like wall-thickenings at the cystitidial apices. *Psilocybe aeruginomaculans* (Hohnel) Singer and Smith, once considered as conspecific with *P. subaeruginascens* (Guzmán, 1983), has no pleurocystidia and is lignicolous with a gelatinized pileipellis. *Psilocybe caeruleoannulata* Singer ex Guzmán, a South American species, differs in lacking pleurocystidia and in having a gelatinized pileipellis. *Psilocybe rostrata* (Petch) Pegler, a Sri Lankan species, is strikingly similar in external morphology but that species differs in lacking pleurocystidia and in having a gelatinized pileipellis and spores of different morphology.

***Psilocybe* sp. 1**

Fig. 28 A-F; Plate 10 A

Pileus 6–30 mm diam., subcomplanate to conico-convex, becoming convex, with a small umbo; surface golden brown (5D7) to light brown (6D7), unicolorous, sometimes with a tint of light orange (5A4) towards margin, hygrophanous and becoming pale orange (5A3), smooth, glabrous, moist, finely translucent striate towards margin when moist; margin decurved, entire when young, sometimes becoming wavy or eroded. Context up to 1.5 mm thick at the centre, light yellow (4A4) or light orange (5A4). Lamellae adnate, greyish brown (8E3, 9E3) or brownish grey (11D2), subcrowded to close, up to 5 mm wide, with lamellulae of 3 lengths; edge pale, entire. Stipe 30–90 x 2–5 mm, central, terete, almost equal, fistulose; surface pale yellow (4A3) towards upper part, greyish orange (5B3) or brownish orange (5C3, 6C4) towards base, finely and inconspicuously floccose especially towards base, without annulus; base frequently radiating with up to $\frac{3}{4}$ th of the stipe buried in soil. Odour not distinctive. Stipe and pileus slowly turning blue on bruise. Spore-print brown (7E4) to dark brown (7F4) or greyish brown (8E3).

Spores 7–9 x 5–6.5 x 4.5–6 ($8.02 \pm 0.54 \times 5.77 \pm 0.47 \times 5.33 \pm 0.34$) μm , $Q=1.3\text{--}1.5$, $Q_m=1.39$, slightly lenticular, ovo-ellipsoid to sub-rhomboid in face-view, ellipsoid in side-view, violet-brown, smooth, thick-walled, apically truncated by a germ-pore. Basidia 19–31.5 x 6.5–9 μm , almost cylindrical with a median constriction, 4-spored, rarely 2-spored;

sterigmata up to 4.5 μm long. Lamella edge sterile with crowded cheilocystidia. Cheilocystidia 10.5–25.5 x 3–8.5 μm , versiform: ventricose-fusoid, lageniform or utriform, frequently with irregular branches at the top, thin-walled, but with a distinct apical thickening, hyaline. Pleurocystidia 11.5–27 x 3–7.5 μm , ventricose-fusoid, lageniform or utriform, rarely branching, scattered, thin-walled, sometimes with apical thickening, hyaline. Hymenophoral trama subregular, often with scattered conducting elements having dark turquoise blue contents; hyphae 2–21.5 μm wide, thin-walled, hyaline. Pileal trama interwoven; hyphae 2–26.5 μm wide, inflated, pale brownish, thin-walled, without encrustations. Pileipellis a cutis; hyphae 1.5–7 μm wide, thin-walled, hyaline, overlying a distinct hypodermial band of brown encrusted tramal hyphae. Stipe trama composed of 2–20 μm wide, thin-walled, brownish hyphae. Stipitipellis a repent cutis; hyphae 1.5–7 μm wide, thin-walled, pale brown. Caulocystidia 10.5–40 x 3–11.5 μm , similar to cheilocystidia in shape, sometimes branched, occurring towards the upper part of the stipe, either in clusters or scattered, thin-walled but mostly with an apical thickening, hyaline. Clamp-connexions present on all hyphae.

On the ground, scattered, July–October.

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 21 July 1999, A. Thomas T319; 25 July 1999, A. Thomas T319b; 1 August 1999, A. Thomas T319c; 17 October 1999, A. Thomas T 319d; 28 October 1999, A. Thomas T 319e.

Guzmán's (1995) key leads straight to *Psilocybe herrerae* Guzmán but that species has much smaller spores and differently-shaped cheilo- and pleurocystidia. *Psilocybe wassoniorum* Guzmán & Pollock is strikingly similar to our collections in macroscopic features but absence of pleurocystidia and presence of smaller spores and differently shaped cheilocystidia make it quite distinct. *Psilocybe subtropicalis* Guzmán is similar to our collections in most of the macroscopic characters and some microscopic features, but that species has smaller spores and a subbulbous hollow stipe-base without a pseudorrhiza.

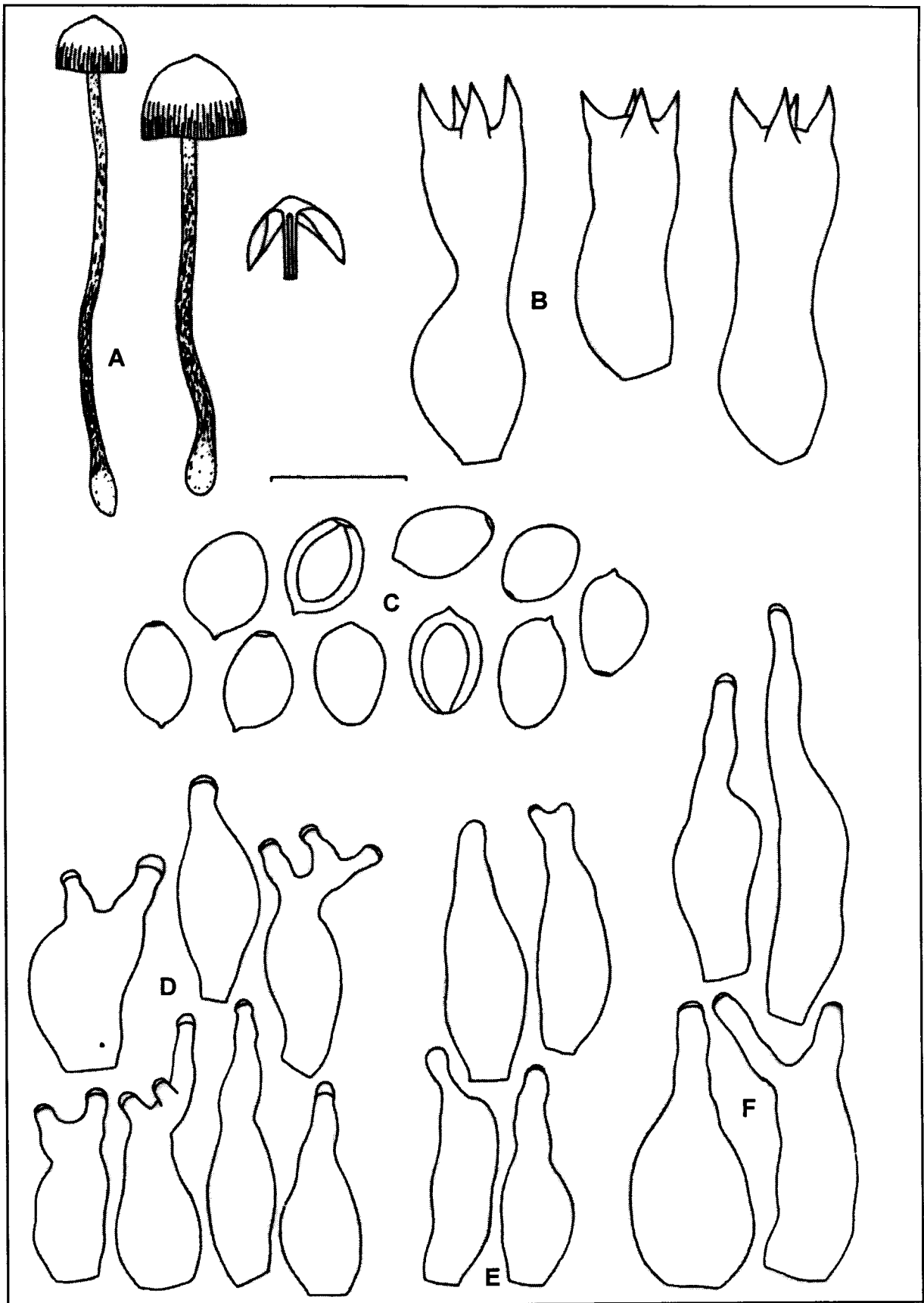


Fig. 28. *Psilocybe* sp. 1. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. Caulocystidia. Scale bar = 10 μ m

***Psilocybe* sp. 2**

Fig. 29 A-E; Plate 10 B

Basidiomata fleshy. Pileus 15–60 mm diam., companulate to conico-convex or convex, with a prominent acuminate umbo; surface greyish orange (6B3), smooth, glabrous, somewhat shining; margin straight, entire, sometimes fissile. Context white. Lamellae adnate to adnato-adnexed, light brown (6D4) to reddish brown (8E4), subcrowded to close, up to 6 mm wide, with lamellae of 4 lengths; edge whitish, entire to broadly wavy. Stipe 30–65 x 3–9 mm, central, terete, slightly tapering apically, solid, turning to fistulose; surface white to orange white (6A2), glabrous, annulate; annulus central. Stipe turns blue on aging or exposure. Odour not distinctive. Spore-print greyish brown (7F3).

Spores 9–11 x 7–9 x 5.5–7.5 (10.0 ± 0.64 x 7.93 ± 0.51 x 6.61 ± 0.49) μm , $Q=1.15$ – 1.36 , $Q_m=1.26$, lenticular, subrhomboid to limoniform in face view, ellipsoid in side view, violet-brown, smooth, thick-walled, apically truncated by a broad germ-pore. Basidia 22.5–35 x 7–10 μm , cylindric to clavate, 4-spored, rarely 2-spored; sterigmata up to 11 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 14–32.5 x 5.5–12.5 μm , ventricose-fusoid to somewhat utriform, thin-walled, with an apical thickening, hyaline. Pleurocystidia scattered, similar to cheilocystidia in size and shape. Hymenophoral trama regular; hyphae 2–13 μm wide, thin-walled, hyaline. Pileal trama interwoven; hyphae 2.5–14 μm , thin-walled, hyaline. Pileipellis a repent undifferentiated cutis; hyphae 2–8.5 μm wide, thin-walled, hyaline. Stipe trama composed of 2–15 μm wide, hyphae, thin-walled, hyaline. Stipitipellis a cutis; hyphae 2–7.5 μm wide, thin-walled, hyaline. Caulocystidia absent. Clamp-connexions present in all parts of the basidioma.

On the ground, amongst decaying bamboo leaves and other plant debris, gregarious to scattered, July.

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 17 July 1997, A. Thomas T110; 18 July 1997, A. Thomas T110b.

Guzmán's (1995) key leads directly to the section *Stuntzii* Guzmán where this species remains as a distinct taxon showing a few similarities with *Psilocybe aquamarina* (Pegler) Guzmán, but differs from that species in having broader spores, distinct occasional

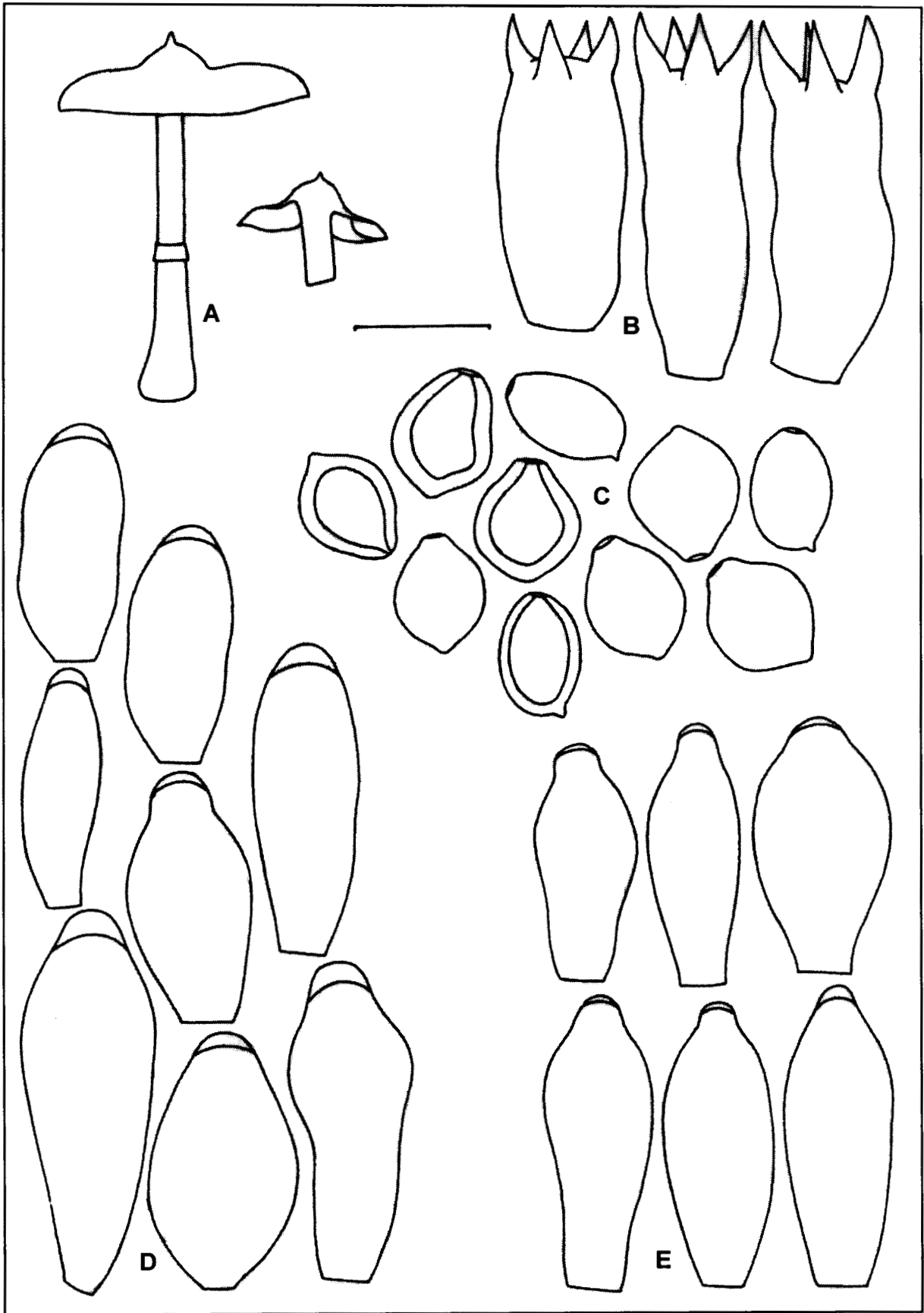


Fig. 29. *Psilocybe* sp. 2. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia. Scale bar = 10 μ m

pleurocystidia, and non-gelatinized lamella-edge and pileal surface. It also looks very similar to the specimen shown in the photograph of *P. argentipes* given in Fungi of Japan (Imazeki, Otani & Hongo, 1988), but very well differs in microscopic features.

***Psilocybe* sp. 3**

Fig. 30 A-E: Plate 10 C

Pileus 35–45 mm diam., convex to plano-convex with a small acute umbo, at times becoming depressed; surface yellowish grey (2D2, 2C3) towards disc, brownish orange (5C3) or brownish grey (5C2) towards margin, hygrophanous, glabrous, smooth, translucent striate towards margin when moist; margin decurved to plane, entire. Context up to 2.5 mm thick at the center, whitish. Lamellae adnate to faintly subdecurrent, greyish brown (8E3), close to subcrowded, up to 5 mm wide with lamellulae of different lengths; edge pale, entire. Stipe 45–55 x 7–8 mm, central, terete, attenuated towards apex, hollow, with a central or almost superior annulus; surface orange white (5A2), smooth. Pileus and stipe turning bluish with age or on drying. Odour not distinctive. Spore-print greyish brown (8E3).

Spores 7–9.5 x 6.5–8.5 x 4.5–6.5 ($8.48 \pm 0.72 \times 7.09 \pm 0.53 \times 5.52 \pm 0.43$) μm , $Q=1.03$ – 1.36 , $Q_m=1.19$, lenticular, rhomboid in face-view, ellipsoid in side-view, violet-brown, smooth, thick-walled, truncated by an apical germ-pore. Basidia 19–30 x 6.5–9.5 μm , clavate to cylindrical, 4-spored; sterigmata up to 6 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 9–29 x 4–13.5 μm , ventricose-fusoid, lageniform or utriform, thin-walled, sometimes slightly thickened at the apex, hyaline to pale yellow. Pleurocystidia absent. Hymenophoral trama regular; hyphae 2–20 μm wide, thin-walled, pale yellow. Pileal trama parallel-interwoven; hyphae 2–17 μm wide, thin-walled, hyaline to pale yellow. Pileipellis a repent cutis, hyphae 2–13 μm wide, thin-walled, hyaline. Stipe trama composed of 1.5–19 μm wide hyphae, thin-walled, hyaline to pale yellow. Stipitipellis a cutis; hyphae 1.5–10 μm wide, thin-walled, hyaline to pale yellow. Caulocystidia 14.5–36.5 x 7–14.5 μm , similar to cheilocystidia in shape, either in clusters or scattered as recurved hyphal tips, restricted towards the uppermost part of the stipe, thin-walled, sometimes slightly thickened at the apex, hyaline to pale yellow. Clamp-connexions present on all hyphae.

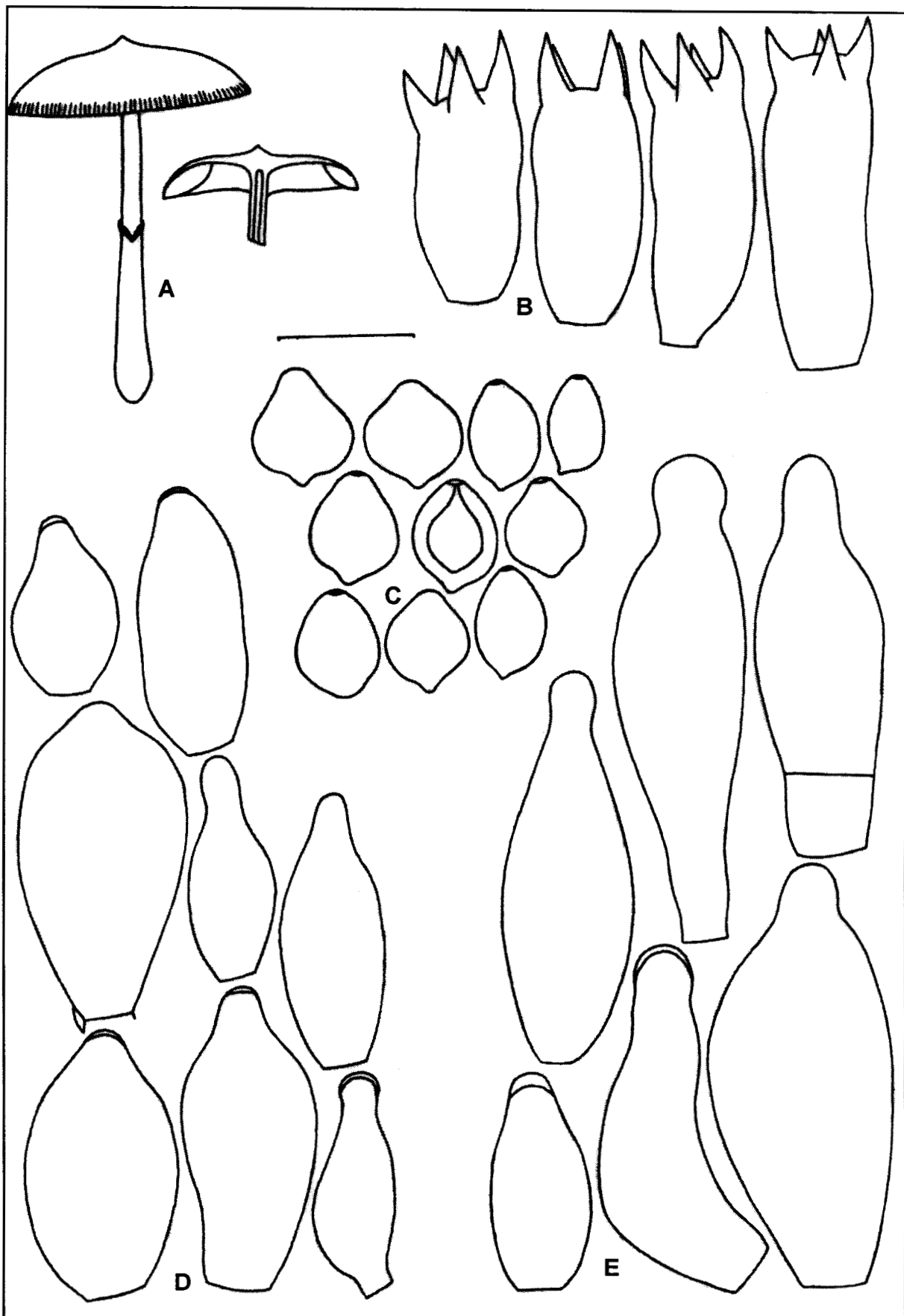


Fig. 30. *Psilocybe* sp. 3. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Caulocystidia. Scale bar = 10 μ m

On elephant dung, scattered, August.

Specimens examined: India, Kerala State, Palakkad District, Nelliampathy: 15 August 1997, A. Thomas T131.

This species is very close to *Psilocybe* sp. 4 and *Psilocybe* sp. 2 described elsewhere in this treatise and along with them it belongs to the section *Stuntzii*. *Psilocybe* sp. 4 differs in having terricolous to lignicolous basidiomata, adnexed lamellae and slightly bigger spores that are only subrhomboidal in face-view. *Psilocybe* sp. 2 differs in having a very prominent, acuminate umbo and in lacking caulocystidia.

***Psilocybe* sp. 4**

Fig. 31 A-F; Plate 11 A

Pileus 10–55 mm diam., convex, becoming applanate to slightly depressed, with a small acute umbo at the centre; surface initially brownish grey (5C2), brownish orange (5C3) or greyish brown (5D3), uniformly turning to greyish brown (6E3, 7E3, 7D3) with brownish grey umbo (5F2, 6F2), sometimes greyish yellow (4C3), greyish orange (5B4), brownish orange (5C5), or light brown (5D6) towards centre, pale yellow (4A3) or greyish yellow (4B3) towards margin with olive brownish grey (4F2) umbo, hygrophanous, smooth, glabrous, slightly sticky when moist, translucent-striate towards margin; margin decurved, becoming plane, entire, sometimes becoming eroded or fissile. Context up to 4 mm thick, concolorous with pileus surface. Lamellae adnexed to sinuate, initially greyish yellow (4B3), orange grey (5B2) or brownish orange (5C3), becoming greyish brown (6D3) to brown (6E4, 7E4), close, up to 7 mm wide, with lamellulae of three lengths; edge pale, entire. Stipe 20–80 x 2–10 mm, central, terete, fistulose to hollow; surface whitish, orange white (4A2) or greyish yellow (4B3), smooth, with a superior annulus; base enlarged, with hairy basal mycelium. Stipe and pileus turning blue on bruising or aging. Odour sharp and unpleasant when mature. Spore-print dark brown (8F4, 8F5).

Spores 8–11 x 6.5–8 x 5.5–6.5 ($9.47 \pm 0.85 \times 7.14 \pm 0.34 \times 5.80 \pm 0.33$) μm , $Q=1.15$ – 1.52 , $Q_m=1.31$, lenticular, subrhomboidal in face-view, ellipsoid in side-view, violet-brown, smooth, thick-walled, apically truncated by a germ-pore. Basidia 25–34 x 7–9.5 μm , cylindric

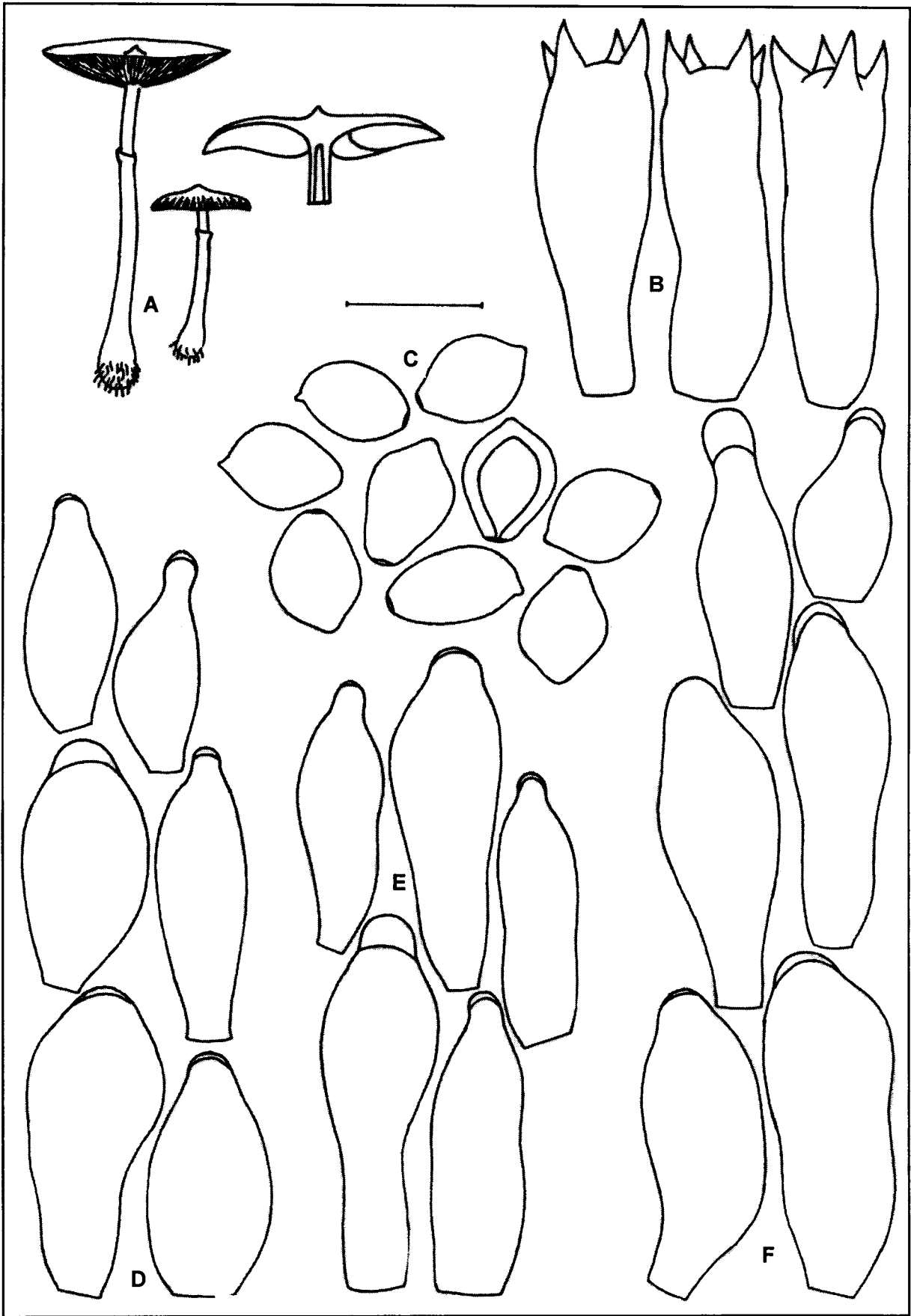


Fig. 31. *Psilocybe* sp. 4. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. Caulocystidia. Scale bar = 10 μ m

to clavate, 4-spored; sterigmata up to 4 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 14–26.5 x 5–11 μm , ventricose-fusoid, lageniform or utriform, thin-walled, at times apex thickened, hyaline. Pleurocystidia scattered, similar to cheilocystidia in size and shape. Hymenophoral trama subregular; hyphae 2–7.5 μm wide, thin-walled, hyaline. Pileal trama interwoven; hyphae 2–20 μm wide, thin-walled, hyaline. Pileipellis an ixocutis; hyphae 2–12.5 μm wide, thin-walled, with faint hyaline encrustations. Stipe trama composed of 2–22 μm wide hyphae, parallel, thin-walled, hyaline or faintly bluish. Stipitipellis a repent cutis; hyphae 1.5–14.5 μm , thin-walled, hyaline or bluish. Caulocystidia 1530 x 6.5–12.5 μm , similar to cheilocystidia in shape, restricted to the extreme tip of the stipe, either in clusters or scattered. Clamp-connexions present on all hyphae.

On the ground rich with wood chips, gregarious to scattered, July–October.

Specimens examined: India, Kerala State, Wayanad District, Muthanga: 21 July 1999, A. Thomas T320; 25 July 1999, A. Thomas T320b; 27 July 1999, A. Thomas T320c; 31 October 1999, A. Thomas T320d.

The subrhomboid, thick-walled spores, the pleurocystidia, the annulus and the bluing of the basidiomata together indicate that this species belongs in section *Stuntzii* where it seems to be very close to *Psilocybe subaeruginascens* Hohnel in most macro- and microscopic characters. This species, however, differs from *P. subaeruginascens* in not being fimicolous and in having a gelatinized pileipellis and a characteristic, sharp, unpleasant odour. The habitat, the odour, and the structure of the pileipellis make it distinct from *Psilocybe septentrionalis* (Guzmán) Guzmán, a species known only from Japan. *P. jacobsii* Guzmán, the only other pleurocystidiate species of section *Stuntzii*, differs in having much smaller spores and cheilocystidia of a different shape.

Psilocybe cubensis (Earle) Singer
in *Syndowia* 2:37 (1948).

Fig. 32 A-F; Plate 11 B

Stropharia cubensis Earle in *An. Estac. Centr. Agron. Cuba* 1:240 (1906).

Naematoloma caerulescens Patouillard in *Bull. Soc. Mycol. Fr.* 23:78 (1907).

Hypholoma caerulescens (Patouillard) Saccardo & Trotter in *Sacc., Syll. Fung.* 21:212 (1912).

Stropharia caerulescens (Patouillard) Singer in *Ann. Mycol.* 34:340 (1936).

Stropharia cyanescens Murrill in *Mycologia* 33:279 (1941).

Pileus 15–100 mm diam., broadly conic, turning to convex and finally applanate, acutely to broadly umbonate, rarely lacking a distinct umbo; surface dark orange (5A8), melon yellow (5A6), greyish orange (5B6) or reddish golden (6C7) at the centre, light yellow (4A5) or light orange (5A4) in the middle, yellowish white (4A2) orange white (5A2) towards the margin, covered with powdery velar remnants when young, becoming glabrous when mature, viscid when moist; margin initially incurved, becoming straight to plane, initially entire, becoming fissile. Context white. Lamellae adnate to adnato-adnexed, greyish brown (5E3, 7D3) in young basidiomata, turning to greyish brown (7F3) or dark brown (7F4) at maturity, somewhat mottled, close to crowded, up to 12 mm wide, with lamellulae of several lengths; edge whitish, entire to broadly wavy. Stipe 45–140 x 4–18 mm, central, terete, fistulose, tapering apically, occasionally with a distinct bulbous base; surface whitish towards apex, pale yellow (4A3) or light yellow (4A4) towards base with fine longitudinal striations, lower part of the stipe fibrillose, annulate; annulus superior, whitish, persistent, membranous. Basidiomata bluing on bruising or aging. Odour not distinctive. Spore-print dark brown (9F5).

Spores 10.5–15.5 x 7.5–10.5 x 6.5–9 (13.77±1.31 x 9.09±0.76 x 7.88±0.68) µm, Q=1.31–1.72, Qm=1.50, lenticular, subhexagonal in face-view, ellipsoid in side-view, smooth, thick-walled, truncated by an apical germ-pore. Basidia 22.5–39 x 9–12.5 µm, cylindrico-clavate, mostly with a median constriction, 4-spored; sterigmata up to 5 µm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 17.5–37.5 x 6.5–10.5 µm, clavate or ventricose with an obtuse or subcapitate apex, thin-walled, hyaline. Pleurocystidia 19–40

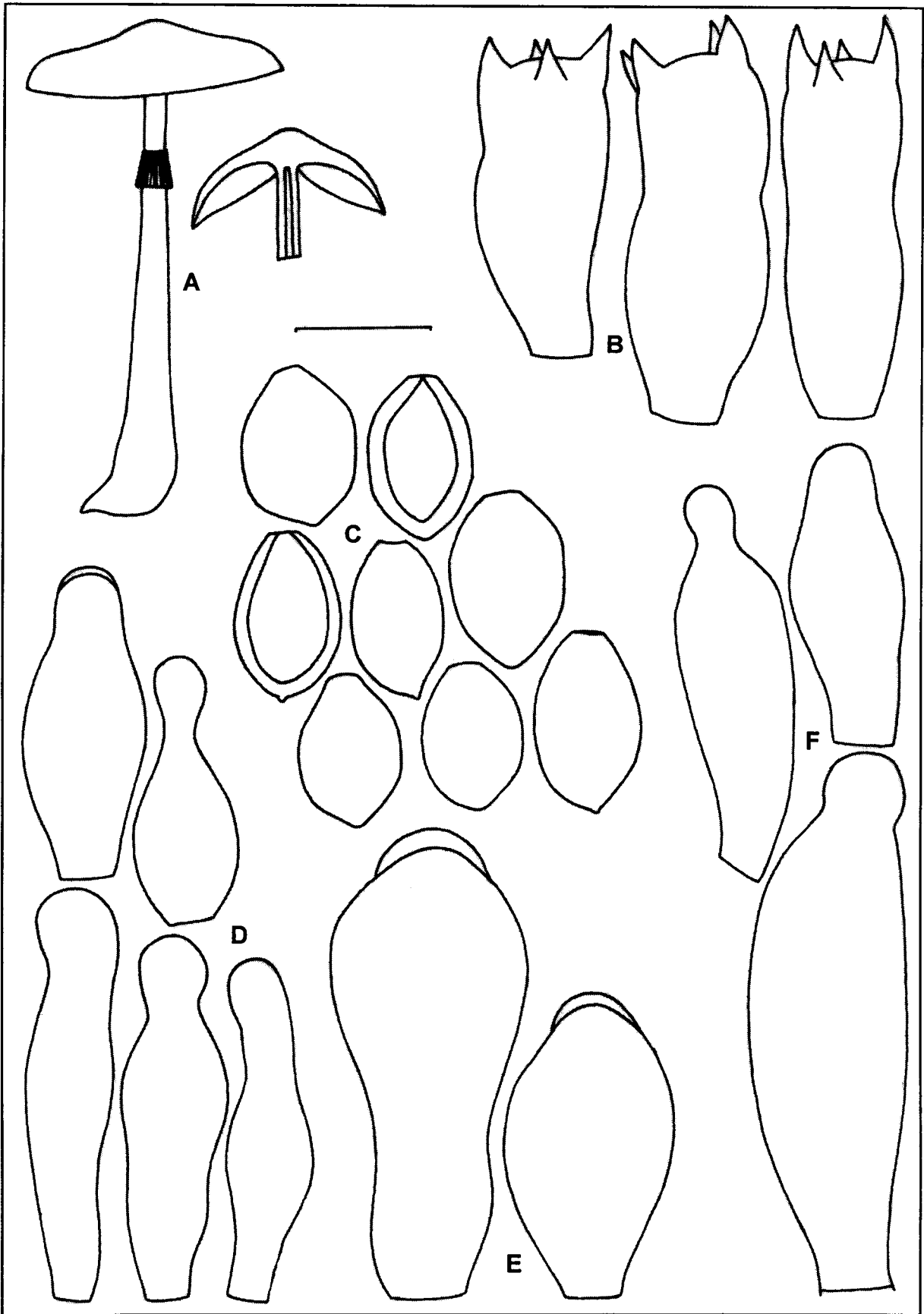


Fig. 32. *Psilocybe cubensis* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. Caulocystidia. Scale bar = 10 μ m

x 10–16.5 μm , clavate or ventricose, sometimes mucronate, apically covered by a refringent encrustation, frequent, hyaline. Hymenophoral trama regular; hyphae 2.5–14 μm wide, thin-walled, hyaline. Pileal trama loosely interwoven; hyphae 2.5–15.5 μm wide, thin-walled, hyaline. Pileipellis an ixocutis of loosely arranged hyphae, 1.5–7 μm wide, encrusted, hyaline, embedded in a gelatinous matrix overlying a hypodermium of parallel hyphae, 2–14.5 μm wide, encrusted with yellow pigment or hyaline. Stipe trama composed of 2–17.5 μm broad hyphae, thin-walled, hyaline. Stipitipellis a cutis; hyphae 2–9 μm wide, hyaline, at times with faint, hyaline encrustations. Caulocystidia 20–60 x 5.5–13 μm , mostly similar to cheilocystidia in shape, occasionally cylindric to cylindrico-clavate, thin-walled, hyaline, distributed towards the upper part of the stipe, in clusters or scattered as recurved, terminal cells of peripheral hyphae. Clamp-connexions present in all parts of the basidiomata.

On elephant dung, scattered or rarely solitary, May- October.

Specimens examined: India, Kerala State, Wayanad District, Muthanga: 17 June 1997, A. Thomas T76; 25 June 1997, A. Thomas T76b; 4 July 1997, A. Thomas T76c; 19 August 1997, A. Thomas T76d; 1 October 1997, A. Thomas T76e; 26 October 1997, A. Thomas T76f; 25 May 1999, A. Thomas T76g; 21 July 1999, A. Thomas T76h.

Our collections of *Psilocybe cubensis* agree remarkably closely with the description of this species given by Guzmán (1983). The only remarkable deviation observed in our collections is the presence of a refringent material covering the apices of pleurocystidia. *Psilocybe subcubensis* Guzmán, the only other species in the section *Cubensis*, differs in having smaller spores and shorter pleurocystidia.

Psilocybe pseudobullacea (Petch) Pegler
in Kew Bull. Addl. Ser. 6:473 (1977).

Fig. 33 A-E; Plate 11 C

Agaricus bullaceus Fries *sensu* Berkeley & Broome in Journ. Linn. Soc. Bot. 11:555 (1871).

Stropharia pseudobullacea Petch in Ann. Roy. Bot. Gard. Peradeniya 9:128 (1924).

Pileus 8–25 mm diam., conico-convex with an obtuse umbo when young, later turning

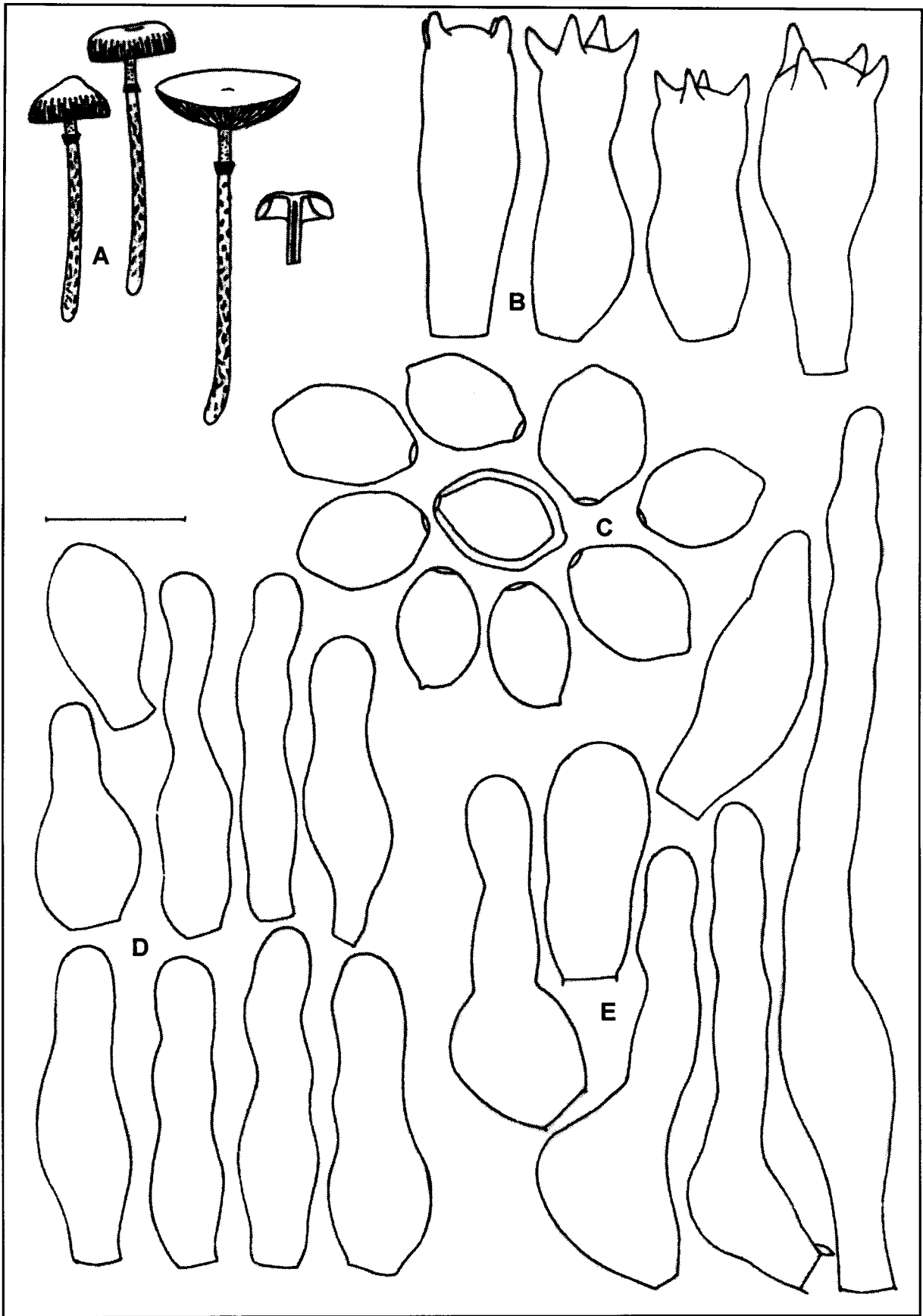


Fig. 33. *Psilocybe pseudobullacea* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Caulocystidia. Scale bar = 10 μ m

to broadly convex, plano-convex, or plane with a small depression at the disc; surface when young brownish orange (6C7), brown (6D7, 7E7) or reddish brown (8E7) at the disc and orange (6A6, 6A7) towards margin with a whitish pileal rim, light brown (7D4, 7D5), brown (7E3, 7E6, 7E7) or rarely dark brown (7F5) on maturity, hygrophorous and becoming pale orange (6A3), glabrous, subviscid when wet, smooth, translucent-striate when moist; margin slightly incurved when young, turning to decurved or pale, entire. Context up to 1.5 mm thick at the center, white with an orange tint. Lamellae adnate to almost subdecurrent, brownish orange (6C4), light brown (6D4, 6D5) or brown (7E4), sometimes greyish brown (8E3) or reddish brown (8E4), mottled, subcrowded to close, up to 6.5 mm wide, with lamellulae of 2 lengths; edge whitish, minutely scalloped under a lens. Stipe 30–90 x 1–3.5 mm, central, cylindric, equal or slightly tapering apically, solid, turning to fistulose; surface orange white (5A2), orange grey (5B2) or greyish orange (5B3, 6B3), floccose-squamulose below the annulus, pruinose above; annulus superior, initially upturned, becoming pendant. Odour not distinctive. Spore-print greyish brown (10F3).

Spores 8–12 x 6.5–8.5 x 5.5–7 (10.30 ± 0.93 x 7.09 ± 0.60 x 6.13 ± 0.37) μm , $Q=1.24$ – 1.6 , $Q_m=1.45$, lenticular, limoniform to subhexagonal in face-view, ellipsoid in side-view, violet-brown, smooth, thick-walled, truncated by an apical germ-pore. Basidia 17.5–29 x 7–9.5 μm , clavate to cylindric, mostly with a median constriction, 4-spored; sterigmata up to 5 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 13–35 x 4.5–9 μm , versiform: lageniform, utriform, flexuose or clavate, thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama subregular; hyphae 2–19 μm wide, thin-walled, with a yellowish brown wall, at times faintly encrusted. Pileal trama interwoven; hyphae 2–19.5 μm wide, thin-walled, sometimes faintly encrusted with a yellowish brown pigment. Pileipellis an ixocutis; hyphae 2–7 μm wide, thin-walled, hyaline, sometimes faintly encrusted. Pileal margin with crowded cystidia resembling cheilocystidia in size and shape. Stipe trama composed of 2–20 μm wide, thin-walled hyphae, with a light yellowish brown wall. Stipitipellis a cutis; hyphae 1.5–7.5 μm wide, thin-walled, sometimes faintly encrusted with a light yellowish brown pigment. Caulocystidia 10–79 x 4.5–10 μm , versiform: vesiculose, clavate, fusoid-

ventricose, lageniform with a long flexuose neck, or irregular in outline, thin-walled, hyaline, occurring towards the upper part of the stipe in dense clusters. Clamp-connexions present in all tissues.

On elephant dung, scattered, June–October.

Specimens examined: India, Kerala State, Thrissur District, Guruvayoor: 11 June 1999, A. Thomas T 311; 17 June 1999, A. Thomas T 311b; 14 July 1999, A. Thomas T 311c; 18 October 1999, A. Thomas T 311e; Palakkad, District, Nelliampathy: 30 August 1999, A. Thomas T 311d; Kasargod District, Adhoor: 16 September 2000, A. Thomas T311f .

Guzmán's (1983) key leads straight to *P. pseudobullacea* and the Kerala collections agree well with his description of the species remarkably well. According to Guzmán (1983), pleurocystidia may be absent or scattered in this species. Pleurocystidia were never observed in our collections. According to Guzmán (1983), the hypodermium is subcellular in this species. Although inflated, encrusted hyphae were seen in the pileal trama, a well-developed subcellular hypodermium was not observed in our collections. Pegler (1977) after examining the original type collection of *P. pseudobullacea* and Petch's collection of the species (Petch 6558), both located at Kew herbarium, stated that neither had spores longer than 12 μm . In his "Agaric Flora of Sri Lanka" Pegler (1986), however, has given the spore length of these collections as 11.5–15 μm without giving any explanation for this change. According to Guzmán (1983) this species is known from several tropical and subtropical regions of the world.

Psilocybe coprophila (Bulliard ex Fries) Kummer
in Fuhr. Pilzk.:71 (1871).

Fig. 34 A-F

Agaricus coprophilus Bulliard ex Fries in Syst. Mycol. 1:297 (1821).

Deconica coprophila (Bulliard ex Fries) Karsten in Hattsvamp. 1:515 (1879).

Geophila coprophila (Bulliard ex Fries) Quélet in Enchiridion:114 (1886).

Stropharia coprophila (Bulliard ex Fries) J. Lange in Dansk Bot. Ark. 9(1):32 (1936).

Pileus 7–17 mm diam., hemispherical to convex, sometimes with an indistinct obtuse

umbo; surface brown (7E5, 7E6), reddish brown (8E7), or dark brown (7F6, 7F7), hygrophanous and becoming brownish orange (6C6), glabrous, viscid, translucent-striate when moist; margin decurved, entire. Context up to 2 mm thick at the centre, white with a tint of brown. Lamellae broadly adnate, greyish brown (7F3) to dark brown (7F4), close, up to 7 mm wide, with lamellulae of 2 – 3 lengths; edge whitish, entire or finely torn. Stipe 15–40 x 0.7–2 mm, central, terete, almost equal, hollow; surface brown (7E6, 7E7), glabrous, pruinose at the apex. Odour not distinctive. Spore-print not obtained.

Spores 10.5–15.5 x 7.5–9.5 x 7–9 ($13.33 \pm 1.47 \times 8.81 \pm 0.55 \times 7.94 \pm 0.59$) μm , $Q=1.1$ – 1.72 , $Q_m=1.50$, slightly lenticular, subhexagonal in face-view, ellipsoid in side-view, smooth, violet-brown, thick-walled, apically truncated by a broad germ-pore. Basidia 20.5–37.5 x 9–13 μm , clavate, mostly with a median constriction, 4-spored; sterigmata up to 4.5 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 15.5–39 x 5.5–13 μm , ventricose-fusoid, utriform or lageniform, thin-walled, hyaline. Pleurocystidia 16.5–41.5 x 5–14 μm , similar to cheilocystidia. Hymenophoral trama subregular; hyphae 2–16.5 μm wide, thin-walled, pale yellow. Pileal trama interwoven; hyphae 2–17.5 μm wide, thin-walled, brownish yellow. Pileipellis an ixocutis; hyphae 1–3 μm wide, thin-walled, hyaline. Stipe trama composed of 2–15.5 μm wide hyphae, thin-walled, pale yellowish brown. Stipitipellis a repent cutis; hyphae 1–5.5 μm wide, thin-walled, yellowish brown. Caulocystidia in clusters at stipe apex, 19.5–119 x 4.5–14 μm , ventricose with a long, flexuose, occasionally branched apical projection, thin-walled, hyaline or yellowish brown towards base. Clamp-connexions present on all hyphae.

On elephant dung, scattered, August.

Specimens examined: India, Kerala State, Idukki District, Munnar: 28 August 1997, A. Thomas T149.

This species has earlier been reported from India by Watling and Gregory (1980) and Natarajan and Raman (1983). *P. argentipes* (Spegazzini) Singer is very close to our specimens in almost all macro- and microscopic features but the spores of that species are larger in size.

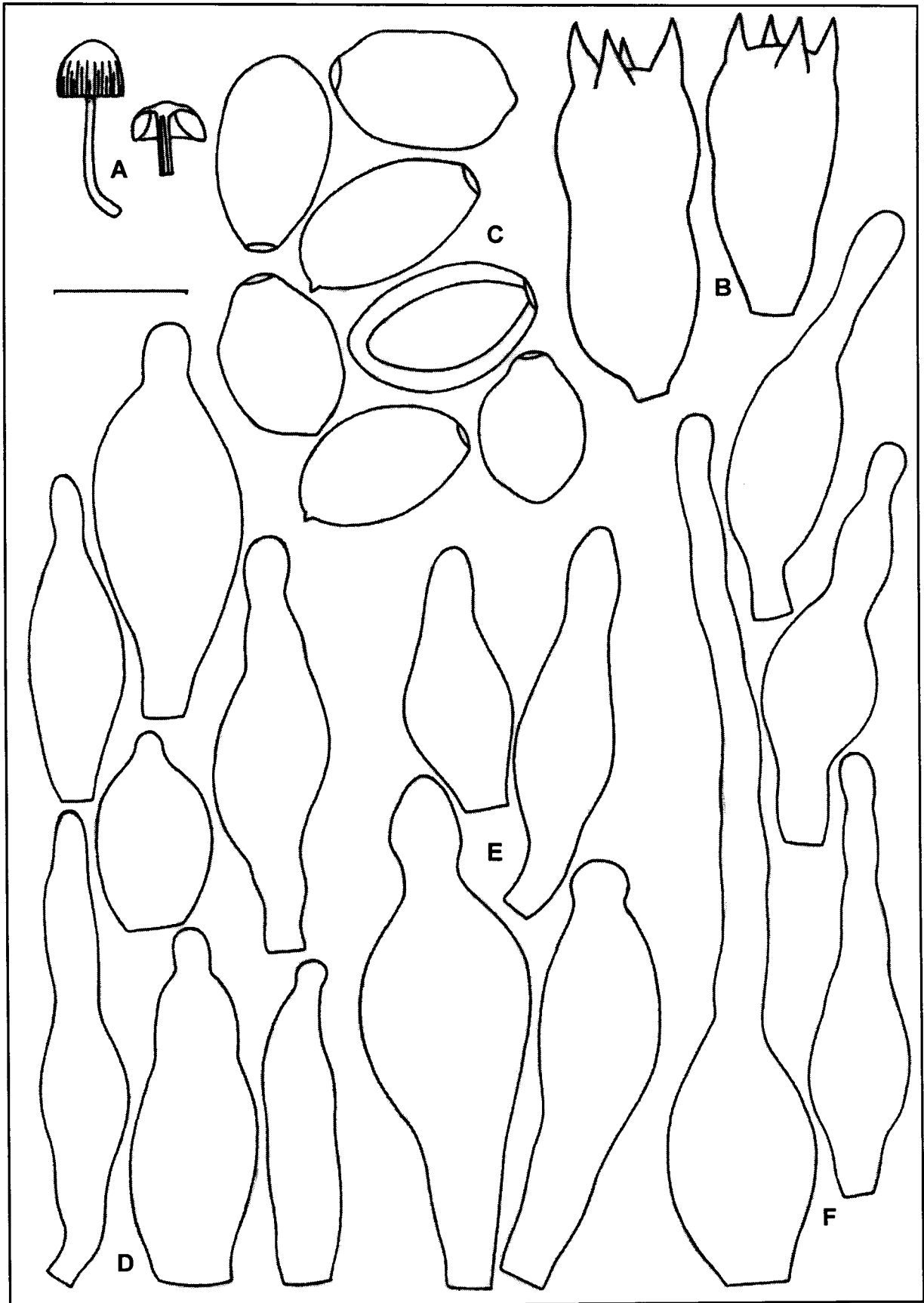


Fig. 34. *Psilocybe coprophila* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. Caulocystidia. Scale bar = 10 μ m

Psilocybe argentina (Spegazzini) Singer
in Beih. Nov. Hedwigia 29:241 (1969).

Fig. 35 A-E; Plate 12 B

Deconica argentina Spegazzini in Ann. Mus. Nac. Buenos Aires 6:152 (1899).

Psilocybe merdicola Huijsman in Persoonia 2:93 (1961).

Basidiomata small. Pileus 7–20 x 4–10 mm, hemispherical to convex; surface brown (7D7) to reddish brown (8D7, 8E7, 8E8), sometimes with an orange tint towards margin, hygrophanous, viscid and translucent-striate when moist, glabrous; margin decurved, almost entire. Context less than 1 mm thick at the centre concolorous with the surface. Lamellae adnate, greyish brown (9D3 to 11F3), mottled, close, up to 8 mm wide, with lamellulae of 2–3 lengths; edge whitish, subentire to scalloped under a lens. Stipe 15–35 x 0.7–2 mm, central, terete, almost equal, hollow; surface light orange (5A4 to 6A4), pruinose towards apex. Odour none. Spore-print dark brown (7F4, 8F4) or greyish brown (8F3).

Spores 12–17 x 9–12 x 8.5–10.5 ($14.64 \pm 1.31 \times 10.33 \pm 0.81 \times 9.41 \pm 0.52$) μm , $Q=1.31$ – 1.57 , $Q_m=1.42$, lenticular, subhexagonal in face-view, ellipsoid in side-view, violet brown, smooth, thick-walled, truncated by an apical germ-pore. Basidia 24.5–32.5 x 10.5–14.5 μm , pedicellate-clavate, 4-spored; sterigmata up to 4.5 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 19–31.5 x 5–9.5 μm , ventricose-fusoid, utriform or lageniform, sometimes with a subcapitate apex, thin-walled, hyaline. Pleurocystidia absent. Hymenophoral trama subregular; hyphae 2–15.5 μm wide, thin-walled, light yellowish brown. Pileal trama interwoven; hyphae 1.5–15 μm wide, thin-walled, sometimes minutely encrusted with a yellowish brown pigment. Pileipellis an ixocutis of 1.5–5 μm wide hyphae, thin-walled, mostly encrusted with a pale yellowish brown pigment, embedded in a gelatinous matrix. Stipe tramal hyphae 2–16.5 μm wide, thin-walled, with a yellowish brown wall pigment. Stipitipellis a cutis; hyphae 1.5–6.5 μm wide, thin-walled, with a yellowish brown wall pigment, sometimes faintly encrusted. Caulocystidia 20–92.5 x 5–13 μm , ventricose-rostrate, utriform, lageniform, clavate or frequently fusoid with a long flexuous apical portion which sometimes furcate apically, in distinct clusters at stipe apex, thin-walled, hyaline or yellowish brown towards base, sometimes branched. Clamp-connexions present in all parts of the basidioma.

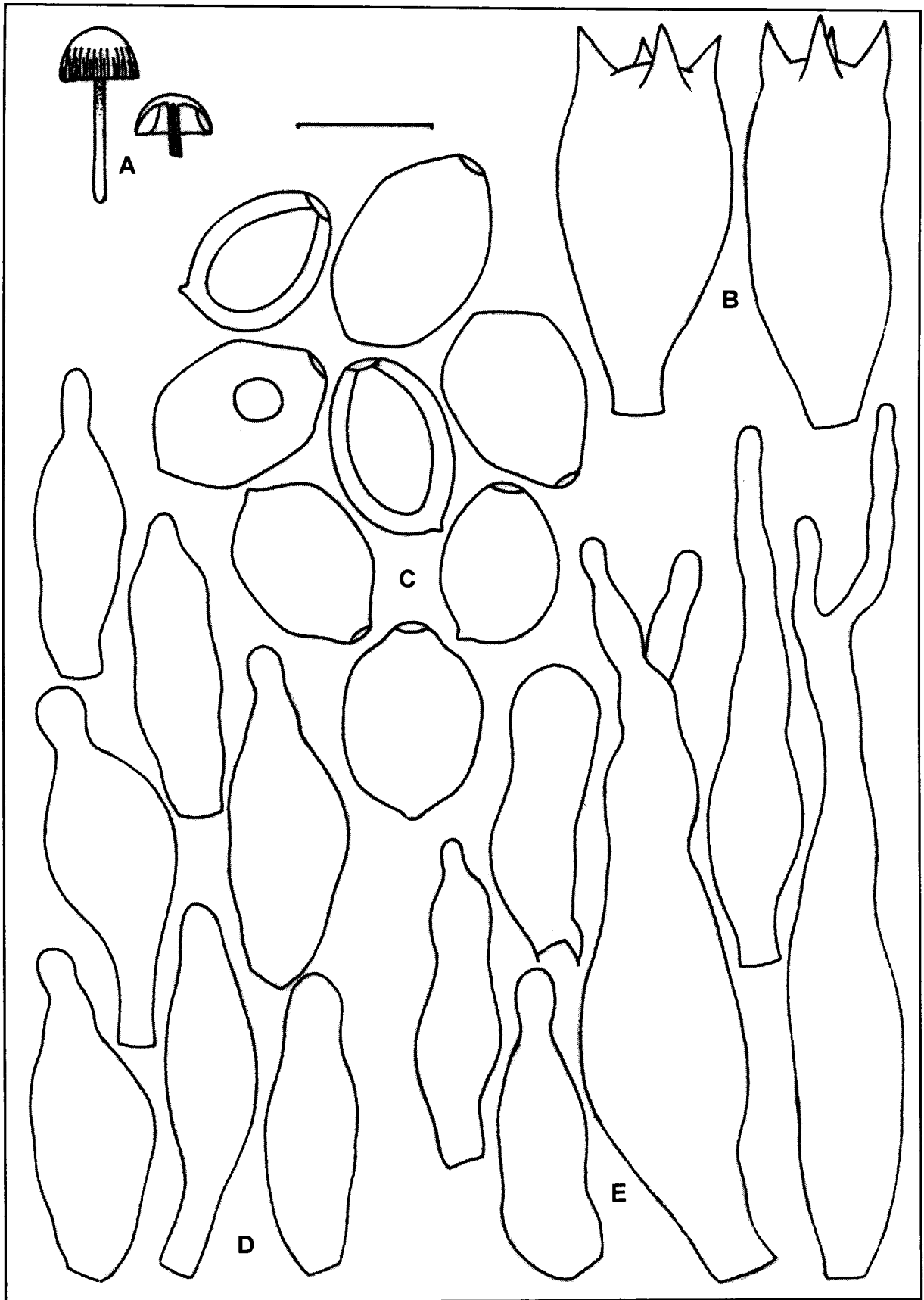


Fig. 35. *Psilocybe argentina* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Caulocystidia. Scale bar = 10 μ m

On cow dung, scattered, August.

Specimens examined: India, Kerala State, Idukki District, Munnar: 28 August 1997, A. Thomas T 150b.

Guzmán's (1983) key leads straight to *Psilocybe argentina* Singer. Although this species is not previously known from tropical and subtropical regions our collections agree remarkably well with the description of this species given by Guzmán (1983). *Psilocybe coprophila* (Bulliard ex Fries) Kummer is extremely close differing only in the spore-size. *Psilocybe subcoprophila* (Britzelmayr) Saccardo is also very close in all macroscopic features and most microscopic features but the spores of that species are subellipsoid to ellipsoid in both face and side-views.

Melanotus Patouillard
in Essai Taxon. Hymen.:175 (1900).

Basidiomata small, pleurotoid. Pileus dimidiate to spathulate, convex, hygrophanous or not. Context thin. Lamellae adnate, pale brown to purplish brown when mature. Stipe reduced or absent, excentric to lateral. Spore-print purplish brown to fuscous sepia. Spores small, ellipsoid, smooth, with an apical germ-pore. Lamella-edge usually sterile. Pleurocystidia present or absent. Hymenophoral trama regular to subregular. Pileipellis a repent cutis or ixocutis. On decaying woody substrates or fabrics. Worldwide, but rare in the temperate regions. Type species: *Melanotus bambusinus* (Patouillard) Patouillard

Only a single species of *Melanotus* was recorded from Kerala during this study.

Melanotus communis Horak
in Persoonia 9(3):324 (1977).

Fig. 36 A-D; Plate 12 C

Pileus 5–35 x 3–25 mm, convex to plane, sometimes with a blunt umbo, suborbicular, dimidate, or reniform with eccentric, subdorsal or lateral attachment; surface off-white with a yellow tint, orange white (5A2, 6A2) or pale orange (5A3), frequently brownish (7D4, 7E5, 7E7, 7F5, 6F6) towards base due to spore deposition

from adjacent basidiomata; dull, smooth, glabrous, dry; margin inrolled when young, becoming incurved and eventually decurved, entire to slightly eroded, sometimes lobate. Context up to 2 mm thick, white. Lamellae adnate, initially whitish, becoming greyish brown (8E3, 9E3, 9D3, 10E3 or 11E3), often with a lilac tint, crowded, up to 2 mm wide, with lamellulae of different lengths; edge pale, entire, at times becoming slightly eroded. Stipe very reduced or almost absent, up to 5 mm long and 1.5 mm wide, eccentric, recurved, cylindric; surface white, glabrous. Odour not distinctive. Spore-print dark brown (7F4, 7F5).

Spores 5–7 x 3.5–5 x 3–4.5 ($6.0 \pm 0.53 \times 4.30 \pm 0.38 \times 3.77 \pm 0.30$) μm , $Q=1.23\text{--}1.57$, $Q_m=1.40$, slightly lenticular, ovoid in face-view, ellipsoid in side-view, brown, smooth, slightly thick-walled, with truncate apical germ-pore. Basidia 16.5–23.5 x 6–9 μm , clavate, 4-spored; sterigmata up to 4 μm long. Lamella-edge sterile when young with crowded cheilocystidia. Cheilocystidia 11.5–24 x 3.5–6 μm , cylindric, flexuose, fusoid or clavate, occasionally with a subcapitate mucronate apex, thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama subregular; hyphae 2–9.5 μm wide, slightly thick-walled, sometimes faintly encrusted, hyaline. Pileal trama interwoven; hyphae 2–12.5 μm wide, slightly thick-walled, some times faintly encrusted, hyaline. Pileipellis an undifferentiated cutis; hyphae 2–8 μm wide, slightly thick-walled, sometimes faintly encrusted, hyaline to pale yellow. Clamp-connexions present in all tissues.

On dead areca (*Areca catechu* Linnaeus, Arecaceae) stem, gregarious to scattered, sometimes, in imbricate clusters, September.

Specimens examined: India, Kerala State, Kannur District, Pulikurumba: 15 September 1997, A. Thomas T172; 21 September 1997, A. Thomas T172b; 22 September 1997, A. Thomas T172c; 28 September 1997, A. Thomas T172d.

The Kerala collections agree remarkably well with the description of *Melanotus communis* by Horak (1977b). The characters mentioned as diagnostic of the species by Horak (1977b), such as the rather large whitish to pale brownish basidiomata, the distinct purple tinge of the lamellae and the clavate to fusoid-subcapitate to mucronate

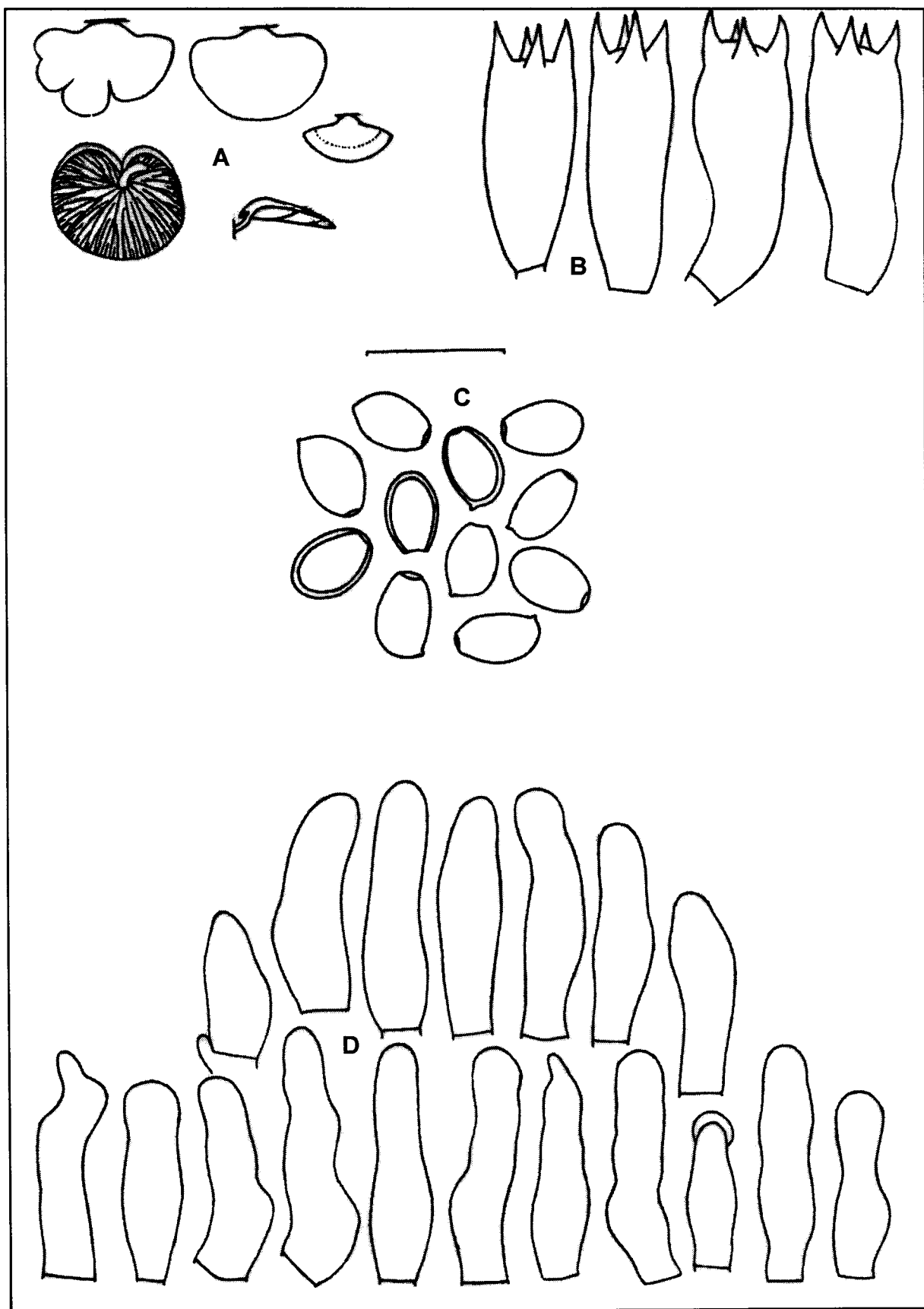


Fig. 36. *Melanotus communis* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; Scale bar = 10 μ m

cheilocystidia were observed in the present collections. Horak (1977b), however, does not mention the host plant of this species. The Kerala collections were seen on decaying areca palm (*Areca catechu* Linn.) stem. *Melanotus proteus* (Kalchbrenner) Singer, known from Africa and Sri Lanka (Pegler, 1977, 1986) is very close differing in having smaller basidiomata and brown stipe with white villose hairs. Kits van Waveren (1979) and Sime and Petersen (1999) observed a gelatinized layer just below the pileipellis in *M. proteus* which is absent in the present collections. The Kerala collections also agree with a description of *M. defraudatus* Horak, Desjardin & Petersen given by Horak, Desjardin & Petersen (1990) closely, but the habitat and morphology of cystidia and pileal elements make *M. defraudatus* distinct.

CORTINARIACEAE Roze

in Bull. Soc. Bot. Fr. 23:51 (1876).

Cortinariaceae Heim, Treb. Mus. Cienc. Nat. Barcelona 15:115 (1934).

Basidiomata small to large, mycenoid, tricholomatoid, pholiotoid or at times crepidotoid. Pileus campanulate, conical to plano-convex, smooth, fibrillose or scaly. Lamellae adnexed to decurrent, rarely almost free. Stipe mostly central, rarely eccentric, lateral or even absent. Veil present or absent, if present mostly cortinoid. Spore-print argillaceous brown to rich ferruginous. Spores small to large, globose, ellipsoid, amygdaliform, phaseoliform or fusoid, mostly ornamented, often with persistent myxosporial remnants, sometimes smooth, mostly without a germ-pore and if present never truncated. basidia mostly clavate, 2- or 4-spored. Lamella-edge fertile to sterile. Cystidia present frequently on the edges, rare on the sides, sometimes metuloidal. Hymenophoral trama regular. Pileipellis an epicutis formed of repent hyphae or a trichodermium, sometimes gelatinized. Clamp-connexions present in most species, rarely absent. Terrestrial, or lignicolous, mostly forming endo- or ectomycorrhizal associations with forest trees. Worldwide in distribution. Type genus: *Cortinarius* Fries

Key to the genera

1. Spore-print tobacco brown to argillaceous brown; spores non-ornamented, mostly nodulose-gibbous to nodulose subangular or stellate, with smooth spore wall and without perisporial remnants; metuloids often present ***Inocybe***
1. Spore-print ochraceous brown, rust-brown or ferruginous; spores ornamented or with persistent perisporial remnants, never angular or nodulose; metuloids absent 2
2. Typically terrestrial and forming ectomycorrhizal associations with forest trees, mostly with a cortinoid veil ***Cortinarius***
2. Typically lignicolous and not forming mycorrhizal associations with trees, mostly without a cortinoid veil ***Gymnopilus***

Inocybe (Fries) Fries

in Monogr. Hymen. Sueciae 2:346 (1863).

Agaricus Fries tribe *Inocybe* Fries, Syst. Mycol. 1:254 (1821).

Clypeus (Britzelmayr) Fayod in Ann. Sci. Nat., Bot. ser. 7,9:562 (1889).

Astrosporina Schroeter in Cohn., Kryptog. – fl. Schles. Pilze:576 (1889).

Agmocybe Earle in Bull. New York Bot. Gard. 5:439 (1909).

Inocybium Earle, *op. cit.*: 439.

Basidiomata small to medium-sized. Pileus conical to convex, pale to dark brown, ochraceous, white or infrequently with reddish-brown or violaceous tints, radially fibrillose, often rimose or scaly. Context often fleshy. Lamellae adnexed to adnate, pale to ochraceous, olivaceous brown or snuff-brown with pale, often finely fringed edges. Stipe, central, cylindrical, often pruinose to scaly, sometimes bulbous at base. Veil often present at least when young, cortinate, rarely annulate. Odour at times characteristic. Spore-print dull earth-brown, tobacco brown or dull yellowish brown. Spores small to large, ellipsoid, amygdaliform, phaseoliform or subcylindrical, smooth, nodulose, gibbous, stellate or spinose, very rarely with germ-pore. Lamella-edge sterile to heteromorphous. Cheilocystidia and pleurocystidia often present, frequently metuloidal with apical crystalline encrustations, hyaline or yellow. Hymenophoral tram regular. Pileipellis usually a repent cutis, rarely a trichoderm. Clamp-connexions present. Terrestrial, mostly forming mycorrhizal associations with forest trees. Worldwide in distribution, but less common in tropics. Lectotype species: *Inocybe relicina* (Fries) Fries

Key to the species

1. Spores nodulose, gibbous, stellate or spinose in outline 2
1. Spores smooth in outline, usually ellipsoid, ovo-ellipsoid, amygdaliform or phaseoliform 7
2. Cheilocystidia (and pleurocystidia) metuloidal 4
2. Cheilocystidia non-metuloidal 3
3. Pileus conical with a sharply pointed umbo; spores stellate; cheilocystidia broadly fusiform with a crystalloid cap *Inocybe* sp. 1

3. Pileus convex and without a distinct umbo, spores nodulose; cheilocystidia versiform without a crystalloid cap ***Inocybe* sp. 2**
4. Metuloidal cystidia obclavate to subfusiform 5
4. Metuloidal cystidia utriform to broadly utriform 6
5. Pileus and stipe surface white; pileus subviscid ***Inocybe* sp. 3**
5. Pileus and stipe surface light orange or greyish orange; pileus not viscid ***Inocybe* sp. 4**
6. Spores 10.5–14 μm long; pileus somewhat plicate-striate; stipe base almost bulbous and submarginate ***Inocybe* sp. 5**
6. Spores 5–10.5 μm long; pileus not plicate-striate; stipe base slightly enlarged and not submarginate ***Inocybe* sp. 6**
7. Cheilocystidia metuloidal with a crystalloid cap; pleurocystidia present; spores usually with a small germ-pore ***Inocybe* sp. 7**
7. Cheilocystidia non-metuloidal and without a crystalloid cap; pleurocystidia absent; spores without a germ-pore 8
8. Pileus and stipe covered with brown squamules; basidia frequently containing a yellowish brown pigment ***Inocybe* sp. 8**
8. Pileus and stipe usually without squamules; basidia not containing yellowish brown pigment 9
9. Pileus up to 75 mm in diameter; cheilocystidia often capitate; spores 6.5–9 μm long ***Inocybe cutifracta***
9. Pileus never reaching more than 30 mm diameter; cheilocystidia not capitate; spores 7–12.5 μm long ***Inocybe rimosa***

***Inocybe* sp. 1**

Fig. 37 A-F; Plate 13 A

Pileus 7–20 mm diam., 8–21 mm high, conic to conico-companulate, becoming conico-convex with an abrupt acute umbo, up to 3 mm long, never becoming applanate; surface brown (7E6) towards umbo, elsewhere brown (6E7, 6E8) or light brown (6D6),

hygrophanous and the whole basidoma turning orange white (5A2), pale orange (5A3) or greyish orange (5B3), glabrescent, sometimes with small appressed squamules around the umbo, sulcate-striate, sometimes finely rimose, margin incurved becoming decurved, entire. Context up to 1.5 mm thick at the centre, white with a brownish tint. Lamellae adnexed to adnate, initially greyish orange (6B3), later brownish orange (6C3) or light brown (6D4, 6D6), close, up to 4.5 mm wide, with lamellulae of 2–3 lengths; edge whitish, fimbriate under a lens. Stipe 45–90 x 1.5–4 mm, central, terete, almost equal but with a slightly enlarged base, fistulose; surface brownish orange (5C3, 6C3) to light brown (6D5, 6D6), pruinose at apex, at times with fine longitudinal cracks and small, scattered, appressed squamules. Odour not distinctive. Spore-print not obtained.

Spores 11.5–16.5 x 10.5–13 (13.56±1.35 x 12.14±0.76) μm , Q=1.0–1.25, Qm=1.12, stellate, with up to 4 μm long, conic and sometimes furcate projections, yellowish brown. Basidia 26.5–37.5 (50) x 10–15 μm , clavate, 4-spored; sterigmata up to 6.5 μm long. Lamella-edge sterile or occasionally heteromorphous with crowded cheilocystidia. Cheilocystidia 24–49 x 9.5–20 μm , broadly fusiform, thin- to slightly thick-walled, hyaline or rarely with yellowish brown contents, with a crystalloid cap, always intermixed with short, clavate, thin-walled cells 12.5–29 x 6.5–12 μm , containing refractive inclusions. Pleurocystidia not observed. Hymenophoral trama regular; hyphae 2.5–19 (45) μm wide, thin-walled, with light yellowish brown pigment. Pileal trama interwoven; hyphae 2.5–16.5 μm wide, thin-walled, pale yellowish brown. Pileipellis a cutis; hyphae 3–14.5 (25) μm wide, thin- to slightly thick-walled with a yellowish brown pigment encrustation. Stipe trama composed of 3–21.5 μm wide hyphae, thin-walled, with yellowish brown pigment. Stipitipellis a cutis; hyphae 3–9 μm wide, thin-walled, with a yellowish brown pigment encrustation. Caulocystidia 19–92.5 x 5.5–15 μm , mostly clavate or rarely broadly fusiform, mostly with a crystalloid cap, in clusters or scattered, thin- to slightly thick-walled, hyaline, restricted to the upper part of the stipe. Clamp-connexions present in all tissues.

On the forest floor, scattered, probably mycorrhizal. Nearest vegetation include *Hopea* spp. (Dipterocarpaceae) and *Meiogyne* sp. (Annonaceae), July–October.

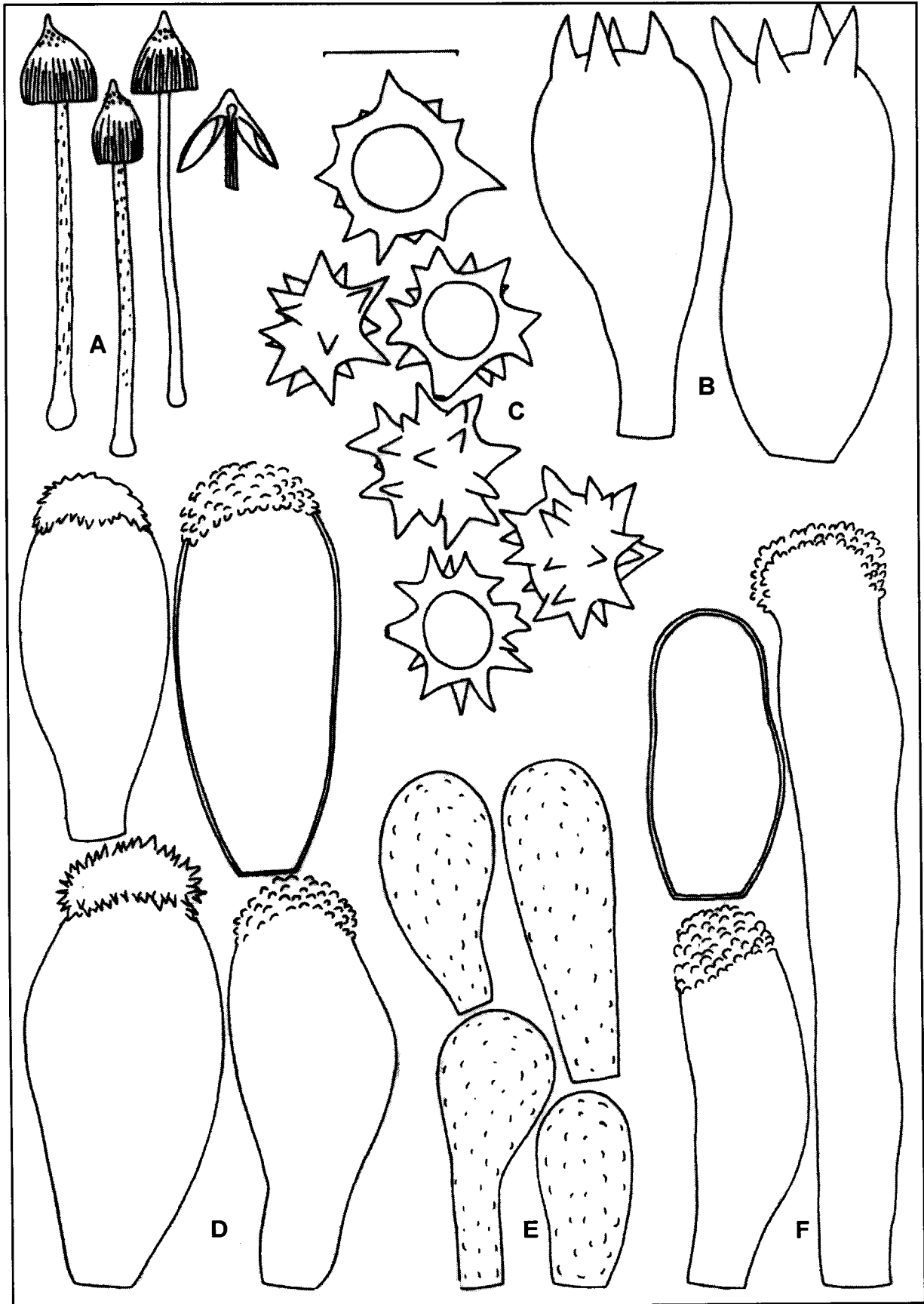


Fig. 37. *Inocybe* sp. 1. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia with a crystalloid cap; E. Cheilocystidia without a crystalloid cap; F. Caulocystidia. Scale bar = 10 μ m

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 28 October 1999, A. Thomas T345; 31 October 1999, A. Thomas T345b; 17 July 1997, A. Thomas T126; 11 August 1997, A. Thomas T126b; 13 October 1998, A. Thomas T126c; 1 August 1999, A. Thomas T126d; Malappuram District, Calicut University Campus: 2 August 1996, A. Thomas T38.

In several macro- and microscopic features this species is very similar to *Inocybe petchii* Boedijn, widely distributed in south and south-east Asia. The similarities include the overall morphology and colour of the basidiomata, stellate spores, and cheilocystidia with crystalloid caps. However, the Kerala collections deviate from *I. petchii* in the following respects: 1) pileus never reach more than 2 cm in diameter and never become appanate; 2) stipe is pruinose only at the extreme tip; 3) the stipe base is never marginate; 4) the cheilocystidia with crystalloid cap are either thin-walled or only slightly thick-walled (less than 1 mm thick and hence can not be called metuloids; 5) pleurocystidia are absent; 6) caulocystidia are mostly clavate and are seen only at the extreme tip of the stipe; and 7) the stellate spores are more irregular in outline and the ellipsoid or globose outline illustrated for *I. petchii* by Horak (1979) and Pegler (1986) is not seen. Owing to these differences the author considers that the Kerala collections belong to a new species. This species has already been recorded from Kerala as *I. petchii* by Manimohan and Leelavathy (1989). The Kerala collections were always seen associated with *Hopea parviflora* Beddome (Dipterocarpaceae).

***Inocybe* sp. 2**

Fig. 38 A-E; Plate 13 B

Pileus 10–30 mm diam., hemispherical turning to convex to plano-convex, sometimes sub-umbonate or with a slightly depressed centre; surface pale orange (5A3), greyish orange (5A4), brownish orange (6C6), light brown (6D6) or brown (6D7, 6E7), entirely covered with small brownish orange (7C6), brown (7E5) or dark brown (6F6, 7F6, 7F7) scales, densely squarrose towards disc, sparsely and inconspicuously appressed squamulose towards margin, mostly faintly rimose at margin, dull, dry; margin incurved

when young turning to decurved and finally plane, thin, papery, almost entire or faintly crenate, sometimes eroded or wavy. Context cream-coloured. Lamellae adnate to somewhat subdecurrent, light orange (5A3) when young, turning to light brown (6D5, 6D6) or brown (6E7), subcrowded to close, up to 3 mm wide, with lamellulae of 3 lengths; edge pale, fimbriate under a lens. Stipe 15–35 x 1.5–4.5 mm, central, cylindric, almost equal, sometimes broader towards both ends or slightly tapering basally, solid; surface concolorous with the pileus, fibrillose to squamulose. Odour not distinctive. Spore-print not obtained.

Spores 6.5–8.5 x 5.5–7 (7.44±0.62 x 6.09±0.47) μm , Q=1.05–1.41, Qm=1.22, subglobose, nodulose, nodules not prominent, up to 1 μm high, thin-walled, yellowish brown. Basidia 29–39.5 x 7–11.5 μm , clavate, collapsed in mature basidioma, mostly 4-spored, rarely 2-spored, sterigmata up to 6 μm long. Lamella-edge heteromorphous. Cheilocystidia 20–75 x 7.5–20 μm , versiform: clavate, fusoid, utriform, lageniform or tibiiform, thin-walled, wall sometimes slightly thickened towards apex, containing a yellowish brown amorphous inclusion, sometimes hyaline. Pleurocystidia none. Hymenophoral trama regular; middle region composed of broader (2–22.5 μm wide), short-segmented hyphae flanked on either side by a narrower (2–9 μm wide), long-segmented hyphae; both hyphae thin-walled, hyaline. Pileal trama interwoven; hyphae 2–20 μm wide, thin-walled, hyaline. Pileipellis a cutis, frequently disrupted, especially towards the disc, by erect hyphal clusters; hyphae 6–17 μm wide, short-segmented, thin-walled, encrusted with yellowish brown pigment. Stipe trama composed of 2–12 μm wide, thin-walled, hyphae hyaline or pale yellowish brown. Stipitipellis a cutis often disrupted by sub-erect to erect clusters of loosely woven hyphae; hyphae 2–8 μm wide, thin-walled, with yellowish brown encrusting pigment. Caulocystidia 14–60 x 4–13 μm , similar to cheilocystidia in shape, thin-walled, or sometimes slightly thick towards apex, hyaline or with a yellowish brown wall. Clamp-connexions present on all hyphae.

On the forest floor, under a tree (*Knema attenuata* Warburg, Myristicaceae), mostly attached to subterranean roots, December.

Specimens examined: India, Kerala State, Wayanad District, Meppady: 27 December 1997, A. Thomas T229; 31 December 1997, A. Thomas T229b; 8 October 1998, A. Thomas T229c; 1 December 1998, A. Thomas T229d.

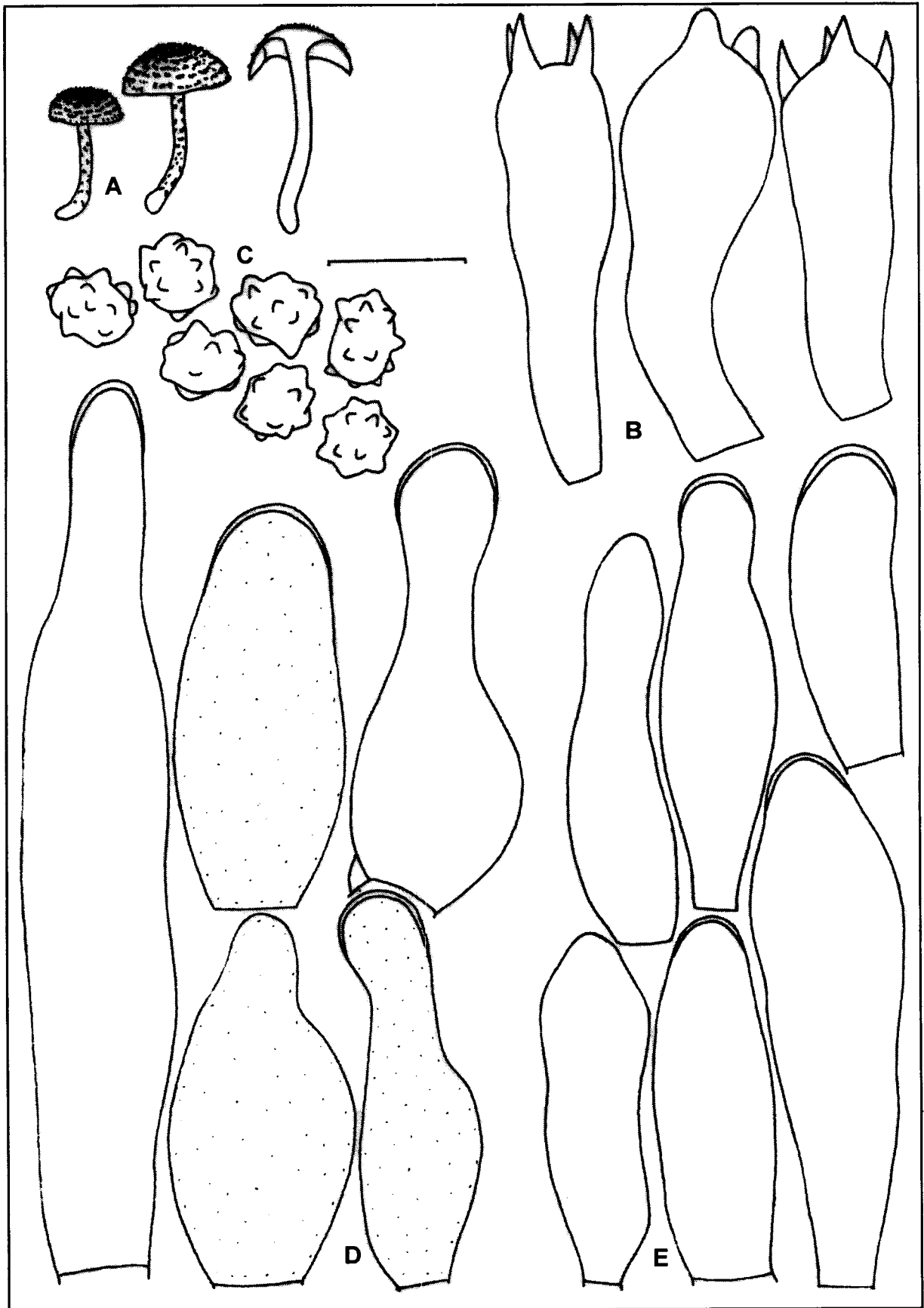


Fig. 38. *Inocybe* sp. 2. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Caulocystidia. Scale bar = 10 μ m

This species belongs to the subgenus *Leptocybe* Kobayashi. It is remarkably similar to *Inocybe leptophylla* Atkinson in most microscopic features and almost all macroscopic features. Our collections are strikingly similar to the photograph of *I. leptophylla* given by Grund and Stuntz (1983). However, that species differs in having larger spores with ellipsoidal outline and basidiomata that grow on rotten wood in conifer forests. Microscopically the Kerala collections are somewhat similar to *Astrosporina cingulatipes* Corner & Horak, but that species has conic pileus expanding to form an umbonate centre, sulcate-striate pileus margin, adnexed lamellae, and a subperonate stipe surface with white, fibrillose veilar remnants.

***Inocybe* sp. 3**

Figs. 39(a) A-E & 39(b) A-C; Plate 13 C

Pileus 7–20 mm diam., conico-convex to plano-convex, with a small obtuse umbo; surface white, minutely rimose, slightly viscid; margin decurved to plane, sometimes slightly upturned, almost entire, sometimes eroded. Context white, up to 1.5 mm thick at the centre. Lamellae adnexed to free, orange white (5A2) or pale orange (5A3) turning to brownish orange (6C5), subcrowded, up to 2 mm wide, with lamellulae of 3–4 lengths; edge almost pale, fimbriate under a lens. Stipe 10–30 x 1.5–3.5 mm, central, terete, almost equal or slightly attenuated towards apex, solid; surface white, pruinose under a lens. Odour not distinctive. Spore-print not obtained.

Spores 7.5–10 x 6.5–8 (8.94±0.68 x 7.09±0.50) μm, Q=1.13–1.41, Qm=1.26, nodulose, yellowish brown. Basidia 20–35 x 9–13 μm, clavate, 4-spored; sterigmata up to 4 μm long. Lamella-edge almost sterile with occasional basidia. Cheilocystidia of two types: metuloidal and non-metuloidal; metuloidal cystidia 39–62.5 x 20–31.5 μm, obclavate, with a crystalloid cap, thick-walled (up to 5 μm), hyaline; non-metuloidal cystidia 10–22.5 x 5–14.5 μm, clavate, vesiculose or obpyriform, crowded, thin- to slightly thick-walled, hyaline. Pleurocystidia metuloidal, 46.5–67.5 x 21.5–32.5 μm, with a crystalloid cap, thick-walled, hyaline. Hymenophoral trama regular; hyphae 2–22 μm wide, inflated, thin-walled, hyaline. Pileal trama parallel-interwoven; hyphae 2–21.5 μm wide, thin-walled, hyaline. Pileipellis an

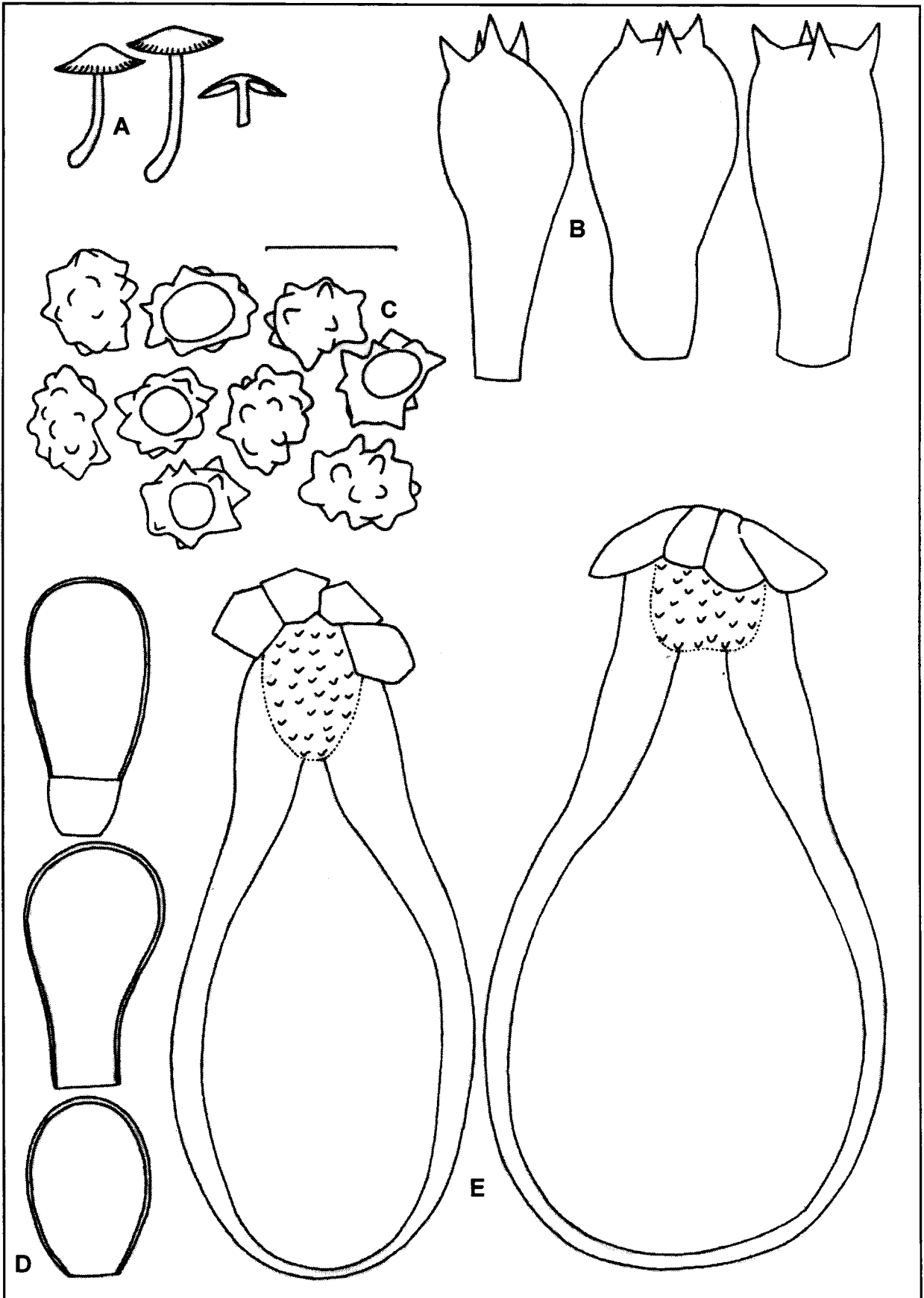


Fig. 39(a). *Inocybe* sp. 3. A. Habit x 1; B. Basidia; C. Spores; D. Non-metuloidal cheilocystidia; E. metuloidal cheilocystidia. Scale bar = 10 μ m

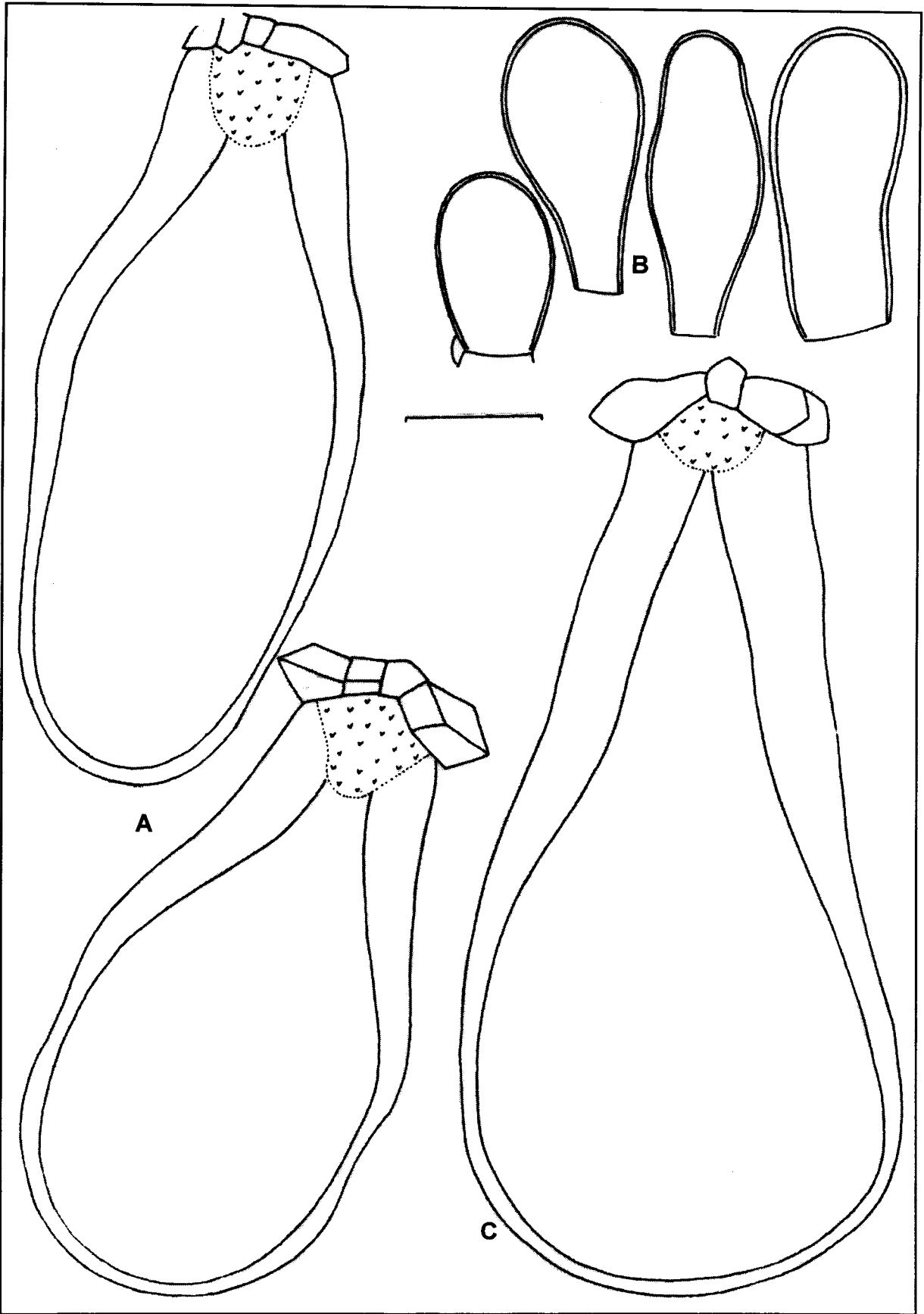


Fig. 39 (b). *Inocybe* sp. 3. A. Pleurocystidia; B. Non-metuloidal caulocystidia; C. Metuloidal caulocystidium. Scale bar = 10 μ m

ixocutis with 2–5.5 μm wide, filamentous hyphae, thin-walled, hyaline. Stipe trama composed of 2–20 μm wide, parallel hyphae, thin-walled, hyaline. Stipitipellis a cutis; hyphae 1.5–10.5 μm wide, thin-walled, hyaline. Caulocystidia of two types: metuloidal and non-metuloidal; metuloidal cystidia 42.5–82.5 x 19–42.5 μm , scattered, with a crystalloid cap, thick-walled, hyaline; non-metuloidal cystidia 10.5–26.5 x 5–12 μm cylindric, clavate, utriform or vesiculose, in clusters around metuloids, thin- to slightly thick-walled, hyaline. Clamp-connexions present on all hyphae, but inconspicuous.

On the forest floor, on riverbank, mostly around *Hopea parviflora* Beddome (Dipterocarpaceae) trees, scattered, July-October.

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 17 July 1997, A. Thomas T107; 11 August 1997, A. Thomas T107c; 1 October 1997, A. Thomas T107d.

Macroscopically the Kerala collections are strikingly similar to *Astrosporina alboviscida* Horak (section *Marginatae* Kühner) described from Papua New Guinea but that species has smaller spores and spermatic odour. In addition that species has only metuloidal cheilocystidia and the thin-walled, clavate cheilocystidia, which cluster around the metuloids of our collection, are absent. Microscopically our specimens are similar to *Inocybe mixtilis* (Britzelmayr) Saccardo in many features but that species has fulvous to brassy yellow pileus, marginate-bulbous stipe base, duplex-type pileipellis, and brown membrane pigment as well as pigment encrustation on the hyphae of pileipellis.

***Inocybe* sp. 4**

Fig. 40 A-H; Plate 14 A

Pileus 20–40 mm diam., conico-convex becoming applanate with a sub-umbonate centre; surface initially pale orange (5A3), light orange (5A4) or greyish orange (5B3), with age the whole surface or the centre alone becoming brownish orange (6C5, 6C6) or light brown (6D5, 6D6), faintly squamulose especially towards the disc, radially fibrillose to minutely rimose under a lens, dry; margin decurved to plane, almost entire, sometimes finely fissile or eroded. Context white with an orange tint. Lamellae adnexed, pale orange (5A2) or light

orange (5A3) when young, turning to light brown (6D5) or brown (6E6, 7E6, 6E8) with age, crowded to subcrowded, up to 2.5 mm broad, with lamellulae of different lengths; edge paler or concolorous with the sides, fimbriate under a lens. Stipe 20–40 x 2.5–5 mm, central, terete, almost equal or broader towards both ends, solid; surface pale orange (5A2), light orange (5A3) or greyish orange (5B3), pruinose, sometimes with faint grooves; base with a broad hyphal mat, at times sub-marginate. Odour unpleasant. Spore-print not obtained.

Spores 6.5–9 x 5–7 (7.31 ± 0.69 x 6.02 ± 0.51) μm , nodulose, $Q=1.09$ – 1.33 , $Q_m=1.21$, yellow-brown, thin-walled. Basidia 21.5–30.5 x 5.5–9 μm , clavate to cylindrical, often with a slight constriction, 4-spored; sterigmata up to 5.5 μm long. Lamella-edge heteromorphous. Cheilocystidia of two types - metuloidal and non-metuloidal. Metuloidal cystidia 34–60 x 17.5–26.5 μm , obclavate to subfusoid, with a crystalloid cap and a very thick wall (up to 7 μm), hyaline or yellowish to yellowish brown. Non-metuloidal cystidia 10–27.5 x 5–13 μm , vesiculose, clavate or pyriform, thin- to slightly thick-walled, light yellow to hyaline, in dense clusters. Pleurocystidia metuloidal, similar to metuloidal cheilocystidia in all aspects. Hymenophoral trama regular; hyphae 2–16.5 μm wide, thin-walled, hyaline to light yellow, sometimes faintly encrusted. Pileal trama interwoven; hyphae 2–22.5 μm wide, thin- to thick-walled, hyaline or at times faintly encrusted with a light yellow pigment. Pileipellis a disrupted cutis of 2–15 μm wide hyphae, thin-walled, encrusted with a yellowish brown pigment. Stipe trama composed of parallel, 2–15 μm wide hyphae, thin-walled, with light yellow wall pigment. Stipitipellis a cutis; hyphae 1.5–8 μm wide, thin-walled, with yellowish brown to yellow wall pigments, sometimes faintly encrusted. Caulocystidia two types - metuloidal and non-metuloidal, similar to cheilocystidia in every respect. Clamp-connexions present in all tissues.

On the forest floor, scattered, October-December.

Specimens examined: India, Kerala State, Wayanad District, Meppady: 31 December 1997, A. Thomas T231; 8 October 1998, A. Thomas T231b; 1 December 1998, A. Thomas T231c.

The present collections seem to represent an undescribed species. In all macroscopic

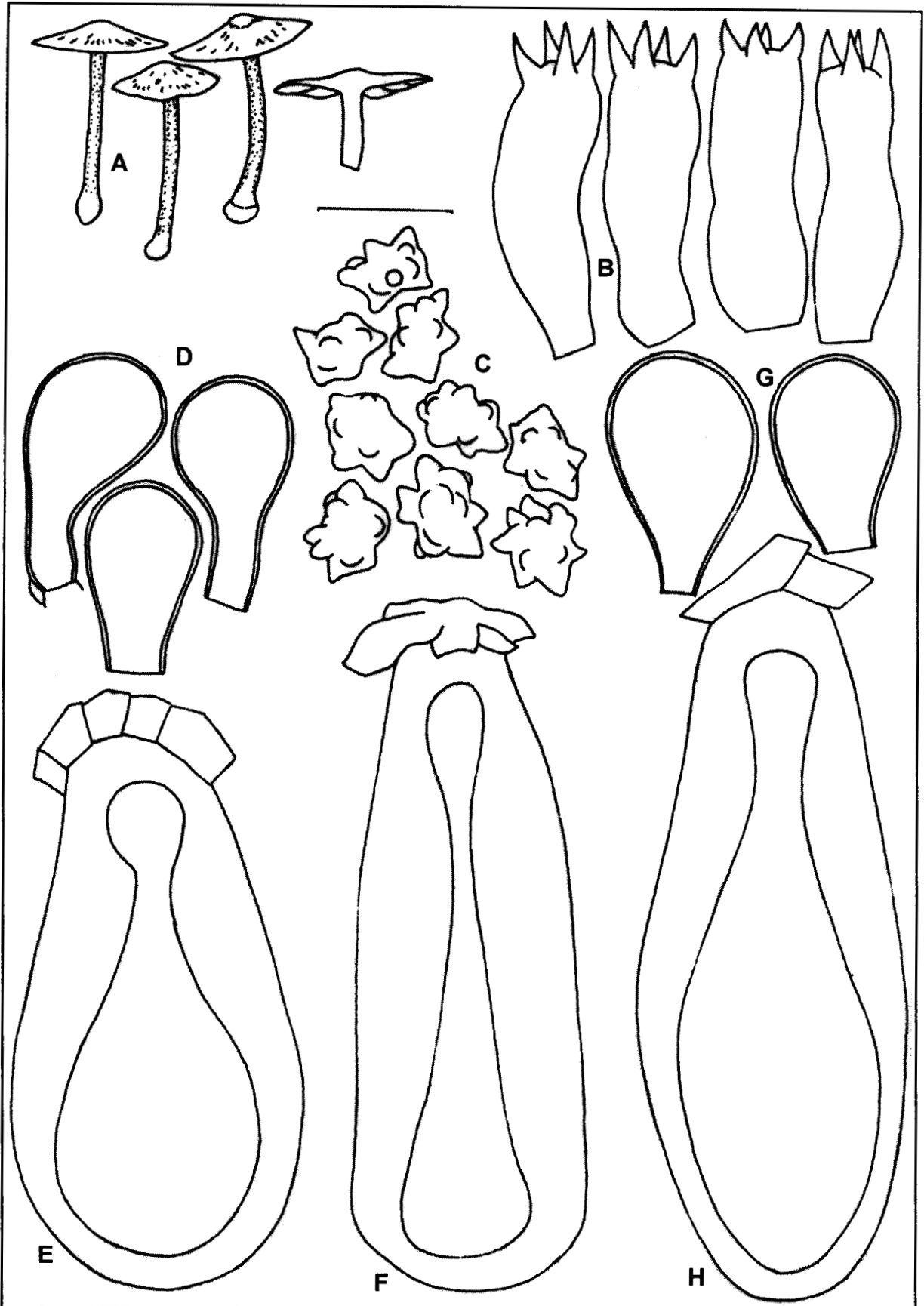


Fig. 40. *Inocybe* sp. 4. A. Habit x 1; B. Basidia; C. Spores; D. Non-metuloidal cheilocystidia; E. Metuloidal cheilocystidium; F. Pleurocystidium; G. Non-metuloidal caulocystidia; H. Metuloidal caulocystidium. Scale bar = 10 μ m

and in most microscopic characters they are indistinguishable from *Astrosporina angustifolia* Corner & Horak, but the Kerala collections have cheilocystidia of two types: metuloidal and non-metuloidal. The metuloidal cystidia are obclavate with an extremely thick wall (up to 7 μm) as against the fusoid metuloids of *A. angustifolia* with a less thick (up to 4 μm) wall. The clavate, non-metuloidal cystidia are not reported for *A. angustifolia* (see Horak, 1979). *Astrosporina lutea* Kobayasi & Hongo, which is very close to *A. angustifolia*, can also be separated by the same cystidial characters. *Inocybe umbratica* Quélet is similar in many features but its metuloidal morphology is different and all parts of its basidioma are whitish at first.

***Inocybe* sp. 5**

Figs. 41(a) A-E & 41(b) A-C; Plate 14 B

Pileus 15–40 mm diam., conico-convex, becoming applanate, disc broadly umbonate or sometimes slightly depressed; surface brown (6E4, 6E6, 7E4) or darker towards the centre, elsewhere plicate-striate with brownish orange (6C4), light brown (6D4, 6D5) or brown (6E6) ridges and off-white, orange white (5A2) or pale orange (5A3) furrows, dull, dry; margin decurved to plane, almost entire to crenate. Context white, up to 2.5 mm thick at the centre. Lamellae adnexed to almost free, white, turning to brownish orange (6C5, 6C6), light brown (6D6, 7D6) or brown (6D7, 7D7), close, up to 4.5 mm wide, with lamellulae of 3–4 lengths; edge pale, fimbriate under a lens. Stipe 30–60 x 2.5–6 mm, central, terete, slightly tapering apically and with a somewhat bulbous, submarginate base, fistulose; surface light orange (5A3) or greyish orange (6B3), pruinose under a lens. Odour unpleasant. Spore-print not obtained.

Spores 10.5–14 x 9–11.5 (12.28 \pm 0.70 x 9.84 \pm 0.66) μm , Q=1.11–1.46, Qm=1.25, nodulose to sub-stellate, yellowish brown, spines up to 3 μm long. Basidia 25–44 x 10.5–15.5 μm , clavate, 4-spored, sterigmata up to 7.5 μm long. Lamella-edge heteromorphous, with two types of cheilocystidia - metuloidal and non-metuloidal. Metuloidal cystidia 40.5–68 x 16.5–24 μm , utriform, scattered, wall up to 5 μm thick, hyaline. Non-metuloidal cystidia 13–27.5 x 9–15 μm , clavate, vesiculose or obpyriform, in clusters, thin- to slightly thick-

walled, hyaline. Pleurocystidia metuloidal, similar to metuloidal cheilocystidia in all respects. Hymenophoral trama regular; hyphae of the middle region comparatively wider or inflated (2–29 μm wide), flanked by narrower (up to 8 μm wide) hyphae on either sides; both types of hyphae thin-walled, hyaline. Pileal trama parallel-interwoven; hyphae 1.5–25 μm wide, inflated, thin-walled, hyaline, or sometimes encrusted. Pileipellis a cutis; hyphae 2.5–12 μm wide, thin-walled, encrusted with yellowish brown pigment. Stipe trama composed of 2–21.5 μm wide, parallel hyphae, thin-walled, hyaline. Stipitipellis a cutis; hyphae 2–10 μm wide, thin-walled, hyaline. Caulocystidia two types - metuloidal and non-metuloidal, former occurring either in clusters or scattered, surrounded by dense clusters of non-metuloidal cystidia, similar to cheilocystidia in all aspects. Clamp-connexions present in all parts of the basidioma.

On the forest floor, gregarious to scattered, July-November.

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 17 July 1997, A. Thomas T109; 22 July 1997, A. Thomas T109b; 1 October 1997, A. Thomas T109d; 20 November 1997, A. Thomas T109e.

These collections are characterized by distinctly plicate-striate pileus with brownish ridges and whitish furrows; subbulbous, submarginate base of stipe; and large (>10 μm), nodulose-stellate spores. This combination of features makes it quite distinct from all hitherto described species of *Inocybe*. It seems to be very close to *Asterosporina avellanea* Horak and *Inocybe asterospora* Quélet owing to the marginate-bulbous stipe base, pruinose stipe surface, large nodulose to stellate spores and the metuloidal cystidia with crystalloid caps. However, the plicate-striate pileus makes the Kerala collections quite distinct. *Asterosporina avellanea* differs also in having conspicuous conic umbo and smaller spores. *Inocybe asterospora* also has conspicuous, conic umbo. *Inocybe imbricata* Peck, a North American species seems to be similar in several features but has non-plicate pileus, adnate lamellae and smaller spores.

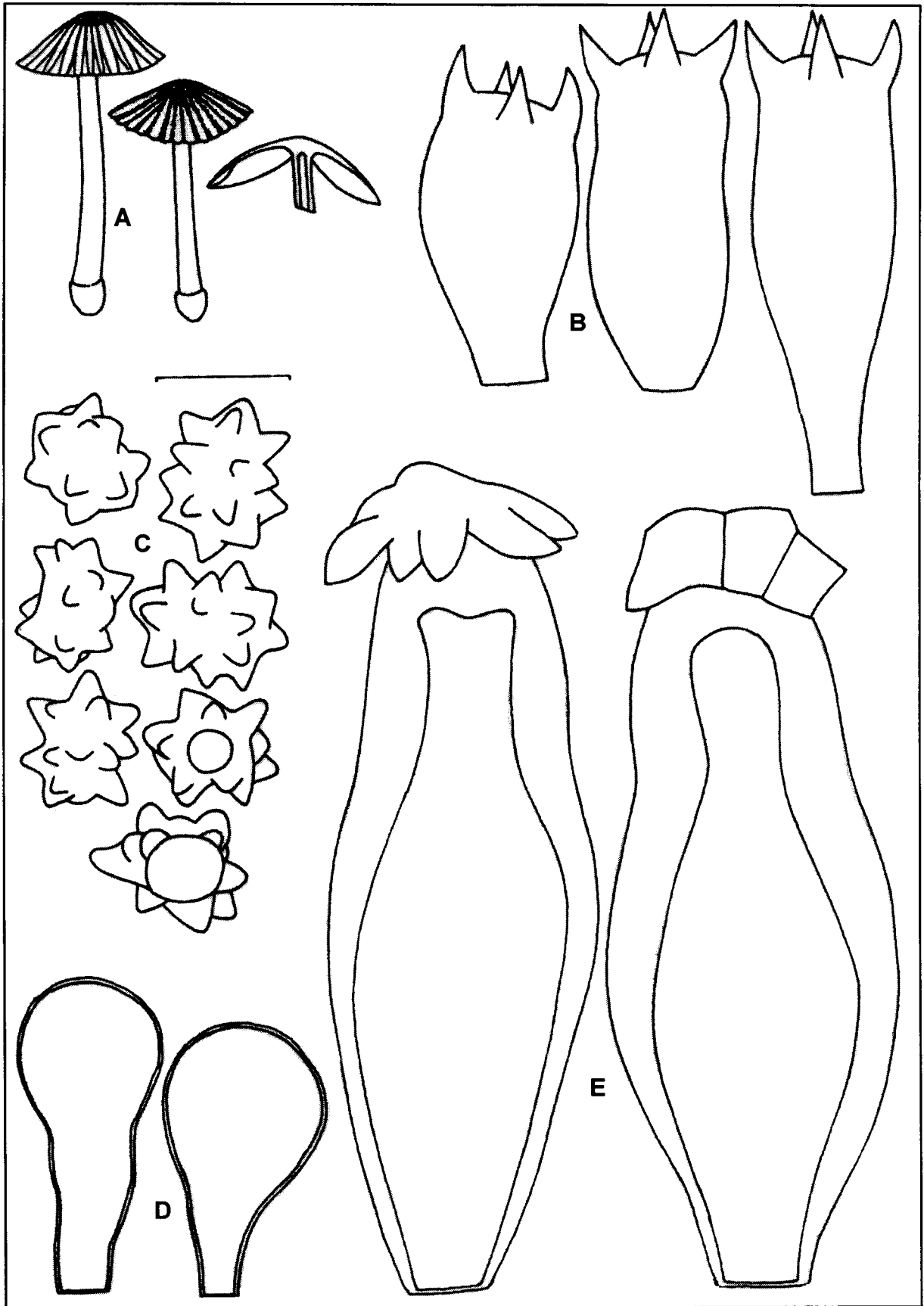


Fig. 41(a). *Inocybe* sp. 5. A. Habit x 1; B. Basidia; C. Spores;
 D. Non-metuloidal cheilocystidia; E. Metuloidal cheilocystidia; Scale bar = 10 μ m

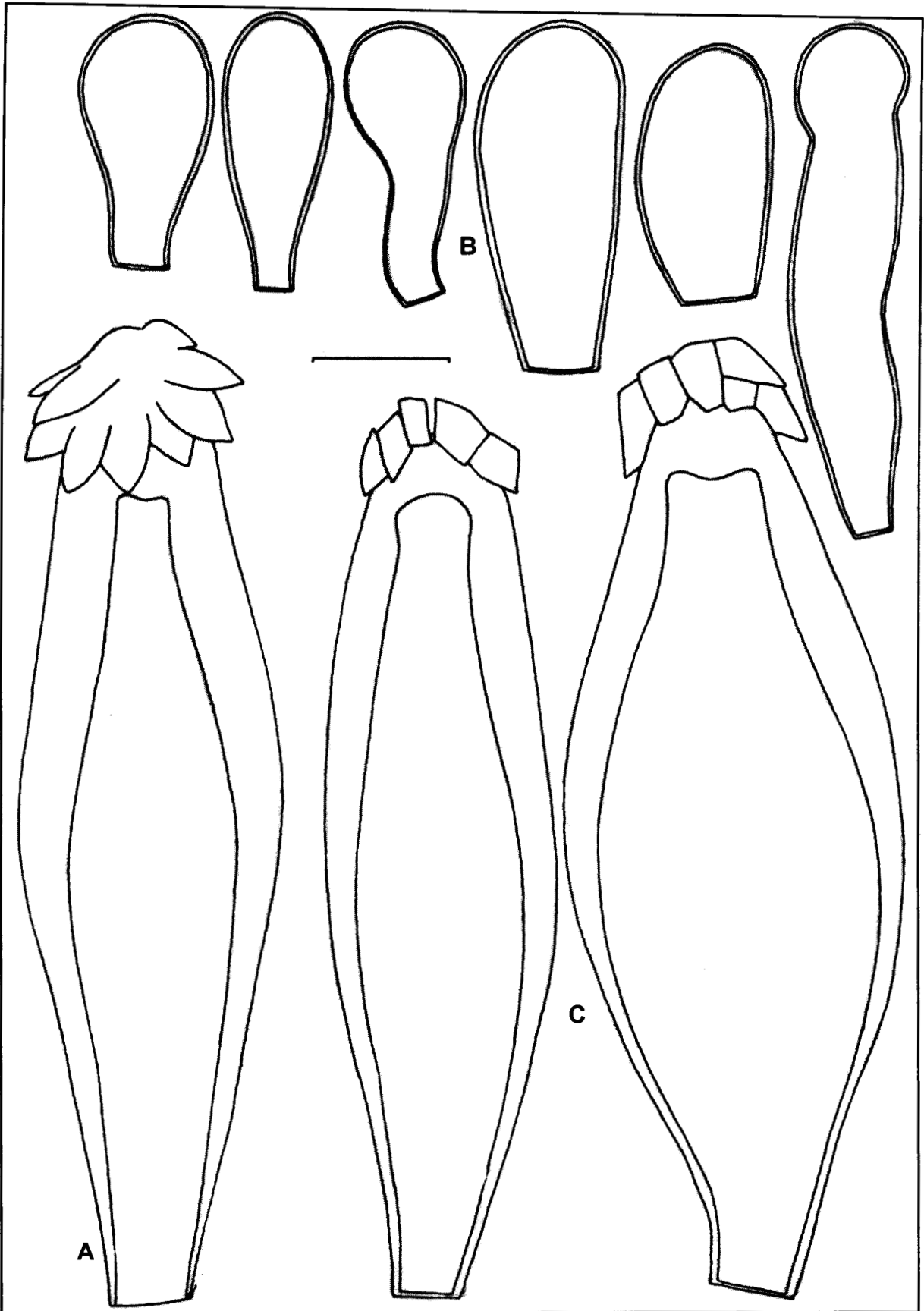


Fig. 41(b). *Inocybe* sp. 5. A. Pleurocystidium; B. Non-metuloidal caulocystidia; C. Metuloidal caulocystidia. Scale bar = 10 μ m

***Inocybe* sp. 6**

Figs. 42(a) A-D & 42(b) A-C; Plate 14C

Pileus 7–30 mm diam., conico-convex, turning to convex or plano-convex with a papillate to acute umbo at the disc; surface brown (6E6, 6E7, 7E6) or dark brown (6F7, 6F8, 7F7), sometimes slightly paler at margin, glabrous, mostly rimose towards margin, at times prominently grooved radially, dry, dull; margin incurved to decurved, almost entire, sometimes fissile or eroded. Context up to 3 mm thick at the centre, whitish. Lamellae adnexed, almost greyish orange (5B3) to brownish orange (5C4) when young, turning to brown (6E6) at maturity, subcrowded, up to 5 mm wide, with lamellulae of 3–4 lengths; edge paler or whitish, scalloped under a lens. Stipe 15–40 x 2–6.5 mm, central, terete, almost equal or slightly tapering apically, solid to fistulose; surface greyish orange (5B3) to light brown (6D5, 6D6), pruinose towards apex, almost velutinous towards base. Odour not distinctive. Spore-print light brown (6D6).

Spores 5–10.5 x 4–7.5 ($7.66 \pm 1.62 \times 5.95 \pm 1.07$) μm , $Q=1.0\text{--}1.54$, $Q_m=1.28$, nodulose to angular, yellowish brown, slightly thick-walled. Basidia 22.5–36.5 x 7–10 μm , pedicellate-clavate, 4-spored; sterigmata up to 4 μm long (most of the basidia collapsed in mature basidiomata). Lamellae-edge heteromorphous. Cheilocystidia 32.5–67.5 x 11.5–29 μm , scattered, utriform to broadly utriform, metuloidal, with or without crystalline encrustations at the apex, at times branched, hyaline, with an unevenly thickened wall especially towards apex. Pleurocystidia resembling cheilocystidia in all respects. Hymenophoral trama subregular; hyphae 2–28 μm wide, inflated, thin-walled, pale yellowish brown. Pileal trama parallel-interwoven; hyphae 2–25.5 μm wide, thin-walled, pale yellowish brown. Pileipellis a cutis; hyphae 2–16.5 μm wide, thin-walled, encrusted with a brown pigment. Stipe trama composed of 2–19.5 μm wide hyphae, thin-walled, light yellowish brown, faintly encrusted. Stipitipellis a cutis; hyphae 2–12.5 μm wide, thin-walled, encrusted with a yellowish brown pigment. Caulocystidia 21.5–142.5 x 7–23 μm , flexuous, clavate or fusoid, rarely branched, in clusters or scattered, thin- to slightly thick-walled, light yellowish brown, sometimes faintly encrusted, occasionally intermixed with paracystidia of 12.5–25.5 x 5–12 μm , thin- to slightly thick-walled. Clamp-connexions present in all parts of the basidioma.

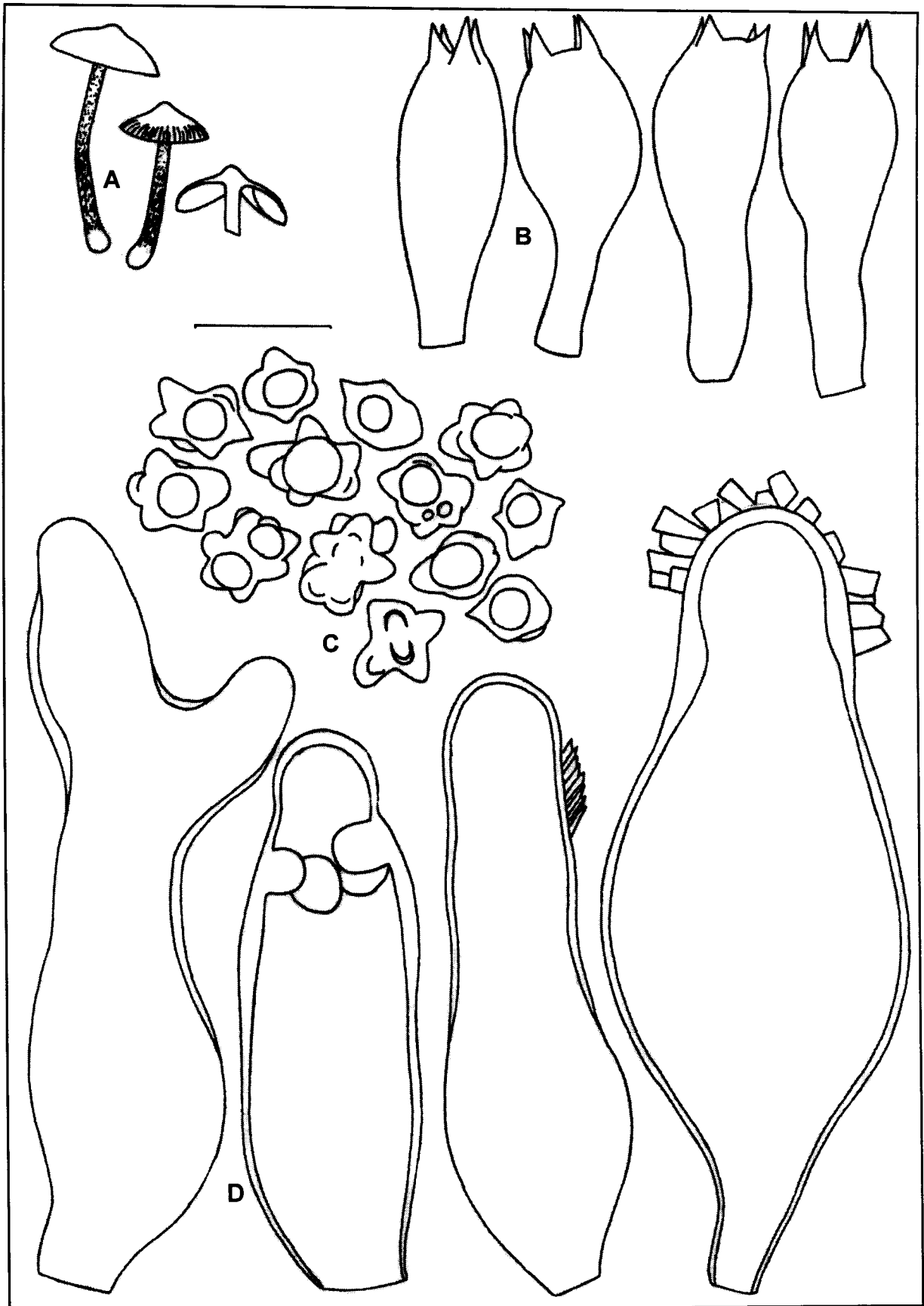


Fig. 42(a). *Inocybe* sp. 6. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia. Scale bar = 10 μ m

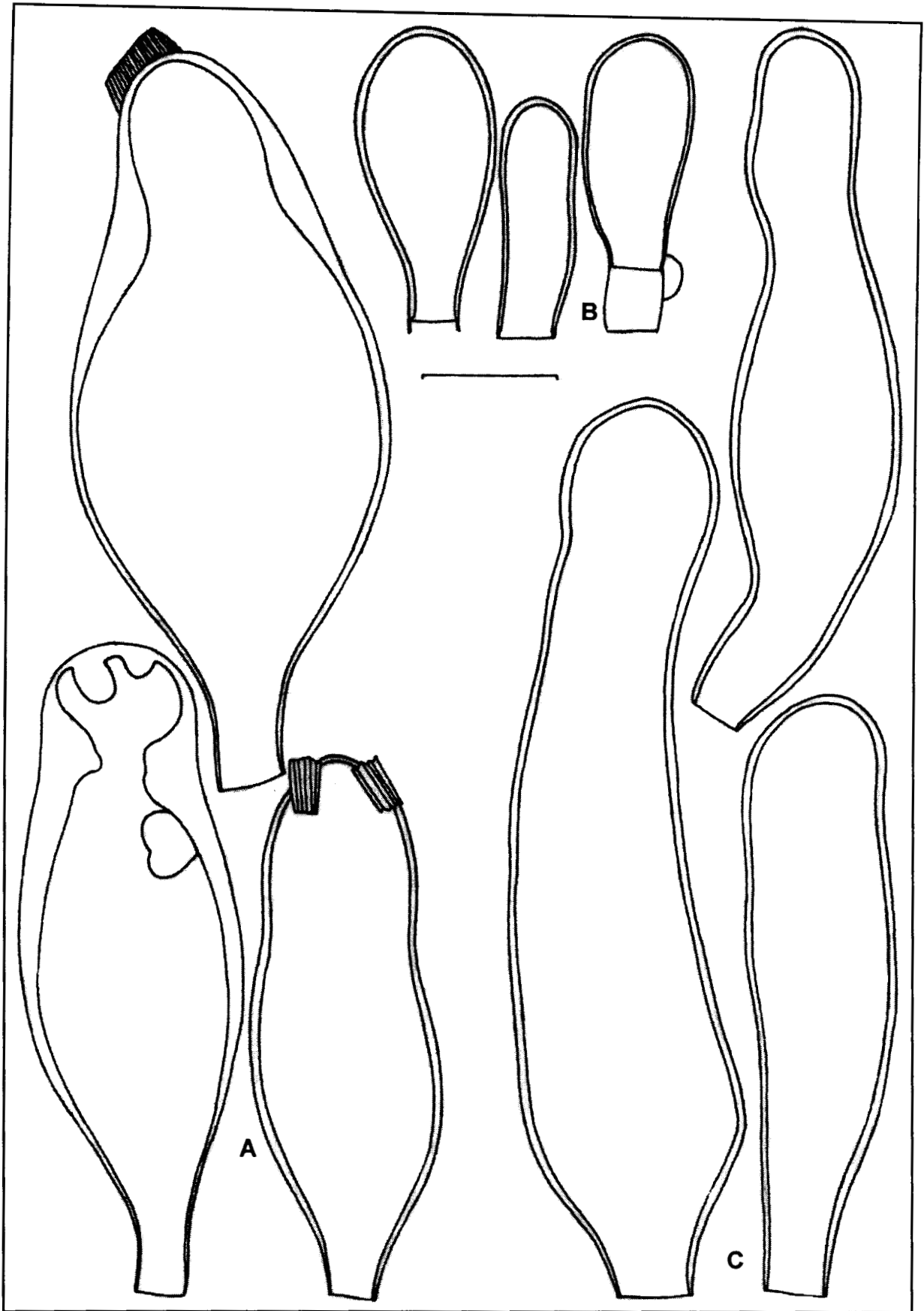


Fig. 42(b). *Inocybe* sp. 6. A. Pleurocystidia; B. Paracystidia; C. Caulocystidia. Scale bar = 10 μ m

On the ground, under acacia (*Acacia melanoxylon* Robert Brown, Mimosaceae) trees, in groups or scattered, August-October.

Specimens examined: India, Kerala State, Idukki District, Munnar: 8 August 1999, A. Thomas T323; 11 October 1999, A. Thomas T323b; 12 October 1999, A. Thomas T323c.

These collections seem to represent an as yet undescribed species as they are not agreeing with any known species of *Inocybe* or *Astrosporina*. They are characterized by 1) brownish glabrous pileus with an acute umbo; 2) a stipe with a slightly enlarged, non-marginate base and a pruinose to velutinate surface; 3) absence of distinctive odour; 4) nodulose to angular spores; utriform, metuloidal cheilocystidia and pleurocystidia with unevenly thickened wall; and 5) flexuous caulocystidia. *Inocybe asterospora* Quélet is similar in many characters but the marginate bulbous stipe, the larger spores and the differently shaped caulocystidia make it distinct.

***Inocybe* sp. 7**

Figs. 43(a) A-E & 43(b) A-C; Plate 15 A

Pileus 5–15 mm diam., conic to conico-convex, at times convex, with a papillate or acute umbo; surface brownish orange (5C6, 6C6) towards disc, greyish orange (5B4, 5B5) towards margin, faintly rimose towards margin, dull, dry; margin decurved, crenate, sometimes fissile. Context off-white with a brownish tint. Lamellae adnexed, greyish orange (5B4) to light brown (6D6), subcrowded to close, up to 3.5 mm wide, with lamellulae of 3 lengths; edge pale, faintly fimbriate under a lens. Stipe 15–30 x 1–2.5 mm, central, terete, equal or slightly attenuated towards apex, solid; surface greyish orange (5B4) to brownish orange (6C6) or light brown (6D6), pruinose over entire surface; base slightly swollen. Odour not distinctive. Spore-print not obtained.

Spores 8–11.5 x 4.5–6.5 (9.64 ± 0.84 x 5.39 ± 0.52) μm , $Q=1.53\text{--}2.14$, $Q_m=1.80$, amygdaliform to ellipsoid, yellowish brown, smooth, thin-walled, with a small apical germ-pore. Basidia 24–36.5 x 7–10.5 μm , clavate, 4-spored; sterigmata up to 4.5 μm long. Lamella-edge heteromorphous. Cheilocystidia two types: metuloidal and non-metuloidal. Metuloidal cystidia 35–79 x 8–19.5 μm , either in clusters or scattered, fusoid-ventricose, apically

encrusted with crystals, thick-walled (up to 4 μm), hyaline or pale yellowish. Non-metuloidal cystidia 12.5–29 x 5.5–15 μm , clavate, pyriform or vesiculose, thin to slightly thick-walled, hyaline to pale yellow. Pleurocystidia metuloidal, scattered, similar to metuloidal cheilocystidia in size and shape. Hymenophoral trama regular; hyphae 1.5–21.5 μm wide, inflated, thin-walled, hyaline to pale yellow, sometimes faintly encrusted. Pileal trama parallel-interwoven; hyphae 1.5–22 μm wide, inflated, thin-walled, hyaline or pale yellow. Pileipellis a repent cutis; hyphae 2–7 μm wide, narrow and sparsely septate, with a thick, brown wall without encrustation; tramal hyphae beneath the pileipellis somewhat inflated and closely septate, thin-walled, with encrustation. Stipe trama composed of 15–20.5 μm wide hyphae, thin-walled, hyaline. Stipitipellis a cutis; hyphae 2–5 μm wide, thin-walled, sometimes faintly encrusted, pale yellowish brown. Caulocystidia two types: metuloidal and non-metuloidal. Metuloids 29–96.5 x 11.5–21.5 μm , either in clusters or scattered, broadly ventricose below with a tapering, obtuse apex, apices mostly encrusted with crystals, up to 4 μm thick; non-metuloidal cystidia 12.5–35 x 6.5–17.5 μm , clavate to vesiculose, thin- to slightly thick-walled, sparse, hyaline to pale yellow. Clamp-connexions present in all parts of the basidioma.

On the ground, gregarious to scattered, August.

Specimens examined: India, Kerala State, Idukki District, Munnar: 30 August 1997, A. Thomas T155; 31 August 1997, A. Thomas T155b.

This species is characterized by an acutely umbonate, faintly rimose pileus; non-reddening context; stipe which is pruinose over the entire surface; amygdaliform spores with a small but distinct germ-pore; and metuloidal cheilo-, pleuro- and caulocystidia. It seems to belong to the subgenus *Inocibium* (Earle) Singer section *Splendentes* Singer. The most distinctive feature of this species is the presence of a germ-pore at the apex of the spores which is shared by only two other species of *Inocybe*: *I. subporospora* Kuyper and *I. luteipes* J. Favre (Kuyper, 1986). The latter two species, however, differ in several other features.

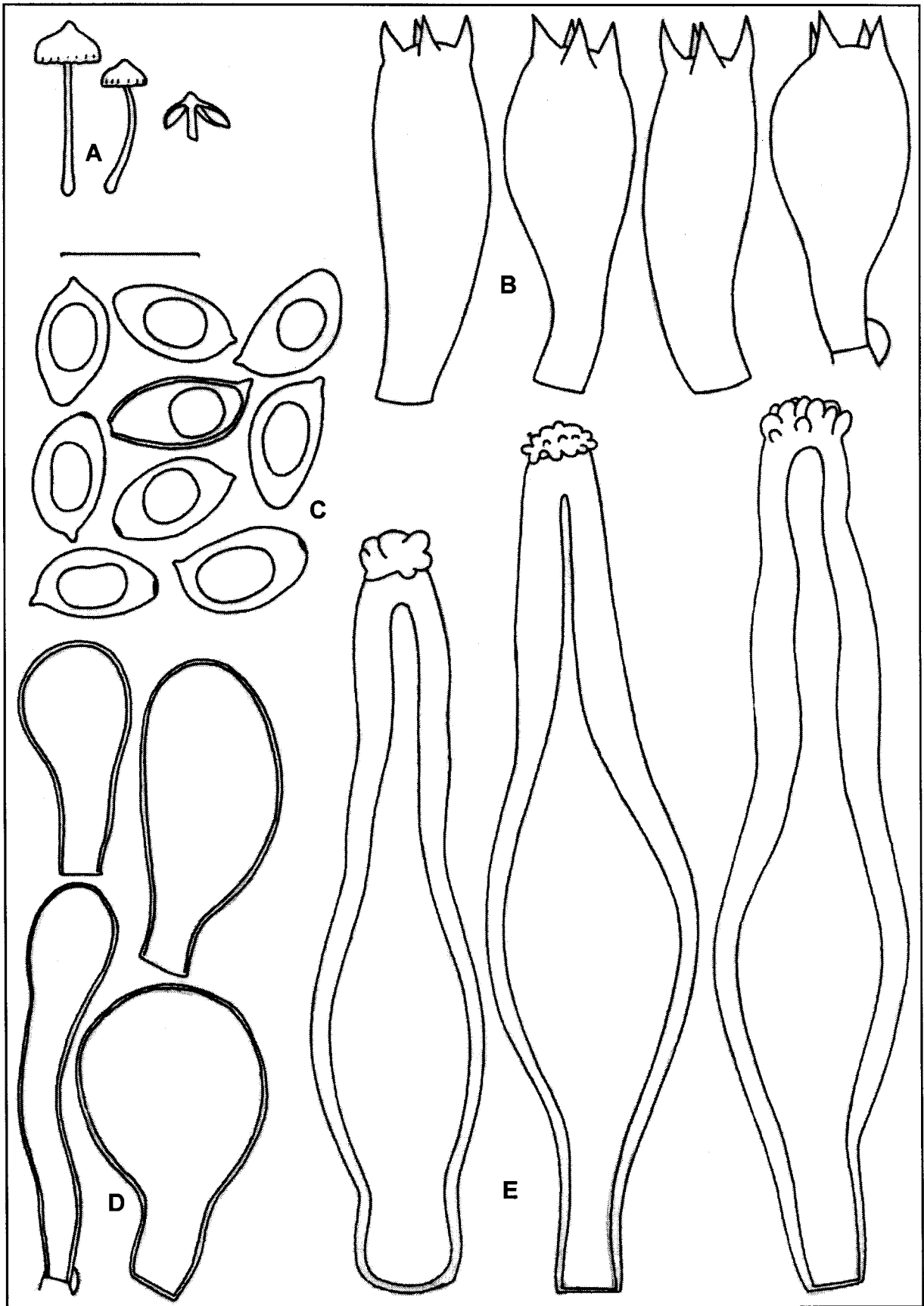


Fig. 43(a). *Inocybe* sp. 7. A. Habit x 1; B. Basidia; C. Spores; D. Non-metuloidal cheilocystidia; E. Metuloidal cheilocystidia. Scale bar = 10 μ m

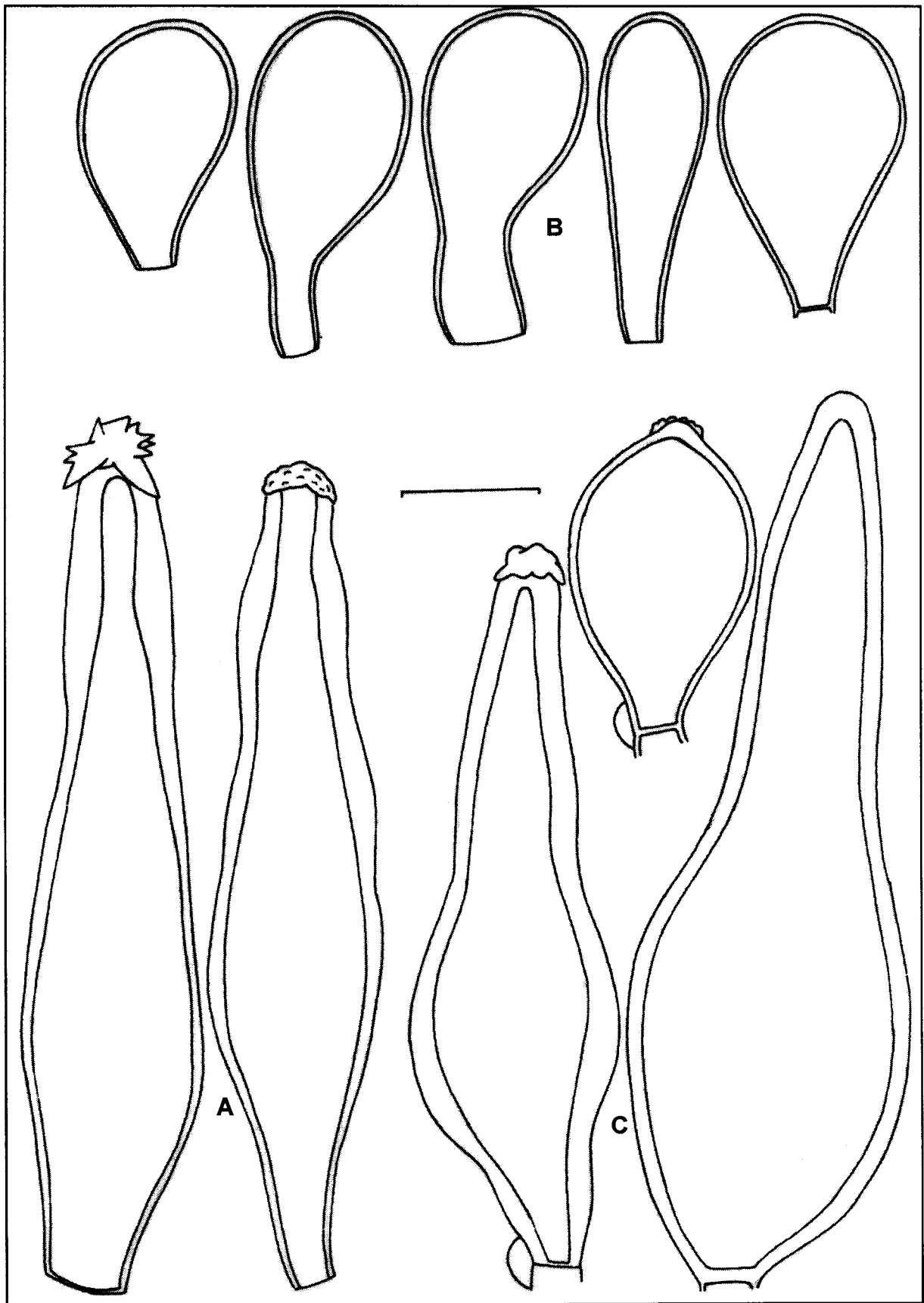


Fig. 43(b). *Inocybe* sp. 7. A. Pleurocystidia; B. Non-metuloidal caulocystidia; C. Metuloidal caulocystidia. Scale bar = 10 μ m

***Inocybe* sp. 8**

Fig. 44 A-E; Plate 15 C

Pileus 10–35 mm diam., hemispherical, becoming convex to plano-convex, disc mostly becoming slightly depressed at maturity; surface brown (6D7, 6E8, 7E8) to dark brown, all over covered with small, concolorous squamules, sometimes rimose towards margin, dull, dry; margin decurved to plane, almost entire when young, at times irregularly wavy on maturity, sometimes fissile. Context up to 2 mm thick at the centre, white or with a yellow (4A2) tint. Lamellae adnate to slightly subdecurrent, brown (6E7, 6E8), to dark brown, subcrowded to close, up to 5 mm wide, with lamellulae of 3–4 lengths, edge whitish, fimbriate under a lens. Stipe 15–35 x 2–5 mm, central, terete, slightly tapering towards apex, sometimes broader towards both ends, solid, at times hollow; surface concolorous with the pileus, or pale or light orange (5A3 or 5A4) at apex and brown (6E7, 6E8) towards base, covered with small concolorous squamules, slightly fibrillose-striate, sometimes with fibrillose annular remnants; base slightly bulbous. Odour not distinctive. Spore-print yellowish brown (5E8).

Spores 8–12.5 x 4.5–7 (10.45±1.31 x 5.64±0.69) µm, Q=1.55–2.25, Qm=1.87, ellipsoid to oblong, rarely sub-amygdaliform or phaseoliform, yellowish brown, smooth, thin-walled, without an apical germ-pore. Basidia 27.5–52.5 x 7–10 µm, clavate, frequently containing a yellowish brown pigment, 4-spored; sterigmata up to 7.5 µm long. Lamella-edge heteromorphous with crowded cheilocystidia. Cheilocystidia 16.5–57.5 x 8–20.5 µm, cylindrical, clavate, fusoid or flexuous, with a thin- to slightly thick, hyaline to light yellowish brown wall, rarely with a resinous substance at the apex. Pleurocystidia none. Hymenophoral trama regular; hyaline 2–21.5 µm wide, thin-walled, sometimes encrusted, with light yellow to hyaline wall. Pileal trama parallel interwoven; hyphae 2–14 µm wide, sometimes faintly encrusted, thin-walled, with a hyaline to pale yellow wall. Pileipellis a disrupted cutis; hyphae 3–12.5 µm wide, thin- to slightly thick-walled, with yellowish brown encrusting pigment. Stipe trama composed of 2–15.5 µm wide, thin-walled, light yellow to hyaline hyphae. Stipitipellis a slightly disrupted cutis; hyphae 2.5–12 µm wide, thin- to slightly thick-walled, encrusted with a yellowish brown pigment. Caulocystidia 14–56.5 x 5.5–19 µm, similar to cheilocystidia in

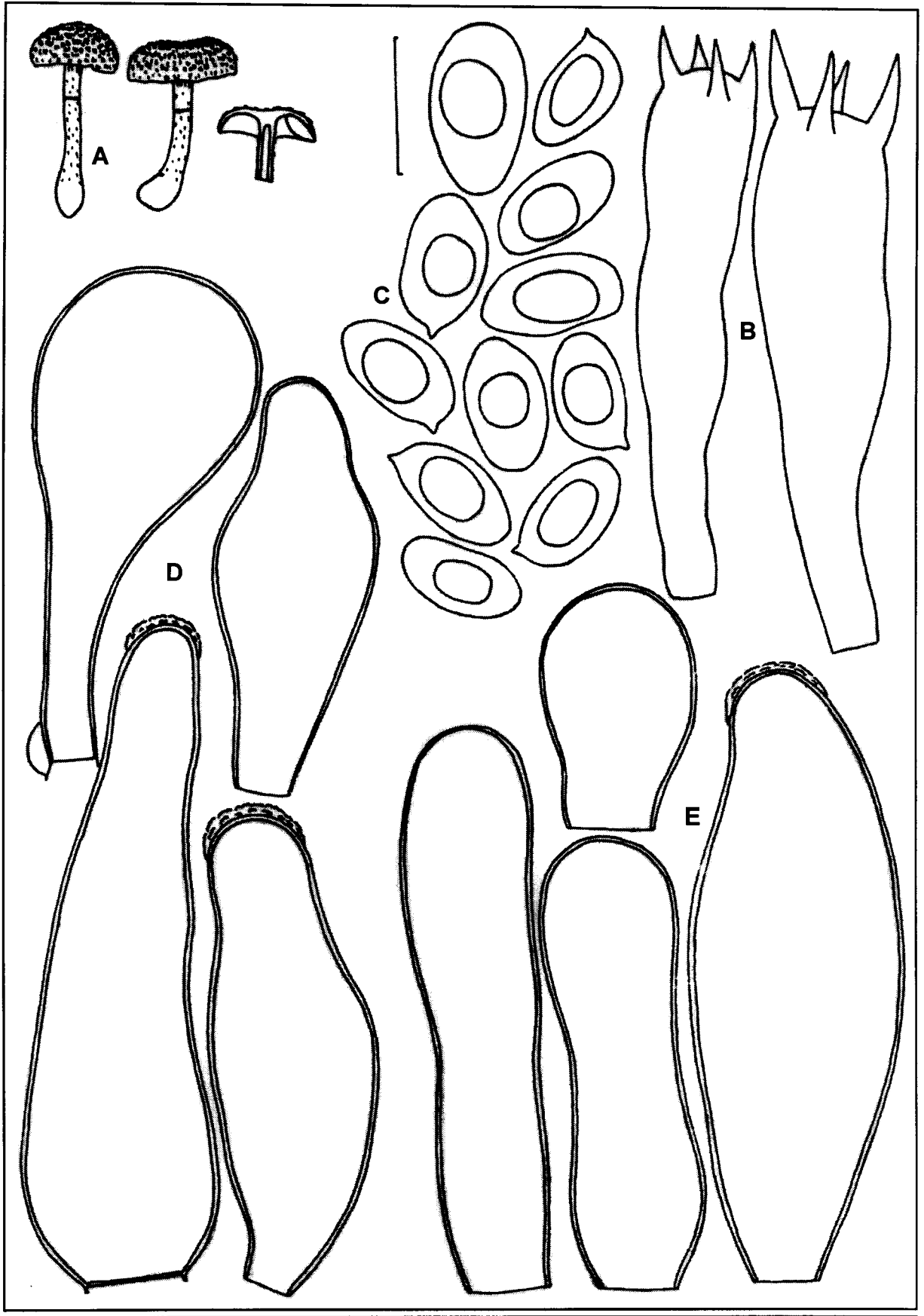


Fig. 44. *Inocybe* sp. 8. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Caulocystidia. Scale bar = 10 μ m

shape, thin- to slightly thick-walled, sometimes encrusted, hyaline to light yellowish brown, restricted towards the apex of the stipe, either in clusters or scattered. Clamp-connexions present in all parts of the basidioma.

On the forest floor, scattered, July-August.

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 17 July 1997, A. Thomas T111; 22 July 1997, A. Thomas T111b; 11 August 1997, A. Thomas T111c; 13 August 1997, A. Thomas T111d.

This species is characterized by dark brown squamulose pileus; brownish, squamulose stipe, evenly outlined ellipsoid to oblong spores; versiform cheilocystidia and caulocystidia, absence of pleurocystidia, and non-reddening context. Owing to this combination of features it can be placed in subgenus *Inosperma* Kühner, section *Depauperatae* Lange, but the author could not find a comparable species description in the literature with which it corresponds exactly. In macroscopic features and in the size and shape of spores it is somewhat close to *Inocybe hirsuta* (Lasch) Quélet but the reddening context of the latter is very distinctive.

Inocybe cutifracta Petch
in Ann. Roy. Bot. Gard., Peradeniya 6:201 (1917).

Fig. 45 A-D; Plate 15 C

Basidiomata medium-sized to large, robust. Pileus 30–75 mm diam., conico-convex or convex, turning applanate, subumbonate in some; surface initially entirely brown (7E6, 6E7) or dark brown (7F6, 7F7), later light brown (7D6, 6D7) brown (7E6) or dark brown (7F6) towards disc, fades towards margin to light brown (6D6) brownish orange (6C6), greyish orange (5B3) or pale orange (5A3), initially entirely covered by a very thin, sticky pellicle which soon disrupts and disappears, finally fibrillose-rimose to rimose, dull, dry; margin incurved initially, becoming decurved to almost upturned, entire, sometimes irregularly lobate, finally fissile. Context up to 4 mm thick at the centre, white with a brown tint or orange-white (5A2). Lamellae adnexed, becoming free, initially white, becoming orange grey (5B2, 6B2), grayish orange (5B3), brownish orange (6C3), or rarely light brown (6D4,

6D5), subcrowded, up to 4 mm wide, with lamellulae of different lengths; edge whitish, fimbriate. Stipe 50–85 x 5–12 mm, central, terete, equal or with a bulbous base in a few, solid; surface orange white (5A2), or pale orange (5A3) throughout, faintly longitudinally fibrillose in some, at times with small longitudinal cracks. Fresh basidiomata when crushed emit a mild but distinctive, somewhat unpleasant odour. Spore-print brown (6E7).

Spores 6.5–9 x 4.5–6 ($7.91 \pm 0.70 \times 5.42 \pm 0.46$) μm , $Q=1.26\text{--}1.61$, $Q_m=1.45$, ellipsoid, ovo-ellipsoid or subphaseoliform, yellowish brown, smooth, thin- to slightly thick-walled, without a germ-pore. Basidia 22.5–34 x 7–9 μm , clavate, 4-spored; sterigmata up to 4 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 16.5–57.5 x 4.5–12.5 μm , clavate or flexuous, often capitate, thin-walled, hyaline or with a yellowish brown or slightly refractive content. Pleurocystidia none. Hymenophoral trama regular; hyphae 2–26.5 μm wide, gradually becoming inflated towards the centre, thin-walled, hyaline to pale yellow. Pileal trama parallel; hyphae 2–25 μm wide, thin-walled, sometimes faintly encrusted, hyaline to pale yellow, occasionally intermixed with oleiferous hyphae having yellowish brown contents. Pileipellis a cutis; hyphae 2–20 μm wide, thin-walled, encrusted with a yellowish brown pigment, some hyphae with yellowish brown contents. Stipe trama parallel; hyphae 2–27.5 μm , thin-walled, sometimes faintly encrusted, hyaline to pale yellow. Stipitipellis a cutis; hyphae 2–11.5 μm wide, similar to pileipellis; at the extreme tip of the stipe, cutis gets disrupted to form bundles of ascending hyphae with clavate end cells. All hyphae with clamp-connexions.

On the ground, gregarious to scattered, June–November.

Specimens examined: India, Kerala State, Malappuram District, Calicut University Campus: 26 June 1996, A. Thomas T24; 12 August 1997, A. Thomas T24b; 11 August 2000, A. Thomas T24C; 18 August 2000, A. Thomas T24d; 24 August 2000, A. Thomas T24e.

The Kerala collections are indistinguishable from *Inocybe cutifracta* Petch, known only from Sri Lanka, except for the occasional, scattered cystidioid terminal cells of hyphae of the stipitipellis. According to Horak (1980a) and Pegler (1986), this species is a close

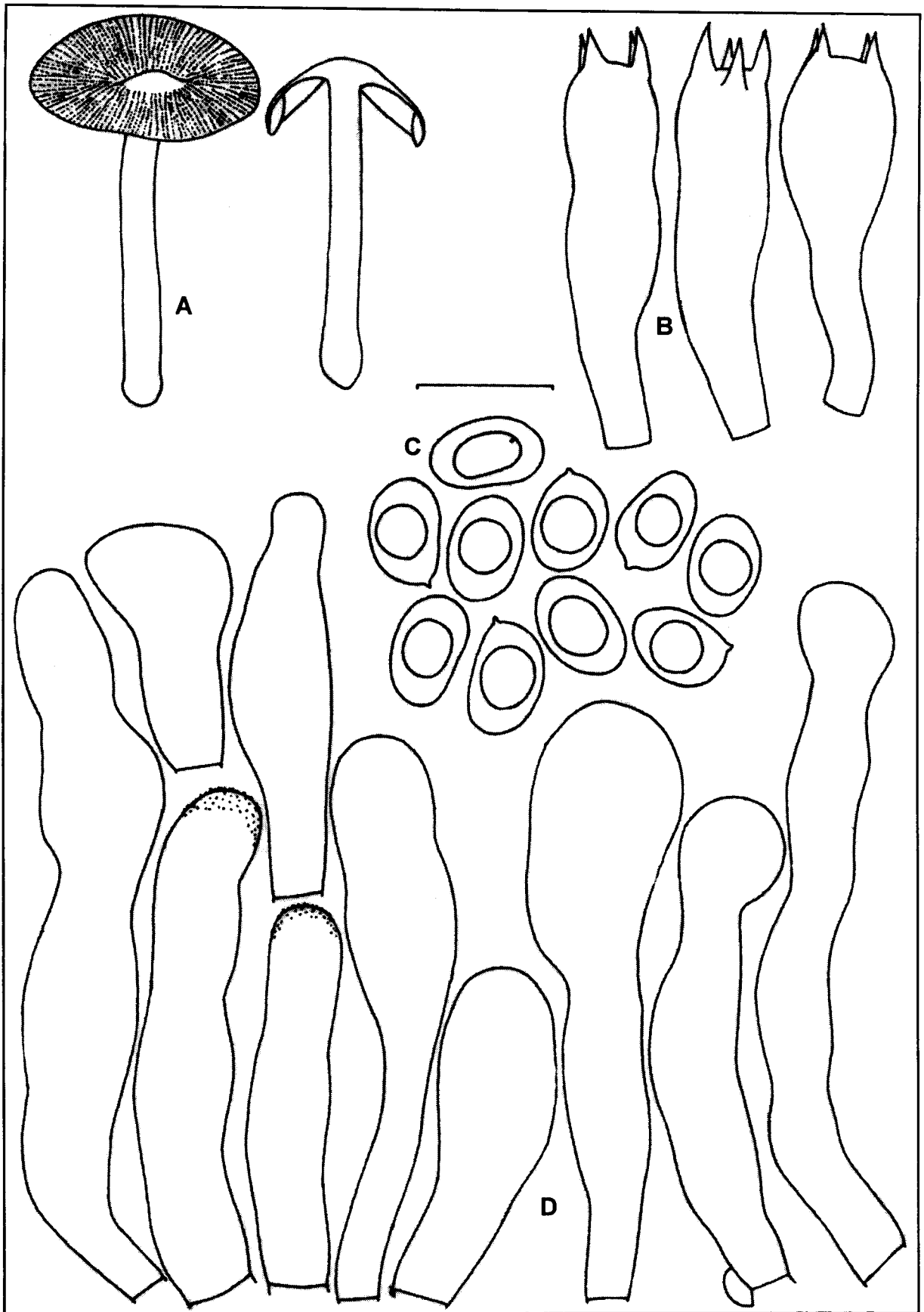


Fig. 45. *Inocybe cutifracta* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia. Scale bar = 10 μ m

relative of *I. fastigiata* (Schaeffer ex Fries) Quélet [= *I. Rimosa* (Bulliard: Fries) Kummer]. *Inocybe umbrina* Masee, a species widely distributed in Indomalaya and Australasia, is very similar in most characters. The author suspects that *I. cutifracta* is a synonym of *I. umbrina*. Examination of the type specimens of these two species is essential for a final verdict.

Inocybe rimosa (Bulliard: Fries) Kummer
in Fuhr. Pilzk.:78 (1871).

Fig. 46 A-E; Plate 16 A

Agaricus rimosus Bulliard: Fr. in Syst. mycol. 1 : 258 (1821).

Agaricus fastigiatus Schaeffer in Fung. Bavariae 4: 13 (1774)

Inocybe fastigiata (Schaeffer) Quélet in Mem. Soc. Emul. Montbeliard, ser. II, 5: 180 (1872).

Agaricus aurivenius Batsch in Elench. Fung. Cont. 1: 137 (1786).

Inocybe aurivenia (Batsch) Bresadola in Iconogr. Mycol. 15: pl. 726 (1930).

Agaricus curreyi Berkeley in Outl. Brit. Fungol.: 155 (1860).

Inocybe curreyi (Berkeley) Saccardo in Syll. Fung. 5: 776 (1887).

Inocybe brunnea Quélet in Bull..Soc. Amis Sci. nat. Rouen, ser. II, 15: 162 (1880).

Agaricus injunctus Britzelmayer in Dermis Sudbayern: 5 (1882).

Inocybe injuncta (Britzelmayer) Saccardo in Syll. Fung. 5: 776 (1887)

Agaricus servatus Britzelmayer in Ber. naturw. Ver. Augsburg 28: 154 (1885)

Inocybe servata (Britzelmayer) Saccardo in Syll. Fung. 11: 53 (1895).

Agaricus perlatus Cooke in Grevillea 15: 40 (1886).

Inocybe perlata (Cooke) Saccardo in Syll. Fung. 5: 774 (1887).

Agaricus schista Cooke & W. G. Smith in Cooke, Handb. Brit. Fungi: 154 (1886).

Inocybe schista (Cooke & W. G. Smith) Saccardo in Syll. Fung. 5: 774 (1887).

Inocybe confusa P. Karsten in Meddn Soc. Fauna Flora fenn. 16: 39 (1888).

Inocybe umbrinella Bresadola in Annls mycol. 3: 161 (1905).

Inocybe fastigiata var. *umbrinella* (Bresadola) R. Heim in Genre Inocybe: 188 (1931).

Inocybe infracta Velenosky in Ceske Houby: 384 (1920).

Inocybe pseudofastigiata Rea in Trans. Br. Mycol. Soc. 12: 210 (1927).

Inocybe conica Larsen in Kolderup-Rosenvinge & Warming, Bot. Iceland 1: 534 (1931).

Inocybe pusilla F. Moller in Fungi Faroes 1: 225 (1945).

Inocybe obsoleta Romagnesi in Bull. trimmest. Soc. mycol. Fr. 74: 145 (1958).

Inocybe orbata Malencon in Mal. & Bert., Fl. Champ. sup. Maroc 1:386 (1970).

Inocybe holoxantha Grund & Stuntz in Mycologia 73: 667 (1981).

Inocybe obsoleta var. *lutea* M. Bon & Chevassut in Docs mycol. 3(11): 18 (1973).

Inocybe fastigiata f. *alpina* R. Heim in Genre Inocybe: 185 (1931).

Inocybe pseudocookei Metrod in Schweiz. Z. Pilzk. 31: 158 (1953).

Inocybe laeta Alessio in Econ. Trent., Suppl. 1: 98 (1979).

Basidiomata small. Pileus 10–30 mm diam., conico-convex to convex, becoming appanate with a subumbonate centre, surface greyish orange (5B3, 5B4), dull, glabrous, with fine rimose splitting under a lens, sometimes squamulose; margin decurved to plane, mostly becoming upturned, initially entire, becoming irregularly wavy to slightly eroded. Context yellowish white (4A2), up to 2.5 mm thick at the centre. Lamellae adnexed to narrowly adnate, initially whitish, becoming orange grey (5B2) to greyish orange (5B3 or 5A3), close, up to 4 mm wide, with lamellulae of 2–3 lengths; edge pale, finely scalloped under a lens. Stipe 15–45 x 2.5–6 mm, central, terete, equal or broader at base, solid; surface white to orange white, slightly pruinose, finely longitudinally striate under a lens. Odour not distinctive. Spore-print cinnamon-brown (6D6).

Spores 7–12.5 x 5–8 (9.50±1.33 x 6.33±0.84) µm, Q=1.38–1.81, Qm=1.50, ovo-ellipsoid to ellipsoid to phaseoliform, brown, smooth, slightly thick-walled, lacking germ-pore. Basidia 25–41.5 x 7.5–11.5 µm, clavate, 4-spored; sterigmata up to 5 µm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 12.5–57.5 x 5.5–12.5 µm, cylindrical, clavate, utriform or flexuous, thin-walled, hyaline. Pleurocystidia absent. Hymenophoral trama regular; hyphae 2.5–16.5 µm wide, thin-walled, hyaline. Pileal trama parallel-interwoven; hyphae 2.5–16.5 µm wide, thin-walled, hyaline. Pileipellis a cutis; hyphae 3–14 µm wide, thin-walled, spirally encrusted with a brownish pigment. Stipe trama

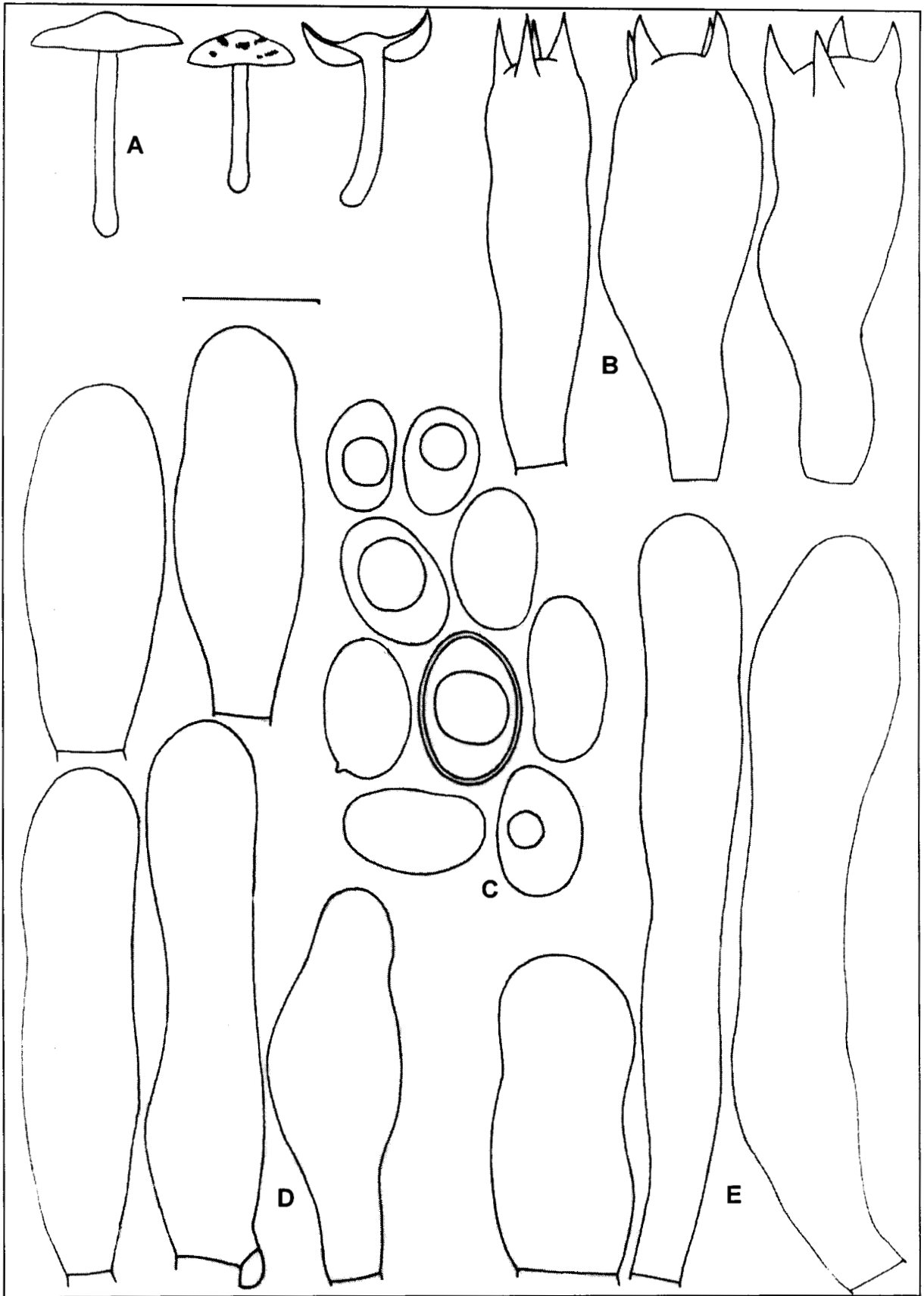


Fig. 46. *Inocybe rimosa* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Caulocystidia. Scale bar = 10 μ m

composed of thin-walled, hyaline, 2.5–14 µm wide hyphae. Caulocystidia 19–94 x 7.5–15.5 µm, clavate, cylindrical or flexuous, formed of modified terminal cells of hyphae of stipitipellis, thin-walled, hyaline. Clamp-connexions present on all hyphae.

On the ground, gregarious to scattered, mostly around casuarina (*Casuarina equisetifolia* Linnaeus, Casuarinaceae) trees, June-December.

Specimens examined: India, Kerala State, Malappuram District, Calicut University Campus: 11 July 1996, A. Thomas T27; 16 June 1997, A. Thomas T27b; 22 December 1997, A. Thomas T27c; 15 June 1997, A. Thomas T69; 13 June 1999, A. Thomas T69b; 14 June 1999, A. Thomas T69c; 16 June 1999, A. Thomas T69d; 8 June 1998, A. Thomas T258.

This species is characterized by ochraceous yellow, subumbonate pileus with fine rimose splitting; whitish stipe; smooth, ellipsoid to phaseoliform spores; versiform cheilocystidia, and caulocystidia; and absence of pleurocystidia. It can be placed in the subgenus *Inosperma* section *Rimosae* (Fries) Quélet owing to the evenly outlined spores; absence of pleurocystidia and metuloids; and smooth and glabrous pileus with fine rimose splitting. Except for the slightly smaller spores, the Kerala collections are indistinguishable from the very variable and widely distributed North Temperate species, *Inocybe rimosa*. The Kerala collections are suspected to be mycorrhizal with casuarina trees.

Cortinarius Fries
in *Genera Hymenomycetum*, P.7 (1836).

Basidiomata small to very large. Pileus shape variable from companulate to plano-convex with or without an umbo. Pileus surface viscid or non-viscid; hygrophanous or non-hygrophanous; fibrous-tomentose, scaly or glabrous; with different colours. Lamellae adnexed to decurrent, narrow to broad, whitish to dark rust-brown. Stipe central, thin to thick, viscid or dry, fibrous or glabrous, with or without a blue or violet tint. Veil mostly cortinoid, annulate or sometimes unrecognizable, often forms woolly or fibrous covering on the pileus and/or stipe or belt-like structures on the stipe, or rarely a membranous volva at

stipe base. Spore-print deep rusty or somewhat dusty. Spores warty or rarely almost smooth, globose, subglobose, ellipsoid, ellipsoid-oblong, lemon shaped or amygdaliform. Cystidia present or absent. Hymenophoral trama regular. Terrestrial, always forming ectomycorrhiza with forest trees. Type species: *Cortinarius violaceus* (Linnaeus ex Fries) Fries

Key to the species

1. Pileal and stipe surface viscid; cheilocystidia-balloon shaped; clamp-connexions lacking *Cortinarius pseudosalor*
1. Pileal and stipe surface non-viscid; cheilocystidia versiform; clamp-connexions present 2
2. Basidiomata non-hygrophanous; pileal surface not pellucid-striate; spores more than 11 μm long; pleurocystidia and subcellular hypodermium present *Cortinarius sp. 1*
2. Basidiomata hygrophanous; pileal surface pellucid-striate; spores less than 11 μm long; pleurocystidia and subcellular hypodermium absent 3
3. Basidiomata small, slender, mycenoid; pileus less than 15 mm broad with a distinct umbo; stipe without violaceous tint *Cortinarius sp. 2*
3. Basidiomata larger; pileus hemispheric to convex, reaching up to 80 mm broad, non-umbonate; stipe surface with violaceous tints at least initially *Cortinarius sp. 3*

Cortinarius pseudosalor Lange

Fig. 47 A-D; Plate 16 B

Pileus 20–60 mm diam., conico-convex becoming plano-convex, sometimes with a broad, blunt umbo; surface initially dark brown (6F8, 7F8), turning to brown (6E8, 7E8) at the centre and almost greyish orange (5B3) or brownish orange (5C3, 6C4) towards margin, hygrophanous and becoming greyish orange (5B3), glabrous, smooth and viscid when wet, becoming dry and wrinkled; margin somewhat incurved, turning decurved, slightly appendiculate when young, becoming entire with maturity, sometimes eroded or fissile.

Context up to 5 mm thick at the centre, white. Lamellae adnate, initially violet grey (16D2) or sometimes dull violet (16D3), later light brown (6D6), subcrowded to close, up to 5 mm wide, with lamellulae of different lengths; edge white or paler than the sides, finely torn under a lens. Stipe 45–75 x 5–10 mm, central, cylindrical, almost equal or tapering apically, solid, becoming fistulose; surface violet-grey (16D2) or dull violet (16D3) when young, changing to brownish orange (5C3) or greyish brown (5D3) with maturity, covered with a glutinous white, fibrillose-floccose veil. When the basidioma matures, pileus gets separated from the stipe apex and falls down. Odour not distinctive. Spore-print greyish brown/light brown (6D4).

Spores 10.5–15 x 6–8.5 (12.28 ± 1.31 x 7.17 ± 0.66) μm , $Q=1.5\text{--}2.0$, $Q_m=1.7$, amygdaliform, yellowish-brown, thin- to slightly thick-walled, with warty to tuberculate ornamentation, frequently with an apical callus, lacking a germ-pore. Basidia 30–46.5 x 8–14 μm , clavate, 4-spored; sterigmata up to 6.5 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 13–56.5 x 9.5–31.5 μm , balloon-shaped, thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama regular; hyphae 2–24 μm wide, thin-walled, sometimes faintly encrusted, hyaline. Pileal trama parallel-interwoven; hyphae 2–29 μm wide, inflated, thin-walled, frequently encrusted, hyaline. Pileipellis an ixotrichodermium; hyphae 2–7 μm wide, thin-walled, sometimes encrusted, hyaline. Hypodermium composed of 1.5–21.5 μm wide hyphae arranged in two layers, the upper layer of inflated hyphae and the lower layer of narrow, filamentous hyphae, both hyphae thin-walled, and encrusted with a yellowish brown pigment. Stipe trama composed of 2–24 μm wide hyphae, parallel, thin-walled, hyaline. Stipitipellis a cutis; hyphae 2–13 μm wide, thin-walled, encrusted, pale yellow to hyaline. Caulocystidia absent. Clamp-connexions not observed.

On the ground, attached to some underground roots, scattered or sometimes in groups of two in the vicinity of *Hopea* spp. (Dipterocarpaceae), *Meiogyne pannosa* (Dalzell) Sinclair (Annonaceae) and *Cansjera rheedii* Gmelin (Opiliaceae).

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 28 October 1999, A. Thomas T344; 31 October 1999, A. Thomas T344b.

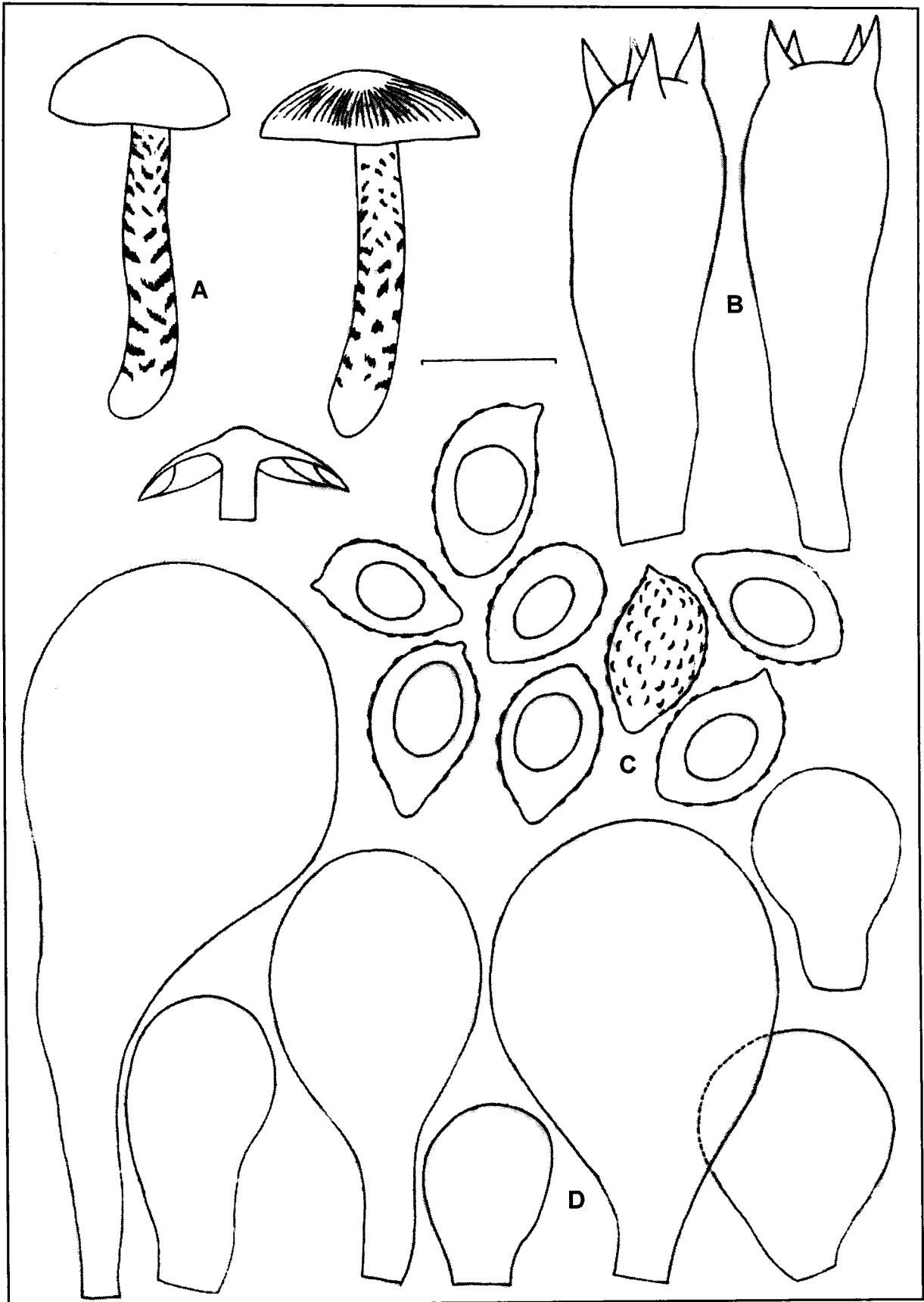


Fig. 47. *Cortinarius pseudosalor* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia. Scale bar = 10 μ m

The Kerala collections are inseparable from the north-temperate species *Cortinarius pseudosalor*. The characteristic features of this species are the viscid, yellowish brown pileus, violet-coloured stipe covered with glutinous veil, balloon-shaped cystidia and the large, amygdaliform spores. Owing to the viscid pileus and stipe it belongs to the subgenus *Myxacium* (Fries) Loudon where because of the absence of clamp-connexions it is placed in the section *Defibulati* Fries.

***Cortinarius* sp. 1**

Fig. 48 A-F; Plate 16 C

Pileus 9–30 mm diam., hemispherical, conico-convex or convex when young becoming plano-convex to appanate when mature, sometimes with a small depression at the centre; surface pale orange (5A3), greyish orange (5B4), light brown (6D6, 6D7) brownish orange (7C6) or brown (7D7) towards centre, unicolorous or mostly fading towards margin to orange white (5A2), pale orange (5A3) or greyish orange (6B3, 6B4), non-hygrophanous, smooth, glabrous, estriate, slightly sticky when moist; margin incurved and entire when young becoming decurved and fissile with age. Context pale brown. Lamellae adnate, initially whitish, becoming pale orange (5A3), greyish orange (6B3, 6B4), brownish orange (6C4), or light brown (6D4, 6D5), sometimes brown (7E6, 6E7) on maturity, subcrowded to close, up to 5 mm wide, with lamellulae of 3–4 lengths; edge concolorous with the sides or slightly paler, fimbriate under a lens. Stipe 15–55 x 2–6.5 mm, central, terete, almost equal or broader towards both ends, at times tapering apically, solid, sometimes fistulose; surface off-white, orange white (5A2), or light orange (5A3) towards apex, brown or light brown (6E6) towards base, sometimes weakly longitudinally striate, or with minute longitudinal cracks, at times with a cortina when young which often leaves inconspicuous annular remnants. Odour not distinctive. Spore-print brown (7E5, 7E6).

Spores 11–14 x 6.5–8.5 (11.56 ± 1.52 x 7.66 ± 0.58) μm , $Q=1.4-1.75$, $Q_m=1.53$, amygdaliform, acyanophilous, thick-walled, with a warty-rough exosporial ornamentation, lacking an apical germ-pore, with a conspicuous callus. Basidia 25–35 x 7.5–10.5 μm , with a median constriction, 4-spored, rarely 2-spored; sterigmata up to 6.5 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 11.5–62.5 x 4.5–16.5 μm , versiform:

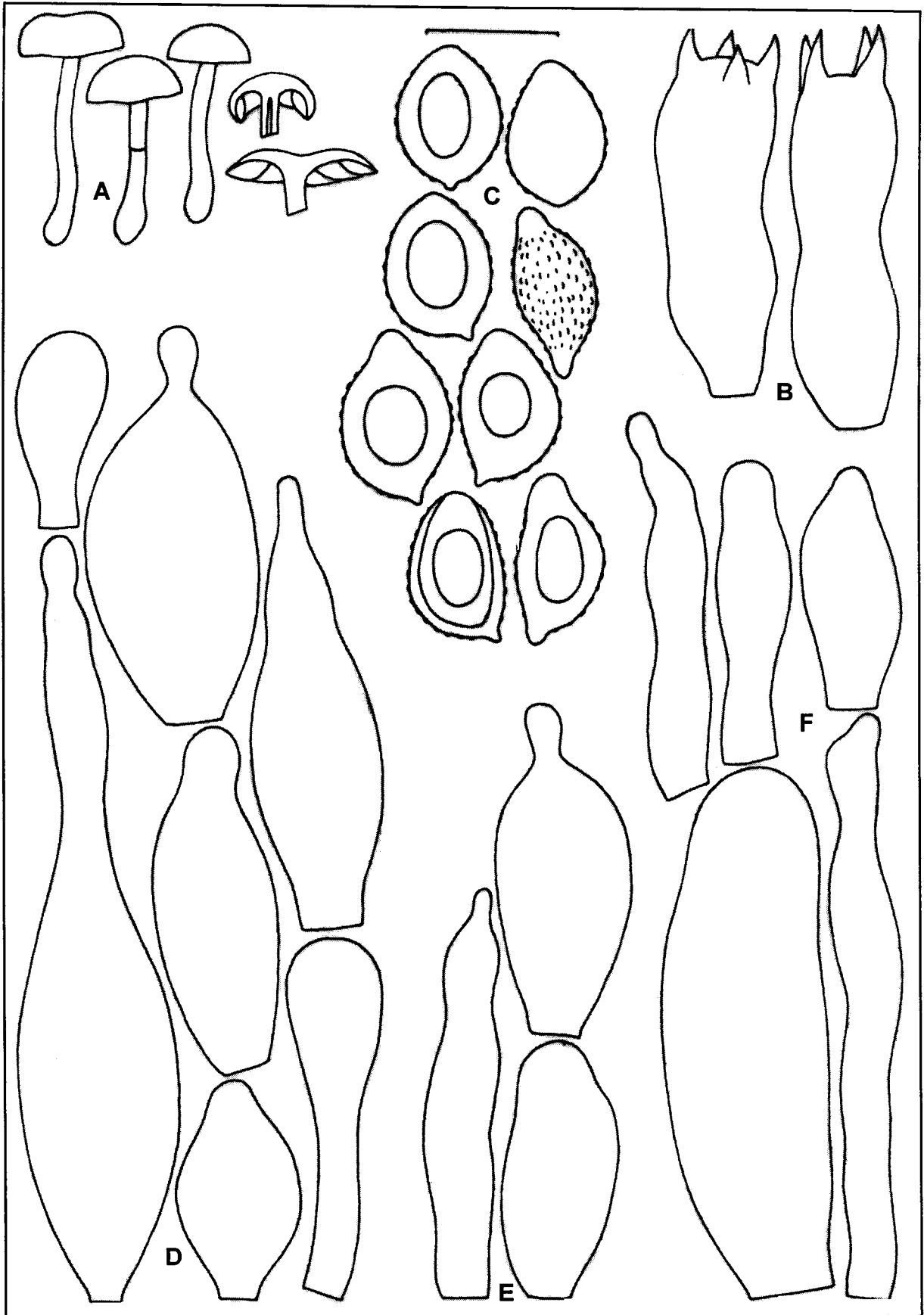


Fig. 48. *Cortinarius* sp. 1. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia; F. Caulocystidia. Scale bar = 10 μ m

clavate, pedicellate-clavate, utriform or fusoid, frequently with a subcapitate, mucronate or rostrate apex, thin-walled, hyaline. Pleurocystidia 17.5–42.5 x 5–12 μm , scattered, versiform and similar to cheilocystidia in shape, thin-walled, hyaline. Hymenophoral trama regular; hyphae 2–15 μm wide, closely packed, thin-walled, hyaline. Pileal trama interwoven; hyphae 1.5–16.5 μm wide, thin-walled, hyaline. Pileipellis a cutis; hyphae 1.5 - 10 μm wide, thin-walled, with hyaline or brownish encrustation. Hypodermium distinct and well-developed, sub-cellular, composed of swollen, versiform elements (including many isodiametric ones), 10–47.5 x 6.5–13 μm , thin-walled, with coarse, brown pigment encrustation. Rim of the pileus bearing numerous cystidia indistinguishable from cheilocystidia. Stipe trama composed of 2–14 μm wide, parallel hyphae, thin-walled, hyaline. Stipitipellis a cutis; hyphae 2–7.5 μm wide, thin-walled, hyaline. Caulocystidia 20–77.5 x 4.5–15 μm , versiform, similar to cheilocystidia in shape, thin-walled, hyaline, occurring either in small clusters or scattered. Clamp-connexions present in all tissues.

On the forest floor, gregarious to scattered, usually near *Hopea* spp. (Dipterocarpaceae).

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 17 July 1997, A. Thomas T108; 23 July 1997, A. Thomas T108b, 11 August 1997, A. Thomas T108c, 13 October 1998, A. Thomas T280; 1 August 1999, A. Thomas T280b.

This species is characterized by non-hygrophanous ochre-yellow to brownish smooth pileus, lamellae that are initially whitish, large amygdaliform spores, versiform cheilo- and pleurocystidia and subcellular hypodermium. It is not agreeing fully with any previously described species. Position of this species within the genus is also not clear.

***Cortinarius* sp. 2**

Fig. 49 A-D; Plate 17 A

Pileus 4–15 mm diam., initially almost campanulate, conic or conico-convex, becoming convex to plano-convex, with a blunt to almost pointed umbo; surface dark brown (6F8, 6F7) or brown (6E8) towards the centre, brown (6E7) or light brown (6D6, 6D7) elsewhere, hygrophanous and eventually entirely turning to greyish orange (5B3), glabrous,

dull, faintly translucent-striate when moist; margin decurved, entire to almost crenate, sometimes fissile. Context up to 1.5 mm thick, brownish. Lamellae adnate to adnexed, brownish orange (6C6) becoming light brown (6D7), close, up to 2 mm wide, with lamellulae of 3 lengths; edge pale, scalloped or eroded under a lens. Stipe 25–60 x 1.5–3 mm, central, terete, slightly tapering apically, solid; surface brownish orange (6C6) to light brown (6D7), glabrous. Odour not distinctive. Spore-print not obtained.

Spores 6.5–9.5 x 3.5–5.5 (8.41 ± 0.98 x 4.48 ± 0.42) μm , $Q=1.5\text{--}2.15$, $Q_m=1.87$, amygdaliform, yellowish brown, slightly thick-walled, with asperulate ornamentation, without apical germ-pore. Basidia 20.5–32 x 6–9 μm , clavate, sometimes with yellowish content, gets deformed with maturity, 4-spored; sterigmata up to 4.5 μm long. Lamella-edge sterile to heteromorphous with crowded to scattered cheilocystidia. Cheilocystidia 11.5–51.5 x 4.5–15.5 μm , versiform: clavate, vesiculose, lageniform or fusoid, thin-walled, sometimes very faintly encrusted, hyaline. Pleurocystidia none. Hymenophoral trama regular; hyphae 2.5–22.5 μm wide, inflated, thin-walled, faintly encrusted, light yellowish brown. Pileal trama parallel; hyphae 2–25 μm wide, thin-walled, faintly encrusted, yellow to yellowish brown. Pileipellis a cutis; hyphae 2–7.5 μm wide, narrow, thin-walled, sometimes faintly encrusted, hyaline to yellowish. Stipe trama formed of parallel, 2–16.5 μm wide hyphae, thin-walled, faintly encrusted, yellow to yellowish brown. Stipitipellis a cutis; hyphae 2–7.5 μm wide, thin-walled, faintly encrusted, hyaline to pale yellowish brown. Clamp-connexions present in all hyphae.

On the forest floor, mostly in clusters or scattered, attached to small subterranean roots, probably mycorrhizal with nearby trees: *Hopea* sp., (Dipterocarpaceae), *Meiogyne pannosa* (Dalzell) Sinclair (Annonaceae) and *Cansjera rheedii* Gmelin (Opiliaceae).

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 17 October 1999, A. Thomas T341; 28 October 1999, A. Thomas T341b; 31 October 1999, A. Thomas T341c.

Macroscopically this species looks very much like a *Galerina* because of the small mycenoid basidioma with companulate to conical, hygrophanous, pellucid-striate pileus but the combination of characters such as the plage-less spores, clamped hyphae and the

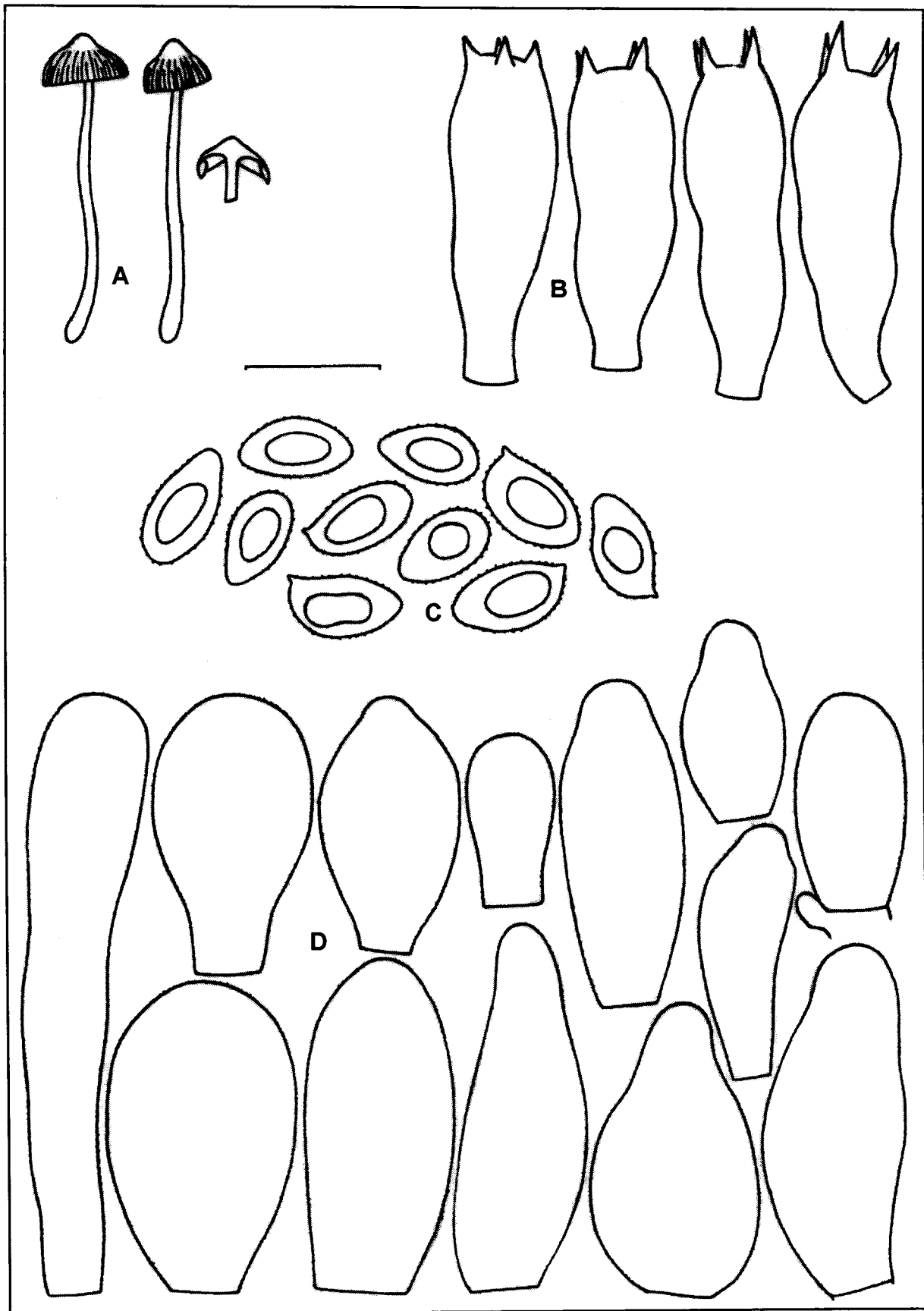


Fig. 49. *Cortinarius* sp. 2. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia. Scale bar = 10 μ m

suspected mycorrhizal association indicates that it is not a *Galerina* but a *Cortinarius*. This species is characterized by small slender basidiomata with brown, conical to campanulate pileus with a distinct umbo, brownish orange to light brown lamellae and stipe, total absence of veil, and amygdaliform spores. In some respects it is somewhat similar to *Cortinarius atropusillus* Favre of subgenus *Telamonia* (Fries) Loudon. The author could not find a previously published species description where the present collections can comfortably fit in.

***Cortinarius* sp. 3**

Fig. 50 A-D; Plate 17 B

Pileus 15–80 mm diam., initially subspherical, becoming convex, with or without a central depression when mature; surface dark brown (7F6, 7F7, 8F6, 8F7), unicolorous, hygrophanous and slowly becoming brownish orange (6C6 or 6D6), smooth, glabrous, faintly translucent-striate and slightly lubricous when moist; margin incurved when young, becoming or decurved, almost entire, at times becoming fissile. Context pale brown. Lamellae broadly adnate to adnate with a decurrent tooth, cinnamon-brown (6D6) or slightly darker, subcrowded to close, up to 7 mm wide, with lamellulae of 3 lengths; edge paler than the sides or white, finely torn. Stipe 35–65 x 5–13 mm, central, terete, slightly tapering apically and with a slightly swollen base, solid; surface somewhat white, apically and sometimes basally with a purplish grey (13C2) shade, initially with a well-developed cortina which leaves annular remnants, sometimes with a booted appearance. Odour not distinctive. Spore-print rust brown (6E8).

Spores 8–10.5 x 4–6 (9.27 ± 0.68 x 4.77 ± 0.52) μm , $Q=1.64\text{--}2.35$, $Q_m=1.97$, amygdaliform, yellowish brown, thin to slightly thick-walled, with a fine warty-rough ornamentation, lacking apical germ-pore. Basidia 25–47.5 x 6.5–10 μm , clavate to cylindrical, 4-spored, rarely 2-spored; mature basidia sometimes contain yellowish brown plasmatic pigment; sterigmata up to 4.5 μm long. Lamella-edge heteromorphous to almost sterile with crowded cheilocystidia. Cheilocystidia 13–54.5 x 4.5–13 μm , mostly clavate, occasionally utriform or lageniform, sometimes encrusted, thin-walled, hyaline.

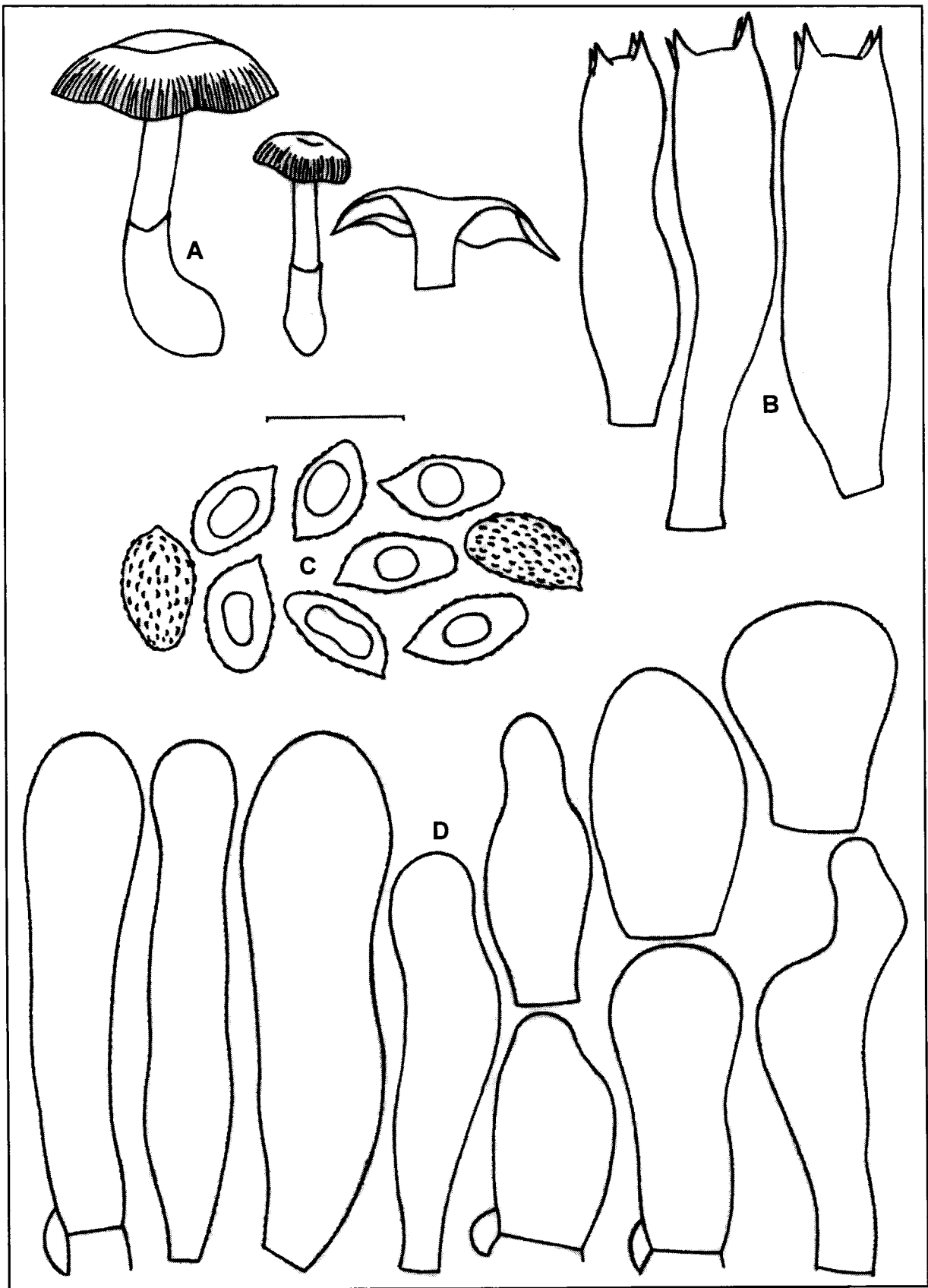


Fig. 50. *Cortinarius* sp. 3. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia. Scale bar = 10 μ m

Pleurocystidia none. Hymenophoral trama regular; hyphae 1.5–24 μm wide, inflated, thin-walled, faintly encrusted, pale yellowish brown. Pileal trama parallel-interwoven; hyphae 2–24 μm wide, inflated, thin-walled, encrusted, with yellowish brown pigment. Pileipellis a cutis; hyphae 1.5–7.5 μm wide, thin-walled, faintly encrusted, pale yellow to almost hyaline. Stipe trama of 2–20 μm wide hyphae, parallel, thin-walled, faintly encrusted, hyaline or with pale yellow wall pigment. Stipitipellis a cutis; hyphae 2–7.5 μm wide, thin-walled, faintly encrusted, pale yellow to almost hyaline.

On the forest floor, in clusters or scattered, nearby vegetation: *Hopea* spp. (Dipterocarpaceae), *Calophyllum* sp. (Clusiaceae), *Meiogyne* sp. (Annonaceae) and *Cansjera rheedii* Gmelin (Opiliaceae).

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 2 September 1999, A. Thomas T118; 17 October 1999, A. Thomas T118b; 28 October 1997, A. Thomas T118c.

This species belongs to the subgenus *Telamonia* owing to the large basidiomata with dark brown, hygrophanous, non-viscid pileus, well-developed cortina and booted stipe. It is characterized by dark chestnut- to chocolate brown, shiny pileus and violaceous tints on the upper part of the stipe. The Kerala collections are somewhat similar to the brief descriptions of *Cortinarius castaneus* (Bulliard ex Fries) Fries given by Moser (1983) including the size of the spores.

Gymnopilus Karsten
in Bidr. Kann. Finl. Nat. Folk. 32:xxi, 400 (1879).

Ryssonospora Fayod in Ann. Sci. Nat., Bot. ser 7,9:361 (1889).

Basidiomata small to large. Pileus convex to plano-convex, usually in bright colours of yellow, orange-brown, fulvous or rarely red or lilac, viscid, hygrophanous or dry, glabrous, fibrillose or scaly. Lamellae adnexed to decurrent, with bright colours of yellow or ferruginous. Stipe central to excentric, glabrous or fibrillose, mostly yellow or so. Veil cortinoid or membranous, evanescent or sometimes persistent as an annulus. Spore-print rust-brown. Spores ovoid, ellipsoid or subamygdaliform with a complex wall and a distinct verrucose to tuberculate ornamentation, without a germ-pore. Basidia clavate, 2- or 4-spored. Lamella-

edge sterile or heteromorphous. Cheilocystidia small, lageniform, tibiiform or lecythiform with a capitate, subcapitate or even non-capitate apex. Pleurocystidia absent or rarely present and then resembling cheilocystidia. Hymenophoral trama regular. Pileipellis an epicutis formed of pigment-encrusted hyphae, often disrupted to form trichodermial fascicles. Clamp-connexions usually present or rarely absent. Lignicolous or rarely humicolous. Not ectotrophically mycorrhizal. Worldwide in distribution. Type species: *Gymnopilus liquiritiae* (Persoon ex Fries) Karsten

Key to the species

1. Pileus surface glabrous; spores less than 7 μm long *Gymnopilus* sp. 1
1. Pileus surface fibrillose or scaly; spores mostly exceeds 7 μm in length 2
2. Basidioma terrestrial; pileus less than 20 mm broad *Gymnopilus* sp. 2
2. Basidioma lignicolous; pileus more than 20 mm broad *G. lepidotus*

Gymnopilus sp. 1

Fig. 51 A-E; Plate 17 C

Pileus 15–55 mm diam., convex to plano-convex; surface orange (5A7-6A7), fading to light orange (5A6), smooth to naked eye but very finely scurfy under a lens, dry; margin incurved to decurved, entire to lobate. Context up to 5 mm thick at the centre, white with a yellow tint. Lamellae adnate to sinuate, light orange to orange (5A6, 5A7), crowded to subcrowded, up to 5 mm wide, with lamellulae of different lengths; edge concolorous with the sides, eroded. Stipe 15–35 x 3–8 mm, central becoming eccentric, terete, almost equal or tapering basally, solid; surface light orange (5A4, 5A5), smooth; base inserted into the decaying wood. Odour not distinctive. Spore-print orange (5A7).

Spores 5.5–7 x 3.5–4.5 (6.27 \pm 0.47 x 4.23 \pm 0.40) μm , Q=1.27–1.66, Qm=1.47, ovoid to ellipsoid, occasionally subamygdaliform, yellowish brown, thin-walled, with fine verrucose ornamentation, without a germ-pore. Basidia 21.5–30 x 5–7 μm , cylindrico-clavate, sometimes with yellowish brown inclusion, 4-spored; sterigmata up to 4 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 15–37.5 x 3.5–7 μm , tibiiform,

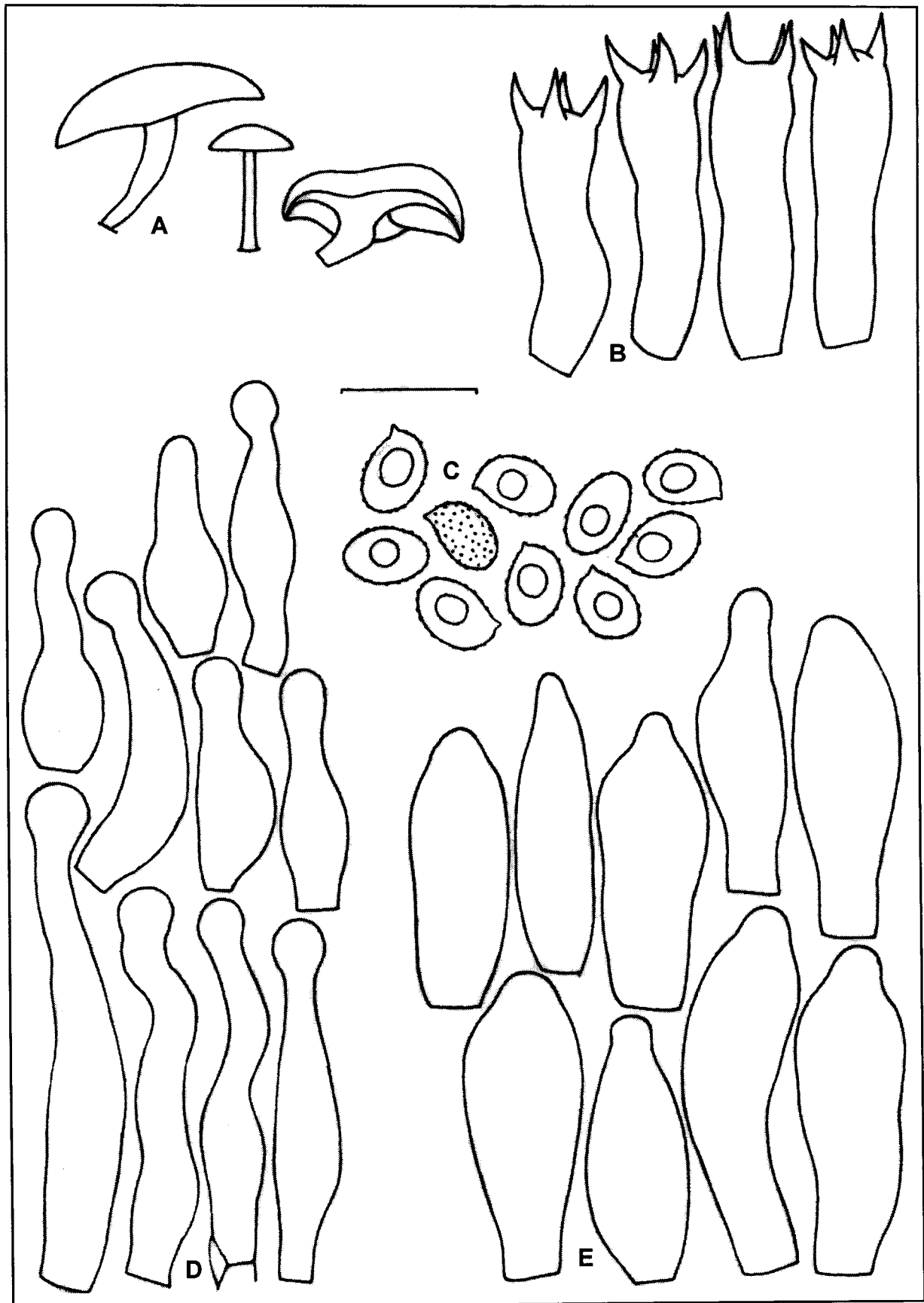


Fig. 51. *Gymnopilus* sp. 1. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia. Scale bar = 10 μ m

narrowly utriform or almost lecythiform, thin-walled, hyaline or rarely with yellowish brown content. Pleurocystidia 16.5–27.5 x 5.5–9.5 μm , numerous, thin-walled, with yellowish or brown content. Hymenophoral trama regular; hyphae 2–24 μm wide, thin- to slightly thick-walled, yellowish to light yellowish brown. Pileal trama interwoven; hyphae 2–22.5 μm wide, thin- to slightly thick-walled, hyaline to pale yellow. Pileipellis a cutis, occasionally disrupted by small ascending hyphal clusters; hyphae 2–11.5 μm wide, thin-walled, encrusted with a yellow pigment. Stipe trama parallel; hyphae 2–21.5 μm wide, thin- to slightly thick-walled, yellow. Stipitipellis a cutis; hyphae 1.5–7.5 μm wide, thin-walled, encrusted with a yellow pigment, sometimes with cystidioid end cells. Clamp-connexions present in all parts of the basidioma.

On a decaying wood, gregarious, October.

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 1 October 1997, A. Thomas T177; 3 October 1997, A. Thomas T177b.

These collections seem to represent an undescribed species belonging to the section *Gymnopilus*. In gross morphology and in most microscopic characters, including the size and shape of spores, it is very similar to *Gymnopilus dryophilus* Murrill but the cheilocystidia of the present collections have a different morphology. It is also somewhat close to *G. chrysopellus* (Berkeley & Curtis) Murrill but that species lacks pleurocystidia and the pileus surface is golden yellow.

***Gymnopilus* sp. 2**

Fig. 52 A-E; Plate 18 A

Basidiomata small. Pileus 6–18 mm diam., hemispherical to convex; surface light brown (6D7, 7D6) or reddish brown (8D6, 8E6) at the disc, light orange (5A4) or greyish orange (5B4, 6B4) towards margin, densely squarrose at the centre, squamules sparse or absent towards margin, dry; margin decurved, entire, sometimes fissile. Context pale orange (5A3), less than 1 mm at the disc. Lamellae sinuate to adnexed, light orange (5A4, 6A4) when young, becoming orange (6B7, 6B8) or brownish orange (6C7) when mature, subcrowded to close, up to 5 mm wide, with lamellulae of 2–3 lengths; edge concolorous

with the sides, entire to slightly wavy. Stipe 10–25 x 1–2.5 mm, central, terete, almost equal, solid; surface pale orange (5A3) towards apex, greyish orange (5B3, 5B4) or faintly bluish grey towards base, fibrillose apically. Odour none. Pileus surface darkens with aqueous KOH. Spore-print brownish orange (6C7) to brown (6D7).

Spores 6.5–8 x 4.5–5.5 ($7.31 \pm 0.46 \times 5.22 \pm 0.32$) μm , $Q=1.31\text{--}1.50$, $Q_m=1.40$, ovoid in face-view, ellipsoid to subamygdaliform in side-view, yellowish brown, thin-walled, with finely verrucose ornamentation. Basidia 21.5–31.5 x 6.5–9 μm , clavate to cylindrical, sometimes with a median constriction, hyaline, sometimes with brown contents, 4-spored; sterigmata up to 4.5 μm long. Basidioles measuring 12.5–27 x 5.5–9 μm and having yellowish brown content scattered on the edge and sides of lamellae. Lamella-edge heteromorphous with scattered or occasionally crowded cheilocystidia. Cheilocystidia 13–29 x 3.5–7.5 μm , fusoid, narrowly utriform to lageniform, rarely with a subcapitate apex, thin-walled, hyaline. Hymenophoral trama subregular; hyphae 2–16.5 μm wide, thin-walled, with pale yellow pigment. Pileal trama interwoven; hyphae similar to those of hymenophoral trama. Pileipellis a disrupted cutis; hyphae 3–14 μm wide, with a thin, yellowish brown wall with encrustations, often aggregating into erect fascicles with clavate, clavato-mucronate, or fusoid end-cells. Stipe trama composed of 1.5–16.5 μm wide hyphae, thin-walled, with a light yellow pigment. Stipitipellis a cutis, often disrupted towards the stipe apex with erect hyphal fascicles having clavate, clavato-mucronate, or fusoid end cells; hyphae 2.5–13 μm wide, thin-walled, light yellowish brown, at times faintly encrusted. Clamp-connexions present in all parts of the basidioma.

On the ground, scattered, not attached to any decaying ligno-cellulosic material, May-June.

Specimens examined: India, Kerala State, Malappuram District, Calicut University Campus: 10 June 1998, A. Thomas T261; 11 June 1998, A. Thomas T261b; 12 June 1998, A. Thomas T261c; 12 May 1999, A. Thomas T261d; 16 May 1999, A. Thomas T261e.

This species belongs to the section *Gymnopilus*. It is very similar to the Sri Lankan species, *Gymnopilus crocias* (Berkeley & Broome) Singer in almost all characters but the

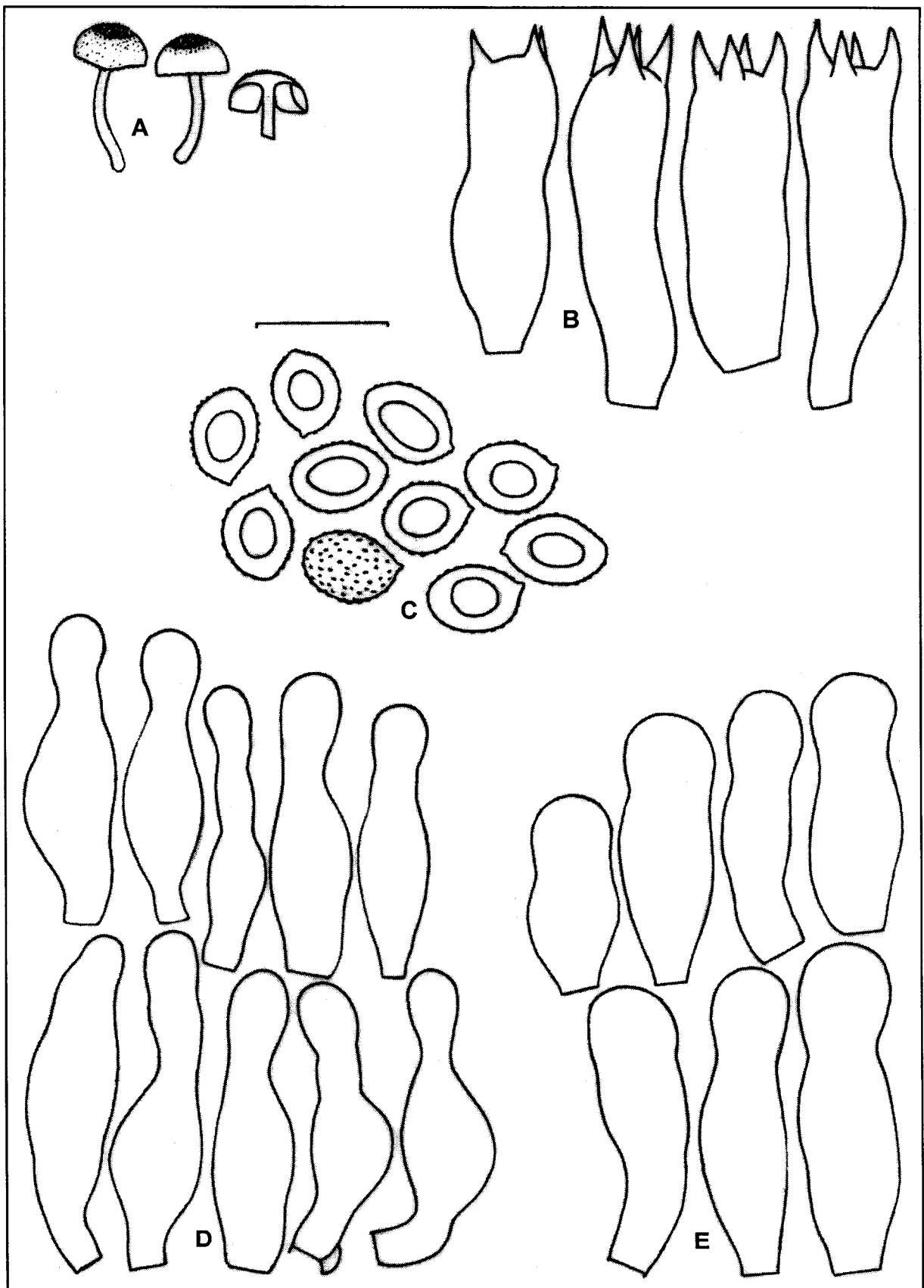


Fig. 52. *Gymnopilus* sp. 2. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Basidioles. Scale bar = 10 μ m

Sri Lankan species is lignicolous whereas the Kerala collections were always growing on soil. The spore morphology is also slightly different. There are several terrestrial species of *Gymnopilus* but none of them agrees fully with the Kerala collections. In *G. terrestris* Hesler, the pileus is glabrous, the spores are smaller and both pleurocystidia and cheilocystidia are absent. *Gymnopilus abramsii* Murrill has grey brown pileus and pleurocystidia are absent in that species. In *G. arenicola* Hesler the pileus is not squamulose, and the spores are subfusoid to pip shaped. In *G. fulgens* (Favre & Maire) Singer which grows on peaty or burnt soil, the pileus is glabrous and the spores are bigger with very prominent warts. *Gymnopilus angustifolius* Hesler has fragrant odour, arachnoid veil and pileocystidia in mounds. *Gymnopilus decipiens* (W. G. Smith) Orton occurs on burnt soil and has lageniform-capitate to lecythiform cystidia. *Gymnopilus odini* (Fries) Kühner & Romagnesi has smooth cap and occur either on peaty humus soil or on burnt soil.

Gymnopilus lepidotus Hesler
in North Am. Sp. *Gymnopilus*. 40 (1969).

Fig. 53 A- E; Plate 18 B

Pileus 10–40 mm diam., convex to plano-convex, at times slightly umbonate; surface light orange (5A5, 6A5) towards centre, pale orange (5A3) or light orange (5A4, 6A4) towards margin, squamulose; squamules blackish brown, erect, and comparatively denser at the centre, sparse and appressed in the middle, almost absent towards margin; margin decurved to plane, almost entire. Context concolorous with the pileus surface. Lamellae adnate, sometimes somewhat subdecurrent, light orange (5A5, 6A5) or orange (5A6), subcrowded to close, up to 6 mm wide, with lamellulae of 3–4 lengths; edge almost concolorous with the sides, entire to somewhat wavy. Stipe 20–40 x 2–6 mm, central, terete, almost equal or slightly tapering basally, hollow; surface pale or light orange (5A3 or 5A4), becoming brown or dark brown (6F6) towards base, sometimes with indistinct longitudinal striations. Odour not distinctive. Spore-print light brown (6D8).

Spores 6.5–9 x 4.5–5.5 (7.28 ± 0.70 x 4.81 ± 0.36) μm , Q=1.31–1.75, Qm=1.51, ellipsoid to ovoid, yellowish brown, thin-walled, verrucose, without germ-pore. Basidia 20.5–

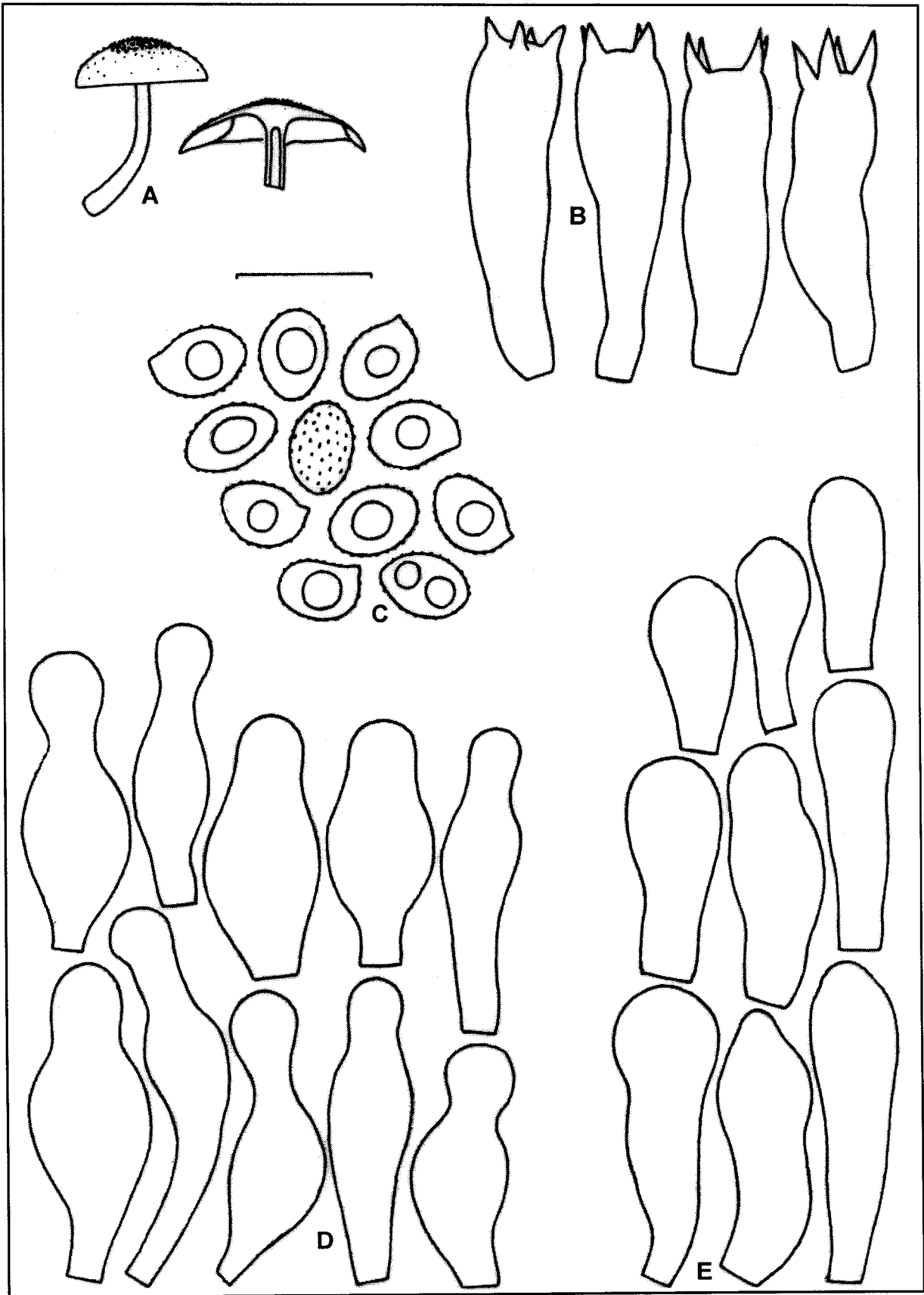


Fig. 53. *Gymnopilus lepidotus* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Basidioles. Scale bar = 10 μ m

30 x 6.5–8.5 μm , clavate to cylindrico-clavate, rarely with yellowish brown content, 4-spored; sterigmata up to 5 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 15.5–31.5 x 4.5–10.5 μm , utriform to lageniform with a short neck and a non-capitate or subcapitate apex, thin-walled, hyaline. Basidioles 10.5–30.5 x 5–9 μm , clavate with rounded or conical apex, thin-walled, with brown contents, scattered on lamella-edge and sides. Hymenophoral trama regular; hyphae 2–22.5 μm wide, thin-walled, pale yellow to hyaline, sometimes with yellowish brown content. Pileal trama interwoven; hyphae 2–20 μm wide, thin-walled, yellowish. Pileipellis a cutis, at times disrupted by ascending hyphal bundles; hyphae 2–15 μm wide, thin-walled, faintly encrusted, yellow to yellowish brown. Stipe trama composed of 2–29 μm wide hyphae, parallel, thin- to slightly thick-walled, yellowish. Stipitipellis a cutis; hyphae 2–11.5 μm wide, thin- to slightly thick-walled with yellow to brown wall pigment. Clamp-connexions present on all hyphae.

On dead coconut trunk, scattered, June.

Specimens examined: India, Kerala State, Malappuram District, Calicut University Campus: 12 June 1996, A. Thomas T13; 14 June 1996, A. Thomas T13b.

Gymnopilus lepidotus was first described from Florida by Hesler (1969). It is similar to *G. dilepis* (Berkeley & Broome) Singer in many characters including the size and shape of spores and the habitat but differ from that species in having basidioles with coloured contents and cheilocystidia with subcapitate apex and in the absence of reddish purple colour on the pileus surface. It is also close to *G. aureobrunneus* (Berkeley & Curtis) Murrill but in that species pileus is golden yellow and pleurocystidia are absent. It belongs to the section *Gymnopilus* owing to the lack of an annulus.

CREPIDOTACEAE (Imai) Singer
in Lilloa 22:584 (1951).

Agaricaceae Fries tribe *Crepidoteae* Imai in Journ. Fac. Agric. Hokkaido Imp. Univ. 48:238 (1938)

Basidiomata pleurotoid, collybioid, cyphelloid or omphalinoid. Pileus convex, glabrous or squamulose. Context thin, sometimes with a gelatinized zone. Lamellae adnexed to decurrent when stipe is present. Stipe central, excentric, lateral or absent. Veil present or absent, if present mostly cortinoid. Spore-print yellowish brown to cinnamon-brown, rarely cream coloured. Spores small to medium-sized, globose, ovoid, ellipsoid, amygdaliform or phaseoliform, smooth or with an exosporial ornamentation, without a germ-pore. Lamella-edge usually sterile with cheilocystidia. Pleurocystidia mostly absent. Hymenophoral trama regular to subregular. Pileipellis a cutis of repent hyphae, more rarely epithelial with pileocystidia, mostly with an encrusting pigment. Clamp-connexions present or absent. Lignicolous or humicolous. Type genus: *Crepidotus* (Fries) Staude

Only the type genus of the family was recorded from Kerala during this study.

Crepidotus (Fries) Staude
in Die Schwanne Mitteldeutschl. 25:71 (1857)

Agaricus tribus *Crepidotus* Fries in Syst. Mycol. 1:272 (1821).

Dochmiopus Patouillard in Hymen. Eur., 113 (1887).

Derminus Schroter in Cohn, Krypt. – Fl. Schlesien, Pilze 1:578 (1889).

Tremellopsis Patouilliard apud Duss in Fl. Crypt. Ant. Fries:223 (1904).

Conchomyces Van Overeem in Bull. Jard. Bot. Buitenzorg 9:19 (1927).

Basidiomata small to medium-sized, pleurotoid. Pileus convex, orbicular, dimidiate, flabelliform or spatulate, glabrous, tomentose or scaly. Context thin, sometimes with a gelatinized zone. Lamellae radiating from an excentric or lateral point or decurrent when stipe is present; dull brown to greyish brown or rarely pinkish brown when mature. Stipe mostly absent, when present reduced, excentric or lateral, sometimes disappearing with

age. Velar structures absent or indistinct. Spore-print dull brown or clay-coloured. Spores globose, ellipsoid or amygdaliform, smooth or with echinulate to verrucose ornamentation, without a germ-pore. Lamella-edge sterile or heteromorphous with cheilocystidia. Pleurocystidia rare. Hymenophoral trama regular to subregular. Pileipellis a cutis, often with pigment encrusted hyphae. Clamp-connexions present or absent. Cosmopolitan in distribution. On decaying wood and other plant material. Type species: *Crepidotus mollis* (Schaeffer: Fries) Staude

Key to the species

1. Spores warty-punctate or echinulate 2
1. Spores smooth 5
2. Hyphae without clamp-connexions; basidiomata red *C. cinnabarinus*
2. Hyphae with clamp-connexions; basidiomata never red 3
3. Spores ovoid to subglobose; basidiomata palm-inhabiting *C. palmarum*
3. Spores subglobose to globose; basidiomata not palm-inhabiting 4
4. Basidiomata on decaying areca palm; pileus not squamulose; cheilocystidia versiform
..... *Crepidotus epicrocinus*
4. Basidiomata on decaying eucalyptus tree; pileus squamulose; cheilocystidia clavate-
capitate *Crepidotus* sp. 1
5. Clamp-connexions present; cheilocystidia cylindric-flexuous
..... *Crepidotus* sp. 2
5. Clamp-connexions absent; cheilocystidia versiform 6
6. Spores fusoid to subamygdaliform; cheilocystidia without finger-like protuberances;
pileocystidia present *Crepidotus* sp. 3
6. Spores ovo-ellipsoid to amygdaliform; cheilocystidia with finger-like protuberances;
pileocystidia absent *Crepidotus* sp. 4

Crepidotus cinnabarinus Peck
in Bull. Torrey bot. Club 22:489 (1895).

Fig. 54 A-E; Plate 18 C

Pileus 10–45 mm diam., pleurotoid, laterally attached, flabelliform, convex to applanate when seen from the side; surface tomato red (8C8), may leach out during rain and become light orange (6A4) or greyish orange (6B4), sparsely dotted with fine, appressed squamules especially towards the margin; margin entire, at times turning fissile, initially inrolled, becoming incurved or decurved, deeply and irregularly lobate when old. Context up to 3 mm thick, white to orange white (5A2). Lamellae adnate, initially pale yellow (4A3) to pale orange (5A3), becoming light brown (6D4), subcrowded, up to 3 mm wide, with lamellulae of different lengths; edge tomato red (8C8), finely torn under a lens. Stipe 10–20 x 4–7 mm, lateral, stout, solid; surface white, tomentose at base. Odour not distinctive. Spore-print light brown (6D4).

Spores 5–8 x 4–5.5 (6.14±0.80 x 4.83±0.44) μm , Q=1.13–1.47, Qm=1.26, ovoid to subglobose, yellowish brown, thin- to slightly thick-walled, warty-punctate, without a germ-pore. Basidia 21.5–29 x 5.5–8 μm , clavate, 4- or sometimes 2-spored; sterigmata up to 5.5 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 13–80 x 5–14.5 μm , mostly ventricose-fusoid with long flexuose apices which are at times furcate, sometimes clavate, thin- or sometimes slightly thick-walled, with a light reddish brown plasmatic pigment and frequently with a fine, hyaline encrustation on the wall. Pleurocystidia scattered, occasional, similar to cheilocystidia in all aspects. Hymenophoral trama regular; hyphae 1.5–2.5 μm wide, thin-walled, hyaline to pale yellow, at times finely encrusted. Pileal trama interwoven; hyphae 2–10.5 μm wide, almost thin-walled, light yellow to hyaline. Pileipellis a disrupted cutis; hyphae 1.5–7 μm wide, thin-walled, with light reddish brown plasmatic pigment, at times with faint, hyaline encrustations. Clamp-connexions absent.

On the base of a decaying wood stump, in imbricate clusters, October.

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 28 October 1999, T343; 31 October 1999, A. Thomas T343b.

Crepidotus cinnabarinus is characterized by the distinctive tomato red colour of the

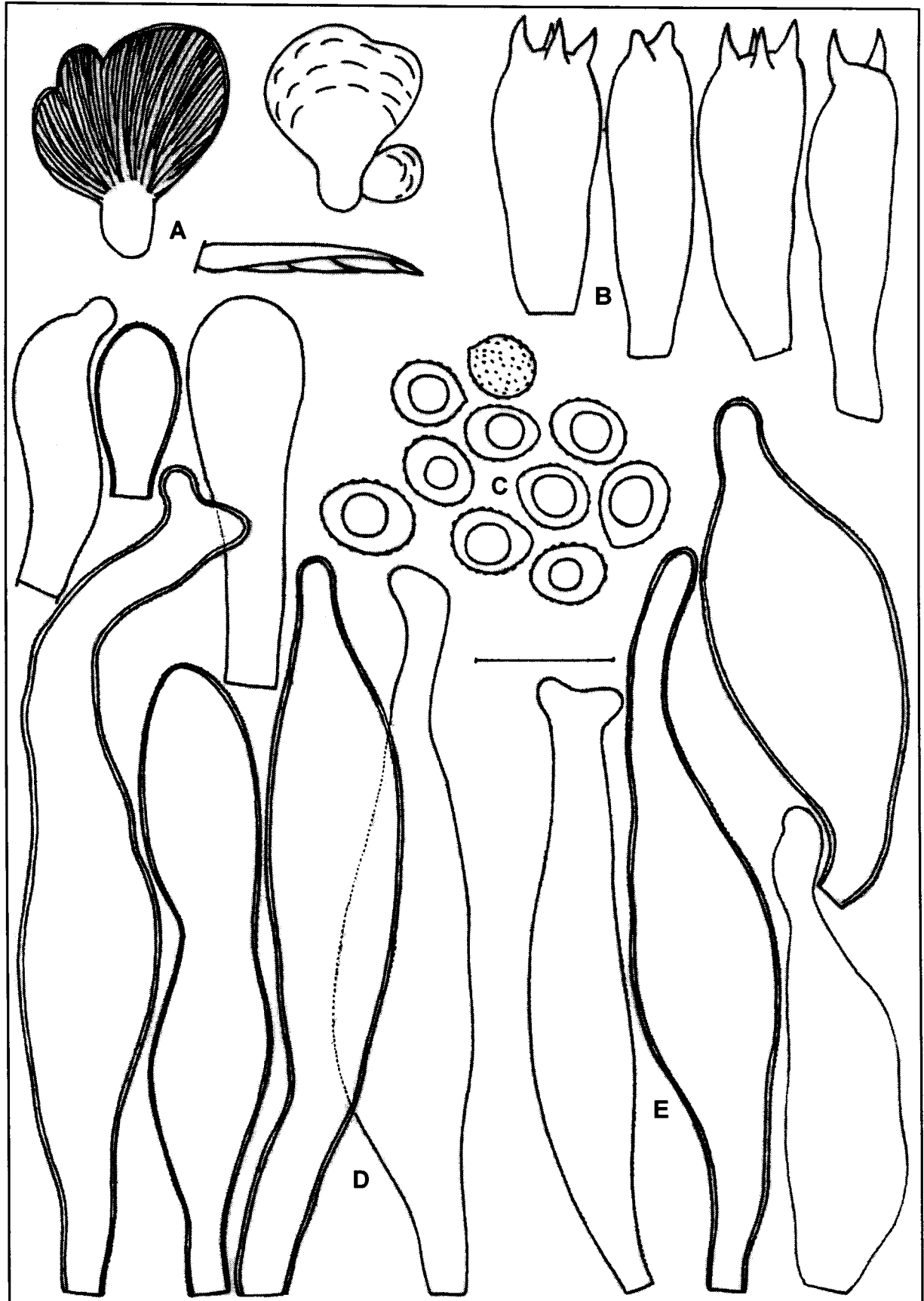


Fig. 54. *Crepidotus cinnabarinus* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pleurocystidia. Scale bar = 10 μ m

pileus and lamella-edge; ovoid to subglobose, warty-punctate spores; ventricose-fusoid cheilocystidia with reddish brown plasmatic pigment; non-gelatinized trama; and absence of clamp-connexions. In Singer's (1986) system, it will come under section *Echinospori* Pilát, subsection *Aporpini* Singer. In Hesler and Smith's (1965) classification, it is placed in subgenus *Crepidotus*, section *Cinnabarini* Hesler & Smith where only *C. cinnabarinus* is known. The Kerala collections showed some minor deviations from that species which include larger and robust basidiomata; presence of pleurocystidia; fine, hyaline encrustations on the cheilocystidia, tramal hyphae and pileipellis hyphae; and absence of pileocystidia.

Crepidotus palmarum Singer
in Sing. & Digilio, Lilloa 25:406 1951 (1952).

Fig. 55 A-D; Plate 19 A

Pileus 4–15 mm diam., spatuloid or flabelliform, fleshy, sessile, arising from a small, white mycelial tomentum; surface pale orange (5A3) or greyish orange (5B3, 5B4, 6B4), glabrous, smooth, dull, very faintly translucent striate when moist; margin decurved to plane, almost entire when young, becoming eroded, lobate or fissile. Context up to 2 mm thick, concolorous with the pileus surface. Lamellae radiating from a lateral point, orange white (5A2), pale orange (5A3) or greyish orange (5B3), subcrowded to close, up to 2.5 mm wide, with lamellulae of 3–5 lengths; edge concolorous with the sides, fimbriate. Stipe absent. Odour none. Spore-print not obtained.

Spores 5.5–7.5 x 4.5–6.5 (6.84 ± 0.52 x 5.64 ± 0.53) μm , $Q=1.1-1.4$, $Q_m=1.21$, broadly ovoid to subglobose, yellowish brown, thin- to slightly thick-walled, finely echinulate. Basidia 19.5–29 x 7–10.5 μm , clavate, 4-spored; sterigmata up to 4 μm long. Lamella-edge sterile to heteromorphous with crowded or scattered cheilocystidia. Cheilocystidia 20–87.5 x 5.5–24 μm , clavate-capitate or pedicellate-clavate, rarely flexuous, thin- to slightly thick-walled, faintly encrusted, hyaline. Pleurocystidia none. Hymenophoral trama regular; hyphae 2–10.5 μm wide, thin-walled, hyaline. Pileal trama loosely interwoven; hyphae 1.5–12 μm wide, thin-walled, hyaline. Pileipellis an undifferentiated cutis; hyphae 2–7 μm wide, thin- to

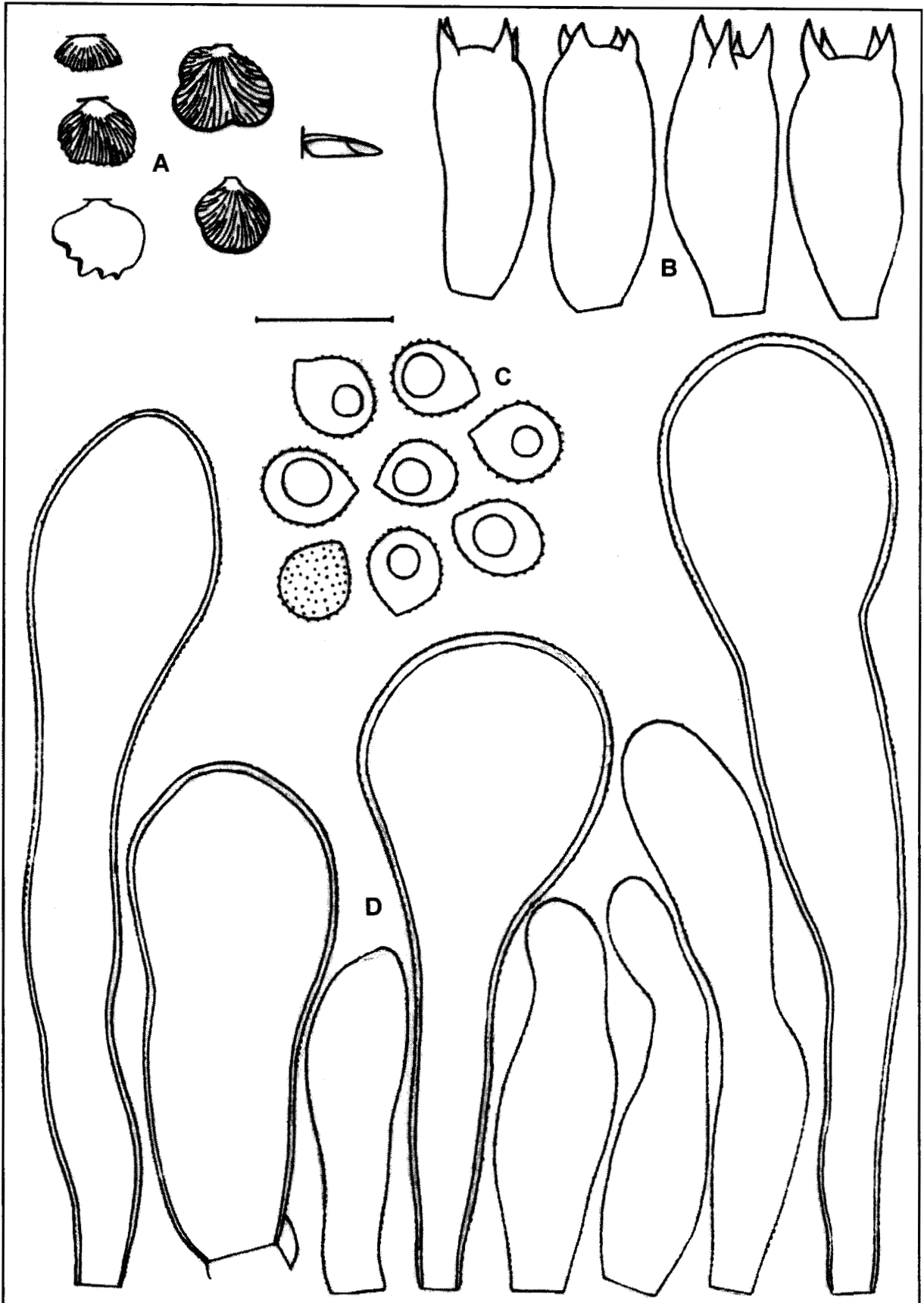


Fig. 55. *Crepidotus palmarum* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia.
Scale bar = 10 μ m

slightly thick-walled, sometimes faintly encrusted, hyaline. Clamp-connexions prominent in all tissues.

On decaying leaf base of toddy palm (*Caryota urens* Linnaeus, Arecaceae), scattered, June-July.

Specimens examined: India, Kerala State, Malappuram District, Calicut University Campus: 1 July 1997, A. Thomas T89; 15 June 1998, A. Thomas T89b; 24 August 2000, A. Thomas T89c; 26 August 2000, A. Thomas T89d; 29 August 2000, A. Thomas T89e.

Crepidotus palmarum is characterized by small, sessile, palmicolous basidiomata; ovoid to subglobose, finely echinulate spores; clavate-capitate or pedicellate-clavate cheilocystidia; and absence of pileocystidia. In Singer's (1986) classification, it is placed in section *Echinospori*, subsection *Porpophorini* Singer. In the system of classification proposed by Hesler and Smith (1965), it can be placed in the subgenus *Sphaerula* Hesler & Smith, section *Sphaerula*. *Crepidotus cuneiformis* Patouillard shows many similarities but in that species spores are subglobose to globose and pileocystidia are frequently present. In most macro- and microscopic characters this species is remarkably similar to *C. applanatus* (Persoon) Kummer, but the latter species differs in having more globose spores and pileocystidia.

Crepidotus epicrocinus (Berkeley & Broome) Saccardo Fig. 56 A-D; Plate 19 B in Syll. Fung. 5:884 (1887).

Agaricus epicrocinus Berkeley & Broome in Journ. Linn. Soc., Bot. 11:545 (1871).

Pileus 5–22 mm diam., flabelliform or dimidiate with lateral or dorsal attachment, convex to applanate when seen from the side; surface pale yellow (4A2, 3A3) or light yellow (4A4), infrequently turning brown (6E7) towards base, slightly tomentose towards the point of attachment to the substratum, smooth elsewhere, glabrescent, dry; margin inrolled, becoming incurved, entire when young, becoming lobate or undulating. Context up to 2 mm thick, white with a yellow tint. Lamellae radiating from a lateral point, light yellow (3A4, 4A5), maize yellow (4A6) or greyish yellow (4B6), becoming brownish (6D6), subcrowded, up to

3 mm wide, with lamellulae of 3-4 lengths; edge slightly paler than the sides, almost entire. Stipe absent. Odour none. Spore-print not obtained.

Spores 6.5–9 x 5.5–8 (7.73±0.80 x 6.92±0.70) μm , Q=1.04–1.22, Qm=1.11, subglobose to globose, yellowish brown, thin- to slightly thick-walled, echinulate. Basidia 19.5–29 x 6.5–9.5 μm , clavate, 2- or 4-spored; sterigmata up to 4.5 μm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 14–46.5 x 5.5–10 μm , versiform: utriform, lageniform, ventricose-fusoid or flexuose, sometimes with a subcapitate apex, rarely furcate at the apex, thin-walled, at times slightly thickened or encrusted at the distal end, hyaline. Pleurocystidia absent. Hymenophoral trama regular; hyphae 2–4 μm wide, thin-walled, hyaline to pale yellow. Pileal trama composed of loosely interwoven, 2–9.5 μm wide hyphae, thin- to slightly thick-walled, hyaline. Pileipellis an undifferentiated cutis; hyphae 2.5–5.5 μm wide, slightly thick-walled, hyaline to pale yellow. Prominent clamp-connexions present on all hyphae.

On decaying stem of *Areca catechu* Linnaeus (Arecaceae), in clusters or scattered, September-October.

Specimens examined: India, Kerala State, Kannur District, Pulikurumba: 15 September 1997, A. Thomas T173; 22 September 1997, A. Thomas T173b; 28 October 1997, A. Thomas T173c; 26 October 1997, A. Thomas T173d.

Crepidotus epicrocinus is first described from Sri Lanka. Pale yellow pileus and lamellae; echinulate, subglobose to globose spores; versiform cheilocystidia; non-gelatinized trama; cutis-type pileipellis; and prominent clamp-connexions are the diagnostic features of this species. It may be placed in the section *Echinospori* subsection *Porpophorini* of Singer's (1986) system of classification or in subgenus *Sphaerula* section *Sphaerula*, subsection *Colorantes* Hesler & Smith in the system of classification of Hesler and Smith (1965). The Kerala collections are indistinguishable from *C. epicrocinus* except for the slightly different morphology of the cheilocystidia.

The present collections are close to *C. cesatii* (Rab.) Saccardo also, differing only in the yellow colour of the basidiomata and in the absence of antler-like branching at the

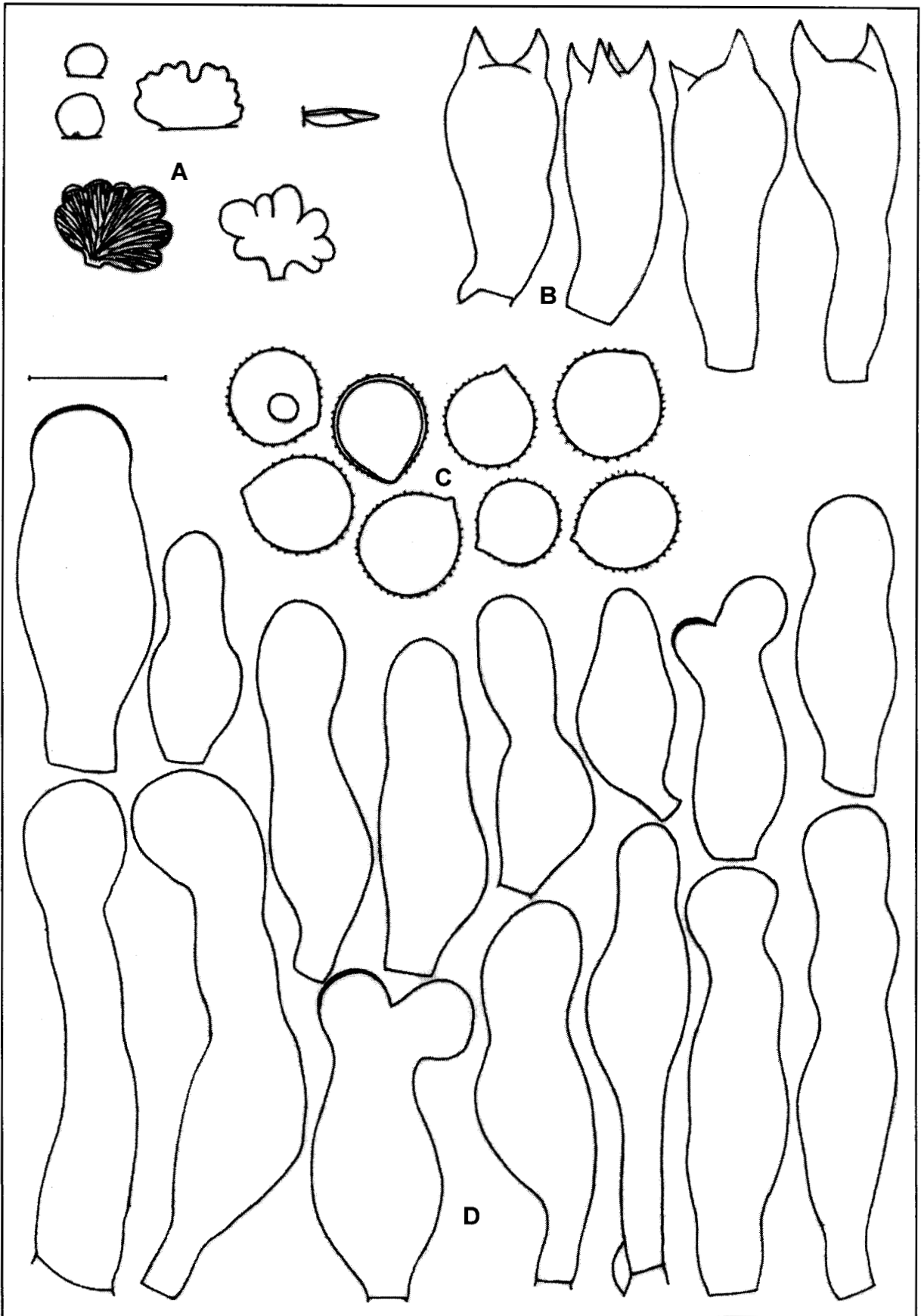


Fig. 56 *Crepidotus epicrocinus* A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia.
Scale bar = 10 μ m

apices of cheilocystidia. The Kerala collections also show close similarity in many characters to *C. citrinus* Petch but cheilocystidia are not very similar. Singer (1973b), however, has included collections with cheilocystidia of more bizarre shapes in *C. citrinus*.

***Crepidotus* sp. 1**

Fig. 57 A-D; Plate 19 C

Pileus 12–45 mm diam., flabelliform to dimidiate, with lateral attachment, sessile; surface initially whitish, turning to pale yellow (4A3), orange white (5A2) or pale orange (5A3), with brown (6D6, 6D7) squamules which are denser at base, and gradually diminishing towards margin, dull, dry; margin inrolled becoming incurved, entire. Context up to 4 mm thick, white. Lamellae radiating from a lateral point, initially whitish, later pale orange (5A3) to greyish orange (5B3), crowded, up to 6 mm wide, with lamellulae of different lengths; edge concolorous with the sides, fimbriate to almost entire under a lens. Stipe none. Odour unpleasant. Spore-print light brown (5D5, 5D6).

Spores 5.5–8 x 5–7.5 (6.95 ± 0.67 x 6.33 ± 0.73) μm , $Q=1.00-1.22$, $Q_m=1.09$, subglobose to almost globose, yellowish brown, finely echinulate, thin- to slightly thick-walled, without germ-pore. Basidia 21.5–35 x 7–9.5 μm , clavate, 4-spored; sterigmata up to 3.5 μm long. Lamella-edge sterile when young with crowded cheilocystidia. Cheilocystidia 14–70 x 6.5–15 μm , clavate-capitate, often constricted, thin- to slightly thick-walled, sometimes thickening restricted to the apex, hyaline. Pleurocystidia none. In mature specimens some hyphal tips at the edge and sides of lamellae projecting out to form flexuous, cystidia-like structure. Hymenophoral trama regular; hyphae 2–15.5 μm wide, thin-walled, hyaline. Pileal trama loosely interwoven; hyphae 1.5–19 μm wide, almost thin-walled, hyaline. Pileipellis a cutis; hyphae 2.5–15 μm wide, thin-walled encrusted by a yellowish brown pigment, frequently disrupted by trichodermial bundles of ascending or erect, 4–16.5 μm wide hyphae, thin-walled, encrusted with a dark brown pigment. Clamp-connexions present in all tissues.

On a dead eucalyptus tree trunk, scattered, October.

Specimens examined: India, Kerala State, Idukki District, Munnar: 11 October 1999, A. Thomas T333; 12 October 1999, A. Thomas T333b.

cutis?

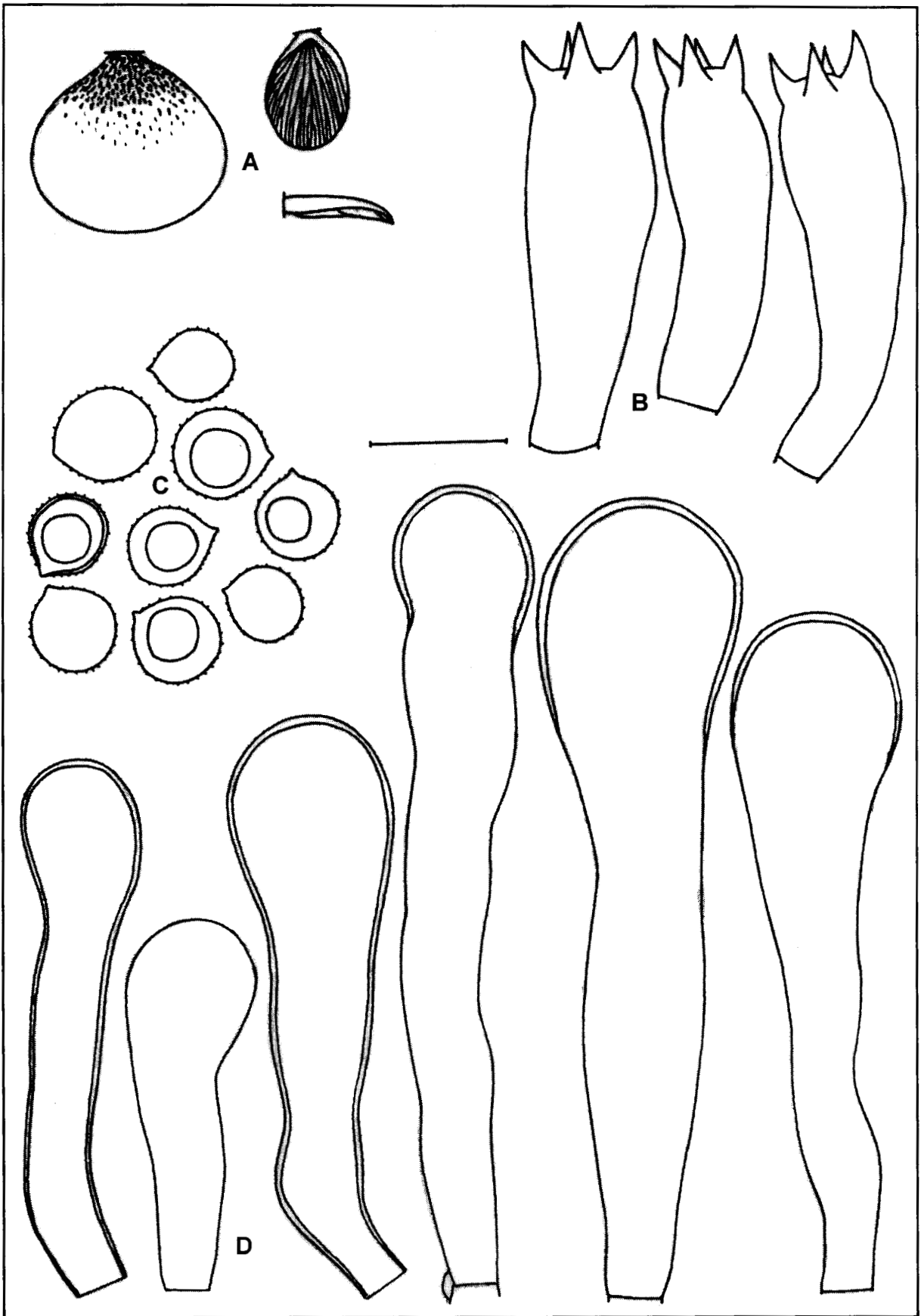


Fig. 57. *Crepidotus* sp. 1. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia. Scale bar = 10 μ m

This species is characterized by whitish to pale brown, squamulose pileus; echinulate, subglobose to globose spores; clavate-capitate cheilocystidia; non-gelatinized trama; and clamp-connexions. It may be placed either in section *Echinospori*, subsection *Porpophorini* in Singer's (1986) system of classification or in subgenus *Sphaerula*, section *Sphaerula*, Subsect, *Fulvofibrillosi* Hesler & Smith in Hesler and Smith's (1965) classification.

The present collections seem to represent an undescribed species. *Crepidotus grumosopilosus* (Berkeley & Broome) Saccardo is very close in most macro- and microscopic features but it has a pileus surface which although initially whitish, becomes ferruginous brown towards base and is radially striate with coarse fibrillose fascicles. In addition, the pileal surface is hygrophanous and pellucid-striate half-way from the margin. Microscopically the much smaller basidia and the hyaline, non-encrusted hyphae of the pileipellis differentiate it. Our specimens are strikingly similar to *C. nephrodes* (Berkeley & Curtis) Saccardo in spore size and morphology but that species has pellucid-striate and non-squamulose pileal surface, different cheilocystidial morphology and no pigment encrustation on hyphal wall. *Crepidotus crocophyllus* (Berkeley) Saccardo is also similar in most macro- and microscopic characters but the spores of this species are not echinulate but baculate with truncate rod-shaped warts

***Crepidotus* sp. 2**

Fig. 58 A-D; Plate 20 A

Pileus 5–18 mm diam., convex to plano-convex, reniform, sometimes dimidiate or flabelliform, with lateral or dorsal attachment; surface white, becoming yellowish white (4A2), orange white (5A2) or greyish orange (5B3), almost silky when young, becoming dull, glabrescent; margin inrolled, becoming incurved, entire, sometimes becoming lobate, finally eroded or fissile. Context up to 1 mm thick, off-white or cream-coloured. Lamellae adnate or radiating from a lateral or eccentric point, orange white (5A2), greyish orange (5B3, 5B4, 6B4/5), close to subclose, up to 2.5 mm wide, with lamellulae of 3–4 lengths; edge concolorous with the sides or slightly lighter, fimbriate under a lens. Stipe either absent or

rudimentary (< 1 x 1 mm), solid; surface whitish. Odour not distinctive. Spore-print clay-coloured (5D5).

Spores 6.5–9.5 x 3.5–5.5 (8.05±0.77 x 4.20±0.49) μm, Q=1.53–2.25, Qm=1.94, oblong to subamygdaliform, light yellowish brown, smooth, thin-walled, without a germ-pore. Basidia 20–30 x 6.5–9.5 μm, clavate, 4-spored; sterigmata up to 5.5 μm long. Lamella-edge sterile with crowded cheilocystidia when young. Cheilocystidia 15–70 x 3–7.5 μm, cylindrical, strongly flexuous, often tapering, rarely branched, thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama regular; hyphae 2–1.5 μm wide, thin-walled, hyaline. Pileal trama parallel-interwoven; hyphae 1.5–10 μm wide, thin-walled, hyaline. Pileipellis a cutis; hyphae 2–6.5 μm wide, thin-walled, hyaline to pale yellow. Clamp-connexions present in all tissues.

On small dead twigs of herbaceous plants, gregarious to scattered, June-July.

Specimens examined: India, Kerala State, Kannur District, Morazha: 21 July 1997, A. Thomas T115; 28 July 1997, A. Thomas T115b; Malappuram District, Calicut University Campus: 19 June 1996, A. Thomas T20; 15 July 1996, A. Thomas T31; 16 July 1996, A. Thomas T31b; 8 July 1997, A. Thomas T31c; 21 June 2000, A. Thomas T31d.

This species is characterized by small basidiomata occurring on decaying herbaceous stems; smooth, oblong to subamygdaliform spores; cylindric-flexuose cheilocystidia; pileipellis of repent, non-encrusted hyphae; and clamp-connexions. In Singer's (1986) system it can be placed in section *Crepidotus*, subsection *Fibulatini* Singer, or in the system of classification of Hesler and Smith (1965) in subgenus *Dochmiopus* (Patouillard) Pilát, Section *Fusisporae* Hesler & Smith. It seems to be very close to *Crepidotus fusisporus* Hesler & Smith especially var. *longicystis* Hesler & Smith, but differs in having less fusoid, perfectly smooth spore. The Sri Lankan species *C. pezizula* (Berkeley & Broome) Saccardo which also occurs on herbaceous stems, has similar spores and almost similar cheilocystidia but it a very tiny species with a differentiated epicutis of loose, branched, semi-erect hyphae heavily encrusted with a granular pigment. *Crepidotus acanthosyrinus* Singer, from South America, is similar to our collections in some features but that species had broader, ellipsoid to ovoid spores.

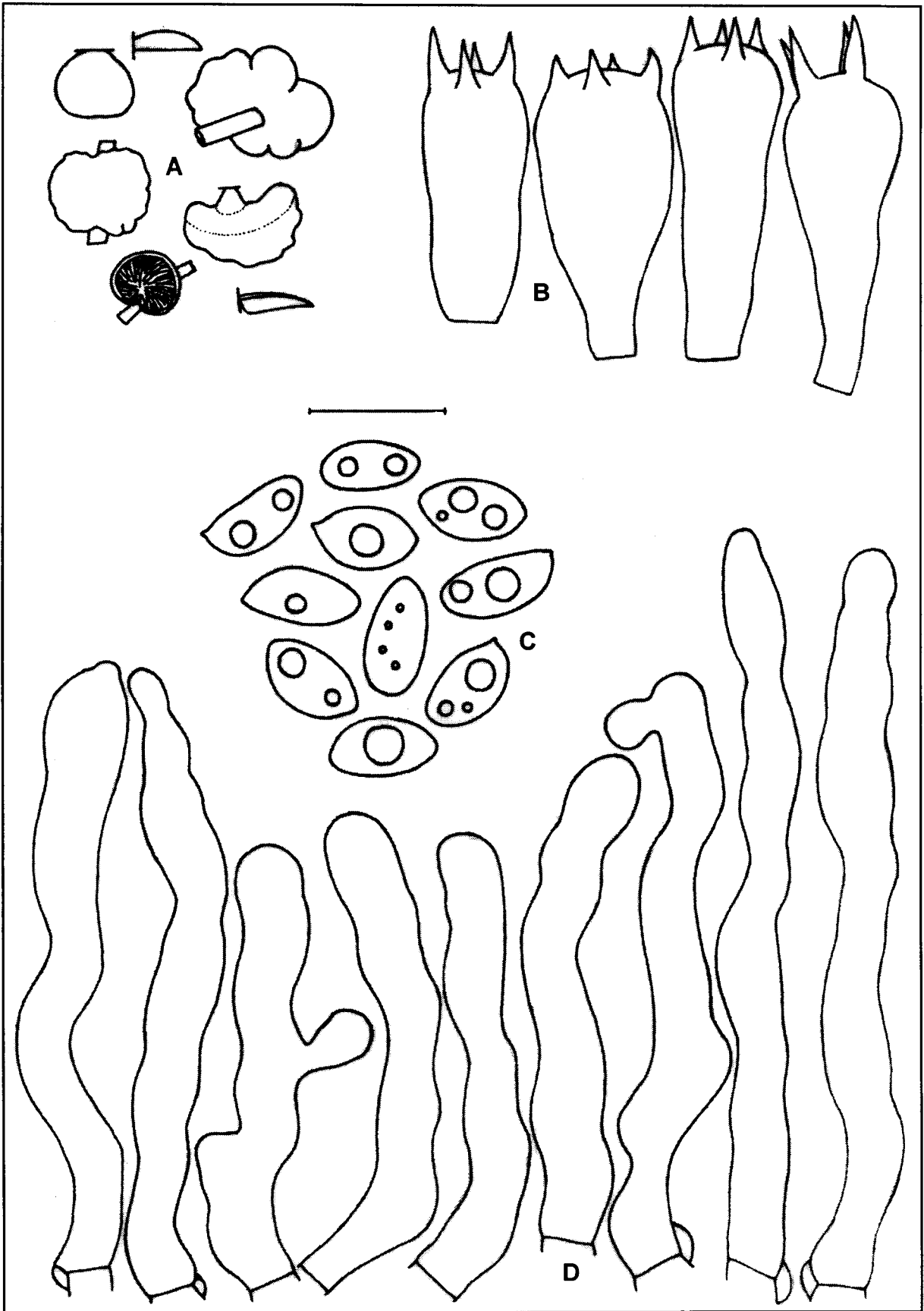


Fig. 58. *Crepidotus* sp.2. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia. Scale bar = 10 μ m

***Crepidotus* sp. 3**

Fig. 59 A-E; Plate 20 B

Pileus 5–37 mm diam., flabelliform or conchate, laterally attached, convex to plane; surface white when young, becoming orange white (5A2), or greyish orange (5B3), light brown (6D5) or slightly darker in some old specimens, smooth, glabrous, finely translucent-striate towards margin when moist; margin decurved, initially entire, becoming undulating or eroded. Context up to 3 mm thick, white. Lamellae adnate or radiating from a lateral point, initially white, becoming greyish orange (5B3), finally light brown (6D5), subcrowded to close, up to 3 mm wide, with lamellulae of different lengths; edge pale or almost concolorous with the sides, finely scalloped under a lens. Stipe either absent or very short and rudimentary, < 3 x 3 mm, whitish, tomentose at base. Odour none. Spore-print brown (6E6).

Spores 6–9 x 4–6 (7.67 ± 0.79 x 5.17 ± 0.54) μm , $Q=1.36$ – 1.62 , $Q_m=1.48$, fusoid to subamygdaliform in side-view, ovoid in face-view, yellowish brown, smooth, slightly thick-walled, without a germ-pore. Basidia 16.5–25 x 5–7.5 μm , clavate to cylindrical, 4-spored; sterigmata up to 4 μm long. Lamella-edge sterile to heteromorphous with crowded to scattered cheilocystidia. Cheilocystidia 13–46.5 x 5–13 μm versiform: tibiiform, utriform, lageniform, fusoid or flexuose, thin-walled or sometimes slightly thick-walled around the middle or throughout, hyaline to light yellowish brown. Pleurocystidia none. Hymenophoral trama subregular to almost regular composed of short, inflated, branched elements, 1.5–12.5 μm , thin-walled, hyaline, gelatinized towards the lamella-edge. Pileal trama with a compact lower half and a loosely interwoven upper half; true gelatinization not observed; hyphae 1.5–15.5 μm wide, short-celled, thin-walled, hyaline to light yellow. Pileipellis a cutis; hyphae 1.5–11.5 μm wide, thin-walled, yellowish brown, faintly encrusted. Pileocystidia 15–57.5 x 6–16.5 μm , versiform: mostly irregular, many clavate, modified end cells of pileal hyphae, thin-walled, sometimes slightly thick towards distal end, at times encrusted, hyaline to yellowish brown. Clamp-connexions not observed.

On a decaying wood, gregarious to scattered, October.

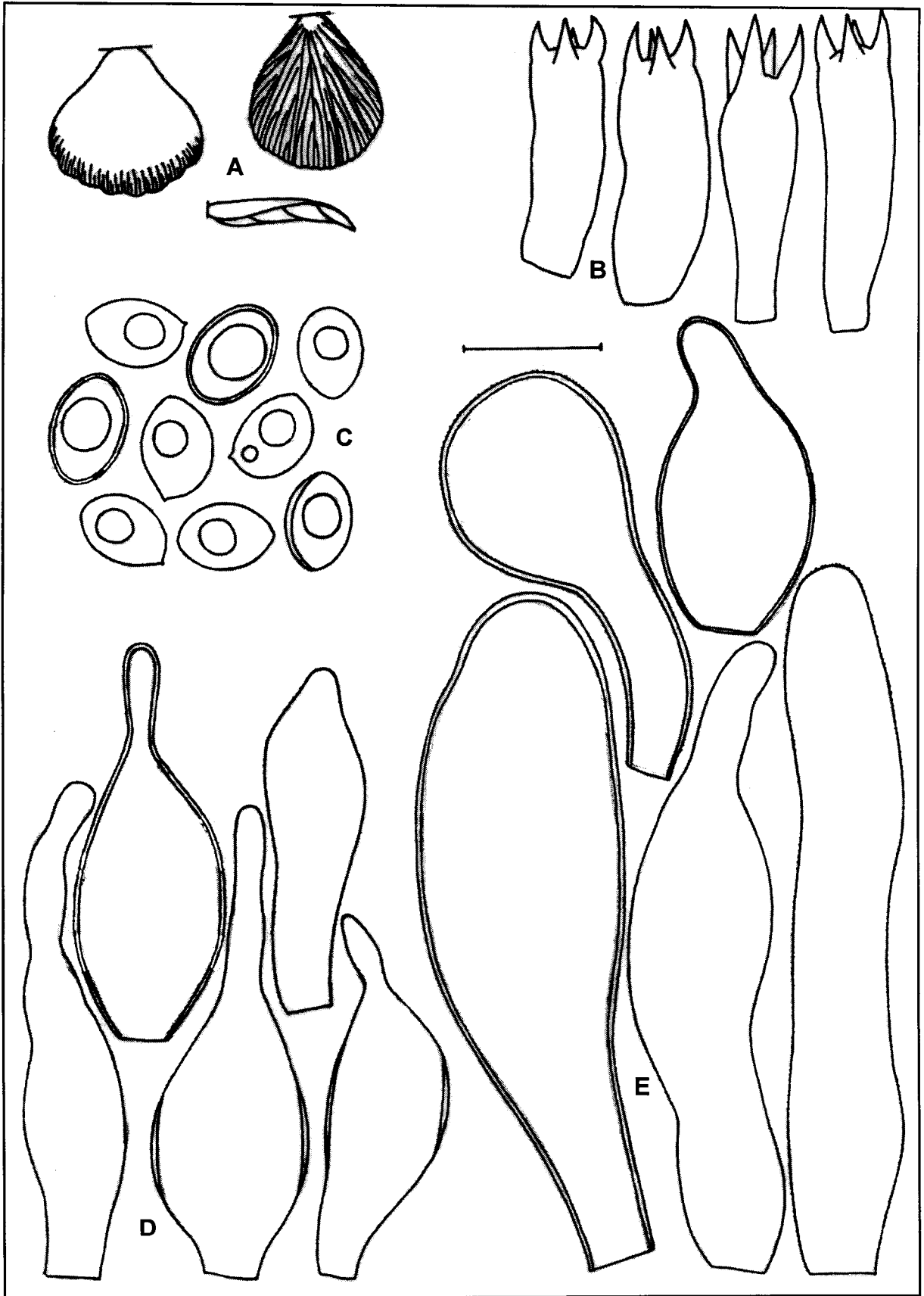


Fig. 59. *Crepidotus* sp. 3. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia; E. Pileocystidia. Scale bar = 10 μ m

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy: 17 October 1999, A. Thomas T337; 28 October 1999, A. Thomas T337b; Palakkad District, Nelliampathy: 15 August 1997, A. Thomas T134; 16 August 1997, A. Thomas T134b.

This species is characterized by whitish basidiomata; smooth, fusoid to subamygdaliform spores; versiform cheilocystidia; subgelatinized hymenophoral trama; pileipellis with repent, faintly encrusted hyphae and versiform pileocystidia; and absence of clamp-connexions. In Singer's (1986) system of classification it can be placed in the section *Crepidotus*, subsection *Defibulatini* Singer. In Hesler and Smith's (1965) system of classification, subgenus *Crepidotus* is the proper place for it, but it is difficult to place it at sectional level as it combines features of section *Tubariopsis* Hesler & Smith (fusoid to subfusoid spores) and Section *Stratosi* Helser & Smith (Pileus structure duplex). Also, it is not agreeing with any of the species classified by Hesler and Smith under these sections. This species is strikingly similar to *Crepidotus melleus* (Berkeley & Broome) Petch in macroscopic features but the shape of cheilocystidia and spores are very different. Also, pileocystidia are present in the Kerala collections. The present collections are also close to *C. mollis* (Schaeffer ex Fries) Staude in most characters but gelatinization of trama is not observed in our collections and the morphology of cheilocystidia is rather different.

***Crepidotus* sp. 4**

Fig. 60 A-D; Plate 20 C

Pileus 3–10 mm diam., almost orbicular, dimidiate, or reniform, with lateral attachment arising from a small, white mycelial tomentum; surface whitish when young, becoming greyish orange (6B3), brownish orange (6C3), or brown (7E5), hygrophanous and becoming whitish, smooth, glabrous, slightly sticky and with translucent striations towards margin when moist; margin decurved, crenate. Context up to 0.5 mm thick, concolorous with the pileus. Lamellae radiating from a lateral point, pale orange (5A3) or greyish orange (5B3), becoming light brown (6D5), subcrowded to subclose, with lamellulae of 3–4 lengths, up to 2.5 mm wide, edge concolorous with sides or pale, fimbriate under a lens. Stipe absent. Odour none. Spore-print oak brown (5D6).

Spores 6.5–9.5 x 4.5–6.5 (8.02±0.95 x 5.58±0.49) µm, Q=1.26–1.72, Qm=1.44, ovo-ellipsoid to subamygdaliform, yellowish brown, smooth, slightly thick-walled, without germ-pore. Basidia 20–29 x 6.5–8 µm, clavate to cylindrical, 4-spored; sterigmata up to 5 µm long. Lamella-edge sterile when young with crowded cheilocystidia. Cheilocystidia 20–60 x 5–10 µm, versiform: tibiiform, utriform, lageniform or flexuose, sometimes with finger-like protuberances at the top, thin-walled, hyaline. Pleurocystidia none. Hymenophoral trama with a subregular, broad middle region composed of short, inflated, branched elements, 16.5–60 x 2.5–16.5 µm, sandwiched between narrow bands of filamentous hyphae, 2–6.5 µm wide; gelatinized towards the lamella-edge. Pileal trama loosely interwoven; hyphae 2.5–16.5 µm wide, composed of short-inflated elements, thin-walled, hyaline. Pileipellis a differentiated cutis of loosely interwoven narrow hyphae; hyphae 2–7 µm wide, thin-walled, hyaline to pale yellowish brown. Clamp-connexions not observed.

On the bark of a living eucalyptus tree, scattered to gregarious, June-July.

Specimens examined: India, Kerala State, Malappuram District, Calicut University Campus: 2 July 1997, A. Thomas T91; 3 July 1997, A. Thomas T91b; 17 June 1998, A. Thomas T267; 3 July 2000, A. Thomas T267b.

This species is characterized by small, whitish to brownish pileus; smooth, ovo-ellipsoid to amygdaliform spores; versiform cheilocystidia; subgelatinized hymenophoral trama; non-gelatinized pileal trama; and absence of clamp-connexions. It may be placed in section *Crepidotus*, subsection *Crepidotus* according to Singer's (1986) system of classification or in subgenus *Crepidotus* in Hesler and Smith's (1965) system.

Senn-Irlet's (1995) key leads directly to *Crepidotus mollis* (Schaeffer: Fries) Staude but the context of that species is a duplex with a distinct, broad gelatinous layer just beneath the pileipellis. The present collections are similar to *C. melleus* (Berkeley & Broome) Petch in spore-size and shape but in that species morphology of cystidia is different and subhymenium is gelatinized. *Crepidotus uber* (Berkeley & Curtis) Saccardo is morphologically somewhat similar and has gelatinized hymenophoral trama but morphology of spores and cheilocystidia are different. The present collections represent a new species.

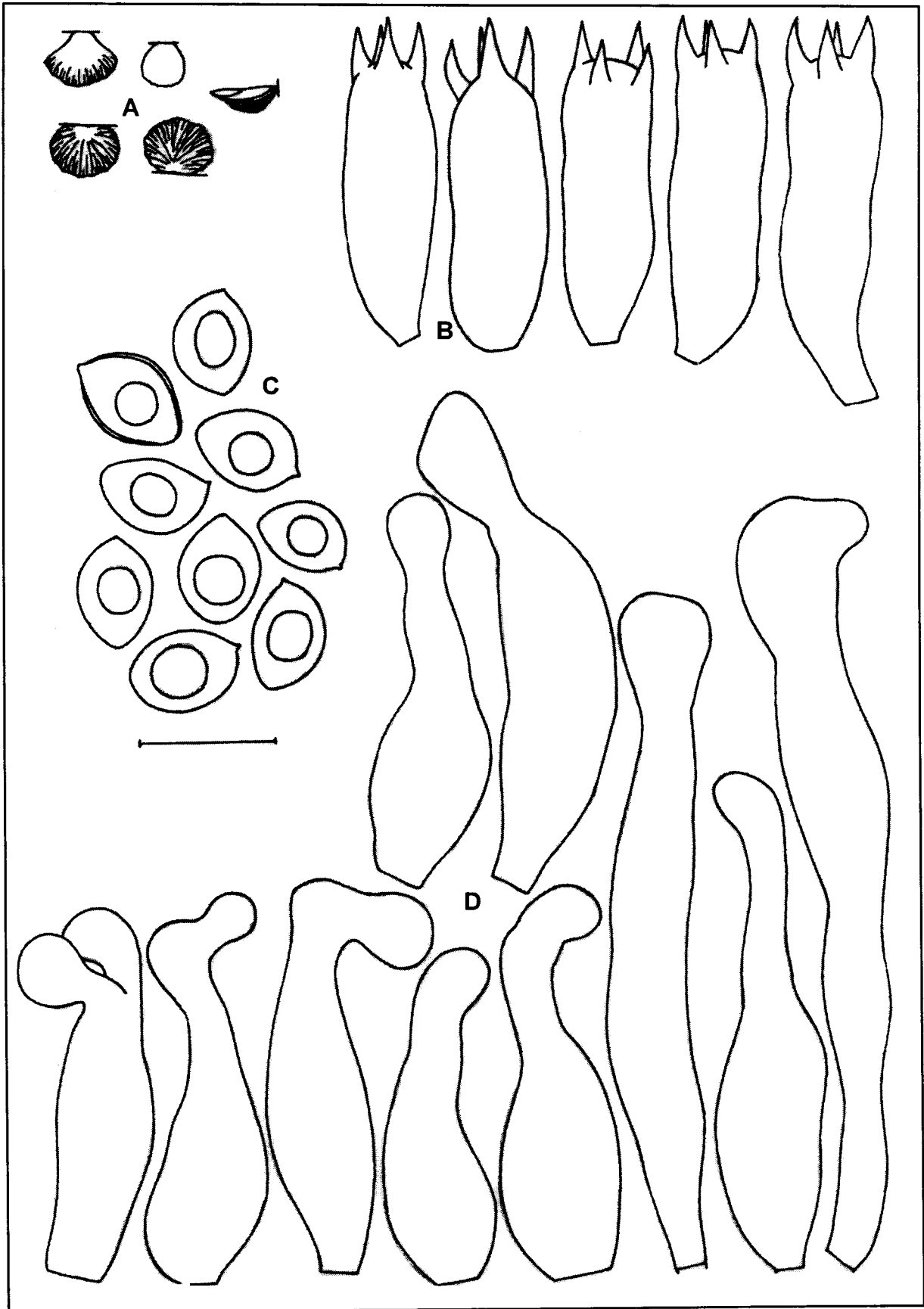


Fig. 60. *Crepidotus* sp. 4. A. Habit x 1; B. Basidia; C. Spores; D. Cheilocystidia. Scale bar = 10 μ m

GENERAL OBSERVATIONS AND DISCUSSIONS

In this treatise, a total number of sixty species belonging to 15 genera of dark-spored agarics of Kerala are described. Among these, 20 species belong to Bolbitiaceae, 16 species represent Strophariaceae, 17 species pertain to Cortinariaceae and 7 species represent Crepidotaceae. A full list of the species included in this work is given in Table 1.

The 15 genera which could be collected and described in this study are:

Bolbitiaceae

1. *Agrocybe* (6 species)
2. *Bolbitius* (1 species)
3. *Conocybe* (9 species)
4. *Descolea* (1 species)
5. *Galerella* (1 species)
6. *Pholiotina* (2 species)

Strophariaceae

7. *Hypholoma* (1 species)
8. *Melanotus* (1 species)
9. *Pholiota* (1 species)
10. *Psilocybe* (11 species)
11. *Stropharia* (2 species)

Cortinariaceae

12. *Cortinarius* (4 species)
13. *Gymnopilus* (3 species)
14. *Inocybe* (10 species)

Crepidotaceae

15. *Crepidotus* (7 species)

Out of these, seven genera are new to Kerala. They are:

1. *Bolbitius*

2. *Descolea*
3. *Galerella*
4. *Pholiotina*
5. *Hypholoma*
6. *Stropharia*
7. *Crepidotus*

The genus *Galerella* is reported for the first time from India.

Out of these 60 species included here, except *Agrocybe pediades* and *Inocybe cutifracta*, all the other 58 species are new records to Kerala.

Of the total 60 species described, nine species are already known from various parts of India. They are:

1. *Agrocybe pediades*
2. *Agrocybe semiorbicularis*
3. *Hypholoma subviride*
4. *Inocybe cutifracta*
5. *Inocybe rimosa*
6. *Psilocybe argentina*
7. *Psilocybe coprophila*
8. *Psilocybe cubensis*
9. *Psilocybe pseudoaztecorum*

The following 14 taxa are considered as new additions to the Indian agaric flora.

1. *Bolbitius coprophilus*
2. *Cortinarius pseudosalor*
3. *Crepidotus cinnabarinus*
4. *Crepidotus epicrocinus*
5. *Crepidotus palmarum*
6. *Descolea maculata*
7. *Galerella plicatella*

8. *Gymnopilus lepidotus*
9. *Melanotus communis*
10. *Psilocybe alnetorum*
11. *Psilocybe pseudobullacea*
12. *Psilocybe subaeruginascens*
13. *Stropharia bicolor*
14. *Stropharia rugosoannulata*

All the remaining 37 species are considered as new to science as an extensive search in the literature could not reveal any previously published names for these taxa. The Kerala collections of *Galerella plicatella* are considered as belonging to a new variety. Valid publication of these new taxa will be done separately in journals devoted to fungal taxonomy.

During this study, the genus *Psilocybe* with 11 species emerged as the largest genus, closely followed by *Inocybe* and *Conocybe* with 10 and 9 species respectively.

A family-wise break-up shows that Bolbitiaceae is the largest family represented by 20 species. All the six genera recognized by Singer (1986) under the family Bolbitiaceae could be collected during this study. A remarkable genus encountered during this study is *Descolea* which was known previously from India only from a single species, *Descolea pretiosa* collected from the State of Himachal Pradesh (Horak, 1983). This rarely-collected genus is considered to have migrated from the Southern hemisphere (Horak, 1983). The genus *Agrocybe* is represented by two cosmopolitan species, *A. pediades* and *A. semiorbicularis* and four previously undescribed species. The genus *Conocybe* seems to be very rich in species diversity. All the nine species of *Conocybe* discovered during the study are new to science. Remarkably, none of the species described by Watling, Little Flower and Leelavathy (1988) from Kerala State were rediscovered during this study. Another noteworthy discovery is that of a new volvate species of *Conocybe*. So far only five species of *Conocybe* with volvate stipe base (Watling & Hausknecht, 1997) were known from the whole world. The genus *Bolbitius* on the other hand is represented by a single species, *B. coprophilus*.

Of the nine genera included in the family Strophariaceae by Singer (1986), five genera viz., *Hypholoma*, *Melanotus*, *Pholiota*, *Psilocybe* and *Stropharia* were collected from Kerala during the present study. The author could not collect species of *Kuehneromyces*, *Pachylepyrium*, *Phaeomarasmius* and *Pleuroflammula*. *Psilocybe* with 11 species is the largest strophariaceae genus in this treatise. The other four genera are represented by only one or two species in each. Incidentally, out of the 11 species of *Psilocybe*, eight are known to be psilocybin-active.

Singer (1986) recognizes 14 genera viz., *Alnicola*, *Cortinarius*, *Cuphocybe*, *Dermocybe*, *Galerina*, *Gymnopilus*, *Hebeloma*, *Hebelomina*, *Inocybe*, *Leucocortinarius*, *Phaeocollybia*, *Pyrrhoglossum*, *Stephanopus* and *Rozites* in the family Cortinariaceae. Out of these, only three genera viz., *Cortinarius*, *Gymnopilus* and *Inocybe* were recorded during the present study.

The most remarkable genus discovered during the study is *Cortinarius*, considered to have no distribution in the tropical regions of the world. During this study four species of *Cortinarius* associated with forest trees, especially of the family Dipterocarpaceae, could be collected. Two earlier reports (Sathe & Daniel, 1980; Bhavanidevi & Nair, 1987) on the occurrence of *Cortinarius* in Kerala on decaying woody substrates probably represent wrong identification, as all species of *Cortinarius* are proved to be mycorrhizal with forest trees and occur on soil. The genus *Inocybe* is also considered to be poorly distributed in the tropics. But in this study ten species of this genus were recorded from Kerala. However, *Gymnopilus*, the only lignicolous genus of the family, is poorly represented in Kerala with only three species.

Singer (1986) recognizes nine genera viz., *Crepidotus*, *Chromocyphella*, *Episphaeria*, *Pellidiscus*, *Phaeosolenia*, *Pleurotellus*, *Melanomphalia*, *Simocybe* and *Tubaria* in the family Crepidotaceae. During the study, the author could collect specimens of only the genus *Crepidotus*. The genus *Crepidotus* is comparatively well represented in Kerala with seven species of which four are considered as new to science.

The remarkably high percentage (61.7%) of new species discovered during this study

is not without parallels. For example, after a single year of intensive collecting in one forest in Kenya, Mibey and Hawksworth (1997) found that 59 of 75 (75 %) of the leaf dwelling ascomycetes encountered were new species. Recent investigations by Hyde, Frohlich and Taylor (1997) on fungi of palms yielded 1,580 species, of which 75 % were new to science. A 2-month visit to Papua New Guinea yielded 6 genera and 89 species of lichen-forming and lichenicolous fungi new to science (Aptroot, Diederich, Serusiaux & Sipman, 1997). According to Hawksworth (1993), 66% of the species collected by Prof. E. J. H Corner during his extended studies on Malaysian macrofungi were new to science. All the studies cited above including the present one provide supportive evidence to the hypothesis that tropics are more species-rich than temperate regions.

The author has not made any comparison of the agaric flora of Kerala emerged during this study with agaric floras of other parts of the world. It has to be emphasized that this was a deliberate decision by the author as he believes that the tropical mycobiota in general and Indian mycobiota in particular remain in the 'pioneer (or exploratory) phase' of the four stages of understanding the species present in a region distinguished by Davis and Heywood (1963). As noted by Hawksworth (1993), 'this phase represent only the first portion of alpha-taxonomy, as defined by these authors, in that consolidated knowledge of the species present and their variability will not be unattainable in the foreseeable future'. In such a stage, no meaningful comparison can be made between species-content of different geographical regions. Such an exercise will be all the more meaningless when more than half of the species described are new and when there is no way of knowing at present how many of them are endemic to the region. As aptly described by Subramanian (1982), 'tropical fungus floras have been mapped unevenly, inadequately and irregularly in both time and space'. Even the present treatise is not free from these unavoidable limitations. In Table 1 the author has compiled information regarding the world-distribution of the species encountered during this study.

Table 1

List of dark-spored agarics described in this treatise and their distribution in other parts of India and the world

Sl. No.	Dark-spored agarics recorded from Kerala	Distribution in other States of India	Distribution in other countries
1.	<i>Agrocybe pediades</i>	Jammu & Kashmir, Maharashtra, Uttar Pradesh	Great Britain, Netherlands, New Zealand, Norway
2.	<i>Agrocybe semiorbicularis</i>	Jammu & Kashmir, Tamil Nadu	Great Britain, Malaysia, Netherlands, Norway, Sri Lanka
3.	<i>Agrocybe</i> sp.1*		
4.	<i>Agrocybe</i> sp.2*		
5.	<i>Agrocybe</i> sp.3*		
6.	<i>Agrocybe</i> sp.4*		
7.	<i>Bolbitius coprophilus</i>		Great Britain, Japan, Malaysia, Netherlands, USA
8.	<i>Conocybe</i> sp. 1*		
9.	<i>Conocybe</i> sp. 2*		
10.	<i>Conocybe</i> sp. 3*		
11.	<i>Conocybe</i> sp. 4*		
12.	<i>Conocybe</i> sp. 5*		
13.	<i>Conocybe</i> sp. 6*		
14.	<i>Conocybe</i> sp. 7*		
15.	<i>Conocybe</i> sp. 8*		
16.	<i>Conocybe</i> sp. 9*		
17.	<i>Cortinarius pseudosalor</i>		Europe, Great Britain
18.	<i>Cortinarius</i> sp.1*		
19.	<i>Cortinarius</i> sp.2*		
20.	<i>Cortinarius</i> sp.3*		
21.	<i>Crepidotus cinnabarinus</i>		Denmark, France, Mexico, USA
22.	<i>Crepidotus epicrocinus</i>		Kenya, Sri Lanka, Tanzania
23.	<i>Crepidotus palmarum</i>		Argentina, Brazil

24.	<i>Crepidotus</i> sp.1*		
25.	<i>Crepidotus</i> sp.2*		
26.	<i>Crepidotus</i> sp.3*		
27.	<i>Crepidotus</i> sp.4*		
28.	<i>Descolea maculata</i>		Australia, Denmark
29.	<i>Galerella plicatella</i> **		
30.	<i>Gymnopilus lepidotus</i>		Mexico, USA
31.	<i>Gymnopilus</i> sp.1*		
32.	<i>Gymnopilus</i> sp.2*		
33.	<i>Hypholoma subviride</i>	Tamil Nadu	Cuba, Dominica, East Africa, Guadeloupe, Jamaica, Lesser Antilles, Martinique, Mexico, Sri Lanka, Trinidad
34.	<i>Inocybe cutifracta</i>		Indonesia, Sri Lanka
35.	<i>Inocybe rimosa</i>	Jammu & Kashmir, Maharashtra	Austria, Belgium, Czechoslovakia, France, Germany, Italy, Netherlands, USA
36.	<i>Inocybe</i> sp. 1*		
37.	<i>Inocybe</i> sp. 2*		
37.	<i>Inocybe</i> sp. 3*		
39.	<i>Inocybe</i> sp. 4*		
40.	<i>Inocybe</i> sp. 5*		
41.	<i>Inocybe</i> sp. 6*		
42.	<i>Inocybe</i> sp. 7*		
43.	<i>Inocybe</i> sp. 8*		
44.	<i>Melanotus communis</i>		Papua New Guinea
45.	<i>Pholiota</i> sp. 1*		
46.	<i>Pholiotina</i> sp.1*		
47.	<i>Pholiotina</i> sp.2*		
48.	<i>Psilocybe alnetorum</i>		Argentina
49.	<i>Psilocybe argentina</i>	Tamil Nadu	Argentina, Brazil, Colombia, Mexico, Switzerland, USA, Venezuela
50.	<i>Psilocybe coprophila</i>	Jammu & Kashmir, Tamil Nadu	Argentina, Australia, Belgium, Brazil, Canada, China, Columbia, Czechoslovakia, East Africa, Ecuador, Guatemala, Hawaii, Hungary, Japan, Mexico, Netherlands, New Zealand, Norway, Panama, Papua New Guinea, Russia, Sweden, USA, Venezuela

51.	<i>Psilocybe cubensis</i>	Tamil Nadu	Argentina, Australia, Bolivia, Brazil, Central America, Columbia, Cuba, Cambodia, Guatemala, Lesser Antilles, Mexico, South America, Thailand, USA, Vietnam
52.	<i>Psilocybe pseudoaztecorum</i>	Tamil Nadu	
53.	<i>Psilocybe pseudobullacea</i>		East Africa, Ecuador, Mexico, Papua New Guinea, Sri Lanka, Venezuela
54.	<i>Psilocybe</i> sp.1*		
55.	<i>Psilocybe</i> sp.2*		
56.	<i>Psilocybe</i> sp.3*		
57.	<i>Psilocybe</i> sp.4*		
58.	<i>Psilocybe subaeruginascens</i>		Indonesia, Japan
59.	<i>Stropharia bicolor</i>		East Africa
60.	<i>Stropharia rugosoannulata</i>		Germany, Great Britain, Japan, Switzerland, USA

* New species discovered during the present study

** New variety discovered during the present study

SUMMARY

This treatise presents the result of a preliminary floristic study of the dark-spored agarics comprising the four families Bolbitiaceae, Strophariaceae, Cortinariaceae and Crepidotaceae as they occur in Kerala State, along with a review of all the concerned genera. All the species described were collected by the author himself from different parts of Kerala during the monsoon seasons of the period extending from the year 1996 to 2000.

Altogether, sixty species belonging to 15 genera are fully described. The concepts of families and genera adopted are those of Singer (1986). Keys are provided, wherever applicable, for families, genera and species. All the species descriptions are accompanied by line drawings of the basidiomata and the microscopic structures. A full synonymy and author citations are given for each species. The collection data of all the specimens are included in the description. Colour photographs of all the species studied, except one are also incorporated.

The 15 genera included in this treatise under the four different families are:

Bolbitiaceae

1. *Agrocybe* (6 species)
2. *Bolbitius* (1 species)
3. *Conocybe* (9 species)
4. *Descolea* (1 species)
5. *Galerella* (1 species)
6. *Pholiotina* (2 species)

Strophariaceae

7. *Hypholoma* (1 species)
8. *Melanotus* (1 species)
9. *Pholiota* (1 species)
10. *Psilocybe* (11 species)
11. *Stropharia* (2 species)

Cortinariaceae

12. *Cortinarius* (4 species)
13. *Gymnopilus* (3 species)
14. *Inocybe* (10 species)

Crepidotaceae

15. *Crepidotus* (7 species)

Among these, the genus *Galerella* is reported for the first time from India. Out of these 15 genera, the following seven are new to Kerala:

1. *Bolbitius*
2. *Descolea*
3. *Galerella*
4. *Pholiotina*
5. *Hypholoma*
6. *Stropharia*
7. *Crepidotus*

Of the 60 species discovered and described, only the following species have earlier been reported from India:

Bolbitiaceae

1. *Agrocybe semiorbicularis*
2. *Agrocybe pediades*

Strophariaceae

3. *Hypholoma subviride*
4. *Psilocybe coprophila*
5. *Psilocybe pseudoaztecorum*
6. *Psilocybe cubensis*
7. *Psilocybe argentina*

Cortinariaceae

8. *Inocybe cutifracta*

9. *Inocybe rimosa*

Except for *Agrocybe pediades* and *Inocybe cutifracta*, all the other 58 species are new to Kerala.

The following 14 species are new records to India:

Bolbitiaceae

1. *Bolbitius coprophilus*

2. *Descolea maculata*

3. *Galerella plicatella*

Strophariaceae

4. *Melanotus communis*

5. *Psilocybe alnetorum*

6. *Psilocybe pseudobullacea*

7. *Psilocybe subaeruginascens*

8. *Stropharia bicolor*

9. *Stropharia rugosoannulata*

Cortinariaceae

10. *Cortinarius pseudosalor*

11. *Gymnopilus lepidotus*

Crepidotaceae

12. *Crepidotus cinnabarinus*

13. *Crepidotus epicrocinus*

14. *Crepidotus palmarum*

Extensive searches in the literature could not reveal any previously published names for 2 species of *Pholiotina*, 4 species of *Agrocybe*, 9 species of *Conocybe*, 4 species of *Psilocybe*, one species of *Pholiota*, 8 species of *Inocybe*, 3 species of *Cortinarius*, 2 species of *Gymnopilus* and 4 species of *Crepidotus*. It is considered that these 37 species represent

hitherto undescribed species. The Kerala collections of *Galerella plicatella* are considered as belonging to a new variety. Valid publications of these taxa will be done separately in journals devoted to fungal taxonomy.

During this study, the genus *Psilocybe* represented by 11 species emerged as the largest genus, closely followed by *Inocybe* and *Conocybe* with 10 and 9 species respectively. The most remarkable outcome of this study, apart from the discovery of so many new taxa, is the discovery of four species of *Cortinarius*, a genus, which to this date, has not been authentically recorded from anywhere else in the entire tropical belt.

BIBLIOGRAPHY

- Abraham, S. P. (1995). Notes on the occurrence of an unusual agaric on *Cymbopogon* in Kashmir valley. *Nova Hedwigia* **60**, 111-117.
- Abraham, S. P. & Nair, L. N. (1987). The genus *Agrocybe* in India. In *Indian Mushroom Science II* (ed. T. N. Kaul & B. M. Kapoor), pp. 389-398. CSIR : New Delhi, India.
- *Alessio, C. L. (1980). *Inocybe*. Museo Tridentino di Scienze Naturali : Trento, Italy
- Alessio, C. L. (1983). *Inocybe pseudograta* sp. nov. *Cryptogamie, Mycologie* **4**, 55-60.
- Alessio, C. L. (1998). *Boletus e Inocybe. Fungi non delineati* **3**, 1-40.
- Ammirati, J., Traquair, J., Martin, S., Gillon, W. & Ginns, J. H. (1979). A new *Melanotus* from gold-mine timbers in Ontario. *Mycologia* **71**, 310-321.
- Aptroot, A., Diederich, P., Serusiaux, E. & Sipman, H. J. M. (1997). Lichens and lichenicolous fungi from New Guinea. *Bibliotheca Lichenologica* **64**, 1-220.
- Arnolds, E. (1989). A preliminary Red Data List of macrofungi in the Netherlands. *Persoonia* **14**, 77-125.
- Arnolds, E. (1997). A quantitative approach to the Red List of larger fungi in the Netherlands. *Mycologia Helvetica* **9**, 47-59.
- Arora, D. (1979). *Mushrooms demystified*. Ten Speed Press : Berkeley, U. S. A.
- Babos, M. (1976). Rare and interesting fungus species of the Hungarian sandy areas II. *Studia Botanica Hungarica* **11**, 3-15.
- Babos, M. & Stangl, J. 1985. *Inocybe javorkae* sp. n. aus Ungarn (Agaricales, Cortinariaceae). *Annales Historico-Naturales Musei Nationalis Hungarici* **77**, 113-120.
- Ballero, M., Contu, M. & Poli, F. (1995). *Cortinarius bisporus* spec. nov. a new toxic species in Sardinia (Italy). *Mycotaxon* **53**, 343-347.
- Bandala, V. M., Montoya, L. & Moreno, G. (1999). Two *Crepidotus* from Mexico with notes on selected type collections. *Mycotaxon* **72**, 403-416.
- Bas, C. (1958). Notes on Agaricaels – 1. *Blumea, Supplement* **4**, 137-143.

- Bas, C. (1988). Orders and families in agarics and boleti. In *Flora Agaricina Neerlandica Vol. I.* (ed. C. Bas, Th. W. Kuyper, M. E. Noordeloos & E.C. Vellinga), pp. 40-49. Balkema : Leiden, The Netherlands.
- Bas, C. & Noordeloos, M. E. (1996). Notulae ad floram agaricinam Neerlandicam XXIX, Two new species of *Psilocybe*. *Persoonia* **16**, 239-244
- Bendiksen, E. & Bendiksen, K. (1992). Contribution to the *Cortinarius* flora of Estonia, including six new species for the country found during CEM 10 (Congress of European Mycologists) 1989. *Folia Cryptogamica Estonica* **30**, 23-29.
- Bendiksen, E. & Bendiksen, K. (1993). A new red-veiled species of *Cortinarius* subgenus *Telamonia*, *C. rubrovioleipes* sp. nov. *Windahlia* **20**, 29-34.
- Bendiksen, E., Brandrud, T. E., Bendiksen, K. & Lindstrom, H. (1993). A study of the *Cortinarius helobius*-complex, with special emphasis on arctic-alpine material. *Bibliotheca mycologica* **150**, 3-15.
- Benjamin, D. R. (1995). *Mushrooms: Poisons and Panaceas*. W. H. Freeman and Company : New York, U. S. A.
- Besl, H. & Mack, P. (1985). Hallucinogenic species of *Inocybe*. *Zeitschrift fur Mykologie* **51**, 183-184.
- Bessette, A. E. & Fatto, R. M. (1998). Two narrow-spored *Inocybes*. *Mycotaxon* **66**, 121-126.
- Bhavanidevi, S. & Nair, M. C. (1987). Additions to Indian Agaricales. In *Indian Mushroom Science – II.* (ed. T. N. Kaul & B. M. Kapoor), pp. 271-274. CSIR : New Delhi, India.
- Bigelow, H. E. (1978). Studies on New England Agarics II. *Rhodora* **80**, 404-416.
- Bohus, G. (1970). Interessantere *Cortinarius*-Arten aus dem Karpaten-Becken. *Annales Historico-Naturales Musei Nationalis Hungarici* **62**, 137-148.
- Bohus, G. (1976). Interesting *Cortinarius* species from the Carpathian Basin II. *Annales Historico-Naturales Musei Nationalis Hungarici* **68**, 51-58.
- Bohus, G. (1979). Interesting *Cortinarius* species from the Carpathian Basin, Agaricales: Cortinariaceae, III. *Annales Historico-Naturales Musei Nationalis Hungarici* **71**, 65-72.

- Bon, M. (1979). *Inocybes Rares, Critiques ou Nouveaux dans le Nord de la France. Beihefte zur Sydowia* **8**, 76-97.
- Bon, M. (1984). *Inocybes from sand dunes. Documents mycologiques* **53**, 9-40.
- Bon, M. (1985). About two noteworthy *Cortinarius* with garlanded stem. *Documents mycologiques* **63-64**, 59-61.
- Bon, M. (1997a). Cle monographique du genre *Inocybe* (Fr.) Fr. *Documents mycologiques* **105**, 1-47.
- Bon, M. (1997b). Cle monographique du genre *Inocybe* (Fr.) Fr. *Documents mycologiques* **108**, 1-77.
- Bon, M. (1998). Cle monographique du genre *Inocybe* (Fr.) Fr. *Documents mycologiques* **111**, 1-45.
- Bon, M. & Chevassut, G. (1988). Contribution to the study of macrofungi on the littoral of the mediterranean area. *Documents mycologiques* **72**, 51-61.
- Bougher, N. L. & Hilton, R. N. (1989). Three *Cortinarius* species from Western Australia. *Mycological Research* **93**, 424-428.
- Bougher, N. L. & Malajczuk, N. (1985). A new species of *Descolea* (Agaricales) from Western Australia; and aspects of its ectomycorrhizal status. *Australian Journal of Botany* **33**, 619-627.
- Breitenbach, J. (1980). *Melanotus phillipsii* (Berk. & Br.) Sing. rare or merely over-looked. *Zeitschrift fur Mykologie* **46**, 11-14.
- Breitenbach, J. & Kranzlin, F. (1995). *Fungi of Switzerland. Vol. 4., Mykologia : Lucerne, Switzerland*
- *Bresadola, G. (1930). *Iconographia Mycologica*. Milano, Italy.
- Chandrasekharan, C. (1962). A general note on the vegetation of Kerala. *Indian Forester* **88**, 440-441.
- Chio, R. E. (1992). New records of the genus *Pholiota* from Mexico. *Revista Mexicana de Micologia* **8**, 63-70.
- Christiansen, A. L., Rasmussen, K. E. & Höiland, K. (1981). The content of psilocybin in Norwegian *Psilocybe semilanceata*. *Planta medica* **42**, 229-235.

- Cifuentes, J. & Guzmán, G. (1981). Description and distribution of tropical fungi (Agaricales) unknown from Mexico. *Boletín de la Sociedad Mexicana de Micología* **16**, 35-61.
- Cifuentes, J., Perez-Ramirez, L. & Villegas, M. (1989). Description of macrofungi little known from Mexico III. *Revista Mexicana de Micología* **5**, 101-115.
- Clemençon, H. (1974). Die Wandstrukturen der Basidiosporen V. *Pholiota* und *Kuehneromyces*, verglichen mit *Galerina* and *Gymnopilus*. *Zeitschrift für Pilzkunde* **40**, 105-126.
- Clemençon, H. (1977). Die Strukturen der Basidiosporenwand und des Apikulus und deren Beziehung zur Exogenisation der Spore. *Persoonia* **9**, 363-380.
- Contu, M. (1987a). Description d'un *Hygrocybe* nouveau; *Cortinarius roberti-henrici* sp. n. *Bulletin de la Société mycologique de France* **4**, 305-307.
- Contu, M. (1987b). Agaricales dalle dune sabbiose della sardegna 1. Su due specie del genere *Agrocybe* Fay. *Sydowia* **40**, 42-45.
- Contu, M. (1992). *Cortinarius bisporiger* spec. nov. una nuova specie del subgen. *Phlegmacium* dalla Sardegna Meridionale. *Cryptogamie, Mykologie* **13**, 99-102.
- Courtecuisse, R. (1994). *Crepidotus brunneoroseus* sp. nov. *Documents mycologique* **24**, 46.
- Courtecuisse, R. (1997). Red List of threatened fungi in Nord-Pas-de-Calais region (Northern France). *Cryptogamie Mycologie* **18**, 183-219.
- Cripps, C & Miller, Jr. O. K. (1994). A new *Cortinarius* from a mature aspen stand in Montana. *Mycotaxon* **50**, 315-321.
- Davis, P. H. & Heywood, V. H. (1963). *Principles of Angiosperm Taxonomy*. D. Van Nostrand Company, Inc. : New York, U. S. A.
- Dennis, R. W. G. (1968). Some Agaricales from the Blue Mountains of Jamaica. *Kew Bulletin* **22**, 73-85.
- Dennis, R. W. G. (1970). Fungus flora of Venezuela and adjacent countries. *Kew Bulletin Additional Series* **3**, 1-531.
- Donk, M. A. (1962). The generic names proposed for Agaricaceae. *Beihefte zur Nova Hedwigia* **5**, 1-320.

- Earle, F. S. (1909). The genera of the North American gill fungi. *Bulletin of the New York Botanical Garden* **5**, 373-451.
- Einhellinger, A. & Stangl, J. (1979). *Inocybe chondrospora* Einhellinger & Stangl, spec. nov. *Zeitschrift fur Mykologie* **45**, 163-165.
- Enderle, M. (1985). Noteworthy Agaricales found in the vicinity of Ulm. II. *Beitrage zur Kenntnis der Pilze Mitteleuropas* **11**, 99-124.
- Enderle, M. (1991a). Studies in *Conocybe* and *Pholiotina* I: Key to European species of *Conocybe* ss. str. *Zeitschrift fur Mykologie* **57**, 55-74.
- Enderle, M. (1991b). Studies in *Conocybe* and *Pholiotina* II: Description of some finds. *Zeitschrift fur Mykologie* **57**, 75-108.
- Enderle, M. (1996). Studies in *Conocybe* and *Pholiotina* VI: Description of finds. *Zeitschrift fur Mykologie* **62**, 19-36.
- Enderle, M. (1997). Studies in *conocybe* and *Pholiotina* VII: Description of finds. *Zeitschrift fur Mykologie* **63**, 3-34.
- Enderle, M. & Stangl, J. (1981). Beitrage zur Kenntnis der ulmer Pilzflora: Risspilze (*Inocyben*). *Mitteilungen des Vereins fur Naturwissenschaft und Mathematik in Ulm a. D.* **31**, 79-171.
- Esteve-Raventos, F. (1988). Some rare and interesting species of *Conocybe* s. l. collected in Central Spain. *Boletin Sociedad Micologica de Madrid* **12**, 57-65.
- Esteve-Raventos, F. (1997). Studies on the genus *Inocybe* in the Iberian Peninsula and Balearic islands. II. *Inocybe catalaunica*. *Mycotaxon* **62**, 421-425.
- Esteve-Raventos, F. & Ortega, A. (1995). Checklist of the genus *Inocybe* in Andalusia (Peninsular Spain). *Mycotaxon* **54**, 245-261.
- Farr, D. F. (1985). Scanning electron microscope observations of basidiospores in *Pholiota* and related genera. *Canadian Journal of Botany* **63**, 603-610.
- Farr, D. F. & Farr, E. R. (1976). Notes on *Phaeocollybia* and *Pholiota* in the Southern Appalachians. In *Proceedings of the Symposium on distributional history of the biota of the Southern Appalachians. Part IV Algae and fungi* (ed. B. C. Parker & M. K. Roane), pp.296-306. University Press of Virginia: Charlottesville, U. S. A.

- Farr, E. R. & Farr, D. F. (1981). Proposals to conserve or reject *Hypholoma* (Fr.) Kummer against *Nematoloma* Karsten or *Psathyrella* (Fr.) Quel. (Agaricales). *Taxon* **30**, 329-334.
- Farr, E. R., Miller, O. K. & Farr, D. F. (1977). Biosystematic studies in the genus *Pholiota* stirps *Adiposa*. *Canadian Journal of Botany* **55**, 1167-1180.
- *Fayod, V. (1889). Prodrome d'une Histoire Naturelle des Agaricines. *Annales des Sciences Naturelles (Botanique), Series 7, 9*, 181-411.
- *Fries, E. M. (1821). *Systema Mycologicum*. Vol. 1. Lund, Sweden.
- *Fries, E. M. (1836). *Genera Hymenomycetum*. Uppsala, Sweden.
- *Fries, E. M. (1838). *Epicrisis Systematis Mycologici*. Uppsala, Sweden.
- *Fries, E. M. (1849). *Summa Vegetabilium Scandinaviae*. Stockholm, Sweden.
- *Fries, E. (1863). *Monographia Hymenomycetum Sueciae*. Uppsala, Sweden.
- Ghosh, R. N., Pathak, N. C. & Tewari, I. (1967). Studies on Indian Agaricales – 1. *Indian Phytopathology* **20**, 237-242.
- Gruber, I. (1969). Fluorezierende Stoffe der *Cortinarius* – Untergattung *Leproclybe*. *Zeitschrift für Pilzkunde* **35**, 249-262.
- Grund, D. W. & Stuntz, D. E. (1968). Nova Scotian *Inocybes*. I. *Mycologia* **60**, 406-425.
- Grund, D. W. & Stuntz, D. E. (1970). Nova Scotian *Inocybes*. II. *Mycologia* **62**, 925-939.
- Grund, D. W. & Stuntz, D. E. (1975). Nova Scotian *Inocybes*. III. *Mycologia* **67**, 19-31.
- Grund, D. W. & Stuntz, D. E. (1977). Nova Scotian *Inocybes*. IV. *Mycologia* **69**, 392-408.
- Grund, D. W. & Stuntz, D. E. (1980). Nova Scotian *Inocybes*. V. *Mycologia* **72**, 670-688.
- Grund, D. W. & Stuntz, D. E. (1981). Nova Scotian *Inocybes*. VI. *Mycologia* **73**, 655-674.
- Grund, D. W. & Stuntz, D. E. (1983). Nova Scotian *Inocybes*. VII. *Mycologia* **75**, 257-270.
- Grund, D. W. & Stuntz, D. E. (1984). Nova Scotian *Inocybes*. VIII. *Mycologia* **76**, 733-740.
- Guminska, B. (1974). New locality of *Stropharia albocrenulata* (Peck.) Kreisel in the Pieniny Mountains. *Zeszyty Naukowe Uniwersytetu Jagiellonskiego* **2**, 201-208.
- Guzmán, G. (1978a). Further investigations of the Mexican hallucinogenic mushrooms with descriptions of new taxa and critical observations on additional taxa. *Nova Hedwigia* **29**, 625-644.

- Guzmán, G. (1978b). The species of *Psilocybe* known from Central and South America. *Mycotaxon* **7**, 225-255.
- Guzmán, G. (1979). Observations on the evolution of *Psilocybe* and description of four new hallucinogenic species from Mexican tropical forests. *Beihefte zur Sydowia* **8**, 168-181.
- Guzmán, G. (1980). Three new sections in the genus *Naematoloma* and a description of a new tropical species. *Mycotaxon* **12**, 235-240.
- Guzmán, G. (1982). New records and new species of *Psilocybe* in Mexico. *Boletín de la Sociedad Mexicana de Micología* **17**, 89-94.
- Guzmán, G. (1983). The genus *Psilocybe*. *Beihefte zur Nova Hedwigia* **74**, 1-439.
- Guzmán, G. (1995). Supplement to the monograph of the genus *Psilocybe*. *Bibliotheca Mycologica* **159**, 91-141.
- Guzmán, G. (1998). Las especies de *Psilocybe* conocidas de Jalisco (Mexico) y descripción de dos nuevas para la ciencia. *Acta Botanica Mexicana* **43**, 23-32.
- Guzmán, G., Bandala, V. M. & Allen, J. W. (1993). A new bluing *Psilocybe* from Thailand. *Mycotaxon* **46**, 155-160.
- Guzmán, G., Bandala, V. M. & King, C. C. (1991). A new species of *Psilocybe* of section *Zapotecorum* from New Zealand. *Mycological Research* **95**, 507-508.
- Guzmán, G., Bandala, V. M. & King, C. C. (1993). Further observations on the genus *Psilocybe* from New Zealand. *Mycotaxon* **46**, 161-170.
- Guzmán, G. & Bas, C. (1977). A new bluing *Psilocybe* from Europe. *Persoonia* **9**, 233-238.
- Guzmán, G. & Horak, E. (1978). New species of *Psilocybe* from Papua New Guinea, New Caledonia and New Zealand. *Sydowia* **31**, 44-54.
- Guzmán, G., Montoya-Bello, L. & Bandala-Munoz, V. M. (1988). New records of hallucinogenic mushrooms of the genus *Psilocybe* in Mexico and analysis of the distribution of the known species. *Revista Mexicana de Micología* **4**, 255-265.
- Guzmán, G. & Ott, J. (1976). Description and chemical analysis of a new species of hallucinogenic *Psilocybe* from the Pacific Northwest. *Mycologia* **68**, 1261-1267.

- Guzmán, G., Ott, J., Boydston, J. & Pollock, S. H. (1976). Psychotropic mycoflora of Washington, Idaho, Oregon, California and British Columbia. *Mycologia* **68**, 1267-1272.
- Guzmán, G., Saldarriaga, Y., Pineda, F., Garcia, G. & Velazquez, L. F. (1994). New species of *Psilocybe* from Columbia and discussion on the known species. *Mycotaxon* **51**, 225-235.
- Guzmán, G., Tapia, F., Nieves-Rivera, A. M. & Betancourt, C. (1997). Two new bluing species of *Psilocybe* from Puerto Rico. *Mycotaxon* **63**, 377-382.
- Guzmán, G., Tapia, F. & Stamets, P. (1997). A new bluing *Psilocybe* from U S A. *Mycotaxon* **65**, 191-195.
- Guzmán, G. & Watling, R. (1978). Studies in Australian Agarics and Boletes. 1: some species of *Psilocybe*. *Notes from the Royal Botanic Garden, Edinburgh* **36**, 179-210.
- Guzmán-Dávalos, L. (1994). New species of *Gymnopilus* (Agaricales, Cortinariaceae) from Mexico. *Mycotaxon* **50**, 333-348.
- Guzmán-Dávalos, L. (1995). Further investigations on *Gymnopilus* (Agaricaceae, Cortinariaceae). New section, new species and new records from Mexico. *Mycotaxon* **54**, 117-124.
- Guzmán-Dávalos, L. (1996a). First record of *Gymnopilus* (Agaricales, Cortinariaceae) from Guatemala and an analysis of Caribbean and Centroamerican species. *Revista Mexicana de Micología* **12**, 89-96.
- Guzmán-Dávalos, L. (1996b). New records of the genus *Gymnopilus* (Agaricales, Cortinariaceae) from Mexico. *Mycotaxon* **59**, 61-78.
- Guzmán-Dávalos, L. & Guzmán, G. (1986). Fungi from the state of Jalisco, VII. The genus *Gymnopilus* (Cortinariaceae). *Revista Mexicana de Micología* **2**, 157-185.
- Guzmán-Dávalos, L. & Guzmán, G. (1991). Additions to the genus *Gymnopilus* (Agaricales, Cortinariaceae) from Mexico. *Mycotaxon* **41**, 43-56.
- Guzmán-Dávalos, L. & Guzmán, G. (1995). Toward a monograph of the genus *Gymnopilus* (Cortinariaceae) in Mexico. *Documents mycologiques* **98-100**, 197-212.

- Harding, H., Lyon, T. & Tomblin, G. (1996). *How to identify edible mushrooms*. Harper Collins Publishers: London, U. K.
- Harmaja, H. (1979). *Conocybe nemoralis* n. sp., a new species of the Agaricales from Northern Finland. *Beihefte zur Sydowia* **8**, 182-185.
- Hausknecht, A. (1993). Beitrage zur Kenntnis der Bolbitiaceae 1. *Pholiotina subnuda* und *Conocybe hexagonospora*. *Osterreichische Zeitschrift fur Pilzkunde* **2**, 33-43.
- Hausknecht, A. (1995a). *Conocybe roseipes*, a new species from loess slopes in eastern Austria. *Beihefte zur Sydowia* **10**, 97-100.
- Hausknecht, A. (1995b). *Conocybe ochroalbida*, a new species from Central and Southern Europe. *Documents mycologiques* **98-100**, 213-217.
- Hausknecht, A. (1995c). Some remarkable records in genera *Conocybe*, *Galerella* and *Psathyrella* from Franken. *Rheinland Pfalzisches Pilzjournal* **5**, 43-53.
- Hausknecht, A. (1995d). Beitrage zur Kenntnis der Bolbitiaceae 2. Die Variabilitat von *Conocybe dumentorum*. *Osterreichische Zeitschrift fur Pilzkunde* **4**, 107-117.
- Hausknecht, A. (1996). Beitrage zur Kenntnis der Bolbitiaceae 3. Europaische *Conocybe*-Arten mit wurzelndem oder tief im Substrat eingesenktem Stiel. *Osterreichische Zeitschrift fur Pilzkunde* **5**, 161-202.
- Hausknecht, A. (1998a). *Conocybe singeriana*, a new species of section *Pilosellae*. *Agarica* **15**(24/25), 1-6.
- Hausknecht, A. (1998b). Beitrage zur Kenntnis der Bolbitiaceae 4. Die Sektion *Candidae* und andere hellhutige Arten der Gattung *Conocybe*. *Osterreichische Zeitschrift fur Pilzkunde* **7**, 91-121.
- Hausknecht, A. (1999). Beitrage zur Kenntnis der Bolbitiaceae 5. Die *Conocybe rickeniana* und *C. magnicapitata* – Gruppe in Europa. *Osterreichische Zeitschrift fur Pilzkunde* **8**, 35-61.
- Hausknecht, A. & Enderle, M. (1992). Studies in *Conocybe* and *Pholiotina* III. Three new species of *Conocybe* from Italy. *Zeitschrift fur Mykologie* **58**, 197-204.
- Hausknecht, A. & Krisai-Greilhuber, I. (1988). A new species of *Crepidotus* (Crepidotaceae). *Plant Systematics and Evolution* **161**, 183-188.

- Hausknecht, A. & Krisai-Greilhuber, I. (1992). Schwarzhutige *Conocybe*-Arten. *Persoonia* **14**, 655-661.
- Hausknecht, A. & Krisai-Greilhuber, I. (1998). *Conocybe spinulosa*, a new species of *Conocybe* subgen. *Ochromarasmius* from Tanzania. *Osterreichische Zeitschrift für Pilzkunde* **7**, 1-12.
- Hausknecht, A. & Singer, R. (1986). A new species of *Psilocybe* (Agaricales). *Plant Systematics and Evolution* **151**, 295-301.
- Hausknecht, A., Zuccherelli, A. & Cetto, R. O. (1998). Ritrovamenti interessanti dal Ravennate. 5 Parte: diverse Agaricales, nuovi reperti e aggiunte a gruppi già trattati e altri. *Bollettino Del Gruppo Micologico G. Bresadola – Nuova Serie* **41**, 91-134.
- Hawksworth, D. L. (1991). The fungal dimension of biodiversity magnitude, significance, and conservation. *Mycological Research* **95**, 641-655.
- Hawksworth, D. L. (1993). The tropical fungal biota: census, pertinence, prophylaxis, and prognosis. In *Aspects of Tropical Mycology* (ed. S. Isaac, J. S. Frankland, R. Watling, & A. J. S. Whalley), pp. 265-293. Cambridge University Press : Cambridge, U. K.
- Hawksworth, D. L. & Rossman, A. Y. (1997). Where are all the undescribed fungi? *Phytopathology* **87**, 888-891.
- *Heim, R. (1931). Le genre *Inocybe*. *Encyclopedie mycologique* **1**, 1-423.
- Heim, R., Genest, K., Hughes, D. W. & Belec, G. (1966). Botanical and chemical characterisation of a forensic mushroom specimen of the genus *Psilocybe*. *Journal of the Forensic Science Society* **6**, 192-201.
- Heim, R. & Hofmann, A. (1958). Isolement de la psilocybine a partir du *Stropharia cubensis* Earle et d'autres especes de champignons hallucinogenes mexicains appartenant au genre *Psilocybe*. *Comptes rendus des séances de l'Académie des Sciences* **247**, 557-561.
- Henry, R. (1982). Etude de quelques especes appartenant aux genres *Rozites* et *Cortinarius*. *Cryptogamie, Mykologie* **3**, 171-189.
- Henry, R. & Contu, M. (1985). Study of two new *Cortinarii* growing under *Cistus*. *Documents mycologiques* **61**, 29-34.

- Henry, R. & Contu, M. (1986). A new xero-thermophilous species: *Cortinarius xerophilus*. *Documents mycologiques* **63-64**, 63-65.
- Henry, R. & Contu, M. (1987). New xero-thermophilous species. *Documents mycologiques* **67**, 39-43.
- Henry, R. & Contu, M. (1989). A New Hydrocybe associated with *Cistus*: *Cortinarius cistophilus* sp. nov. *Documents mycologiques* **77**, 51-52.
- Hesler, L. R. (1969). *North American species of Gymnopilus*. Hafner Publishing Company : New York, U. S. A.
- Hesler, L. R. & Smith, A. H. (1965). *North American species of Crepidotus*. Hafner Publishing Company : New York, U. S. A.
- Heykoop, M. & Esteve-Raventos, F. (1994). The genus *Inocybe* (Fr.) Fr., in the province of Guadalajara (Spain). *Boletín Sociedad Micologica de Madrid* **19**, 71-86.
- Hofmann, A., Heim, R., Brack, A. & Kobel, H. (1958). Psilocybin, ein psychotroper Wirkstoff aus dem mexikanischen Rauschpilz *Psilocybe mexicana* Heim. *Experimentia* **14**, 107-112.
- Höiland, K. (1977). A revision of the sand-dwelling fungus *Inocybe maritima*. *Norwegian Journal of Botany* **24**, 249-254.
- Höiland, K. (1978). The genus *Psilocybe* in Norway. *Norwegian Journal of Botany* **25**, 111-122.
- Höiland, K. (1980). *Cortinarius* subgenus *Leprocybe* in Norway. *Norwegian Journal of Botany* **27**, 101-126.
- Höiland, K. (1984). *Cortinarius* subgenus *Dermocybe*. *Opera Botanica* **71**, 1-112.
- Höiland, K. (1990). The genus *Gymnopilus* in Norway. *Mycotaxon* **39**, 257-279.
- Höiland, K. (1998). *Gymnopilus purpureosquamulosus* and *G. ochraceus* spp. nov. (Agaricales, Basidiomycota) - Two new species from Zimbabwe. *Mycotaxon* **69**, 81-85.
- Höiland, K & Watling, R. (1990). Some *Cortinarius* spp. (Agaricales) of the Cooloola Sandmass, Queensland, Australia. *Plant Systematics and Evolution* **171**, 135-146.
- Hongo, T. (1959). Agaricales of Japan (1) 1. *Memoirs of Faculty of Liberal Arts Education, Shiga University, Natural Science* **9**, 47-94.

- Hongo, T. (1969). Notes on Japanese larger fungi (20). *The journal of Japanese Botany* **44**, 230-238.
- Hongo, T. (1973). On some interesting larger fungi from New Guinea. *Report of the Tottori Mycological Institute (Japan)* **10**, 357-364.
- Horak, E. (1964). Fungi austroamericani XI. *Crepidotus* Kummer (1871). *Nova Hedwigia* **8**, 333-346.
- Horak, E. (1971a). Contribution to the knowledge of the Agaricales s.l. (Fungi) of New Zealand. *New Zealand Journal of Botany* **9**, 463-493.
- Horak, E. (1971b). Studies on the genus *Descolea* Sing. *Persoonia* **6**, 231-248.
- Horak, E. (1977a). Fungi Agaricini Novazelandiae. VI. *Inocybe* (Fr.) and *Astrosporina* Schroeter. *New Zealand Journal of Botany* **15**, 713-747.
- Horak, E. (1977b). The genus *Melanotus* Pat. *Persoonia* **9**, 305-327.
- Horak, E. (1979). *Astrosporina* (Agaricales) in Indomalaya and Australasia. *Persoonia* **10**, 157-205.
- Horak, E. (1980a). *Inocybe* (Agaricales) in Indomalaya and Australasia. *Persoonia* **11**, 1-37.
- Horak, E. (1980b). New and remarkable hymenomycetes from tropical forests in Indonesia (Java) and Australasia. *Sydowia* **33**, 39-63.
- Horak, E. (1981). On Himalayan species of *Astrosporina* and *Inocybe* (Agaricales). *Persoonia* **11**, 303-310.
- Horak, E. (1983). Mycogeography in the South Pacific region: Agaricales, boletales. *Australian Journal of Botany, Supplement* **10**, 1-41.
- Horak, E. (1989). New and additional data concerning *Pyrrhoglossum* and eccentric or laterally stipitate taxa of *Gymnopilus* (Agaricales). *Opera Botanica* **100**, 115-129.
- Horak, E. (1995). *Cortinarius* Fr. (Agaricales in Australasia) 2. Subgen. *Phlegmacium* in Papua New Guinea. *Beihefte zur Sydowia* **10**, 101-126.
- Horak, E., Desjardin, D. E. & Hemmes, D. E. (1996). Agaricales of the Hawaiian Islands. 3: The genus *Galerina* and selected other brown-spored agarics. *Mycologia* **88**, 278-294.
- Horak, E., Desjardin, D. E. & Petersen, R. H. (1990). A new species of *Melanotus* from the Southern Appalachian mountains. *Mycologia* **82**, 493-495.

- Huijsman, H. S. C. (1978). Notes on *Inocybe*. *Persoonia* **9**, 473-484.
- Hyde, K. D., Frohlich, J. & Taylor, J. (1997). Diversity of ascomycetes on palms in the tropics. In *Biodiversity of Tropical Microfungi*. (ed. K. D. Hyde), pp. 141-156. Hong Kong University Press : Hong Kong.
- Imazeki, R., Otani Y. & Hengo, T. 1988. *Fungi of Japan*. Yama-Kei Publishers Co. Ltd. : Tokyo, Japan.
- *Ing, B. (1992). A provisional Red Data List of British fungi. *Mycologist* **6**, 124-128
- *Ing, B. (1993). Towards a Red List of endangered European macrofungi. In *Fungi of Europe: investigation, recording and conservation*. (ed. D. N. Pegler, L. Boddy, B. Ing & P. M. Kirk), pp. 231-237. Royal Botanic Gardens : Kew, U. K.
- Jacobsson, S. (1986). A taxonomic survey of the *Pholiota alnicola* group in Europe. *Windahlia* **16**, 129-143.
- Jacobsson, S. (1987). On the correct interpretation of *Pholiota adiposa* and a taxonomic survey of section *Adiposae*. *Windahlia* **17**, 1-18.
- Jacobsson, S. (1989). Studies on *Pholiota* in culture. *Mycotaxon* **36**, 95-145.
- Jacobsson, S. (1990). *Pholiota* in northern Europe. *Windahlia* **19**, 1-86.
- Jacobsson, S. & Vauras, J. (1989). *Inocybe rivularis*, a new boreal agaric. *Windahlia* **18**, 15-24.
- Jahnke, K. D., Hoffmann, P. & Pacioni, G. (1988). A new species of *Stropharia* from Southern Italy: *Stropharia halophila* sp. nov., characterized by DNA analysis and mating experiments. *Transactions of the British Mycological Society* **91**, 577-580.
- Johnston, P. R. & Buchanan, P. K. (1995). The genus *Psilocybe* in New Zealand. *New Zealand Journal of Botany* **33**, 379-388.
- Joseph, A. V., Abraham T. K., Vrinda, K. B. & Pradeep, C. K. (1995). New Agarics from India. *Mushroom Research* **4**, 1-6.
- Karcher, R. & Seibt, D. (1988). A contribution to the knowledge of the fungus-flora of the Rhine-Main. Fungi-associations (*Cortinarius*) in a sweet-chestnut forest in the vicinity of Kronberg (Taunus). *Zeitschrift fur Mykologie* **54**, 77-92.

- Karcher, R. & Seibt, D. (1990). A contribution to the knowledge of the fungus-flora of the Rhine-Main area. Noteworthy records of *Cortinarius* subgenus *Phlegmacium* in the observation areas of W. Villinger near Offenbach-Frankfurt. *Zeitschrift fur Mykologie* **56**, 47-66.
- Karcher, R. & Seibt, D. (1991). A contribution to the knowledge of the fungus-flora of the Rhine-Main area, Part 3: Further knowledge about *Cortinarius coalescens* as well as discussion on related taxa of deciduous woods. *Zeitschrift fur Mykologie* **57**, 249-252.
- Karcher, R. & Seibt, D. (1993). A contribution to the knowledge of the fungus-flora of the Rhine-Main area, Part 4. An undescribed, easy to determine *Telamonia* found underneath sweet-chestnut trees - *Cortinarius croceobasalis* sp. n. *Zeitschrift fur Mykologie* **59**, 45-50.
- *Karsten, P. (1879). Rysslands, Finlands, och den Skandinaviska halfons Hattsvampar. Forra delen: Skifsvampar. *Bidrag til kannedom om Finlands natur och folk* **32**, 1-571.
- *Kauffman, C. H. (1924). *Inocybe*. *North American Flora* **10**, 227-260.
- Keay, S. M. & Brown, A. E. (1990). Colonization by *Psilocybe semilanceata* of roots of grassland flora. *Mycological Research* **94**, 49-56.
- Keizer, P. J. & Arnolds, E. (1995). Taxonomical notes on macrofungi in roadside verges planted with trees in Drenthe (The Netherlands) – II. *Persoonia* **16**, 81-122.
- Kibby, G. (1979). *Mushrooms and toadstools*. Oxford University Press : Oxford, U. K.
- Kits van Waveren, E. (1970). The genus *Conocybe* subg. *Pholiotina* I. European annulate species. *Persoonia* **6**, 119-165.
- Kits van Waveren, E. (1979). *Melanotus proteus*, a species new to Europe. *Transactions of the British Mycological Society* **73**, 176-179.
- Kobayashi, T. (1993). A new subgenus of *Inocybe*, *Leptocybe* from Japan. *Mycotaxon* **48**, 459-469.
- Kobayashi, T. (1994). On the *Inocybe* collected by Kumagusu Minakata (I). *Transactions of the Mycological Society of Japan* **35**, 189-191.
- Kobayashi, T. (1995). A new *Inocybe* from Tokyo, *I. fastuosa* spec. nov. *Mycologia Helvetica* **7**, 7-13.

- Kobayashi, T. & Courtecuisse, R. (1993). Two new species of *Inocybe* from Japan. *Mycotaxon* **46**, 27-33.
- Kobayashi, T. & Hongo, T. (1993). *Inocybe flocculosa* rediscovered in Japan. *Transactions of the Mycological Society of Japan* **34**, 507-510.
- *Kobayasi, Y. (1952). On the genus *Inocybe* from Japan. *Nagaoa* **2**, 76-115.
- Korf, R. P. (1986). Report of the Committee for Fungi and Lichens. *Taxon* **35**, 552-556.
- Kornerup, A. & Wanscher, J. H. (1978). *Methuen Handbook of colour*. (3rd edn.). Methuen : London, U K.
- Kostyra, H. (1993). Chemical and crystal-optical analysis on cystidial crystals in the genus *Inocybe*. *Zeitschrift fur Mykologie* **59**, 77-98.
- Kühner, R. (1935). *Le Genre Galera*. *Encyclopedie Mycologique* **7**, 1-240.
- *Kühner, R. (1936). Observations sur le genre *Hypholoma*. *Bulletin de la Societe Mycologique de France* **52**, 9-30.
- *Kühner, R. (1980). Les Hymenomycetes agaricoides. Etude generale et classification. *Bulletin mensuel de la Societe Linneenne de Lyon* **49** (Special Number).
- *Kühner, R. & Boursier, J. (1932). Notes sur le genre *Inocybe*. *Bulletin de la Societe mycologique de France* **48**, 118-161.
- *Kühner, R. & Romagnesi, H. (1953). *Flore analytique des champignons superieurs*. Masson & Cie: Paris, France.
- *Kummer, P. (1871). *Der Fuhrer in die Pilzkunde*. Zerbst.
- Kuyper, Th. W. (1986). A revision of the genus *Inocybe* in Europe. I. Subgenus *Inosperma* and the smooth-spored species of subgenus *Inocybe*. *Persoonia Supplement* **3**, 1-247.
- Kuyper, Th. W. (1988). Specific and infraspecific delimitation. In *Flora Agaricina Neerlandica* Vol. I. (ed. C. Bas, Th. W. Kuyper, M. E. Noordeloos & E. C. Vellinga), pp. 30-37. Balkema : Leiden, The Netherlands.
- Kuyper, Th. W. & Tjallingii-Beukers, D. (1986). Notes on *Pholiota*. *Persoonia* **13**, 77-82.
- *Lange, J. E. (1938). *Flora Agaricina danica*. Vol. III. Copenhagen, Denmark.

- Lange, M. & Hora, F. B. (1965). *Collins guide to Mushrooms and Toadstools*. Collins : London, U. K.
- Largent, D. L. & Thiers, H. D. (1977). *How to identify mushrooms to genus II. Field identification of Genera*. Mad River Press : Eureka, U. S. A.
- Leung, A. Y. & Paul, A. G. (1968). Baeocystin and norbaeocystin: new analogs of psilocybin from *Psilocybe baeocystis*. *Journal of Pharmacological Science* **57**, 1667-1671.
- Lincoff, G. & Mitchel, D. H. (1977). *Toxic and hallucinogenic mushroom poisoning*. Van Nostrand Reinhold Company : New York, U. S. A.
- Manimohan, P. & Leelavathy, K. M. (1986). New records of *Inocybe* from India. *Calicut University Research Journal* **1**, 1-3.
- Manjula, B. (1983). A revised list of the agaricoid and boletoid basidiomycetes from India and Nepal. *Proceedings of the Indian Academy of Sciences (Plant Sciences)* **92**, 81-213.
- Manoharan, T. M., Uniyal, V. K. & Sathish Kumar, C. (1997). The biodiversity wealth and its conservation in Kerala. In *Conservation and economic evaluation of biodiversity* (ed. P. Pushpangadan, K. Ravi & V. Santhosh), pp. 103-124. Oxford & IBH Publishing Company : New Delhi, India.
- Margot, P & Watling, R. (1981). Studies in Australian agarics and boletes. II. Further studies in *Psilocybe*. *Transactions of the British Mycological Society* **76**, 485-489.
- Massee, G. (1904). A monograph of the genus *Inocybe* Karsten. *Annals of Botany* **18**, 459-504.
- May, T. W. & Wood, A. E. (1997). *Fungi of Australia. Vol. 2A, Catalogue and Bibliography of Australian Macrofungi I. Basidiomycota p.p.* Australian Biological Resources Study: Canberra, Australia.
- Meusers, M. (1996). Bestimmungsschlüssel für europäische Arten der Gattungen *Conocybe* und *Pholiotina*. *Osterreichische Zeitschrift für Pilzkunde* **5**, 245-272.
- *Mibey, R. K. & Hawksworth, D. L. (1997). Meliolaceae and Asterinaceae of the Shimba Hills, Kenya. *Mycological Papers* **174**, 1-108.
- Michelot, D. & Tebbett, I. (1990). Poisoning by members of the genus *Cortinarius* – a review. *Mycological Research* **94**, 289-298.

- *Miller, O. K. & Farr, D. (1975). *An index of the common Fungi of North America*. J. Cramer : Lehre, Germany.
- Mitchel, D. H. & Smith, A. H. (1978). Notes on Colorado fungi III: New and interesting mushrooms from the Aspen zone. *Mycologia* **70**, 1040-1063.
- Moser, M. (1960). A new species of *Cortinarius* from the Himalayas. *Kew Bulletin* **14**, 66-67.
- Moser, M. (1983). *Keys to Agarics and Boleti*. Roger Phillips : London, U K.
- Moser, M. (1989). On some interesting *Cortinarius* species from the Femsjo area (Sweden). *Opera Botanica* **100**, 177-183.
- Moser, M. (1993). Studies on North American Cortinarii. III. The *Cortinarius* flora of dwarf and shrubby *Salix* associations in the alpine zone of the Windriver Mountains, Wyoming, USA. *Sydowia* **45**, 275-306.
- Moser, M. (1995). Some interesting Cortinarii from upper Austria. *Osterreichische Zeitschrift fur Pilzkunde* **4**, 95-106.
- Moser, M. (1996). Two new species of *Cortinarius* (*Telamonia*) sections *Bovini* and *Armillati*. In *Botany and Mycology for the Next Millennium* (ed. S. P. Wasser) National Academy of Sciences of Ukraine : Kyiv, Ukraine.
- Moser, M. & Ammirati, J. F. (1996). Studies in North American Cortinarii II. Interesting and new species collected in the North Cascade Mountains, Washington. *Mycotaxon* **58**, 387-412.
- Moser, M. & Ammirati, J. F. (1999). Studies in North American Cortinarii V. New and interesting *Phlegmacia* from Wyoming and the Pacific Northwest. *Mycotaxon* **72**, 289-321.
- Moser, M. & Ammirati, J. F. (2000). Studies in North American cortinarii VI. New and interesting taxa in subgenus *Phlegmacium* from the Pacific States of North America. *Mycotaxon* **74**, 1-36.
- Moser, M., McKnight, K. H. & Ammirati, J. F. (1995). Studies in North America Cortinarii I. New and interesting taxa from the Greater Yellowstone area. *Mycotaxon* **55**, 301-346.

- Moser, M., McKnight, K. H. & Sigl, M. (1994). The genus *Cortinarius* (Agaricales) in the Greater Yellowstone area; mycorrhizal host associations and taxonomic considerations. In *Plants and their Environments: Proceedings of the first biennial scientific conference on the Greater Yellowstone ecosystem* (ed. D. G. Despain), pp. 239-246. Natural Resources Publication Office: Denver, U. S. A.
- Natarajan, K. & Raman, N. (1981). South Indian Agaricales VII. *Nova Hedwigia* **34**, 163-176.
- Natarajan, K. & Raman, N. (1983). South Indian Agaricales. *Bibliotheca Mycologica* **89**, 1-203.
- Natarajan, K. & Raman, N. (1985). A new *Psilocybe* from India. *Mycologia* **77**, 158-161.
- Nauta, M. (1986). De in Nederland voorkomende Leemhoeden (*Agrocybe*). *Coolia* **29**, 36-43.
- Nishida, F. H. (1988). New species of *Inocybe* from Southern California. *Mycotaxon* **33**, 213-222.
- Nishida, F. H. (1989). Key to the species of *Inocybe* in California. *Mycotaxon* **34**, 181-196.
- Noordeloos, M. E. (1995). Notulae ad floram agaricinam neerlandicam XXIII: *Psilocybe* and *Pholiota*. *Persoonia* **16**, 127-129.
- Noordeloos, M. E. (1998). *Pholiota*, *Psilocybe* and *Panaeolus*. *Fungi Non Delineati*. **4**, 1-48.
- *Norstein, S. (1990). *The genus Crepidotus (Basidiomycotina, Agaricales) in Norway*. Fungiflora : Oslo, Norway.
- Ortega, A. & Buendia, A. G. (1989). Notas sobre el genero *Crepidotus* (Fr.) Staude en Espana peninsular. *International Journal of Mycology and Lichenology* **4**, 93-105.
- Orton, P. D. (1960). New checklist of British Agarics and Boleti. Part III. Notes on genera and species in the list. *Transactions of British Mycological Society* **43**, 159-439.
- Orton, P. D. (1976). Notes on British Agarics VI. *Notes from the Royal Botanic Garden, Edinburgh* **35**, 147-153.
- Orton, P. D. (1977). Notes on British Agarics. V. *Kew Bulletin* **31**, 709-721.
- Orton, P. D. (1984). Notes on British Agarics: VIII. *Notes from the Royal Botanic Garden, Edinburgh* **41**, 565-624.
- Orton, P. D. (1987). Notes on some Agarics from Scotland. *Notes from the Royal Botanic Garden, Edinburgh* **44**, 485-502.

- Pathak, V. N., Yadav, N. & Gaur, M. (1998). *Mushroom production and processing Technology*. Agrobios : Jodhpur, India.
- *Patouillard, N. (1900). *Essai taxonomique sur les familles et less genres des Hymenomycetes*. Lons-le-Saunier : Duclume, France.
- Pearson, A. A. (1946). New records and observations III. *Transactions of the British Mycological Society* **29**, 191-210.
- Pearson, A. A. (1948). New records and observations IV. *Transactions of the British Mycological Society* **32**, 258-272.
- Pegler, D. N. (1966). Tropical African Agaricales. *Persoonia* **4**, 73-124.
- Pegler, D. N. (1977). A preliminary agaric flora of East Africa. *Kew Bulletin Additional Series* **6**, 1-615.
- Pegler, D. N. (1983). Agaric flora of the Lesser Antilles. *Kew Bulletin Additional Series* **9**, 1-668.
- Pegler, D. N. (1986). Agaric Flora of Sri Lanka. *Kew Bulletin Additional Series* **12**, 1-519.
- Pegler, D. N. (1988). Agaricales of Brazil described by M. J. Berkeley. *Kew Bulletin* **43**, 453-473.
- Pegler, D. N. (1996). Agarics described from Cape Province, South Africa. *Kew Bulletin* **51**, 787-797.
- Pegler, D. N. & Rayner, R. W. (1969). A contribution to the agaric flora of Kenya. *Kew Bulletin* **23**, 347-412.
- Pegler, D. N. & Young, T. W. K. (1971). Basidiospore morphology in the Agaricales. *Beihefte zur Nova Hedwigia* **35**, 1-210.
- Pegler, D. N. & Young, T. W. K. (1972a). Basidiospore form in the British species of *Inocybe*. *Kew Bulletin* **26**, 499-537.
- Pegler, D. N. & Young, T. W. K. (1972b). Basidiospore form in the British species of *Crepidotus*. *Kew Bulletin* **27**, 311-323.
- Phillips, R. (1981). *Mushrooms and other fungi of Great Britain and Europe*. Pan Books : London, U. K.

- Phillips, R. (1991). *Mushrooms of North America*. Little, Brown and Company : Hong Kong.
- *Pilát, A. (1948). Monographie des especes europeennes du genre *Crepidotus*. *Atlas des champignons de l'Europe* **6**, 1-84.
- Pilát, A. (1950). Revision of the types of some extra-European species of the genus *Crepidotus* Fr. *Transactions of the British Mycological Society* **33**, 215-249.
- Poder, R. & Ferrari, E. (1984). *Crepidotus roseornatus* sp. n. –eine auffallend gefarbte Art auf *Robinia pseudoacacia*. *Sydowia* **37**, 242-245.
- *Quélet, L. (1872). Les Champignons du Jura et des Vosges. *Memoires de la Societe d'emulation de Montbeliard, Series II* **5**, 45-332.
- *Quélet, L. (1886). *Enchiridion fungorum in Europa Media et praesertim in Gallia vigentium*. Paris, France.
- Rea, C. (1922). *British Basidiomycetae*. Cambridge University Press : Cambridge, U. K.
- Redhead, S. A. & Kroeger, P. (1984). *Melanotus textilis*, a new fabric- and wood-inhabiting North American agaric. *Mycologia* **76**, 868-872.
- Redhead, S. A. & Kroeger, P. (1987). A sclerotium-producing *Hypholoma* from British Columbia. *Mycotaxon* **29**, 457-465.
- *Readhead, S. A. & Malloch, D. W. (1980). *Melanotus caricicola*. *Fungi Canadenses* 189. Agriculture Canada: Ottawa, Canada.
- Rees, B. J., Orlovich, D. A. & Marks, P. B. D. (1999). Treading the fine line between small-statured *Gymnopilus* and excentrically stipitate *Galerina* species in Australia. *Mycological Research* **103**, 427-442.
- Reid, D. A. & Eicker, A. (1999). South African Fungi 9: *Psilocybe natalensis* - a blueing hallucinogenic species from South Africa. *Mycotaxon* **72**, 265-270.
- *Ricken, A. (1915). *Die Blatterpilze*. Leipzig, Germany.
- *Romagnesi, H. (1936). Essai d'una classification generique des agarics Lanthinospores et Melanospores. *Revue de mycologie* **1**, 27-36.
- *Romagnesi, H. (1968). Un nouveau *Conocybe* de la section des *Piliferae* Kühner: *Conocybe aeruginosa* nov. spec. *Bulletin de la Societe mycologique de France* **84**, 365-368.

- Saini, S. S. & Atri, N. S. (1982). North Indian Agaricales – 1. *Indian Phytopathology* **35**, 265-272.
- Sathe, A. V. & Daniel, J. (1979). New species of *Panaeolus* from India. *Current Science* **20**, 905-906.
- Sathe, A. V. & Daniel, J. (1980). Agaricales (Mushrooms) of Kerala State: Agaricales (Mushrooms) of South West India. *Maharashtra Association for the Cultivation of Science Monograph* **1**, 75-108.
- Sathe, A. V. & Deshpande, S. (1980a). Agaricales (Mushrooms) of Maharashtra State: Agaricales (Mushrooms) of South West India. *Maharashtra Association for the Cultivation of Science Monograph* **1**, 9-42.
- Sathe, A. V. & Deshpande, S. (1980b). A new species of *Pholiota* from India. *Current Science* **49**, 517-518.
- Sathe, A. V. & Kulkarni, S. M. (1980). Agaricales (Mushrooms) of Karnataka State: Agaricales (Mushrooms) of South West India. *Maharashtra Association for the Cultivation of Science Monograph* **1**, 43-73.
- Sathe, A. V. & Sasangan, K. C. (1977). Agaricales from south-west India – III. *Biovigyanam* **3**, 119-121.
- Seidl, M. T. (1989). A new species of *Gymnopilus* from northern California. *Mycotaxon* **34**, 217-220.
- Senn-Irlet, B. (1991). *Crepidotus*, *Pellidiscus* and *Ramicola* in Greenland (Agaricales: Crepidotaceae). *Nordic Journal of Botany* **11**, 587-597.
- Senn-Irlet, B. (1992a). *Crepidotus* in Nederland. *Coolia* **35**, 1-12.
- Senn-Irlet, B. (1992b). Type studies in *Crepidotus* – I. *Persoonia* **14**, 615-623.
- Senn-Irlet, B. (1993). Type studies in *Crepidotus* – II. *Persoonia* **15**, 155-167.
- Senn-Irlet, B. (1995). The genus *Crepidotus* (Fr.) Staude in Europe. *Persoonia* **16**, 1-80.
- Senn-Irlet, B. & Krieglsteiner, L. (1996). *Crepidotus brunneoroseus*, first German record. *Zeitschrift fur Mykologie* **62**, 201-204.
- Senn-Irlet, B. & Meijer, A. A. R. (1998). The genus *Crepidotus* from the state of Parana, Brazil. *Mycotaxon* **66**, 165-199.

- Sime, A. D. & Petersen, R. H. (1999). Intercontinental interrelationships among disjunct populations of *Melanotus*. *Mycotaxon* **71**, 481-492.
- *Singer, R. (1936). Das System der Agaricales. *Annales mycologici* **34**, 286-378.
- Singer, R. (1947). Contribution towards a monograph of the genus *Crepidotus*. *Lilloa* **13**, 59-95.
- *Singer, R. (1948). New and interesting species of Basidiomycetes II. *Papers from the Michigan Academy of Science, Arts and Letters* **32**, 103-150.
- *Singer, R. (1951a). The Agaricales (mushrooms) in modern taxonomy. *Lilloa* **22**, 1-832.
- *Singer, R. (1951b). *Descolea antarctica*, genero y especie nuevos de Tierra del Fuego (New genera of fungi V). *Lilloa* **23**, 255-258.
- Singer, R. (1955). Type studies on Basidiomycetes. VIII. *Sydowia* **9**, 367-431.
- Singer, R. (1958). Mycological investigations on Teonanacatl, the Mexican hallucinogenic mushroom. Part I. The history of Teonanacatl, field work and culture work. *Mycologia* **50**:239-261.
- Singer, R. (1959). New and interesting species of Basidiomycetes - VII. *Mycologia* **51**, 578-594.
- *Singer, R. (1962). *The Agaricales in modern taxonomy*. (2nd edn.) J. Cramer : Weinheim, Germany.
- Singer, R. (1969). Mycoflora Australis. *Beihefte zur Nova Hedwigia* **29**, 1-405.
- *Singer, R. (1973a). Diagnoses fungorum novorum Agaricalium III. *Beihefte zur Sydowia* **7**, 1-106.
- Singer, R. (1973b). The genera *Marasmiellus*, *Crepidotus* and *Simocybe* in the neotropics. *Beihefte zur Nova Hedwigia* **44**, 1-517.
- Singer, R. (1975). *The Agaricales in Modern Taxonomy*. (3rd edn.). J. Cramer : Vaduz, Germany.
- Singer, R. (1978). Keys for the identification of the species of Agaricales. *Sydowia* **30**, 192-279.
- Singer, R. (1986). *The agaricales in modern taxonomy*. (4th edn.). Koeltz Scientific Books : Koenigstein, Germany.

- Singer, R. (1988). On some *Crepidotaceae*. *Zeitschrift fur Mykologie* **54**, 69-72.
- Singer, R. (1989a). Diagnoses Fungorum Novorum Agaricalium IV. *Fieldiana: Botany, New Series* **21**, 1-133.
- Singer, R. (1989b). Agaricales from Henderson Islands (South Pacific). *Mycologia* **81**, 793-796.
- Singer, R. & Digilio, A. P. L. (1952). Prodrómo de la flora agaricina, Argentina. *Lilloa* **25**, 5-462.
- Singer, R. & Hausknecht, A. (1988). Notes on *Conocybe* (Bolbitiaceae). *Plant Systematics and Evolution* **159**, 107-121.
- Singer, R. & Hausknecht, A. (1989). *Conocybe hornana* – a new volvate species from Austria. *Beitrage zur Kenntnis der Pilze Mitteleuropas* **5**, 87-91.
- Singer, R. & Hausknecht, A. (1992). The group of *Conocybe mesospora* in Europe (Bolbitiaceae). *Plant Systematics and Evolution* **180**, 77-104.
- *Singer, R. & Smith, A. H. (1946a). Proposals concerning the nomenclature of gill fungi including a list of proposed lectotypes and genera conservanda. *Mycologia* **38**, 240-299.
- Singer, R. & Smith, A. H. (1946b). The taxonomic position of *Pholiota mutabilis* and related species. *Mycologia* **38**, 500-523.
- Singer, R. & Smith, A. H. (1958). Mycological investigations on Teonanacatl, the Mexican hallucinogenic mushroom. Part II. A taxonomic monograph of *Psilocybe*, section *Caerulescentes*. *Mycologia* **50**, 262-303.
- Singh, R. N. & Tewari, V. P. (1976). A new record of Agaricales from India. *Indian Phytopathology* **29**, 68-70.
- Smith, A. H. (1938). New and unusual agarics from North America - I. *Mycologia* **30**, 20-41.
- Smith, A. H. (1939a). Studies in the genus *Cortinarius* I. *Contributions from the University of Michigan Herbarium* **2**, 1-42.
- Smith, A. H. (1939b). Studies in the purple-brown spored agarics. *Mycologia* **31**, 544-557.
- Smith, A. H. (1941a). Studies of North American Agarics - I. *Contributions from the University of Michigan Herbarium* **5**, 5-73.

- Smith, A. H. (1941b). New and unusual agarics from North America. II. *Mycologia* **33**, 1-16.
- Smith, A. H. (1944a). New and interesting cortinarii from North America. *Lloydia* **7**, 163-235.
- Smith, A. H. (1944b). New North American agarics. *Mycologia* **36**, 242-262.
- Smith, A. H. (1948). Studies in the dark-spored agarics. *Mycologia* **40**, 669-707.
- Smith, A. H. (1951). The North American species of *Naematoloma*. *Mycologia* **43**, 467-521.
- Smith, A. H. (1977). Comments on hallucinogenic agarics and the hallucinations of those who study them. *Mycologia* **69**, 1196-1200.
- Smith, A. H. (1979). Generic relationships within the Strophariaceae of the Agaricales. *Taxon* **28**, 19-21.
- Smith, A. H. & Hesler, L. R. (1968). *The North American species of Pholiota*. Hafner Publishing Company : New York, U. S. A.
- *Smith, W.G. (1870). *Clavis Agaricinarum*. London, U.K.
- Stamets, P. (1996). *Psilocybin mushrooms of the world*. Ten Speed Press : California, U. S. A.
- *Stangl, J. (1989). Die Gattung *Inocybe* in Bayern. *Hoppea* **46**, 5-388.
- Stangl, J. & Enderle, M. (1983). Bestimmungsschlüssel für europäische eckigsporige Risspilze (subgenus *Inocybe*). *Zeitschrift für Mykologie* **49**, 111-136.
- Stangl, J. & Vauras, J. (1988). Finnish records on the genus *Inocybe*. The new species I. *mytiliodora* and *urceolicystis*. *Karstenia* **27**:15-21.
- *Staude, F. (1857). *Die Schwämme Mitteldeutschlands, insbesondere des Herzogthums Coburg*. Coburg, Germany.
- Stuntz, D. E. (1947). Studies in the genus *Inocybe*. I. New and noteworthy species from Washington. *Mycologia* **39**, 21-55.
- Stuntz, D. E. (1954). Studies on the genus *Inocybe* II. New and noteworthy species from Michigan. *Papers from the Michigan Academy of Science, Arts and Letters* **39**, 53-84.
- Subramanian, C. V. (1982). Tropical mycology: future needs and development. *Current Science* **51**, 321-325.
- Subramanian, C. V. (1995). Mushrooms: Beauty, diversity, relevance. *Current Science* **69**, 986-998.

- Thiers, H. D. & Smith, A. H. (1969). Hypogeous *cortinarii*. *Mycologia* **61**, 526-536.
- Thorn, R. G. & Malloch, D. W. (1994). Species of *Cortinarius* subgenus *Leprocybe*, sections *Orellani* and *Limonei*, in North America. *Canadian Journal of Botany* **72**, 520-532.
- Tjallingii-Beukers, D. (1976a). Een blauwwordende *Psilocybe* (*P. cyanescens* Wakef.). *Coolia* **19**, 38-43.
- Tjallingii-Beukers, D. (1976b). Voorlopige soortenlijst van het geslacht *Pholiota*. *Coolia* **19**, 142-151.
- Tjallingii-Beukers, D. (1987). De fungi van Nederland: het gestacht *Pholiota*. *Wetenschappelijke Mededelingen van de Koninklijke Nederlandse Natuurhistorische Vereniging* **185**, 1-75.
- Ueki, R. & Smith, C. F. (1973). The genus *Crepidotus* in Hawaii. *Canadian Journal of Botany* **51**, 1251-1254.
- Valenzuela, E. & Esteve-Raventos, F. (1994). *Cortinarius horakii*, a new species from Chile. *Mycological Research* **98**, 937-938.
- Vauras, J. (1989). *Inocybe* section *Calosporae* in NW Europe. *Karstenia* **28**, 79-86.
- Vauras, J. (1994a). Finnish records on the genus *Inocybe*. The new species *I. hirculus*. *Aquilo Ser Botanica* **33**, 155-160.
- Vauras, J. (1994b). *Inocybe diabolica*, a new agaric from subarctic regions. *Mycologia Helvetica* **2**, 121-128.
- Vrinda, K. B., Pradeep, C. K. & Abraham, T. K. (1997). Some *Inocybes* new to India. *Journal of Economic and Taxonomic Botany* **21**, 41-45.
- Vrinda, K. B., Pradeep, C. K., Joseph, A. V. & Abraham, T. K. (1996). A new *Inocybe* (Cortinariaceae) from Kerala State, India. *Mycotaxon* **57**, 171-174.
- Vrinda, K. B., Pradeep, C. K., Mathew, S. & Abraham, T. K. (1997). *Inocybe purpureoflavida* sp. nov. (Cortinariaceae) from Western Ghats of Kerala State, India. *Mycotaxon* **64**, 1-6.
- Walters, M. B. (1965). *Pholiota spectabilis*, a hallucinogenic fungus. *Mycologia* **57**, 837-838.
- *Wasson, R. G. (1958). The divine mushroom: Primitive religions and hallucinatory agents. *Proceedings of the American Philosophical Society* **102**, 221-223.

- *Wasson, R. G. (1959). The hallucinogenic mushrooms of Mexico. An adventure in ethnomycological exploration. *Transactions of the New York Academy of Sciences* **21**, 325-339.
- *Wasson, R. G. (1961). The hallucinogenic fungi of Mexico: An inquiry into the origin of the religious idea among primitive people. *Harvard University Botanical Museum Leaflets* **19**, 47.
- *Wasson, R. G. (1962). The hallucinogenic mushrooms of Mexico and Psilocybin: a bibliography. *Harvard University Botanical Museum Leaflets* **20**, 25-73.
- Watling, R. (1965). Observations on the Bolbitiaceae 2. A conspectus of the family. *Notes from the Royal Botanic Garden, Edinburgh* **26**, 289-323.
- Watling, R. (1971). The genus *Conocybe* subgenus *Pholiotina* II. Some European exannulate species and North American annulate species. *Persoonia* **6**, 313-319.
- Watling, R. (1975a). Observations on the Bolbitiaceae – 11. A species of *Bolbitius* with ornamented basidiospores. *Notes from the Royal Botanic Garden, Edinburgh* **34**, 241-243.
- Watling, R. (1975b). Observations on the Bolbitiaceae – 12. The affinities of two anomalous species. *Notes from the Royal Botanic Garden, Edinburgh* **34**, 245-251.
- Watling, R. (1977a). An analysis of the taxonomic characters used in defining the species of the Bolbitiaceae. *Bibliotheca Mycologica* **61**, 11-53.
- Watling, R. (1977b). Observations on the Bolbitiaceae, 13 & 14. *Kew Bulletin* **31**, 587-594.
- Watling, R. (1977c). Observations on the Bolbitiaceae – 16. *Conocybe* sect. *Giganteae*. *Notes from the Royal Botanic Garden, Edinburgh* **35**, 281-295.
- Watling, R. (1977d). Observations on the Bolbitiaceae – 18. On the status of two Greenland species of *Conocybe*. *Astrate* **10**, 57-59.
- Watling, R. (1980a). Observations on the Bolbitiaceae – 19. Validation of some species of *Conocybe*. *Notes from the Royal Botanic Garden, Edinburgh* **38**, 331-343.
- Watling, R. (1980b). Observations on the Bolbitiaceae – 20. New British species of *Conocybe*. *Notes from the Royal Botanic Garden, Edinburgh* **38**, 345-355.

- Watling, R. (1980c). A hypogeous *Cortinarius* from Kashmir. *Notes from the Royal Botanic Garden, Edinburgh* **38**, 357-362.
- Watling, R. (1982). *British Fungus Flora, Agarics and Boleti 3. Bolbitiaceae: Agrocybe, Bolbitius and Conocybe*. Royal Botanic Garden : Edinburgh, U. K.
- Watling, R. (1983a). Observations on the Bolbitiaceae – 22. Further validations. *Notes from the Royal Botanic Garden, Edinburgh* **40**, 537-558.
- Watling, R. (1983b). Observations on the Bolbitiaceae – 23. Interesting Danish members of the family. *Nordic Journal of Botany* **3**, 261-268.
- Watling, R. (1986). Observations on the Bolbitiaceae – 28. The *Conocybe pubescens* (C. Gillet) Kühner complex. *Galerula neoantipus* and its various interpretations. *Boletín de la Sociedad Micologica de Madrid* **11**, 91-96.
- Watling, R. (1988a). Observations on the Bolbitiaceae – 28. Nordic records 28 A. The genus *Agrocybe* and *Conocybe* sg. *Pholiotina* and *Piliferae*. *Agarica* **9**, 39-59.
- Watling, R. (1988b). Observations on the Bolbitiaceae – 29. Nordic records 29B. The genus *Conocybe* sg. *Conocybe*. *Agarica* **9**, 11-37.
- Watling, R. (1989). The natural history of the Bolbitiaceae (Agaricales): ecological strategies. *Opera Botanica* **100**, 259-265.
- Watling, R. (1992). Observations on the Bolbitiaceae – 30. Some Brazilian taxa. *Boletín de la Sociedad Argentina de Botanica* **28**, 77-103.
- Watling, R. (1994). Observations on Malaysian Bolbitiaceae with records from Solomon Islands. *Garden's Bulletin Singapore* **45**, 359-381.
- Watling, R. & Abraham, S. P. (1986). Observations on the Bolbitiaceae – 26. Bolbitiaceae of Kashmir with particular reference to the genus *Agrocybe*. *Nova Hedwigia* **42**, 387-415.
- Watling, R. & Bigelow, H. E. (1983). Observations on the Bolbitiaceae – 22. *Mycotaxon* **17**, 377-397.
- Watling, R., Esteve-Raventos, F. & Moreno, G. (1986). Observations on the Bolbitiaceae – 27. A new *Conocybe* of conifer forests. *Boletín Sociedad Micologica de Madrid* **11**, 85-89.
- Watling, R. & Gregory, N. M. (1980). Larger Fungi from Kashmir. *Nova Hedwigia* **32**, 493-564

- Watling, R. & Gregory, N. M. (1981). Census catalogue of world members of the Bolbitiaceae. *Bibliotheca Mycologica* **82**, 1-224.
- Watling, R. & Gregory, N. M. (1987). *British Fungus Flora, Agarics and Boleti*. 5. *Strophariaceae and Coprinaceae* p.p. Royal Botanic Garden : Edinburgh, U. K.
- Watling, R. & Gregory, N. M. (1989). *British Fungus flora, Agarics and Boleti* 6. *Crepidotaceae, Pleurotaceae and other pleurotoid agarics*. Royal Botanic Garden: Edinburgh, U. K.
- Watling, R. & Gregory, N. M. (1993). *British Fungus Flora, Agarics and Boleti* 7. *Cortinariaceae* p.p. Royal Botanic Garden : Edinburgh, U. K.
- Watling, R. & Hausknecht, A. (1997). *Conocybe anthuriae*, a new volvate species from Mauritius (Africa). *Osterreichische Zeitschrift fur Pilzkunde* **6**:55-59.
- Watling, R., Little Flower & Leelavathy, K. M. (1988). Observations on the Bolbitiaceae – 27. *Bolbitius* and *Conocybe* in India with particular reference to the state of Kerala. In *Advances in Mycology* (ed. G. S. Rawla), pp. 28-43, Chandigarh, India.
- Watling, R. & Taylor, G. M. (1987). Observations on the Bolbitiaceae – 27. Preliminary account of the Bolbitiaceae of New Zealand. *Bibliotheca Mycologica* **117**, 1-61.
- Yam, P., Helfer, S. & Watling R. (1994). Poisoning of a domestic dog by *Inocybe phaeocomis* (Pers.) Kuyper. *Mycologist* **8**(2):50-51.
- Yang, Z., Zang, M. & Liu, X. (1993). *Agrocybe salicacola*, a new species of sect. *Aporus* from Japan. *Acta Botanica Yunnanica* **15**, 18-20.
- Yokoyama, K. (1973). Poisoning by a hallucinogenic mushroom, *Psilocybe subcaerulipes* Hongo. *Transactions of the Mycological Society of Japan* **14**, 317-320.
- Yokoyama, K. (1976). A new hallucinogenic mushroom, *Psilocybe argentipes* K. Yokoyama sp. nov. from Japan. *Transactions of the Mycological Society of Japan* **17**, 349-354.
- Yokoyama, T., Park, Y. H., Kim, Y. S., Kim, B. K. & Hongo, T. (1979). Distribution of *Descolea flavoannulata* (Vasilieva) Horak in far eastern Asia. *Transactions of Mycological Society of Japan* **20**, 63-72.
- Zhishu, B. (1991). Two new species of *Psathyrella* and *Gymnopilus* from Guangdong Province. *Guihaia* **11**, 131-134.

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Plate 1. A. *Descolea maculata* x 3/4; B. *Bolbitius coprophilus* x 1/2;
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2.38 D



Plate 2. A. *Agrocybe semiorbicularis* x 3/4; B. *Agrocybe* sp. 1. x 1; C. *Agrocybe* sp. 2. x 3/4

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C. *Conocybe* sp. 1. x 1/2

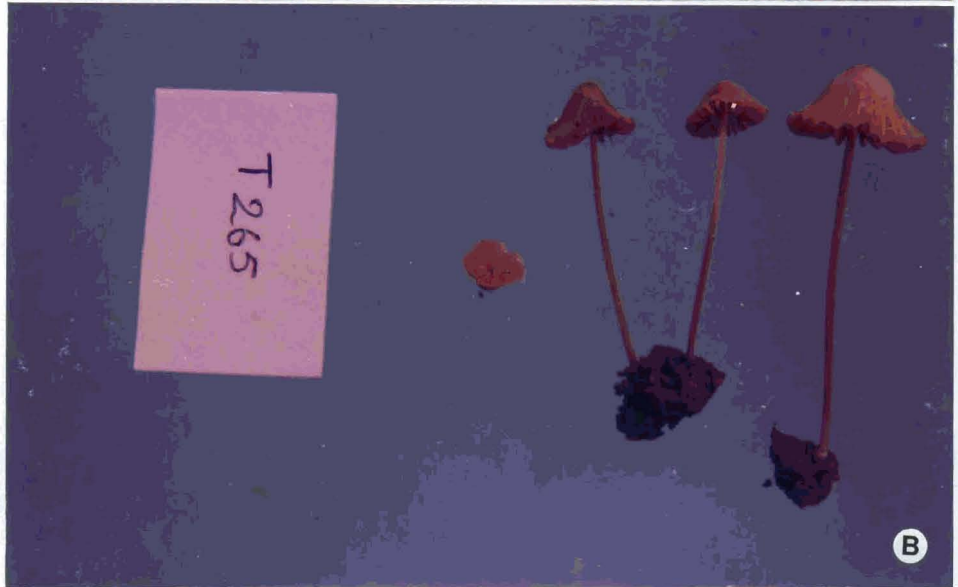


Plate 5. A. *Conocybe* sp. 2. x 1; B. *Conocybe* sp. 3. x 1;
C. *Conocybe* sp. 4. x 3/4

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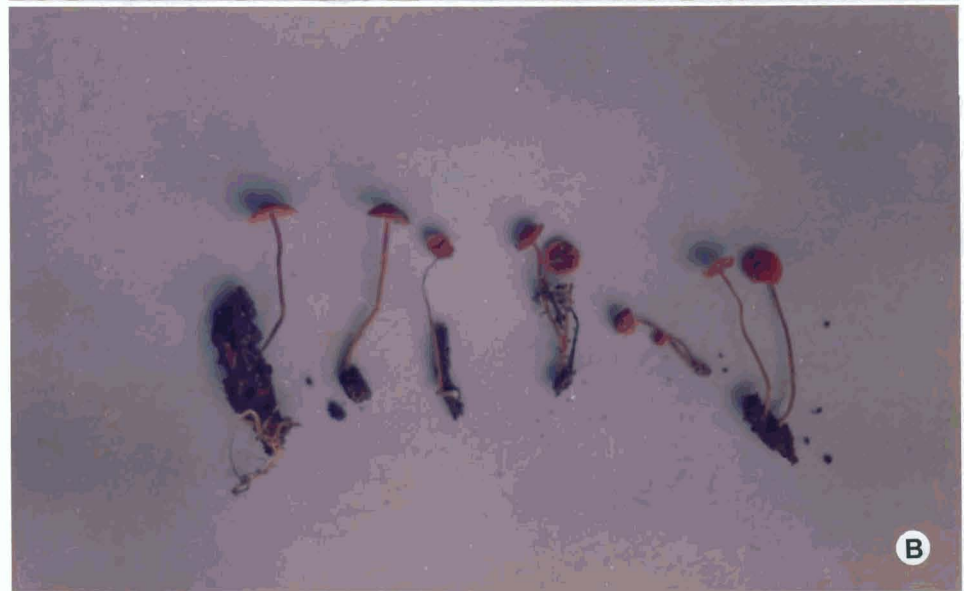
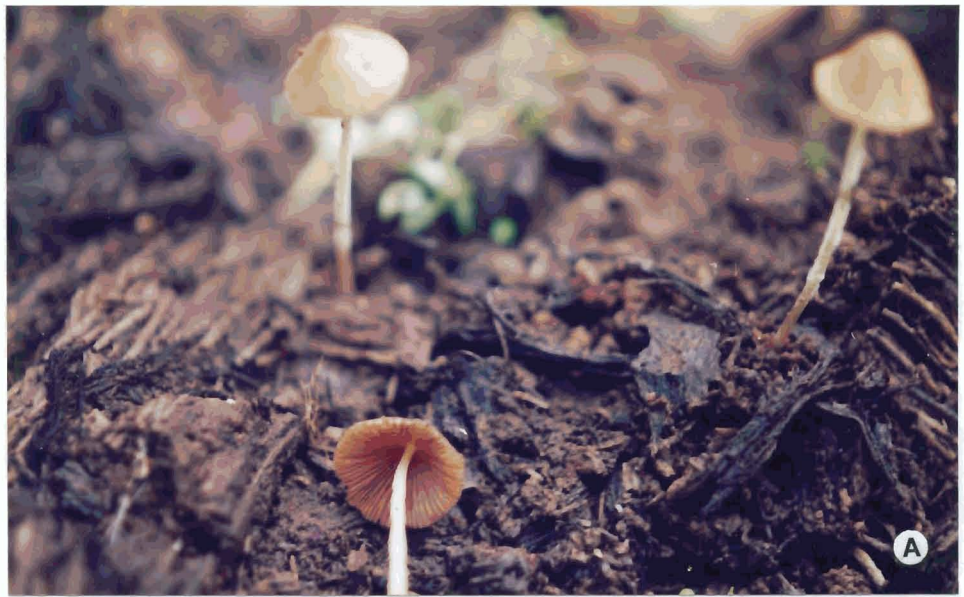


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C. *Conocybe* sp. 7. x 1

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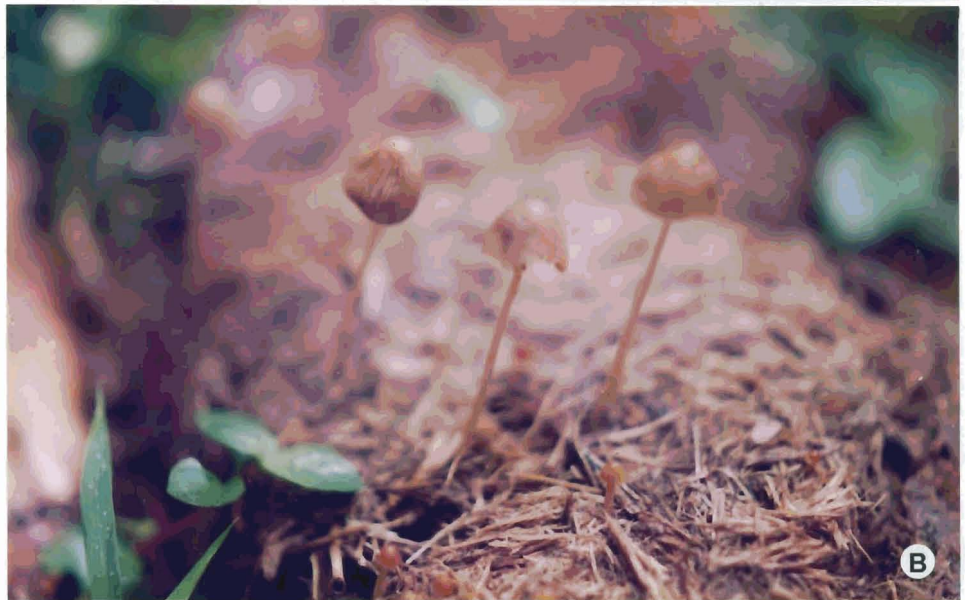


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