WHITE-SPORED PLEUROTOID FUNGI (BASIDIOMYCOTINA) OF CENTRAL NEPAL

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ABSTRACT

Pleurotoid agarics are a group of fleshy mushrooms characterized mainly by eccentric (slightly or strongly off-centered to lateral or sessile) stipes. They belong to the several families of Agaricales in accordance with their spore color. White-spored (light-spored) pleurotoid agarics are members of three different families [viz. Polyporaceae (= Pleurotaceae), Russulaceae, and Tricholomataceae] comprising approximately 50 (including 10 cyphelloid) genera and 400 (including 70 cyphelloid) species worldwide. Here 32 species (belonging to 15 genera from the three families) are reported from central Nepal. Twenty species are found to be new to science and an additional two species are new to Nepal. Four additional taxa could be identified only to genus. Remaining six species were reported from Nepal also by earlier workers. Taxonomic identification of all these agarics was made by comparing their diagnostic features with those of resembling species mentioned in world mycological literature and also by comparing (some) specimens from the mycology herbarium of University of Tennessee, Knoxville [TENN].

The 32 taxa are described with detailed macroscopic and microscopic features of their fruitbodies. Their distinguishing macro- and micro-morphological features are discussed and compared with their look-alikes. All taxa are illustrated. A provisional world key to the genera of white-spored pleurotoid and cyphelloid agarics and dichotomous keys to the pleurotoid species now known from Nepal (approximately 40 species) are also provided.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
	Statement of the problem	5
	Study area	5
	Nepal; Climate and Vegetation	5
	Central Nepal; Ecology, Climate and Vegetation	9
	Economic importance of pleurotoid fungi in Nepal	15
II.	MATERIALS AND METHODS	20
	Collection of specimens	21
	Macroscopic examination	21
	Microscopic examination	22
III.	TAXONOMIC TREATMENT	26
	World key to the genera of white-spored pleurotoid and cyphelloid agarics	27
	Taxonomic treatment of white-spored pleurotoid genera of central Nepal	39
	Campanella	39
	Description of Nepalese species	42
	Chaetocalathus	47
	Description of Nepalese species	48
	Hohenbuehelia	52
	Key to Nepalese species	56
	Descriptions of Nepalese species	57
	Lactarius	79

Description of Nepalese species..... 82

Lentinus..... 88

Key to Nepalese species..... 93

Descriptions of Nepalese species..... 94

Marasmiellus..... 120

Key to Nepalese species..... 123

Descriptions of Nepalese species..... 124

Neolentinus..... 133

Key to Nepalese species..... 136

Description of Nepalese species..... 136

Omphalotus..... 141

Description of Nepalese species..... 144

Panellus..... 149

Key to Nepalese species..... 152

Descriptions of Nepalese species..... 152

Pleurotopsis..... 163

Description of Nepalese species..... 165

Pleurotus..... 170

Key to Nepalese species..... 176

Descriptions of Nepalese species..... 177

Resupinatus..... 186

Description of Nepalese species..... 188

Rimbachia..... 192

Key to Nepalese species..... 196

Descriptions of Nepalese species..... 196

Sarcomyxa..... 215

Description of Nepalese species..... 217

Schizophyllum..... 220

Description of Nepalese species..... 222

White-spored pleurotoid fungal elements of central Nepal.. 227

BIBLIOGRAPHY..... 230

VITA..... 251

LIST OF FIGURES

FIGURE PAGE

1 A-F. Features of Campanella himalensis.
A. Basidiomata (TENN. 51819, holotype). B. Pileipellis hairs from basidioma margin. C. Stipitipellis hairs. D. Basidium. E. Cheilocystidia and pleurocystidia. F. Basidiospores. Standard bar = 1.2 mm for A; 10 µm for B-E; 1.5 µm for F..... 43

2 A-F. Features of Chaetocalathus skeletiformis.
A. Basidiomata (TENN. 51820, holotype). B. Pileipellis hairs. C. Skeletal hyphae. D. Basidia. E. Metuloidal cheilocystidia. F. Basidiospores. Standard bar = 3 mm for A; 30 µm for B & C; 10 µm for D & E; 1.5 µm for F..... 49

3 A-F. Features of Hohenbuehelia albifunicula.
A. Basidiomata (TENN. 51822, holotype). B. Metuloidal pileicystidia. C. basidia. D. Cheilocystidia. E. Metuloids or metuloidal pleurocystidia. F. Basidiospores. Standard bar = 1 mm for A; 30 µm for B; 10 µm for C-E; 1.5 µm for F..... 58

4 A-E. Features of Hohenbuehelia herbicoloa.
A. Basidiomata (TENN. 5123, holotype). B. Basidium. C. Gloeosphex cheilocystidia. D. Metuloids. E. Basidiospores. Standard bar = 3 mm for A; 10 µm for B-D; 1.5 µm for E..... 62

5 A-E. Features of Hohenbuehelia kathmandua.
A. Basidiomata (HRB 17, TENN. 51824, holotype). B. Basidia. C. Gloeosphex cheilocystidia. D. Metuloidal pleurocystidia. E. Basidiospores. Standard bar = 3 mm for A; 10 µm for C-D; 1.5 µm for E..... 66

6 A-E. Features of Hohenbuehelia mucrometuloidea.
A. Basidiomata (TENN. 51826, holotype). B. Basidium. C. Gloeosphex cheilocystidia. D. Metuloidal pleurocystidia. E. Basidiospores. Standard bar = 5 mm for A; 10 µm for B-D; 1.5 µm for E..... 69

7 A-F. Features of Hohenbuehelia nepalensis.
A. Basidiomata (TENN. 51827, holotype). B. Basidia. C. Gloeosphex cheilocystidia. D. Pyriform cheilocystidia. F. Metuloids. G. Basidiospores. Standard bar = 3 mm for A; 10 µm for B-D; 1.5 µm for E..... 73

8 A-E. Features of Hohenbuehelia spissifera.
A. Basidiomata (TENN. 51828, holotype). B. Basidia.

C. Gloeosphex cheilocystidia. D. Metuloids. E. Basidiospores. Stndard bar = 3.5 mm for A; 10 µm for B-D; 1.5 µm for E..... 77

9 A-F. Features of Lactarius pleurotoideus. A. Basidiomata (TENN. 51830, holotype). B. Pileipellis with sphaerocyst cells and hairs. C. Basidium. D. Pseudo- or lacto-cheilocystidia. E. Pleurocystidia. F. Basidiospores. Standard bar = 5 mm for A; 10 µm for B-E; 1.5 µm for F..... 83

10 A-G. Features of Lentinus badius. A. Basidioma (NHMTU. 2-2-02168, TENN. 51833). B. Pileipellis hairs. C. Skeleto-ligative hyphae. D. Basidia. E. Cheilocystidia. F. Pleurocystidia. G. Basidiospores. Standard bar = 10 mm for A; 10 µm for B & D-F; 20 µm for C; 1.5 µm for F..... 95

11 A-F. Features of Lentinus chepangiana. A. Basidiomata (TENN. 51834). B. Skeletalized generative hyphae. C. Stipitipellis hairs. D. Basidia and basidiole. E. Cheilocystidia. F. Pleurocystidia. G. Basidiospores. Standard bar = 13 mm for A; 20 µm for B; 10 µm for C-F; 1.5 µm for G..... 99

12 A-E. Features of Lentinus rutus. A. Basidioma (TENN. 51835, holotype). B. Skeletal hyphae. C. Basidium. D. Cheilocystidia. E. Basidiospores. Standard bar = 20 mm for A; 20 µm for B; 10 µm for C & D; 1.5 µm for E..... 104

13 A-F. Features of Lentinus squarrosulus. A. Basidioma (TENN. 51838). B. Skeleto-ligative hyphae. C. Hyphal peg. D. Basidia. E. Cheilocystidia. F. Basidiospores. Standard bar = 20 mm for A; 20 µm for B; 10 µm for C-E; 1.5 µm for F..... 108

14 A-H. Features of Lentinus species 1. A. Basidiomata (TENN. 51836, NH 9009). B. Pileipellis hairs. C. Skeleto-ligative hyphae. D. Hyphal peg. E. Basidia. F. Cheilocystidia. G. Sclerocystidia. H. Basidiospores. Standard bar = 25 mm for A; 10 µm for B & D-G; 20 µm for C; 1.5 µm for H..... 112

15 A-E. Features of Lentinus species 2. A. Basidiomata (NHMTU. 2-2-02707, TENN. 51837). B. Skeletal hyphae. C. Basidia & basidioles. D. Cheilocystidia. E. Basidiospores. Standard bar = 25 mm for A; 10 µm for B; 20 µm for C & D; 1.5 µm for E..... 117

16 A-G. Features of Marasmius kathmanduus. A. Basidiomata (TENN. 51841, holotype). B. Rameales structure of pileicutis. C. Rameales structure of stipitipellis. D. Basidium. E. Cheilocystidia. F. Pleurocystidia.

G. Basidiospores. Standard bar = 7 mm for A; 10 µm for B-F; 1.5 µm for G..... 125

17 A-G. Features of Marasmius transluscentus. A. Basidiomata (TENN. 51842, holotype). B. Rameales structure of pileicutis. B. Rameales structure of Stipitipellis. C. Basidia & basidiole. D. Cheilocystidia. F. Pleurocystidia. G. Basidiospores. Standard bar = 6 mm for A; 10 µm for B-F; 1.5 µm for G..... 130

18 A-F. Features of Neolentinus species 1. A. Basidioma (TENN. 51849). B. Pileipellis hairs. C. Skeletal hyphae. D. Basidia. E. Cheilocystidia. F. Basidiospores. Standard bar = 10 mm for A; 10 µm for B, D & E; 20 µm for C; 1.5 µm for F..... 137

19 A-D. Features of Omphalotus olearius. A. Basidiomata (TENN. 51845). B. Basidia. C. Cheilocystidia. D. Basidiospores. Standard bar = 15 mm for A; 10 µm for B & C; 1.5 µm for D..... 145

20 A-D. Features of Panellus edulus. A. Basidiomata (TENN. 51846, holotype). B. Basidium. C. Cheilocystidia. D. Basidiospores. Standard Bar = 6 mm for A; 10 µm for B & C; 1.5 µm for D..... 153

21 A-F. Features of Panellus stypticus. A. Basidiomata (TENN. 51849). B. Thick-walled (gelatinized) and clamped tramal hyphae. C. Basidium. D. Cheilocystidia. E. Basidiospores. Standard bar = 6.5 mm for A; 10 µm for B-E; 1.5 µm for F..... 158

22 A-F. Features of Pleurotopsis species. A. Basidiomata (NH 88005, TENN. 51850). B. Stipitipellis elements. C. Basidia. D. Diverticulate cheilocystidia. E. Pleurocystidia. F. Basidiospores. Standard bar = 8 mm for A; 10 µm for B-E; 1.5 µm for F..... 166

23 A-E. Features of Pleurotus djamor var. djamor. A. Basidiomata (NHMTU. 2-2-02858, TENN. 51854). B. Skeletal hyphae. C. Basidia. D. Lecythiform and beaked cheilocystidia. E. Basidiospores. Standard bar = 13 mm for A; 10 µm for B-D; 1.5 µm for E..... 178

24 A-D. Features of Pleurotus ostreatus. A. Basidiomata (TENN. 51855 & other specimens). B. Basidia. C. Lecythiform and beaked pleurocystidia. D. Basidiospores. Standard bar = 38 mm for A; 10 µm for B & C; 1.5 µm for D.. 181

25 A-E. Features of Resupinatus nepalensis. A. Basidiomata

(TENN. 51855, holotype). B. Diverticulate epicuticular hyphae. C. Basidia. D. Diverticulate or knobbed cheilocystidia. E. Basidiospores. Standard bar = 1.6 mm for A; 10 µm for B-D; 1.5 µm for E..... 189

26 A-E. Features of Rimbachia campanulata. A. Basidiomata (TENN. 51857, holotype). B. Pileipellis or epicuticular elements. C. Basidia. D. Knobbed cheilocystidium. E. Basidiospores. Standard bar = 2 mm for A; 10 µm for B-D; 1.5 µm for E..... 197

27 A-D. Features of Rimbachia quiesoria. A. Basidiomata (TENN. 51858, holotype). B. Pileipellis or epicuticular elements. C. Basidia and basidiole. D. Basidiospores. Standard bar = 3.5 mm for A; 10 µm for B & C; 1.5 µm for D. 201

28 A-E. Features of Rimbachia kaaliya. A. Basidiomata (TENN. 51859, holotype). B. Pileipellis or epicuticular elements. C. Stipitipellis elements. D. Basidia. E. Basidiospores. Standard bar = 9 mm for A; 10 µm for B-D; 1.5 µm for E..... 205

29 A-E. Features of Rimbachia lamellata. A. Basidiomata (TENN. 51860, holotype). B. Pileipellis or epicuticular elements from basidiomata margin and disc. C. Tramal hyphae. D. Basidia. E. Basidiospores. Standard bar = 11 mm for A; 10 µm for B-D; 1.5 µm for E..... 208

30 A-F. Features of Rimbachia leleya. A. Basidiomata (TENN. 51861, holotype). B. Pileipellis or epicuticular elements. C. Basidia. D. Cheilocystidia. E. Pleurocystidia. F. Basidiospores. Standard bar = 2.5 mm for A; 10 µm for B-E; 1.5 µm for F..... 212

31 A-D. Features of Sarcomyxa serotina. A. Basidiomata (NH. 88102, TENN. 51864). B. Basidia. C. Cheilocystidia. D. Basidiospores. Standard bar = 12 mm for A; 10 µm for B & C; 1.5 µm for D..... 218

32 A-F. Features of Schizophyllum commune. A. Basidiomata (TENN. 51865 and other specimens). B. Detritus encrusted apex of tramal hyphae. C. Basidia. D. Basidioliform pleurocystidia. E. Hyphoid pleurocystidia. F. Basidiospores. Standard bar = 11 mm for A; 10 µm for B-E; 1.5 µm for F..... 223

CHAPTER I

INTRODUCTION

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INTRODUCTION

Pleurotoid agarics are defined as those mushrooms that look like oyster mushroom (Pleurotus). Like the commonly available (from the market) edible oyster mushrooms all pleurotoid mushrooms are either sessile (without stipe) or have eccentrically or laterally placed stipes, attached (joined with stipe) or decurrent (running down the stipe) gills and lignicolous (growing on wood) habit (Corner, 1981). Pleurotoid mushrooms are a heterogenous collection of fleshy mushrooms which are variable in color, shape and size. The spores may be white, pink, yellow, brown, or purple-brown. In this thesis only white-spored pleurotoid mushrooms are taken into consideration. Since most of the pleurotoid fungi are members of the Agaricales, they are generally called pleurotoid agarics. White-spored pleurotoid agarics mainly seem to occur in the families Tricholomataceae and Polyporaceae (a few also in Russulaceae). However, there are also some genera with pale-colored spores in the Tricholomataceae (e.g. cream pinkish-spored Rhodotus etc.) as well as in Polyporaceae (e.g. pink-spored Phyllotopsis). In fact pleurotoid genera are rather widely distributed throughout various other families of the Agaricales.

White-spored pleurotoid mushrooms are important constituents of the mycoflora of Nepal. Despite their abundance, they have not been previously studied collectively or systematically in Nepal, or many other regions as well. Therefore, literature on these fungi is scattered. Berkeley (1854: 244) reported two species of Lentinus and

one species of Hohenbuehelia [reported as Agaricus (Pleurotus) petaloides] collected by Sir J. D. Hooker and Dr. R. Thomson during 1848 from Nepal. Pegler (1976), after studying type specimens of Pleurotus collected by Cooke (1888), reported one Nepalese Pleurotus. According to Pegler (1976), Balfour-Browne's (1955) Pleurotus nepalensis was rather a pink-spored Phyllotopsis species (not dealt with here). Singh (1973) and Singh and Nisha (1976) reported a species of Lentinus and four species of Pleurotus (see Pleurotus) from Kathmandu Valley in central Nepal. Pegler (1983c) reported seven species of Lentinus. Cotter (1987) reported Omphalotus, Panellus and Pleurotus. Adhikary (1988a) reported a Panellus species. Bhandary (1991b) reported Pleurotus ostreatus and Schizophyllum commune. In spite of the above-mentioned works on white-spored pleurotoid fungi, Campanella, Chaetocalathus, Lactarius, Marasmiellus, Neolentinus, Pleurotopsis, Resupinatus, Rimbachia, and Sarcomyxa, reported in this thesis, are not previously reported to occur in Nepal.

The purpose of this project was to make preliminary observations on and report of the the white-spored pleurotoid mushrooms as known to occur in Nepal. Since it would take one's lifetime to survey all white-spored agarics of whole Nepal, as a beginning collections were mostly made in and (or examined from) around central Nepal. Hence, this thesis deals with taxonomic identification of white-spored Nepalese pleurotoid agaric specimens of central Nepal deposited in the Natural History Museum, Swayambhu and some specimens from National Herbarium, Godavary, Kathmandu, Nepal. Information on locality, ecology, and edibility of these exsiccate specimens are from the

collectors themselves. Information mentioned in this work regarding other than the reported pleurotoid fungi, especially the keys to the world genera, discussions about the taxonomic treatment of genera, comments on distribution of pleurotoid species of central Nepal, and climate and vegetation of Nepal (and central Nepal) have been gathered from literature. Since this work is mainly description and scientific identification of Nepalese pleurotoid agaric specimens obtained from two Kathmandu-based herbaria and my personal collections, attempt has not been made to mention descriptions (macroscopic as well as microscopic) of those previously reported Nepalese pleurotoid agarics not available from the two herbaria or from my personal collections (and whose detailed descriptions already appeared elsewhere in the literature dealing with Nepalese fungi). However, such agarics have been incorporated into the keys to the Nepalese species.

The mushroom group I selected for study is white-spored pleurotoid fungi because of the following reasons: 1) as an intact group, pleurotoid agarics have not been taxonomically studied in Nepal; 2) all of these members are lignicolous and hence they are wood-debris decomposers (Gilbertson, 1980) thus playing a very useful ecological role in recycling of otherwise locked carbon and mineral resources of a forest ecosystem; 3) they may play an important role in forest destruction; and 4) some of them are highly popular as wild or cultivated edibles. Many are familiar as important and easily available forest-food resources in various parts of Nepal (see economic importance of pleurotoid fungi of Nepal).

STATEMENT OF THE PROBLEM

This thesis is the result of a few months collection of white-spored pleurotoid fungi mostly from central Nepal and includes: 1) descriptions of the macroscopic and microscopic features of individual species; and 2) determination of species by utilizing taxonomically important macroscopic and microscopic characters in relevant mycological literature. This is a preliminary study mainly based on fungal collections of central Nepal (one collection from far-western Nepal) available from my personal collecting (of 1991) as well as the exsiccate specimens borrowed from Natural History Museum, Swayambhu and the National Herbarium, Godavari in Kathmandu. Hence, this thesis in does not represent a complete report of all white-spored pleurotoid mushroom group of the study area.

STUDY AREA

NEPAL; CLIMATE AND VEGETATION

Nepal, a small country with an estimated area of about 141,400 sq km (about double the size of Virginia), shelters a wide spectrum of ecosystems because of varieties of climatic types. In Nepal, climatic diversity is mainly brought about by physiographical or elevational difference [500-29,000 ft from mean sea level (Hara et al, 1978)] within a comparatively short distance (200 km) as a result of the lofty Himalayan chain juxtaposed to the low lying (200-500 ft) tropical Indogangetic plain of India (northern side). Situated at the

middle of the Himalayan range, 70% of Nepal's total land area is composed of innumerable and closely packed mountains with river valleys, gorges, etc. situated at various elevations. Elevational differences cause a drastic drop in mean annual temperature [lowering of 1°C with every increase of 100 m (Kendrew, 1961)] resulting in permanent snow cover roughly above 16,000 ft altitude. Though located outside the tropics or equator, Nepal is 400 km from the Tropic of Cancer and hence experiences equatorial (very hot tropical and subtropical) climates at low altitude but contrastingly, even without significant difference in latitude (26°20' and 30°10' north $\simeq$ 4°N latitude), it also possesses temperate, subalpine and alpine climates because of high mountains. Nepal is influenced by southeast Asian monsoon rainfall, which is a seasonal reversal of wind and associated rains (Rao, 1981). Four distinct seasons result because of Nepal's location outside the tropics (26°20' and 30°10' north latitude and 80°15' and 88°10' east longitude), influenced by the monsoons when excessive monsoon rainfall (June-September) and post-monsoon rainfall (October-December) is followed by dry and cold (January-February) and dry and hot (March-May) periods. Rain shadow effect (which causes wet condition on south side and dry condition on Transhimalayan side), aspect of Himalayan and lesser Himalayan ranges (south- and west-facing slopes are drier), occurrence of valley winds, water in the form of snowfall in higher altitudes (Stainton, 1974) etc. are other factors which affect climate and vegetation of Nepal. An increment of 4°N latitude towards the western end (than eastern end) of Nepal is

another responsible factor (Stainton, 1974) which causes more snow fall and snow retention in comparatively lower altitudes, thus causing lowering of the snow and timber line areas in western parts in comparison to eastern Nepal. Although rainfall gradually decreases towards higher altitudes, its frequency increases because of constant accumulation of clouds (Kitamura, 1955; Stainton, 1974). This may be the reason why the mycoflora is equally as rich in temperate montane forests as in humid subtropical and tropical forests.

Nepal comprises about one third (800 km) of the entire 2250 km-long Himalayan range. Since the whole country extends along the axis of Himalaya enclosing the latter's entire middle portion, Nepal has become synonymous with "Nepal Himalaya" (Kihara, 1955; Bhatta, 1981) or included in "Central Himalaya" (Gupta, 1981; Mani, 1985; Negi, 1982). According to Burman (1981) and Jain (1984), the floristic elements of Nepal Himalaya are considered more similar to western Himalaya (which includes Kumaon, Kashmir, and Panjab Himalaya), rather than to Eastern Himalaya (with Sikkim, Bhutan, and further eastern regions). According to Takhtajan (1986), however, a large part of subtropical (excluding tropical region) and temperate Nepal [equivalent to Stainton's (1974) central and eastern regions], classified as "Eastern Himalayan Province" (comprising regions of Darjeeling, Sikkim, Assam, Bhutan, South Tibet and Dihang or Tsangpo River Valley), being more younger geologically, had its flora distributed from the more ancient eastern mountain ranges (of China, Burma, and Assam) because. On the basis of Stainton's (1974) observation, Nepal Himalaya can be categorized as central Himalaya

(thus different from western and eastern Himalaya) because: 1) both western and eastern Himalayan elements occur (former occurs in north side and latter in south side of the mountains) in central Nepal; 2) some eastern or western Himalayan floral elements and their eastward or westward extension; 3) locally endemic species are present; 4) some western elements (north Indian) are present which do not occur in east Himalaya; 5) true tropical or subtropical eastern elements are present which are absent in western Himalaya and; 6) some elements are absent which are present in both eastern and western Himalaya. Kitamura (1955) has pointed that the Himalaya works as a two-way migration corridor for temperate east and west Asian flora because of the tropical climate in the south (tropical) and cold and dry climate in the north (Tibet, Chinese Turkestan and Mongolia). Accordingly, there occurs no abrupt change in western (Mediterranean) and eastern Himalayan (Sino-Japanese) elements in Nepal (hence supporting that Nepal Himalaya is a part of western Himalaya, but not central Himalaya) and therefore the Himalayan migration corridor is recent.

Studies on distribution and mycogeography of Nepal Himalaya have not been made in an extensive manner. Publication on mycodistribution was first made by Durrieu (1975) who concluded that the disease-causing microscopic fungi were abundant in subtropical and temperate climatic zones of Nepal rather than in the tropical, subalpine and alpine zones. Hagiwara (1982) reported various phytogeographical factors affecting altitudinal distribution of some dictyostelid, cellular slime molds (Myxomycotina) in central Nepal. Adhikary (1988b)

mentioned distribution of wood-rotting fungi, including some Agaricales (Polyporus species) in various climatic zones of Nepal. Adhikary (1988b) observed occurrence of wood-rotting fungi in all zones (tropical, subtropical, temperate, and subalpine) except the alpine zone and found interesting patterns of distribution of these fungi much affected by topography as well as locality (eastern Nepal is cooler and wetter and western Nepal is warmer and drier).

CENTRAL NEPAL; ECOLOGY, CLIMATE AND VEGETATION

Because of time and resource limitations, only central Nepal (for map, see Stainton, 1974) was selected as a site for this study of white-spored Agaricales. In the present study, central Nepal corresponds to the geographical region mentioned by Stainton (1974) and Polunin and Stainton (1984). It is equivalent to the Central Development Region (among 5 vertically divided Far Western, Middle Far Western, Central, Eastern, and Far Eastern administrative zones of Nepal) also including other two Eastern and Western Developmental Regions. Central Nepal forms about 38 % (53,732 sq km) of the total land area of Nepal. It is bounded by the Kali Gandaki (later Narayani) river system to the west, Arun Kosi (later Sapta Kosi) river system to the east, Tibetan border to the north and India to the south. Central Nepal is an excellent region for collecting fungi because it includes many different climatic zones.

Litter- and wood-decomposing (as well as parasitic) agaricales are distributed along with their substrates, and therefore the distribution and occurrence of pleurotoid agaricales (which are either

litter-, wood-decomposers, root parasitic or bryicolous) is strictly correlated with the forest types and vegetation in an area. Therefore, it is relevant to discuss briefly here the vegetation and climate types available in central Nepal. Kitamura (1955), Dobremez and Jest (1970, 1971), Stainton (1974) etc. gave details on the climatic, vegetational and forest types of central Nepal. Stainton (1974) recognized 5 principal climatic and vegetational zones in central Nepal:

1) Terai and outer foothills with Bhavar and Dun valleys are a small portion of narrow level land (the only considerable plain-land belt of Nepal) located at the northern end of the Indogangetic river plain. Central Terai forms 30 % of total land area of central Nepal. Elevations in central Terai range from 500 ft to 1000 ft (from mean sea level) in the plain and up to 4000 ft towards the closely situated east-west-running Churey mountain range in the north. Since central Terai is connected with western and eastern Terai by homogenous land, an east-west-running long strip result along the southern side of Nepal (and northern border of India) with uniformly tropical climate and vegetation. This whole Terai can be called the breadbasket of forest and agriculture resources of Nepal. Therefore, central Terai is important refuge area for conservation of flora and fauna thriving on the Indian Plain as well as the lower foothills of Himalaya. Most of the forest here has already been cleared for arable land due to human migration from the mountainsides and also for supplying wood and timbers for the central midland. Land asigned for national parks and

wildlife reserves, however, are doing a good job for floral and faunal conservation.

Stainton (1974) characterized the forest of central (also east and west) Terai as deciduous and semideciduous, made chiefly of tropical Sal forest. Sal is a Nepali word for a hardwood tree (Shorea robusta of the family Dipterocarpaceae, members of which are distributed all along the Indo-Malayan and South-East Asian forests). Components of Sal forest may vary in different places, but common tropical elements are Pandanus furcatus, Phoenix humilis, tree ferns (Cyathea sp.), wildfigs, and silk-cotton trees. In Terai forest, true tropical evergreen forest is also frequent observed (in shady gullies and damper places) but South-East Asian tropical rainforest is totally absent because of seasonal monsoon rainfall. Sal forests, being generally subhumid (Kitamura, 1955), virtually lacks epiphytic plants and moss flora. A number of Lentinus e.g. (Lentinus chepangiana, L. rutus, and L. squarrosulus) and a Pleurotus species were collected in central Terai.

2) Central midland is a mountain-filled region located north of Terai and south of snow-filled Himalayan ranges. It comprises 55 % of and is the largest land area of central Nepal. Elevation ranges from 2000 ft (in subtropical river valleys) to more than 16,000 ft-high snow peaks. In the past, when Terai was infectious with malaria, the lower temperate belt of the midlands must have served as a habitation center for the people migrating northward and southward from India and China. This is the most populated area of central Nepal despite very rugged topography. Most of the forests have been replaced in

constructing arable terraces. The common preexisting (and rudimentary) agroforestry practices, age-old ways of preserving woodlots around holy temples, together with strictly prohibited parks and wildlife reserve areas and forest privatization act (recent) are all playing important roles in preserving natural habitat of central Nepal.

Forest types in central midland are more diverse. Hill Sal (or Shorea robusta) forest similar to Terai Sal forest is widespread in subtropical river valleys and mountain sides up to 3000 ft elevation. Above 3000 ft, warm-temperate and cold-temperate zones occur. In the warm-temperate zone, Indian chestnut (Castanopsis indica) is dominant in lower elevations. In upper elevations, another chestnut (Castanopsis tribuloides) and Myrica esculenta-Photinia integrifolia forests mingled with various oaks (Quercus glauca, Q. semicarpifolia, Q. leucotricophora, Q. lamellosa etc.) become dominant. A characteristic feature of warm temperate forest of central Nepal is the occurrence of deciduous species (e.g. Rhus, Ficus, Engelhardtia, Acer spp. etc.) together with the evergreen species [various species of oaks (as mentioned above), rhododendrons, various laurels, Schima wallichii, Lithocarpus pachyphylla etc]. The cold-temperate zone occurs between 8000 ft and 13000 ft. Here, the lower parts are covered by coniferous forest of Tsuga dumosa, Picea smithiana, and Taxus wallichiana with a number of maple species (Acer campbellii etc.) sometimes mixed with another conifer Laryx griffithiana (Himalayan larch) and some birch (Betula utilis). Rhododendron and Berberis species are abundant in this forest as undergrowth or lower canopy.

The temperate zone of central midland, humid because of frequent rainfall (due to cloud retention by mountains) during the monsoon season, is rich in epiphytes and mosses (Stainton, 1974). Kathmandu Valley (4000-8500 ft elev.) was found to be a very good collecting place for temperate mycoflora. A number of interesting and newly described parasitic, litter- and wood-decomposing as well as bryophilic pleurotoid fungi were collected.

Above the temperate zone, at altitude 13000-17000 ft, there is an arctic zone (Kitamura, 1955) composed of alpine shrubs (with thorny bushes) and alpine grasses. Zones of alpine shrubs and grasses are mixed with a number of other perennial or ephemeral flowering herbs. In this zone, an arid exposed area faces south or west, a dry alpine shrub zone can be observed composed of shrubs with long spines or spine-like branches e.g. Caragana, Lonicera, Ribes etc. Relatively humid north-facing slopes are covered with moist alpine scrubs made of Juniperus, Berberis etc. This zone together with arid and inner valley zone, are not rich in mycoflora because of severe cold condition, extreme differences in day and night temperatures (Zang, 1984), fewer varieties of woody substrates and less shade-providing plants (Favre, 1955). However, some locally endemic hardy fungi may be available in these zones as observed by Favre (1955) in Swiss arctic-alpine zones. This zone, also rich for mosses (see economic importance of pleurotoid agarics in Nepal) and lichens, was not extensively visited for collection of pleurotoid fungi.

According to Kitamura (1955) the warm-temperate chestnut (Castanopsis indica) forest of the central midland resembles the Indo-

Malayan mountain flora and the rest of the warm as well as cold temperate forest resembles the flora of temperate Eastern Asia, Western China, Eastern Tibet, other parts of Himalaya, and Japan.

3) Pokhara region or the country south of Annapurna and Himalchuli is situated in the central midland. The climate and vegetation of this region are more similar to those of eastern Nepal where rainfall is relatively higher than other parts of Nepal (Stainton, 1974). This zone comprises about 5% of total land area of central Nepal. The mountain ranges in this zone being lower than 4000 ft (unlike the rest of the central midland with 7000-9000 ft high mountain ranges), the rain-carrying monsoon wind from the Indian plain can reach fairly deeply towards the north, thus pouring relatively larger amounts of rain here than in other parts of the central midland. Therefore, being more humid, this zone is characterized with moist-loving east Himalayan forest. Here, vegetation on north-facing and south-facing slopes are not different, unlike other parts of central Nepal. Most of the low-altitude valleys and mountain sides are covered by Schima-Castanopsis forest instead of sal or Shorea robusta forest. The latter, however, occurs in the drier areas. At higher elevations (5000-7000 ft), lower temperate mixed broad-leaved forest with Michelia doltsopa and various laurel species (as in eastern Himalayan forest) can be observed, while Quercus lamellosa forest extends at 6500-8500 ft on both north and south slopes. At higher elevations, dense Rhododendron forest (of 3-4 species viz. R. arboreum, R. barbatum, R. campanulatum and R. cinnabarinum unlike in

eastern midland with up to 32 species) is common up to the treeline. Coniferous forest is absent. Stands of Abies spectabilis (fir) can occur rarely. Alpine or arctic zone in this region is replaced by moist-loving species of Rhododendron, Berberis, Salix, some perennial grasses, and a number of other flowering herbs. Arctic, temperate as well as the upper part of the subtropical zone of the Pokhara region, being more humid than the rest of central Nepal, is rich in terrestrial and epiphytic moss flora.

This zone offers a number of interesting areas for mushroom collecting. A number of pleurotoid mushrooms e.g. Campanella himalensis, Lentinus badius, etc. were collected here. Pokhara (2500 ft) to Ghorepani (9000 ft) and Jomsom is a popular treking route with a number of pristine rain forest areas rich in mycoflora.

4) Inner valleys comprise five different pockets of inner valleys in central Nepal situated further north (behind) of the main Himalayan range. Since there is another main Himalayan range to the north of these valleys, all these valleys are located between two east-west-running parallel chains of the main Himalaya. Inner valleys also can be called trans-himalayan zones. In central Nepal, inner valleys form about 12 % of the total land area. Here, elevation increases from 7000 ft to above 16000 ft. Monsoon winds with little rain barely reach these valleys, hence, this zone remains relatively dry and cold all year round. Vegetation consists of cold-hardy, bushy Pinus and Juniperus (cedar) species with a number of perennial grassy and herbaceous ground flora which show up only during monsoon. Inner valleys mainly serve as grazing grounds for yak and sheep during

monsoon. In terms of availability of mycoflora, they are similar to the subalpine and alpine zones of the central midland. However, in some relatively moist places near streams, conifers such as Larix and blue pines (Pinus) or Tsuga dumosa, Cupressus torulosa (cypress) and Juniperus (cedars) provide excellent habitat for a number of mycoflora.

5) Arid zone refers to "the treeless zone" because the dry, cold, and windy climate does not permit growth of trees. n 5 % of central Nepal. This zone is similar to Inner Valleys but much drier because of the influence of strong wind generated from the river sides at the valley floor. The wind drives the rain clouds higher up towards the mountain slopes which remain comparatively more humid than the floor but still cannot bear trees because of combined effects of high elevations, coldness and insufficient moisture. The lower areas of the arid zone are covered with dwarf and shrubby Juniperus and Pinus griffithii together with some Myricaria, spiny Rosa, and Berberis species. The ground remains dry and eroded (because of wind) with occasional patches of scruby plants. In higher elevations, thorny scrubs e.g. Caragana, Lonicera etc. are found. The Mustang and Manang valleys are two places which possess this kind of climate and vegetation. According to Kitamura (1955), the floral elements of the arid zone of central Nepal resemble the alpine flora of western and central Asia.

ECONOMIC IMPORTANCE OF PLEUROTOID FUNGI IN NEPAL

Pleurotoid mushrooms, being wood-rotting fungi, are wood destroyers. They are also popular sources of food. The actual amount of wood and forest tree destruction by pleurotoid fungi in Nepl is not known, although some Pleurotus (P. corticatus, P. circinatus, P. ostreatus) are reported as pathogens of a common oak tree, Quercus semecarpifolia (Pawsey, 1989). Since many of the larger pleurotoid fungi reported here seem to occur on various common trees of considerable wood and timber values (about 80 % of all the fuelwood used and 70 % of all the timbers used all over Nepal) throughout the tropical, subtropical, temperate, and timberline zones (e.g. Shorea robusta, Castanopsis species, Quercus species, Pinus species, Schima wallichii, etc.), these fungi may pose problems for forest management people dealing with silvicultural practices in Nepal. Some pleurotoid fungi that act as wound parasites (Panellus stypticus) may also cause death of host trees by combined action with other pathogenic organisms (Singer, 1986).

As food, wild pleurotoid mushrooms are collected throughout Nepal (Singh, 1967; Pandey, 1971-76; Adhikary, 1975, 1981-82; Pegler, 1976, 1983; Singh and Nisha, 1976; Bhandary, 1985, 1991a, 1991b; Aita, 1985 ; Cotter, 1987). According to Adhikary (1987) wild mushrooms are consumed more commonly in central and east Nepal than west Nepal. Of the Indo-Aryan, Tibeto-Burman, Munda, northern-Dravidian, and Kusunda related races of Nepal (Bista, 1965; Toba, 1977), central Nepal is inhabited by all the above caste-groups. Except Indo-Aryan caste,

other castes can be said as mycophilic because most of their subethnic groups have names or words for various edible mushrooms (see Hohenbuehelia, Lentinus, Panellus, Pleurotus, and Schizophyllum) in their dialects and these non-Indo-Aryan subgroups also actively collect wild mushrooms as food or medicine. Therefore, in rural communities of Nepal, poisonous and inedible mushrooms generally do not have any local names because they are not in use and hence unfamiliar to the local people (Bhandary and Shrestha, 1985). Even among the Indo-Aryan community which is generally regarded as mycophobic, ethnic groups e.g. Danuwar, Darai, Kumhaley, Majhi, Rajbanshi, and Tharu (Toba, 1977) use mushrooms as edibles without any restriction from their religio-cultural and social beliefs. For Khas (Brahmins, Chhetris, Damai, Kaami), Maithili, and Abadhi Indo-Aryan community (which however form the major population of Nepal), mushrooms are inedible because they are regarded as "a product of demon's dead body" (Adhikary, 1987) and impure food which brings sickness to physical and spiritual state of human body. In new generations, however, as a result of increased modern information about mushrooms and more availability (due also to cultivated varieties), the old norms about mushrooms are disappearing.

In Nepal, some mushrooms are also used as medicinal herbs (Bhandary, 1991b). However, information on ethnomedical utilization of pleurotoid mushrooms is poorly known. For modern medicine, some mushrooms, including a pleurotoid species of Hohenbuehelia, were reported to possess an antibiotic substance called pleurotin (Singer, 1986). Therefore, it may be worthwhile to test various newly described

Hohenbuehelia as well as other pleurotoid species from central Nepal for their antibiotic properties.

Economic uses of other small pleurotoid mushrooms like Campanella, Hohenbuehelia (some species), Marasmiellus, Rimbachia etc. are not clear. They are not harvested as edibles because of very small basidiomata size. Since all fungi including small pleurotoid species grow on various decomposing or living plant materials they are very important agents for accelerating decomposition thus helping quick carbon recycling in all kinds of climates. In arctic-alpine ecosystems of high mountains, low temperatures becomes the main limiting factor for physiological activities of most larger fungi which are commonly responsible for degradation of organic materials. In such zones, larger pleurotoid as well as agaricoid litter- and wood-decomposing macromycetes are absent also because there are no tree-flora (Kühner & Lamoure, 1972) and since the woody debris become quickly dried because of strong sunlight (because of higher altitude) and insufficient shade (due to dwarf and shrubby flora). Since such zones are rich in various bryophyte flora, bryophilic fungal groups may be richer here (Favre, 1955; Redhead, 1984a).

CHAPTER II

MATERIALS AND METHODS

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COLLECTION OF SPECIMENS

Mushrooms or basidiomata were carefully plucked or cut by a knife at the base along with the substratum and wrapped in suitable sized wax paper to keep the specimens moist until they were reopened and examined for various morphological features. To study spore color, one or two suitably sized basidiomata were placed lamellar side down on an appropriate sized white card (paper) before wrapping them in the wax paper to get their spore prints deposited. Morphological features of basidiomata were noted after they were brought back to the laboratory or camping sites. The basidiomata were then dried with the help of electric air drier (or sometimes also in open fire) and labelled and re-wrapped in a fresh piece of wax paper before they were brought to the museum or laboratory and stored in paper boxes or plastic bags for cataloguing.

MACROSCOPIC EXAMINATION

Various macroscopic features were noted while basidiomata were still in fresh condition. These macroscopic features included shape, size, color, surface, margin, color changes (while handling), and nature of flesh of pileus (thickness, color, color changing reaction, taste, odor); type of hymenium, attachment to stipe, shape, size, color, distance, edge and consistency of lamellae or tubes; position,

shape, size and color of the stipe, color and vestiture of surface, consistency, and color of stipe flesh; presence and nature of basal tomentum or rhizomorphs or subiculum; color of the spore deposit; and nature of substrates and their identification (especially the vascular plant material). Illustrations and measurements of basidiomata were drawn and taken in the field unless otherwise mentioned. All color determinations especially the color codes mentioned in parentheses are from Kornerup and Wanscher (1967). All color examinations were made in daylight. Descriptive terminologies (also for microscopic examination) were taken from sources such as Largent (1986), Largent and Baroni (1988), Largent et al (1977) and Singer (1976, 1986). All specimens were dried and a copy of (duplicate as well as fragments of unicate holotype) specimens have been accessioned in the fungus herbarium, University of Tennessee, Knoxville (TENN).

MICROSCOPIC EXAMINATION

Microscopic examinations were carried out with a Nikon standard light microscope using bright field illumination. Microscopic features (such as pellicular hairs, pileipellis, tramal hyphae, subhymenium, basidia, cheilocystidia, pleurocystidia, and basidiospores) were drawn using a Nikon drawing tube. Size of the microscopic features were determined by using occulomicrometer standardized by means of a stage-micrometer in a fixed combination of eyepiece and objective. Drawings of various microscopic features were magnified and redrawn.

The following anatomical features were described along with their

drawings: size, shape, density, and nature of wall of pellicular hyphae or pileicystidia; size, shape, density, and nature of wall of stipe hairs or caulocystidia; thickness of pileipellis and the size, shape, color, nature of wall and presence or absence of clamp connections of its hyphae; thickness of pileus trama and size shape, color, nature of wall and presence or absence of clamp connections on its hyphae; width of lamellar trama and size, shape, arrangement, color, nature of wall and presence or absence of clamp connections of its hyphae; thickness of subhymenium; size, shape, color, number of sterigmata, and presence or absence of clamp connections of the basidia; size, shape, color, projection and nature of cheilocystidia and pleurocystidia; and size, shape, nature of wall, amyloidity, and contents of the spores.

For microscopic examination free-hand sections of dry material were used. A wedge-shaped piece of pileus was rehydrated (for some unusually soft and thin fleshed basidiomata, dry material was directly sectioned without rehydration) from 20 seconds to 10 minutes (depending on the toughness of the flesh), usually 3-4 minutes in average, in 3 % KOH solution (made in distilled water). The wedge-shaped rehydrated pileal piece was placed between the two sides of a longitudinally split pith stick so that the lamellae were parallel to the longitudinal axis of the pith stick. A sharp two-edged razor blade was then used to cut the rehydrated piece of pileus along with the pith into many (as required) thin transverse sections. Then, each section (along with the pith section) was placed on a slide containing one or two drops of one of various chemicals depending on the purpose

to which the pileus section was to be used. After carefully removing the pith sections, the mounted specimens were subsequently examined at high magnification (100X). For staining examined material for figure drawing and size measurement sections were treated with a mixture of one or two drops of Congo red (to stain spore and hyphal walls) and Phloxine (to stain protoplasmic materials) solutions or either of the two plus one or two drops of 3% KOH. Acetocarmine was used to examine carminophilous or siderophilous granules in the basidia which turn blackish purple or violet black color (Clémençon, 1978); cotton blue solution to examine cyanophilic (a deep blue color accumulation on the walls means positive) reaction in spores and hyphae; cresyl blue solution to examine metachromatic (a red or purple color means positive) reaction and identify gelatinized zones (Largent et al, 1977) and metuloidal cystidia (Miller, 1984); Melzer's reagent was used to test amyloid (= bluish or dark blue color) or dextrinoid (= pseudoamyloid: brown or reddish brown color) or inamyloid (no change of color) reactions; and Sulfobenzol solution was used to observe gloeoplerous (Donk, 1967) or oleiferous (Fayod, 1889) or laticiferous hyphae or gloeovessels (Singer, 1986) which show bluish, bluish grey or dark grey colourations. All these chemicals and reagents were prepared by techniques as mentioned by Largent et al (1977).

To determine the spore size and shape and positive tests of spores with various above mentioned chemicals, a small portion of intact lamella or a little scrap from the hymenial layer (if the pileus had smooth hymenium) was treated (to make sure that there would

be enough spores) with appropriate chemicals. Similarly, to observe cheilocystidia an entire chunk of gill edge was stained and examined carefully at 40X along the gill-edge before squashing.

All spore measurements were made in Melzer's solution excluding their hilar appendages (unless mentioned otherwise). Average spore length is denoted by Lm (mean value of total spore length)], average spore width by Wm (mean value of total spore breadth)], and length/width ratio of spores by Em (minimum and maximum range of Lm/Wm ratio of the smallest and largest individuals)].

All figures except those of fruitbodies, spores, and skeletal hyphae approximately correspond to magnification of 1000X. Figures of spores correspond to 7300X, and figures of skeletal hyphae correspond to 500X. Figures of basidiomata are not true to scale and their measurements are given in descriptions.

CHAPTER III

TAXONOMIC TREATMENT

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TAXONOMIC TREATMENT

WORLD KEY TO THE GENERA OF WHITE-SPORED PLEUROTOID AND CYPHELLOID AGARICS

1. Trama (stipe or pileus) sarcodimitic (presence of inflated as well as thin filamentous hyphae) or sarcotrimitic (filamentous hyphae ramified to form binding hyphae); hymenium smooth, rugose-venose or lamellate; basidiomes often thin fleshed and putrescent (sometimes tough and reviving); spores amyloid or inamyloid.....2

1. Trama (stipe or pileus) not sarcodimitic or sarcotrimitic; hymenium smooth, rugose-venose or lamellate; basidiomes generally tough and reviving (sometimes putrescent); spores amyloid or inamyloid.....7

2. Basidiomata cupulate or cucullate-convex, dorsally attached; hymenium venose or venose reticulate; growing on dead wood with or without mosses (Corner, 1991).....Rhodoarrhenia

2. Basidiomata pleuropodal; hymenium smooth, rugulose, venose or lamellate; lignicolous, lichenized or bryicolous.....3

3. Hymenium smooth or rugulose; basidiomes strongly pleurotoid (strongly eccentric or laterally attached); basal mycelium present; habit bryicolous (Singer, 1986) or lignicolous

among mosses (Redhead, 1984a).*Flabellimycena* (= *Pleuromycenula*)

3. Hymenium generally lamellate or pliciform (rarely smooth or rugose-venose); basidiomes generally weakly pleurotoid; basal mycelium present or absent; habit generally lignicolous, rarely bryicolous or lichenized.....4

4. Basidiomata emitting watery liquid and blackening on bruising; spores amyloid (some inamyloid), or if not, then tramal hyphae dextrinoid; epicutis with broad, ventricose or broadly rounded elements.....*Hydropus*

4. Basidiomata not emitting watery liquid and not blackening on bruising; spores inamyloid; tramal hyphae not dextrinoid; epicutis with or without rameales structure...5

5. Basidiomata generally white (white or slightly pale cream colored); epicuticular hairs undifferentiated; habit lignicolous (Redhead, 1984a).....*Helotium* (= *Hemimycena*)

5. Basidiomata generally pigmented; epicuticular hyphae undifferentiated or of rameales structure; habit lignicolous, bryicolous or lichenized.....6

6. Epicuticular hyphae often of inflated cells or rameales structure; habit strictly lignicolous; clamp connections present; basidiomata reviving (often with tough stipe) to sometimes putrescent; lignicolous, never bryicolous or lichenized (Corner, 1991).....*Trogia*

6. Epicuticular hyphae filamentous, not differentiated into inflated cells or rameales structure; clamp connections

absent in white forms; basidiomata not reviving; often lignicolous, may also be bryicolous or lichenized (Singer, 1986).....Gerronema

7. Spores and /or pileipellis hairs amyloid or dextrinoid.....8

7. Spores and/or pileipellis hairs inamyloid or not dextrinoid.....19

8. Pileus trama gelatinized; gelatinization due to presence of compactly arranged hyphae with more or less thick and gelatinized walls; in a cross-section mount, the individual hypha look covered with its own gelatinized wall but not appearing submerged (unlike in Resupinateae) in a common gelatinous mass; amyloid or dextrinoid long hairs absent; spores amyloid.....9

8. Pileus trama not gelatinized and without gelatinous layer; amyloid or dextrinoid elongated epicuticular hairs present or absent; amyloid or dextrinoid spores present if long epicuticular hairs absent.....12

9. Pileicutis (including pellicular hairs and the whole pileus trama) gelatinized; tetrapolar.....Pleurotopsis

9. Only pileus trama (not pileicutis and pileal hairs) gelatinized.....10

10. Pileus with pellicular veil; tetrapolar.....Tectella

10. Pileus without pellicular veil.....11

11. Pileus up to 100 mm broad; surface viscid; cystidia thick-walled or look encrusted or metuloidal.....Sarcomyxa

11. Pileus often smaller; surface generally dry; cystidia generally thin-walled and do not look incrusted or

metuloidal; tetrapolar.....Panellus

12. Pileipellis with elongated dextrinoid hairs; spores may not be dextrinoid or amyloid (i.e. inamyloid).....13

12. Pileipellis without such hairs; spores amyloid.....16

13. Fruitbodies cyphelloid; hymenophore smooth, auriculoid or lamellate; spores neither amyloid nor dextrinoid.....14

13. Fruitbodies pleuropodal; hymenophore lamellate; spores dextrinoid; tetrapolar.....Chaetocalathus

14. Epicutis with broom-cells containing fine, tapering, filiform dextrinoid appendages; tetrapolar.....Amyloflagellula

14. Epicutis without broom-cells; pellicular hyphae with very long flagelliform hairs.....15

15. Pellicular hairs strongly dextrinoid or amyloid; spores longer than 12 µm.....Lachnella

15. Pellicular hairs weakly amyloid or dextrinoid (only in superposition of several hairs); spores smaller than 12 µm.....Flagelloscypha

16. Spores ornamented; spore ornamentation amyloid; basidiomata laterally or strongly eccentrically stipitate.....17

16. Spores smooth, either amyloid or dextrinoid; basidiomata slightly eccentrically (stipe slightly off-centered or not lateral) attached; lamellae adnate or decurrent.....18

17. Basidiomata fleshy, often producing latex when cut; pileipellis of sphaerocyst cells; spores over 8 µm long.....

.....Lactarius

17. Basidiomata tough, not producing latex; no sphaerocyst cells in pileipellis; spores less than 7 µm long, finely warty or spiny; tetrapolar.....Lentinellus

    18. Spores larger than 6 µm; lamellae not very narrow and crowded; basidiomata growing on earth or woody humus under trees.....Dennisiomyces

    18. Spores smaller than 6 µm; lamellae very narrow and crowded; basidiomata often arising from wood buried in soil; tetrapolar; (one pleurotoid species).....Baeospora

19. Pileus trama gelatinized or with gelatinous layer (see below); trama monomitic.....20

19. Pileus trama not gelatinized or without gelatinous layer; trama mono-, di-, or trimitic.....29

    20. Pileus tramal hyphae collectively submerged in a common gelatinous mass (i.e. gelatinous wall of individual hyphae not observable on unsquashed cross-section mount).....21

    20. Pileus tramal hyphae do not look collectively submerged in a common gelatinous mass, separate gelatinized hyphal walls of individual hypha observable on usquashed cross-section mount.....24

21. Nematophagous gloeosphex cystidia (cheilo- or pleurocystidia) and\or unfascicled short hyphal branches (on pileipellis or cultures) with hour glass-shaped cells (covered by mucoid drop) present; metuloids present; bipolar, tetrapolar or amphithallic.....Hohenbuehelia

21. Nematophagous gloeosphex cystidia and hyphal gloeosphex

apparatuses absent; metuloids absent.....22

22. Basidiomata cyphelloid; hymenophore smooth.....23

22. Basidiomata pleuropodal, pseudostipitate; hymenophore lamellate or venose; tetrapolar.....Resupinatus

23. Basidiomata cespitose, cup-shaped, enclosed within a gelatinous mass.....Stromatocyphella

23. Basidiomata separate, not enclosed within a gelatinous mass; microdroplets may be present but not nematode-toxic.....Stigmatolemma

24. Rameales structure present in epicutis.....25

24. Rameales structure absent.....

25. Basidiomata cyphelloid or campanulate (at least in young stage) and effused at maturity; hymenium strongly intervenose (hence may look alveolate or highly reticulate); primary hymenial folds and interveins sharply distinct; tetrapolar.....Campanella

25. Basidiomata pleuropodal; hymenium sometimes intervenose but never alveolate; primary hymenial folds and interveins not so sharply different (in size).....26

26. Spores cruciate or 4-angled in profile.....Tetrapyrgos

26. Spores not angled in profile.....27

27. Spores spiny or verrucose (Horak, 1981); tetrapolar....Conchomyces

27. Spores smooth.....28

28. Rameales structure present in the epicutis; oily-contents having metachromatic gloeo- or pseudocystidia

absent; clamp connections present or absent; basidiomata not emitting latex on bruising.....Marasmiellus

28. Rameales structure absent but epicutis and hymenium with gloeo- or pseudocystidia which are deep-rooting and metachromatic (cresyl blue positive); clamp connections absent; basidiomata may emit latex on bruising (Singer, 1986); (one pleurotoid species).Lactocollybia

29. Trama (pileus, gill or stipe) dimitic (with thin-walled frequently clamped generative plus thick-walled unclamped skeletal hyphae) or trimitic [with generative plus skeletal plus skeleto-ligative (tapering and ramifying branches of skeletals) hyphae].....30

29. Trama monomitic (generative hyphae thin- or thick-walled).....32

30. Nematophagous lecythiform cystidia (cheilo- or pleurocystidia) and/or microdroplet branches (in pileipellis hairs or cultures) present; tetrapolar....Pleurotus

30. Nematophagous cystidia and microdroplet branches absent.....31

31. Involved in brown-rots; hymenophoral trama regular, spores binucleate; bipolar.....Neolentinus

31. Involved in white-rots; hymenophoral trama irregular or interwoven; spores uninucleate; tetrapolar.....Lentinus

32. Generative hyphae of trama (pileus, gill or stipe) exclusively thick-walled.....33

32. Generative hyphae of trama thin-walled or negligibly thick-walled.....36

33. Hyphae with clamp connections; spores uni- or binucleate.....34

33. Hyphae without clamp connections; spores binucleate.....Heliocybe

34. Lamellae split lengthwise; tetrapolar.....Schizophyllum

34. Lamellae not split lengthwise.....35

35. Pileus fleshy, tough, woody; narrow coralloid cuticular hyphae on stipe and pileus.....Ossicaulis

35. Pileus fleshy but neither woody nor tough; coralloid cuticular hyphae absent; tetrapolar.....Lentinus

36. Nematophagous lecythiform cystidia (either cheilo- or pleurocystidia or both) and/or microdroplet branches on pileipellis or cultures present.....Pleurotus

36. Nematophagous lecythiform cystidia and/or microdroplet branches absent.....37

37. Habit bryophilic or muscicolous; basidiomata never lichenized; basidiomata pleuropodal or cyphelloid; hymenium smooth, auriculoid or lamellate.....38

37. Habit not bryophilic or muscicolous; sometimes lichenized; habitat pleuropodal or cyphelloid; hymenium smooth, wrinkled or lamellate.....39

38. Epicutis or suprapellis or tramal hyphae incrusted, and neither with a rameales structure nor differentiated into subcapitate, clavate, or cystidioid structure.....Arrhenia

38. Epicutis or suprapellis or tramal hyphae never incrusted but always differentiated into subcapitate, clavate, apically branched or cystidioid dermatocystidia.....Rimbachia

39. Basidiomata lichenized; fungus growing on wood, rocks etc.....40

39. Basidiomata not lichenized; fungus lignicolous, saprophytic or terricolous.....41

40. Basidiomata with Botrydina type of lichenized microscopic globules (possessing unicellular algal cells encapsuled by hyphal appressorium, as found in members of Omphalina); lichenized globules developed mostly on basal tomentum; basidiomata flabelliform; hymenium smooth; pileipellis with chains of inflated cells; cystidia absent..... .....Semiomphalina

40. Botrydina type of encapsulated algal components not visible; algal components localized in two layers [outer (shallow) and inner (deep hymenopodium)] of the subhymenium; basidiomata spathuloid or spoon-shaped; hymenium smooth, rugose or lamellate; epicutis with weak rameales structure; hymenial pseudocystidia distinct and fusoid ventricose..... .....Skepperiella

41. Basidiomata often larger than 50 mm, pleuropodal; hymenium lamellate.....42

41. Basidiomata usually not larger than 50 mm, pleuropodal or pezizoid-cyphelloid; hymenium smooth, rugulose, lamellate or venose-reticulate.....47

42. Basidiomata luminescent, brightly colored when fresh.....43

42. Basidiomata not luminescent, dull colored or white when fresh.....44

43. Partial veil present; basidiomata laterally stipitate; spores more than 10 µm long; tetrapolar.....Lampteromyces

43. Partial veil absent; basidiomata never laterally stipitate but rather clitocyboid; spores less than 10 μm long; amphithallic, tetrapolar.....Omphalotus

44. Basidiomata laterally stipitate, white and thin-fleshed when fresh; habit lignicolous but often growing on mossy habitat.....Pleurocybella

44. Basidiomata eccentrically (never laterally) stipitate, often pigmented and relatively thick-fleshed; habit lignicolous, terricolous, or appearing bryophilic.....45

45. Pileus heavily squamulose-fibrillose; cheilocystidia not large or voluminous; basidiomata brightly colored when fresh.....Tricholomopsis

45. Pileus not heavily squamulose-fibrillose; cheilocystidia large or voluminous.....46

46. Basidia with relatively more and uniformly distributed siderophilous granules; habit often terrestrial; not involved in brown-rots.....Lyophyllum

46. Siderophilous granules relatively less in numbers and limited at base of basidia; habit lignicolous; involved in brown-rots (Redhead, 1984b); amphithallic.....Hypsizygus

47. Suprapellis (pileipellis or stipitipellis) differentiated into rameales structure, broom-cells, diverticulate or coralloid hyphae or often with multiseptate hyphae; habit lignicolous.....48

47. Suprapellis not differentiated into rameales or

diverticulate structure (may possess simply capitate or cystidiiform dermatocystidia); lignicolous or bryophilous....58

48. Basidiomata pleuropodal or pezizoid-cyphelloid; hymenium smooth, rugose, or lamellate.....49

48. Basidiomata pezizoid-cyphelloid or campanulate (at least at early stage); hymenium smooth or undulate or venose.....54

49. Habit pleuropodal.....50

49. Habit pezizoid-cyphelloid.....54

50. Hymenium eventually lamellate or lamellate-venose.....51

50. Hymenium smooth or simply undulate.....Cymatella

51. Spores minute (smaller than 6 µm long); epicuticular hyphae with multiseptate or distinctly coralloid apex; clamp connections generally absent (present in only a few species); tramal hyphae neither incrusted nor pseudoamyloid.... .....Pleurocollybia

51. Spores larger than 6 µm; epicticular hyphae with distinctly coralloid apex; clamp connections generally present; tramal hyphae may be incrusted or psedoamyloid.....52

52. Epicuticular hyphae with distinct broom cells; tramal hyphae may be incrusted or pseudoamyloid; bipolar, tetrapolar or amphithallic.....Marasmius

52. Epicuticular hyphae with rameales structure but not with broom cells; tramal hyphae may be incrusted or pseudoamyloid; tetrapolar or amphithallic.....53

53. Lamellae and spores turning cinnamon or green in contact with KOH solution; amphithallic, tetrapolar.....Anthracophyllum

53. Lamellae and spores not turning cinnamon or green in contact with KOH solution; tetrapolar.....Marasmiellus

54. Suprapellis or epicutis with apically dilated cells exhibiting numerous diverticulae or finger-like projections...55

54. Suprapellis or epicutis with rameales and/or broom cells but not with apically dilated and diverticulae possessing cells.....56

55. Suprapellis (at margin of basidiomata) cystidiiform with terminal, broadly rounded or clavate cells possessing dense fine diverticulations similar to acanthocysts (as found in members of Favolaschia); clamp connections absent.....Mycoalvimia

55. Suprapellis with irregularly bent hyphae terminally producing numerous hair-like capitate or claviculate-forked or simple branches; clamp connections present...Cellypha

56. Epicutis with distinct broom cells.....Marasmius

56. Epicutis with rameales structure but without distinct broom cells.....57

57. Spores often carrying fragments of (long) sterigmatal appendage; tramal hyphae without clamp connections; rameales structure confined to pseudostipe (Singer, 1986)..... .....Phaeodepas

57. Spores without long sterigmatal appendage; tramal hyphae with clamp connections; rameales structure common in margin as well as pseudostipe; amphithallic.....Calyptella

58. Basidiomata pleuropodal; suprapellis or pileipellis a trichoderm not differentiated into either rameales structure or subcapitate or cystidiiform dermatocystidia; tramal hyphae often incrusted; bryophilous or lignicolous..... .....Pleurotellus

58. Basidiomata cyphelloid; suprapellis or pileipellis a trichoderm not differentiated into rameales structure (but often subcapitate or cystidiiform dermatocystidia confined to rim of cup); tramal hyphae often incrusted; never bryicolous.....Cyphella

TAXONOMIC TREATMENT OF WHITE-SPORED PLEUROTOID GENERA OF CENTRAL NEPAL

CAMPANELLA

Campanella Hennings. 1895. Engler's Botanische Jahrbücher 22: 95

Type species: C. büttneri Hennings.

Campanella was proposed by P. Hennings (1895, 1897) for a fungus (C. büttneri) characterized by pleurotoid (with eccentric and reduced stipe) habit, auriculoid or venose (not lamellate) reticulate hymenial folds, and white, inamyloid spores. Hennings (1897), in his classification system for hymenomycetes, placed Campanella in the Agaricaceae. The Agaricaceae included fungi which formed ridge-like folds in the hymenium (e.g. Cantharellus in subfamily Cantharelleae etc.) or fungi which formed true lamellae (e.g. subfamilies Agariceae,

Coprineae, Hygrophoreae, Lactarieae, Marasmieae, and Schizophylleae). Campanella was accommodated in subfamily Cantharelleae together with genera Arrhenia, Rimbachia, Trogia, Leptotus (= Arrhenia), and Leptoglossum [= Arrhenia (Redhead, 1974)], and Cantharellus, all with venose hymenium.

Singer (1962a) characterized Campanella by pleurotoid habit (with or without true stipe or a dorsal pseudostipe), almost transparent carpophores (with gelatinized hyphae), auriculoid or strongly anastomosing (eventually forming poroid alveolate) hymenial condition, presence of rameales structure on the epicutis, strongly gelatinized, inamyloid tramal hyphae and inamyloid white spores. According to Singer (1962b, 1986), there is no problem in sharply distinguishing Campanella from other genera with similar inamyloid white spores, cyphelloid habit and auriculoid or reduced hymenium. However, occasional presence of strongly eccentric and true stipe (not the pseudostipe as in most of the other cyphellaceous or cup-shaped species of Campanella) and gelatinized trama in Campanella species sometimes cause confusion with pleurotoid species of Marasmiellus sect. Distantifolii and sect. Nigripedes [= Tetrapyrgos (see below)] sensu Singer both of which possess gelatinous trama and reduced or venose hymenium (Singer, 1962a). Singer (1962a) distinguished Campanella from similar Marasmiellus by the latter's broad and little-anastomosing lamellae and strongly developed eccentric (mostly not lateral), insititous (Singer, 1962b) stipe. Besides, Campanella is (mostly) cyphelloid at least during young stage, possesses completely anastomosed or narrow lamellae as well as may possess metuloids and

other kinds of cystidia. Since Marasmiellus sect. Nigripedes sensu Singer has been transferred to Tetrapyrgos (Horak, 1983b, 1986), the latter can be differentiated by presence of cruciate (or tetrahedral or stellate) spores. Some Micromphale species also may resemble Campanella by possessing strongly gelatinized trama, and occasionally slightly intervenose hymenium. Micromphale, however, mostly have truly lamellate hymenium, no rameales structure in epicutis and pigment encrusted epicuticular hyphae.

Campanella may be confused with a number of cyphelloid or pleurotoid contribal (from tribe Collybieae) genera viz. Calyptella, Cymatella, Mniopetalum (= Rimbachia), and other similar looking Tricholomataceous pleurotoid genera viz. Anthracophyllum, Arrhenia, Leptoglossum (= Arrhenia), Resupinatus, Tetrapyrgos etc. Campanella can be separated from all these look-alikes by features mentioned in the world key. Campanella was thought to be related to a number of poroid fungi called "the Laschia complex" (Singer, 1945) with various genera [viz. Dictyopanus, Favolaschia, Filoboletus, Leptotus, Mycenoporella, Porolaschia, and Poromycena with poroid or alveolate or strongly anastomosing hymenium, gelatinized tramal hyphae and amyloid (mostly) spores (Singer, 1945, 1950)] now asigned to Aphyllophorales as well as Agaricales. Campanella is different from these genera by possessing inamyloid spores.

According to Otieno (1968), Campanella is basically a tropical genus because most species of poroid agarics, to which Campanella belongs, are tropical. Half of the 35 species of Campanella reported

to this date are from tropical and subtropical America (Neotropics) while the remaining half is distributed in Africa (9), Oceania (3), Australia (2), Europe (2), south-western Canada (1) and Asia (3), (Parmasto, 1981). Campanella himalensis is the first report of temperate Campanella species described to date from the world. Campanella subdendrophora reported as a temperate species from North America (Vancouver, Canada) by Redhead (1974) has been transferred to Tetrapyrgos [= Pterospora: (Horak, 1983, 1986)] because of its cruciate spores.

Description of Nepalese species

Campanella himalensis H. R. Bhandary, sp. nov.

Macroscopic features:

Pileus (Fig. 1A) flabelliform or dimidiate, eccentrically attached, applanate, gelatinous transluscent, 40 mm broad, 20 mm wide, Vandyke brown (7E6) or greyish brown (7E3) in the beginning, finally dark brown (8F4) towards center, tawny ochraceous (6C6) or reddish golden (6C7) and finally Brussels brown (6E6) towards margin, glabrous and smooth at center; margin incurved, finally straight, minutely hairy, slightly wrinkled striate; flesh reddish brown, thin (about 0.5 mm) towards attachment area, 0.3 mm towards margin, gelatinized. Lamellae or hymenial folds attached, distant; primary folds 8-9 in number, much broader (about 2 mm broad), orange buff (5A5) or salmon orange (6A5) or finally greyish orange (6B3 or 6B4), forked; secondary folds or lamellulae originating from the margin and alternating with primary folds; interveins and reticulations much shallower than

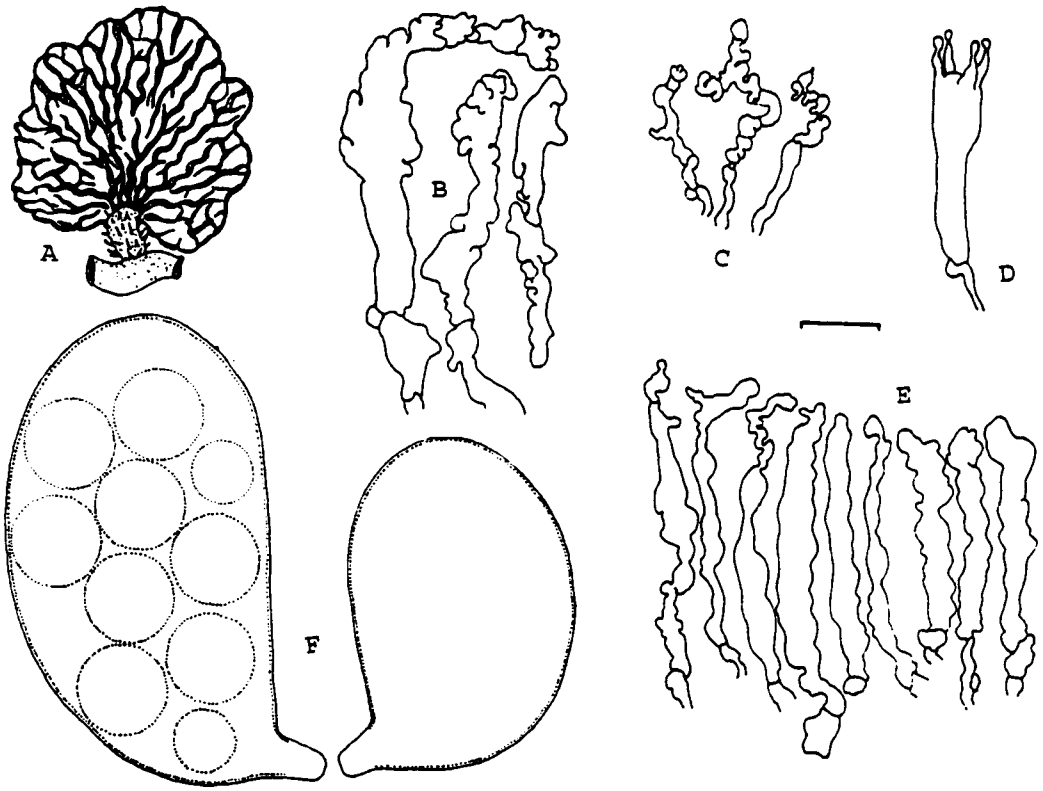


Figure 1 A-F. Features of Campanella himalensis. A. Basidiomata (TENN. 51819, holotype). B. Pileipellis hairs from basidioma margin. C. Stipitipellis hairs. D. Basidium. E. Cheilocystidia and pleurocystidia. F. Basidiospores. Standard bar = 1.2 mm for A; 10 µm for B-E; 1.5 µm for F.

primary and secondary folds; lamellar edge entire, blunt, undulating. Stipe distinct, cylindrical, short, strongly excentric, up to 10 mm long, 3 mm diam, white, fibrous-hairy, curved; flesh fibrous, concolorous to pileus flesh. Odor and Taste indistinct.

Microscopic features

Pileus composed of pileipellis, pileus trama, and lamellar trama. Pileipellis a cutis, up to 8 µm deep; hyphae gelatinized, giving rise to erect or repent, fascicled or scattered hairs. Pileal hairs (Fig. 1B) up to 80 µm long, 1.9-4.6 µm diam, rarely diverticulate, with one or two warty knobs or finger-like diverticulae; hairs at the pileus margin (in longitudinal section of pileus) not frequent, slightly thicker (up to 8.4 µm diam) and more distinctly diverticulate than those at disc, projecting up to 35 µm; wall thick (up to 0.8 µm thick), gelatinized; clamp connections distinct. Pileus trama up to 350 µm deep (at pileus center); hyphae 3.8(-6.5) µm diam, hyaline, smooth, hardly inflated, interwoven, compactly arranged; wall thick (up to 0.8 µm thick), gelatinized; clamp connections prominent, inflated up to 5.7 µm. Lamellar trama up to 200 µm deep (at the disc), irregular, gelatinized; hyphae similar to those of pileus trama. Stipitipellis (Fig. 1C) with undifferentiated fascicled hairs; hairs erect, up to 30 µm long, 3(-4.9) µm diam, strangulate or once or twice constricted, branched, not distinctly diverticulate; wall slightly thick (up to 0.4 µm thick); clamp connections present. Subhymenium conspicuous, up to 20 µm deep, interwoven. Basidia (Fig. 1D) 17.1-30.4 X 6.1-9.9 µm, 4-spored, clavate, clamped at base. Cheilocystidia (Fig. 1E) 20.9-30.4 X 3.4-4.2 µm, non-projecting, clavate or cylindrical,

strangulate, with round undifferentiated tip. Pleurocystidia (Fig. 1E) of two types: 1) similar to cheilocystidia; 2) 26.6-38 X 1.9-6.1 µm, projecting up to 25 µm, clavate or cylindrical, strangulate, occasionally slightly diverticulate (with one or two knobs or finger-like diverticulae), with or without narrow filiform, strangulate, and occasionally branched tip; tip with obtuse end. Basidiospores (Fig. 1F) 6.1-9.5 X 3.8-5.7 µm (Lm = 7.8, Wm = 4.5, E_m = 1.4-2.0, n = 25), white (assumed), ellipsoid to ellipsoid-cylindrical, hyaline, smooth, non-amyloid, multiguttulate, sometimes with an indistinct posterior bulge.

Habitat: Growing singly as a parasite on standing branch of Rhododendron arboreum in humid temperate forest.

Specimen examined: Nepal, Ghorepani (9000 ft), about 15 miles north of Pokhara, coll. HRB, Bhaiya Khanal, Keshav Shrestha, Dandi Lama and Ram Bahadur, 27.vii.84, TENN. 51819 (HOLOTYPE), HRB GP 27 (NHMTU 2-2-02336, ISOTYPE).

Etymology: Himal = Himalaya in Nepali language.

Comments: Campanella himalensis has been accommodated here because of its gelatinized, applanate basidiomata, reticulate hymenium, and weak rameales structure at the pellicular hyphae. It could not be placed in Marasmiellus because of presence of shallow and highly ramified (almost forming alveolate structure) hymenium, contrastingly different width between primary (much broader) and secondary (shallower) hymenial folds, blunt lamellar edge and short and reduced (in relation to the size of the basidiomata) stipe.

Campanella himalensis can be identified in the field by its

highly gelatinized, aplanate basidiomata with wrinkled striate margin, intervenose and reticulate hymenium, blunt-edged lamellae, short, strongly eccentric stipe and parasitic habit. Campanella himalensis can be identified microscopically by the presence of weakly diverticulate pileial hairs, strangulate and sometimes weakly diverticulate cystidia, and spore size.

Campanella himalensis is different from other three Campanella species reported from Asia (Parmasto, 1981; Pegler, 1986) by its larger pileus, spore measurements and occasional weakly diverticulate (with one or two inconspicuous knob like outgrowths) as well as strangulate or flexuous cystidia. Campanella himalensis can be accommodated in sect. Campanella subsect. Campanella because of absence of metuloids, spores (size more than 6.5 µm) with or without asymmetrical bulges, and brown pigmented (not incrusted) pileus (Singer, 1986). It is different from other species of Campanella in subsection Campanella by pileus color [white in C. alba (Singer, 1975b), and C. witteana (Singer, 1945); white or pallid in C. castaneipes (Singer, 1975b); pallid in C. peullensis (Singer, 1969)], spore dimensions [C. alba with 6.5-11 X 3.2-9.7 µm (Singer, 1975b); C. austrochilensis with 5.5-7.5 X 4.8-6.2 µm (Singer, 1969); C. büttneri: 8.7 X 6.3 µm (Singer, 1975b); C. castaneipes: 7.5-10 X 5-7.5 µm (Singer, 1969); C. cucullata: 7.7-9 X 4.2-5 µm (Singer, 1945); C. peullensis: 9-11 X 6-7 µm (Singer, 1969), C. tenuitunicata: 6.3-9 X 3.2-6 µm (Singer, 1975)], and different cystidia [absent in C. cucullata (Singer, 1945); C. inquilina (Redhead, 1974) and C. witteana (Singer, 1975b); ampullaceous with a constriction at the middle in C.

tenuitunicata (Singer, 1975)].

Of the four Asian species of Campanella (Parmasto, 1981), only C. cucullata (= C. junghunii) belongs in Campanella subsection Campanella.

CHAETOCALATHUS

Chaetocalathus Singer. 1942. Lilloa 8: 518

Type species: C. craterellus (Dur. and Lév.) Sing. 1942. ibid.

Chaetocalathus was first used by Singer (1942) for a group of pleurotoid agarics with rudimentary (or sessile) stipe, well-developed lamellae, smooth-walled, pseudoamyloid (mostly) to almost amyloid, long, pileipellis hairs, distinct cheilocystidia, and white, pseudoamyloid or inamyloid spores. Singer (1986) accommodated Chaetocalathus in the Tricholomataceae tribe Marasmieae subtribe Marasmiinae.

Chaetocalathus can be confused with a number of light-spored pleurotoid genera like Arrhenia, Hohenbuehelia, Panellus, Resupinatus, Rimbachia, Tectella, etc. from which it can be distinguished by features mentioned in the world key. Chaetocalathus can be separated from cyphelloid (cupulate and with reduced i.e. smooth or simply rugose hymenium) genera Amyloflagellula, Lachnella, and Flagelloscypha by lamellate fruitbodies and agaricoid (mesopodal) and lamellate confamilial genus Crinipellis by pleurotoid habit and presence of pseudoamyloid cystidia.

There were no previous reports on Chaetocalathus species from

Nepal. Chaetocalathus is predominantly tropical and Atlantic in distribution and is absent from temperate zones (Singer, 1986).

Description of Nepalese species

Chaetocalathus skeletiformis H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 2A) cupuliform, flabelliform to dimidiate, up to 10 mm wide, 7 mm high, laterally attached, milk white, later yellowish white (4A3) or pale orange (5A3) by maturity; surface raised-zonate, dry, leathery, hairy all over, especially at base at 10X when dry; margin striate, crenate, lobed, incurved; flesh soft, pale ochraceous buff (4A2), thin (less than 0.5 mm thick at disc), dry, thinning gradually towards margin. Lamellae decurrent or originated from a single point, milk white at first, then cream (4A3) or pale orange (5A3) by maturity, distant to sub distant, appearing finely frosted at 10X when dry, bifurcated; lamellulae present in one or two ranks. Stipe up to 1 mm long, up to 0.5 mm thick, very short or absent, strongly excentric, lateral or dorsal. Odor and taste none.

Microscopic features

Pileus composed of pileipellis (with hairs), pileus trama and lamellar trama. Pileipellis a loosely arranged repent layer of hyphae giving rise to flexuous epidermal hairs as side branches, 25 µm deep, 4-5 cells thick; hyphae 4-7.5 µm diam, horizontal, septate, hyaline, smooth, thin-walled; clamp connections present, inflated up to 9 µm diam. Pileipellis hairs (Fig. 2B) up to 400 µm long, 4.4-9 µm diam, dextrinoid (pseudoamyloid), tip or base sometimes inamyloid, smooth,

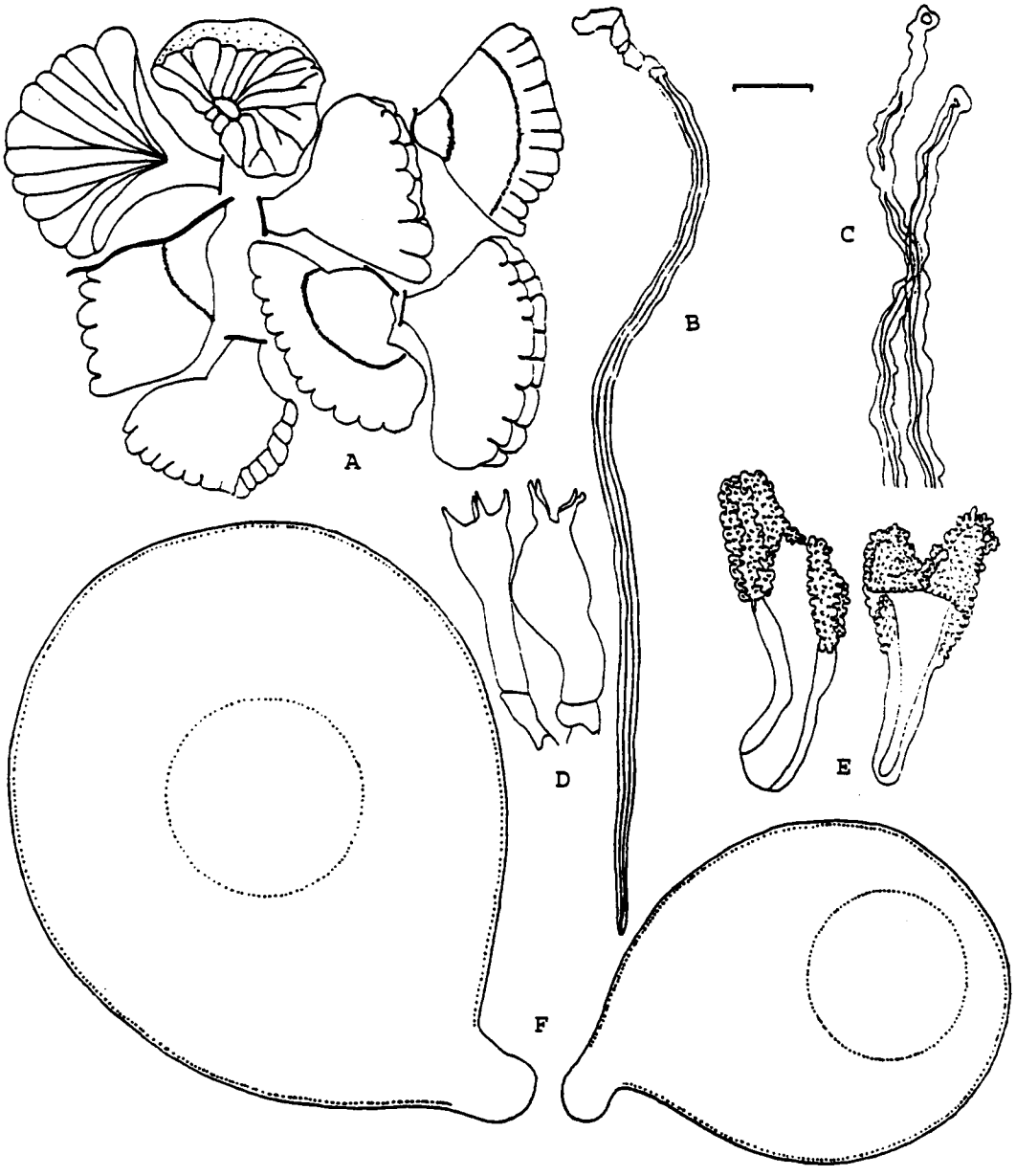


Figure 2 A-F. Features of Chaetocalathus skeletiformis. A. Basidiomata (TENN. 51820, holotype). B. Pileipellis hair. C. Skeletal hyphae. D. Basidia. E. Metuloidal cheilocystidia. F. Basidiospores. Standard bar = 3 mm for A; 20 µm for B & C; 10 µm for D & E; 1.5 µm for F.

hyaline to yellowish grey in KOH solution, occasionally knobby, thick-walled (wall up 3 μm thick); clamp connections present at the base. Pileus trama up to 425 μm deep, dimitic. Generative hyphae 3.5-7.8 μm diam, thin or slightly thick-walled (wall up to 0.4 μm thick), hyaline, smooth, branched, interwoven; clamp connections present. Skeletal hyphae (Fig. 2C) up to 450 μm long, 3.5-7.2 μm diam, thick-walled (wall up to 3.2 μm thick), non-reactive to Melzer's reagent, sulfobenzaldehyde, Congo red and phloxine solutions, traversing radially downward from the upper limit of the trama but not protruding from the hymenium, abundant, occasionally branched with very short branches, non-septate or sometimes distantly septate, smooth, quite often irregulary knobbed, originating from generative hyphae; tip slightly tapering, round. Lamellar trama parallel or regular, continuous with pileus trama; hyphae 3.5-8.2 μm diam, similar to those of pileus trama. Subhymenium up to 11 μm deep, 1-2 cells thick. Basidia (Fig. 2D) 24.2-35.2 X 6.7-11.1 μm, 4-sterigmate, clavate, clamped at base. Cheilocystidia of two types: 1) (Fig. 2E) 24.3-39.6 X 5.6-15.4 μm, metuloidal, or setoid, bifurcate at tip, thick-walled, hyaline, non-amyloid, very rarely dextrinoid, heavily encrusted at tip; encrustation hyaline, distinct only in Melzer's reagent, not conspicuous in Congo red; 2) 35.2-46 X 5.6-14.1 μm, elongated or strangulate (Fig. 2F), thin-walled, apically branched or unbranched, with one or two apical appendages, inamyloid, non-dextrinoid, hyaline. Pleurocystidia of two types: 1) metuloides, identical to metuloidal cheilocystidia; 2) 28.6-35.2(-58.8) X 2.2-7.9 μm, thin-walled, identical to strangulate cheilocystidia, often appearing strap-shaped

or hyphal (Fig. 2G). Basidiospores (Fig. 2H) 8.8-12.3 X 6.6-11 µm (Lm = 12.5, Wm = 10.1, Em = 1.2-1.4, n = 25), subglobose, white (assumed) in print, hyaline, occasionally weakly amyloid, non-dextrinoid, smooth, thin-walled, multiguttulate with one prominent guttule.

Habitat: Gregarious to scattered (not fascicled) on bark of standing moss-covered Ligustrum species and standing Eucalyptus lanceolatus tree.

Specimens examined: Nepal, Kathmandu, (Mt.) Ranibari (4500 ft), coll. HRB, 5.vii.91., TENN. 51820 (HOLOTYPE), [HRB 9, NHMTU s.n. (ISOTYPE)]; Kathmandu, (Mt.) Ranibari, coll. HRB, 5.vii.91., HRB # 16, TENN. 51821.

Etymology: Skeleti = a hard supporting system (formed by the thick-walled skeletal hyphae); formis = in the form of.

Comments: Chaetocalathus skeletiformis can be identified in the field by hairy, white to pale yellowish, small and gregarious pleurotoid basidiomata on the bark of living angiosperms. Long pileipellis hairs, skeletal tramal hyphae, dextrinoid, branched metuloidal and strangulate cystidia (both cheilo- and pleurocystidia), and spore size are its important microscopic characters.

Singer (1942, 1986) divided Chaetocalathus into three sections (viz. Oligocystis, Meristocystis, and Holocystis) based on cystidial morphology. Chaetocalathus skeletiformis can be placed in sect. Holocystis because of presence of branched, pseudoamyloid metuloidal (thick-walled and encrusted) cystidia. However, none of the six species described in sect. Holocystis (Singer, 1942, 1986) as well as

another recently described species (Singer, 1989a) possessed skeletal hyphae in the pileus trama as observed in C. skeletiformis.

HOHENBUEHELIA

Hohenbuehelia Schulzer, in Schulzer, Kanitz & Knapp. 1866. Verhandl. zool.-bot. Ges. Wien 16: 45.

Type species: H. petaloides (Bull.: Fr.) Schulz., Kanitz & Knapp. (H. petalodes according to Thorn & Barron, 1986).

Schulzer (Schulzer et al, 1866) first gave the name Hohenbuehelia to a pleurotoid mushroom described as Agaricus (= Pleurotus) petaloides within the tribe Pleurotus by Fries (1821, 1836-1838) who had attributed this name to Bulliard. Hence, the original circumscription of Hohenbuehelia was entirely based on H. petaloides [= H. petalodes (Thorn & Barron, 1986)]. With subsequent addition of many more taxa, Singer (1975a) renewed and broadened its generic concept, and characterized Hohenbuehelia by pleurotoid habit, presence of non-coralloid or non-diverticulate cuticular hyphae (without rameales structure), gelatinous zone in the context, encrusted or non-metuloids (with incrusted or non-incrusted apex) and capitate or lecythiform cheilocystidia. Barron and Dierkes (1977) found that the imperfect genus Nematoctonus comprised asexual states of Hohenbuehelia in which the vegetative mycelium can produce hour-glass cells (termed gloeosphex) which are surrounded by mucoid drops or adhesive knobs. These gloeosphex cells may also be present as cheilocystidia or pileicystidia. The hour-glass cells or secretory cells with adhesive knobs are nematophagous and can immobilise, kill and digest nematodes

(see below).

Miller (1984) circumscribed Hohenbuehelia by basidiomata with gelatinized pileus trama, inamyloid, elliptical spores, and capitate cheilocystidia which must possess adhesive knobs or mucoid drops. In fact, in Miller's concept, so much emphasis was given to the presence of adhesive knobs that it may be the main basis for distinction of Hohenbuehelia from all other closely resembling genera, including Resupinatus. Miller's (1984) concept had also nearly eliminated the requirement of presence of metuloids in Hohenbuehelia, a concept (Singer, 1951) which is still followed as an easy taxonomic criterion to identify Hohenbuehelia. Thus, basidiomata with gelatinized trama and gloeosphex cystidia (either as cheilocystidia or pileicystidia or simply with hour-glass secretory cells on the hyphal or hyphal-branch tips) but even without any metuloids could be accommodated in Hohenbuehelia. On the basis of presence of adhesive knobs on the cheilocystidial tips, Miller (1984) transferred three species formerly accommodated in Resupinatus (R. cyphelliformis, R. silvana, and R. unguicullaris) to Hohenbuehelia because in these species metuloids were not noticed because they were inconspicuous (thin-walled and non-projecting). Transfer of these species to Hohenbuehelia was verified by Thorn and Barron's (1986) finding that these species could produce nematophagous Nematoctonus asexual state. Besides, metuloids were also observed in these species which needed special staining reagents (e.g. cresyl blue) for their detection (Thorn, 1986). Therefore, it is interesting to note that all species now accommodated in Hohenbuehelia

exhibited presence of metuloids though they are not the critical distinguishing characters. Metuloids, however, could be a readily identifying taxonomic feature to easily separate Hohenbuehelia species from all pleurotoid agaric genera possessing gelatinized tramal hyphae.

Thorn & Barron (1984) first reported that some species of Hohenbuehelia were nematophagous and their asexual spores developed into an anamorph which belonged in the genus Nematoctonus (Drechsler, 1941). Later, Thorn (1986) and Thorn & Barron (1986) observed that almost all species of Hohenbuehelia possessed nematophagous Nematoctonus state. Therefore, presence of an asexual Nematoctonus anamorphic state could be regarded as the most recent critically distinguishing character of Hohenbuehelia.

It should be noted that there are other genera (e.g. Pleurotus) which also possesses adhesive knobs in cheilocystidia and hyphal tips and can also produce nematophagous vegetative monokaryotic mycelial culture from basidiospores. These vegetative monospore mycelial cultures do not belong to Nematoctonus because they lack unique gloeosphex cells and typically shaped (hour-glass-like) conidiospores which can germinate into new vegetative colonies (Thorn & Barron, 1986).

Hohenbuehelia can be confused morphologically with a number of pleurotoid agaric genera with gelatinized fruitbodies, viz. Campanella, Conchomyces, Marasmiellus, Panellus, Pleurotopsis, Resupinatus, and Sarcomyxa. However, during microscopic observation, arrangement and nature of gelatinized tramal hyphae Hohenbuehelia

(including all other genera of Resupinateae) appear distinctly different from that of various other genera (see Panellus and world key). Hohenbuehelia also resembles some pleurotoid genera without gelatinized tramal hyphae (e.g. Pleurotus, etc.). Hohenbuehelia, however, can be distinguished from these genera by various features mentioned in the world key.

Resemblance of Hohenbuehelia to Pleurotus (Polyporaceae or Pleurotaceae of Agaricales) came to be known when Hilber (1982) observed and illustrated secretory cheilocystidia in Pleurotus that resembled the gloeosphex cystidia of Hohenbuehelia. Their close relationship was further supported by the presence of hyaline, thin-walled, and readily collapsing spores (Thorn & Barron, 1986).

Singer (1986) regarded Pleurotopsis and Conchomyces as the synonyms of Hohenbuehelia. Hohenbuehelia species were treated as Acanthocystis, Agaricochaete, Phyllotremella, Pleurotus, and Urceolus species in the past.

From Nepal, Hohenbuehelia species was first reported by Berkeley (1854) who received specimens of Hohenbuehelia petalodes collected by Dr. Hooker in 1848 from east Nepal. I did not encounter H. petalodes from my study area. From other parts of Indian subcontinent, Hohenbuehelia atrocaerulea and H. silvanus (= R. silvanus) were reported from India (Manjula, 1983) and H. silvanus from Sri Lanka (Pegler, 1986). H. petalodes and H. silvanus were also reported from China (Tai, 1979). All six species described here from central Nepal possess diagnostic features different from other Hohenbuehelia species

so far described in various literature (Bon, 1988; Libonati-Barnes, 1981; Miller, 1984; Moser, 1967, 1983; Pegler, 1977; Singer, 1986, 1989a; Singer & Kuthan, 1980; Thorn, 1986; and Thorn & Barron, 1986) from the world.

Hohenbuehelia offers only a few edible species (Singer, 1986). H. albifunicula is regarded edible in central Nepal (see H. albifunicula).

Key to Nepalese species

1. Pileus larger than 15 mm.....2
1. Pileus smaller than 15mm.....4
    2. Metuloidal dermato- or pileicystidia present; spores globose or ellipsoid.....3
    2. Metuloidal dermato- or pileicystidia absent; spores elongated.....H. mucrometuloidea
3. White mycelial cords present at base of stipe; basidiomata flabelliform, spathulate or dimidiate.....H. albifunicula
3. White mycelial cords absent; basidiomata semiinfundibuliform; (not treated here).....H. petalodes
    4. Pileus brown or dark-brown; on decaying herbaceous sticks.....H. herbicola
    4. Pileus other than brown or dark-brown.....5
5. Gloeosphex pileicystidia present.....H. nepalensis
5. Gloeosphex pileicystidia absent.....6
    6. Basidiomata generally semiinfundibuliform; flesh relatively thick; growing on putrified barks and stumps of trees.....

.....H. spissifera

6. Basidiomata not semiinfundibuliform; flesh relatively thin; growing on living or dried upright shrubs.....H. kathmandua

Descriptions of Nepalese species

Hohenbuehelia albifunicula H. R. Bhandary, sp. nov.

Macroscopic feature

Pileus (Fig. 3A) flabelliform, petaloid or conchate, up to 19 mm broad, 20 mm wide, apricot-yellow or orange-grey (5B4) towards margin and all over when young, shiny or silky mustard brown (5E6) or bronze (5E5) or greyish brown or tan (6E4) at center on maturity but fading to topaz (5C5) or clay (5D5) towards margin; surface glabrous, smooth, shiny or silky, here and there appearing delicately striate due to white bloom or white mealy deposits or as a result of uniform and fine breaking of cuticle (exposing white flesh); flesh white to greyish white, up to 1 mm thick, soft, leathery; margin persistently inrolled (at least the margin cuticle), striate, sublobate (broadly lobed). Lamellae decurrent, narrow, very crowded, white at first, becoming pale or topaz (5C5) or pompeian yellow (5C6) especially towards the base on maturity, unchanging on bruising; lamellulae present. Pseudostipe short, up to 4 X 4 mm broad, white to pale or faded clay (5D5) or concolorous to pileus but slightly faded, glabrous, formed by slight lateral elongation of the pileus [hence not sharply differentiated from pileus when viewed from above, a condition described as petaloid pileus by Singer (1986)], tapering towards

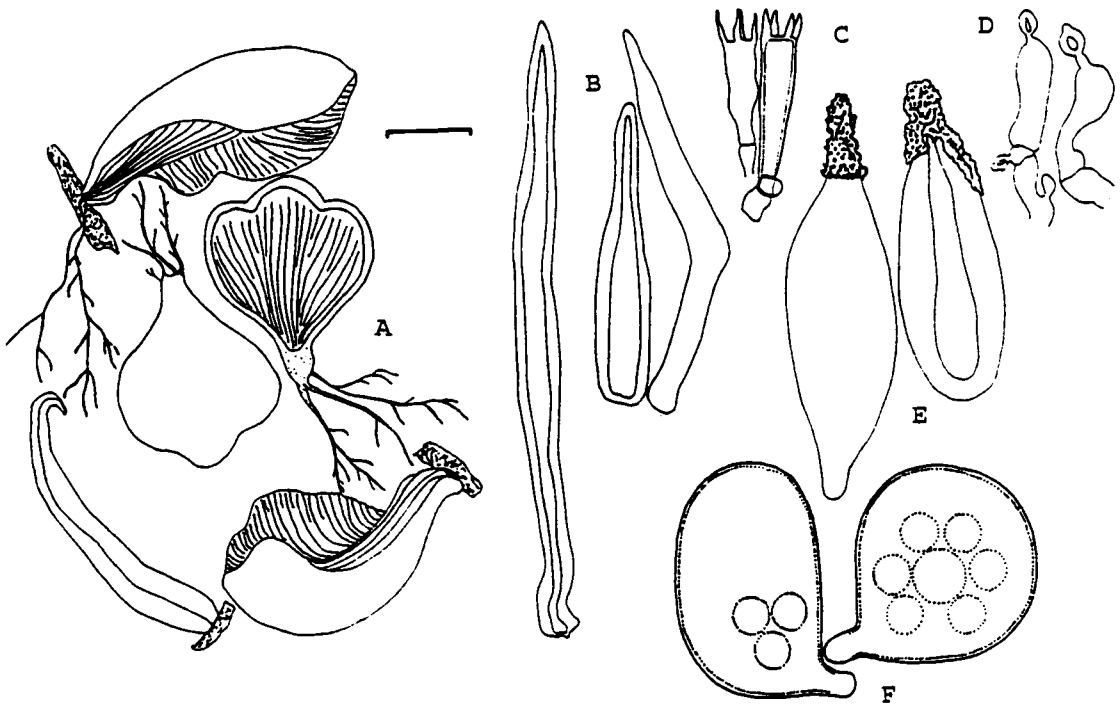


Figure 3 A-F. Features of Hohenbuehelia albifunicula. A. Basidiomata (TENN. 51822, holotype). B. Metuloidal pileicystidia. C. basidia. D. Gloeosphex cheilocystidia. E. Metuloids or metuloidal cystidia. F. Basidiospores. Standard bar = 1 mm for A; 20 µm for B; 10 µm for C-E; 1.5 µm for F.

attachment area, solid when young, hollow at maturity; attachment to substrate with tufts of snow white mycelial strands up to 40 mm long arising from base of pseudostipe. Odor farinaceous. Taste mild.

Microscopic features

Pileus composed of pileipellis, gelatinous zone, lower pileus trama and lamellar trama. Pileipellis a dense interwoven layer about 5-15 µm thick; hyphae repent, (2.5-)5(-6.5) µm diam, pallid to pale brown in KOH, with greenish yellow granular contents; clamp connections present. Metuloidal- or dermato-pileicystidia (Fig. 3B) 56-127 X 7.5-13.5 µm, sometimes inconspicuous, sometimes numerous, acicular or aculeate or narrowly conical, with mucronate to round tip, yellowish or pallid or greyish yellow in Melzer's reagent; wall slightly cyanophilous, up to 2.5 um thick, smooth. Gelatinous zone up to 200 um deep; hyphae (2.5-)3.5(-7.5) µm diam, smooth and slightly thick-walled (wall 0.5-1 µm thick), slender, frequently coiled, hyaline, slightly swollen towards septal ends, horizontal near pileipellis, abruptly radial to obliqely radial and tangled below, greyish to yellowish grey, very rarely terminating with a gloeosphex apparatus like structure with or without mucoid droplet; clamp connections abundant, inflated to 6 µm on a 5 µm diam hypha. Lower pileus trama 100-150 µm deep, continuous with lamellar trama, pallid to brownish yellow in KOH; hyphae 5-11 µm diam, vertically arranged; wall 0.5-1 µm thick, smooth; clamp connections abundant. Lamellar trama up to 200 µm broad; hyphae regular, 5-10 µm diam, smooth; wall up to 2.5 µm thick, greyish in KOH; lumen wide and continuous; clamp

connections prominent. Subhymenium 1-2 cells layer, up to 10 µm broad, hyphae narrower than those of lamellar trama. Basidia (Fig. 3C) 22-28.5 µm, clavate, hyaline, 4-sterigmate; wall slightly thick (0.5-1 µm thick); sterigmata up to 6 µm long; clamp connections present. Cheilocystidia of two types: 1) 20.5-33.3 X 6.4-10.3 µm, lecythiform (Fig. 3D), sometimes cylindrical; neck up to 7 µm long, not branched; apical mucoid drop globular, up to 5 um broad; 2) 20-40 X 6-13.5 µm, non-metuloidal, clavate or sphaeropedunculate or pyriform, non-projecting or projecting up to 15 µm, non-incrusted; wall up to 0.5-2 µm thick. Pleurocystidia metuloidal (Fig. 3E), 40-136 X 12.5-45 µm, obclavate or setiform or fusiform or mucronate, sometimes bifurcate, projecting up to 45 µm, dark yellow to brownish yellow in Melzer's reagent, thick- or thin-walled; apex incrusted or un-incrusted. Basidiospores (Fig. 3F) 3.8-4.6 X 2.7-4.2 µm (Lm = 4.28, Wm = 4.41, Em = 1.0-1.53, n = 27), white in print (assumed), ovate to subglobose, hyaline, inamyloid, smooth, thin-walled, often prominently mono-guttulate.

Habitat: Fascicled on highly decomposed upright stumps of Rhododendron arboreum and Quercus semecarpifolia in very dense and humid temperate oak forest on northern facing slope.

Specimen examined: Nepal, Kathmandu, [Mt.] Shivapuri (6500 ft), coll. HRB, Bhaiya Khanal, Mahendra Shrestha and Man Bahadur Shyangtan (Taar Gaun, Chaap Ward), 25.viii.1991., (TENN. 51822, HOLOTYPE), [HRB 125, NHMTU. s.n. (ISOTYPE)].

Etymology: Albi = white, funicula = small thread or rope.

Comments: This fungus is accommodated in Hohenbuehelia because

of presence of gelatinized tramal hyphae, lecythiform cheilocystidia with mucoid droplets, apically incrusted and thick-walled prominent metuloidal cystidia, and inamyloidal smooth spores. Hohenbuehelia albifunicula can be recognized in the field by its dry, silky brown, flabelliform basidiomata with tufts of white mycelial strands aw well as fascicled and lignicolous habit on well-putrified hardwoods. Microscopically, it can be recognized by acicular dermato-metuloids, slightly thick-walled clavate or pyriform cheilocystidia and subglobose spores.

Tamang people of Shivapuri (Kathmandu) collect H. albifunicula as food and call it Nagi Maarmo in their language (Kukur Kanney Chyaau in Nepali language). Since Panellus edulus also is called by same name in Tamang language, it is obvious that one or more edible pleurotoid mushrooms which resemble Pleurotus may be called by the same name.

Hohenbuehelia herbicola H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 4A) up to 10 mm long X 10 mm broad, sessile to laterally attached, orbicular, reniform to circular when young, dimidiate to flabelliform when mature, brown (7E5) to reddish brown or madeira (8E5) or dark brown (7F5 to 7F4) with prominent white margin when young, pale orange (5A3) to greyish orange (5B3) towards center and whitish towards margin on maturity; margin entire, hairy and incurved when young, glabrous and straignt later, striate-transparent; cuticle slimy, glistening, tacky, gelatinous; flesh white, thin. Lamellae white, minutely frosted at 10 X, flushed with champagne or

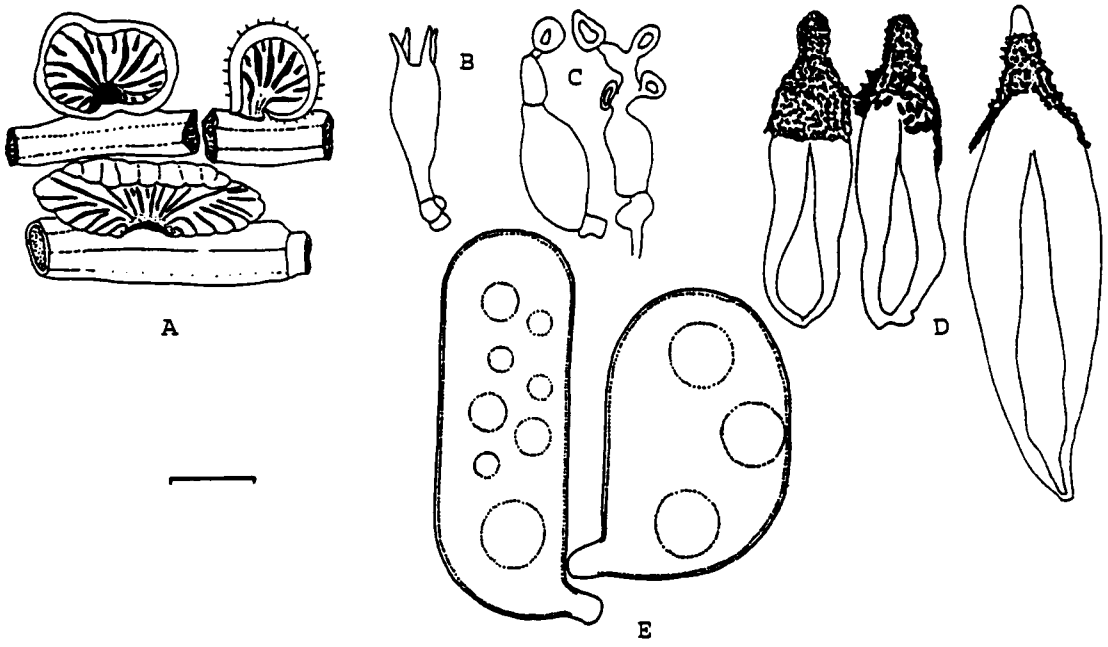


Figure 4 A-E. Features of Hohenbuehelia herbicoloa.
A. Basidiomata (TENN. 5123, holotype). B. Basidium.
C. Gloeosphex cheilocystidia. D. Metuloids. E.
Basidiospores. Standard bar = 3 mm for A; 10 µm for B-D;
1.5 µm for E.

greyish yellow (4B4) towards pileus attachment, moderately crowded to crowded; margin white; lamellulae numerous. Stipe rudimentary in young specimens, absent in mature carpophores, sometimes represented by a white hairy sterile area at union of lamellae. Odor and taste not distinct.

Microscopic features:

Pileus composed of pileipellis, gelatinous zone, pileus trama and lamellar trama layers. Pileipellis about 8 µm deep, densely interwoven, 2-3 cells thick; hyphae 2.5 µm diam, mostly horizontally arranged, loosely woven; clamp connections abundant. Gelatinous zone up to 325 um deep; hyphae 2.5-3.5(-5.5) µm diam, loosely woven, septate, branched, smooth, slightly thick-walled (wall up to 1 µm thick), clamp connections present, inflated up to 7.5 µm broad; hyphae towards peliepellis obliquely and vertically interwoven; hyphal tip and branches subcapitate, obtuse. Pileus trama 110-200 µm deep; hyphae 2.5-6.5(-9.5) µm, compactly interwoven, hyaline, smooth, vertically interwoven upward, downward slightly oblique, dark red in mixture of Congo red and phloxine solution, thick walled (wall 1-2.5 µm thick); clamp connections prominent. Lamellar trama parallel to subparallel, continuous with pilear trama; hyphae (3-)5-6.5(-10) µm diam, thick-walled (wall 1-2.5 µm thick); wall greyish and lumen reddish or pinkish in Congo red and phloxine solution, yellowish in Melzer's reagent; hyphal tips slightly capitate. Subhymenium 7-20 µm deep, up to 5 cells thick, with cells similar in diameter to basidial base. Basidia (Fig. 4B) 29.8-32.4 X 9.1-10.4 µm; contents guttulate;

sterigmata 4, up to 7.5 µm long; clamp connections present; basidioles abundant on lamellar margin. Cheilocystidia (Fig. 4C) 18.5-35 X 7.5-10 µm, fusoid-ventricose or lecythiform, sometimes almost cylindrical, hyaline; neck up to 5 um long, sometimes thick (up to 5 µm thick) and short; branched or unbranched; mucoid drops 3.5-4 X 5 µm, mostly borne apically, sometimes lateral, those born laterally may be without any neck and hence look discoid or wart-like. Pleurocystidia of two types: 1) metuloidal (Fig. 4D), 49-103 X 12.9-31.5 µm, fusiform to broadly fusiform or obclavate or ventricose with or without median constriction, projecting up to 20 µm from the subhymenium, greyish in KOH, pallid or slightly brownish yellow (apical incrustation hyaline to bluish) in Melzer's solution, dark red in Congo red solution, thick-walled (wall up 2 um thick towards base, 12 µm thick towards distal end); tip conical, encrusted; incrustation granular; 2) hyphoid pseudocystidia occasional, 100-225 X 5-7.5 µm long, cylindrical, thick-walled (wall 1.5-2.5 µm thick), hyaline; lumen narrow, granular-guttulate, with round apex. Basidiospores (Fig. 4E) 6.1-7.6 X 2.7-3.8 µm (Lm = 7.9, Wm = 3.36, Em = 1.68-2.81, n = 25), white in print (assumed), elliptic-phaseolifirm or cylindrical, hyaline, inamyloid, smooth, thin-walled, contents prominently uni- to multiguttulate.

Habitat: Gregarious on dead standing herbaceous stick of Eupatorium adenophorum (Asteraceae) in subtropical to temperate forest.

Specimen examined: Nepal, Kathmandu, [Mt.] Shivapuri (4800 ft), coll. HRB, 4.IX.1990, HRB 123, (TENN. 51823, HOLOTYPE).

Etymology: Herb = annual soft green plant; cola = to love.

Comment: This fungus is placed in Hohenbuehelia because of its gelatinous trama, lecythiform cheilocystidia (with distinct mucoid droplets), and elongated or elliptic-phaseoliform non-amyloid spores. Hohenbuehelia herbicola can be identified in the field by its very small, sessile, brown to dark brown sporocarps and growth habit on decaying herbaceous sticks. Microscopically, it can be recognized by thick-walled, long and hyphoid pleurocystidia, metuloids with distally thick-walls and wide lumen and spore measurements.

Hohenbuehelia kathmandua H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 5A) sessile, laterally attached, spathulate-mucronate, flabelliform, finally dimidiate, up to 10 mm diam, 7 mm wide, greyish orange (5B4) to golden brown (5C4), faded to grey (5B1), smooth, slimy, tacky, soft, leathery, drying brittle but not horny; leaf debris attached; margin striate, translucent, incurved. Lamellae very crowded, medium broad, white, finally pale orange (5A3), faded toward margin, appearing finely frosted at 10 X.; lamellulae present. Stipe absent. Basidiomata laterally attached with the help of one side of the pileus. Odor and taste not distinct.

Microscopic features

Pileus composed of pileipellis (outer layer), subpellis (inner layer adjacent to gelatinous zone), and gelatinous zone. Pileipellis a cutis, 1-3 cell layers, loosely arranged; hyphae 2.5-5 µm diam, smooth; clamp connections present. Subpellis or upper trama gelatinized; hyphae loosely interwoven (slightly more compact than the

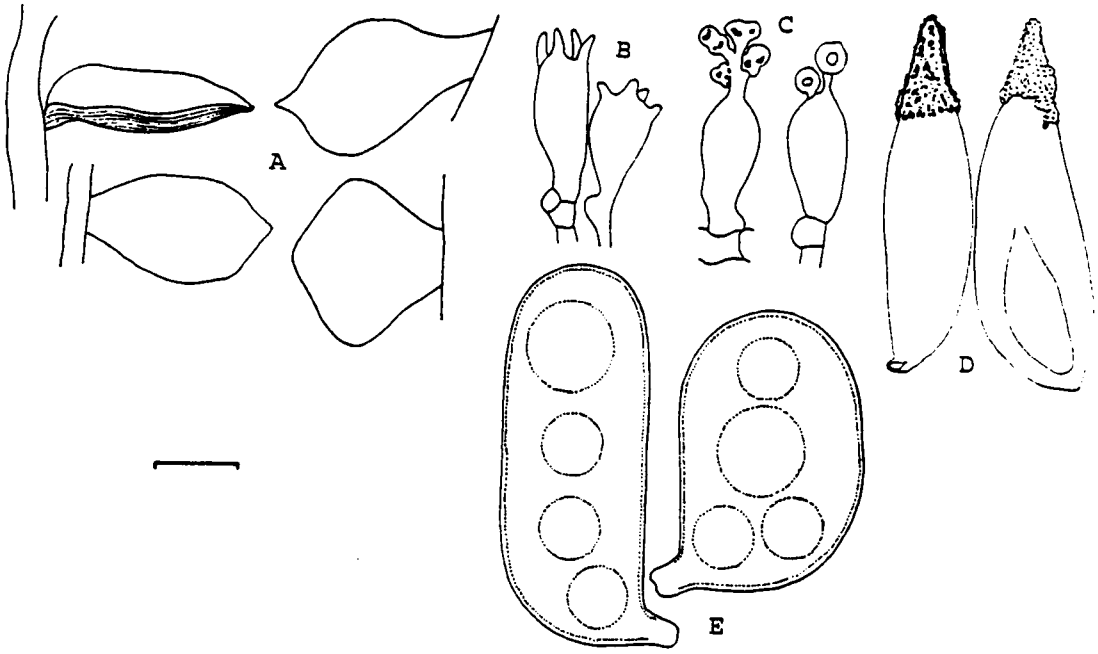


Figure 5 A-E. Features of Hohenbuehelia kathmandua.
A. Basidiomata (HRB 17, TENN. 51824, holotype). B. Basidia. C. Gloeosphex cheilocystidia. D. Metuloids or metuloidal pleurocystidia. E. Basidiospores. Standard bar = 3 mm for A; 10 µm for C-D; 1.5 µm for E.

subseqent (gelatinous) zone but less so than the lower pileus trama, 30-100 um deep; hyphae (2.5-)5(-10) µm diam, similar to those of suprapellis, thick-walled (wall 1-4 µm thick), septate, smooth, periclinally arranged; clamp connections present. Gelatinous zone 550-800 µm deep; hyphae predominantly parallel, loosely arranged, mostly 4(-7) µm diam, thick-walled (wall 1-2.5 µm thick), smooth, with clamp connections. Lower pileus trama up to 520 µm thick, continuous with the lamellar trama; hyphae (2.5-)4.5(-10) µm diam; wall 1-3 µm thick; hyphae adjacent to gelatinous zone vertically arranged and deep red in Congo red reagent, those lying below horizontally arranged and light red (or less stained in Congo red solution); clamp connections abundant, inflated to 4-6.5 µm broad; wall hyaline but lumen staining red in Congo red reagent. Lamellar trama up to 160 µm wide, parallel; hyphae 5(-10) µm diam; wall smooth, thick (wall 1-3 µm thick), hyaline and not stained in Congo red solution; apex clavate or slightly dilated, round. Subhymenium not distinct, 1-3 cell layer. Basidia (Fig. 5B) 23-30 X 7.5-10 µm, hyaline, clavate, 4-sterigmate (sterigmata up to 6 um long); contents strongly guttulate. Cheilocystidia (Fig. 5C) 20-25 X 7.5-10 µm lecythiform, clavate-rostrate or capitate, hyaline, slightly thick-walled (wall up to 1 um thick); neck up to 4-6 X 2-3 µm, branched or unbranched, sometimes appear slightly encrusted; mucoid droplets globular, shrivelled, warted, singly or often crowded, 3-5 µm diam. Pleurocystidia or metuloids (Fig. 5D) 39-110 X 15-25 µm, projecting 10-23 µm, lanceolate, apically encrusted, thick-walled (wall up to 10 µm thick).

Basidiospores (Fig. 5E) 5.7-8.0 X 3.0-3.8 µm (Lm = 6.95, Wm = 3.64, Em = 1.5-2.53, n = 20), white in print (assumed), hyaline, inamyloid, smooth, elliptic-phaseoliform; contents multiguttulate.

Habitat: Growing scattered on living and dead standing stick of Symoplocos shrub in lower temperate forest.

Specimens examined: Nepal, Kathmandu, [Mt.] Ranibari (4500 ft), coll. HRB, 5.VIII.91, (HRB 17, TENN. 51824, HOLOTYPE); Kathmandu, [Mt.] Swayambhu, coll. HRB, 9.vii.91., HRB 49, TENN. 51825.

Etymology: Kathmandu from where the fungus was collected.

Comments: This fungus is accommodated in Hohenbuehelia because of its gelatinous trama, lecythiform gloeosphex cheilocystidia, apically encrusted thick-walled metuloidal pleurocystidia, and elliptic-phaseoliform non-amyloid spores. Hohenbuehelia kathmandua can be identified in the field by its small, greyish orange, glabrous, tacky and sessile sporocarp with white to pale orange crowded lamellae. Microscopically, this fungus can be identified by often crowded and warty looking mucoid droplets, short necked cheilocystidia and spore dimensions.

Hohenbuehelia mucrometuloidea H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 6A) up to 22 mm broad, 13 mm wide, sessile, flabelliform, dimidiate or orbicular, milky white, dull yellow (3B3) or pale yellow (4A3 or 4A2) or greyish yellow (4B3) or flushed raw sienna (6D7) or light brown (6D8) towards margin, drying hazel or rust brown (6E8) or brownish grey (6F8) here and there; surface gelatinous,

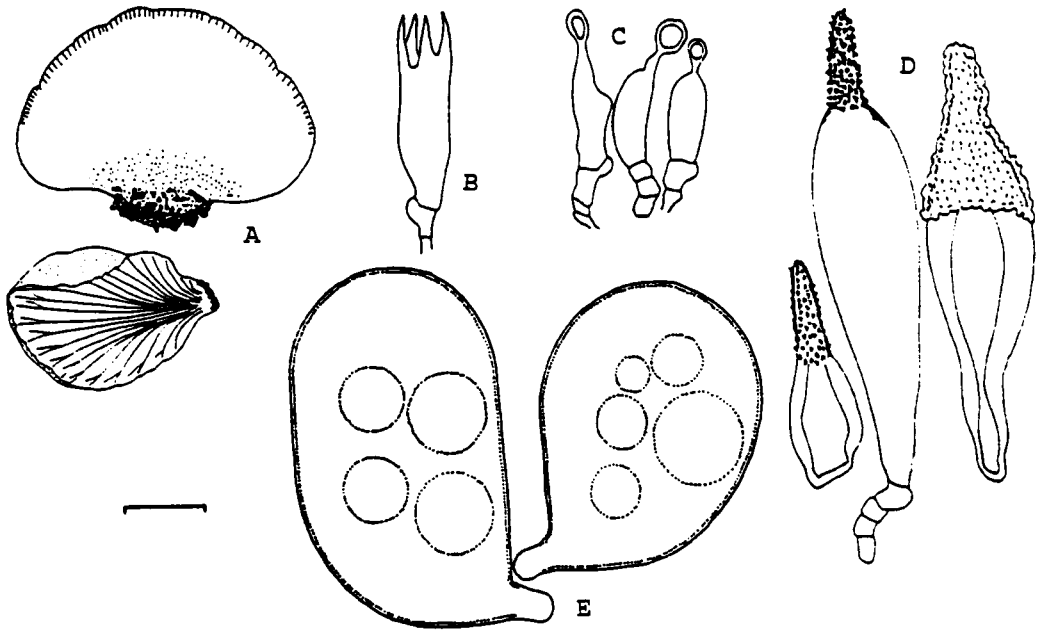


Figure 6 A-E. Features of Hohenbuehelia mucrometuloidea.
A. Basidiomata (TENN. 51826, holotype). B. Basidium.
C. Gloeosphex cheilocystidia. D. Metuloidal pleurocystidia.
E. Basidiospores. Standard bar = 5 mm for A; 10 µm for B-D;
1.5 µm for E.

slimy-tacky, moist, appressed fibrillose inward; margin striate-transparent, incurved at first, flared and upcurved later although margin persistently remains incurved; flesh thick (up to 1 mm) at center, white, moist-watery. Lamellae radiating from point of attachment, crowded to moderately crowded, forked, white or light buff (3A2) or pale or deep olive buff (3B2 or 3C3) or pale ocharaceous buff (4A2) or ivory (4B2) light blonde (4C3), drying light orange (4A3) or pale orange (5A3), greyish orange (5B3 or 5B4) or Sahara (6C5) towards the base, finely frosted at 10 X; edge entire, sharp; lamellulae present towards the margin. Stipe absent; pileus attachment a semicircular sterile area (up to 5 mm diam). Odor and taste not recorded.

Microscopic features

Pileus composed of pileipellis, subpellis, gelatinous zone, pileus trama, and lamellar trama. Pileipellis 4-5 layers of horizontal hyphae similar to the following layer. subpellis (or upper gelatinized trama): 40-120 µm deep; hyphae 3.5-6 µm diam, loosely interwoven, vertically, obliquely, as well as periclinally arranged, smooth, hyaline; clamp connections present, inflated up to 6.5 µm broad. Gelatinous zone up to 350 µm deep; hyphae 2.5-5 µm diam, more loosely interwoven than in subpellis, smooth; contents granular, rusty yellow to brownish orange in Congo red solution; clamp connections present, inflated up to 6 µm broad. Trama up to 200 µm deep, continuous with the lamellar trama; hyphae 3.5-7 µm diam, compactly interwoven, radially or vertically arranged; clamp connections abundant. Lamellar

trama parallel to sub-parallel, up to 100 µm wide; hyphae 2.5-5 µm diam, inflated up to 7.5 µm broad. Basidia (Fig. 6B) 22.5-35(-45) X 6.5-11 µm, hyaline, clavate, 4-sterigmate; sterigmata up to 11 um long, clamped. Cheilocystidia (Fig. 6C) 22.5-27.5 X 8-10 µm, lecythiform or fusoid-ventricose, capitate; projecting up to 19 µm; neck 2.5-5.5 µm long, mucoid droplet 1.5-4.7 µm diam. Pleurocystidia or metuloids (Fig. 6D), 45-100 X 11-22.5 µm, hyaline, lanceolate, mucronate (narrowed tip sometimes half the total length), encrusted, thin- to thick-walled, projecting up to 70 µm; contents often granular. Basidiospores (Fig. 6E) 5.7-7.6 X 3.8-4.6 µm (Lm = 6.87, Wm = 4.13, Em = 1.36-1.89, n = 25), white in print (assumed), hyaline, smooth, ovate to elliptic-phaseoliform, non-amyloid, cyanophilous.

Habitat: Gregarious on putrified bark, wood, and juxtaposed soil and rock in subtropical secondary forest composed of Schima wallichii, Ilex spp., Ligustrum indicum, Litsea sp., Pyrus malus, Pinus roxburghi etc.

Specimen examined: Nepal, Kathmandu, [Mt] Swayambhu (4600 ft), coll. HRB, 25.VII.86, HRB s.n., TENN. 51826 (HOLOTYPE), NHMTU 2-2-02681, (ISOTYPE).

Etymology: Mucro (mucronate = pointed, long-pointed); metuloidea = metuloid.

Comments: This fungus has been accommodated in Hohenbuehelia because of its basidiomata with distinct gelatinized hyphae, gloeosphex or lecythiform cheilocystidia, encrusted metuloidal pleurocystidia and elongated non-amyloid spores. Hohenbuehelia mucrometuloidea can be identified in the field by dimidiate to

flabelliform shaped, yellowish white to light brown tacky basidiomata. A two layered gelatinous tramal zones, often strongly mucronate metuloidal cystidia, and spore measurements are its microscopic features.

Hohenbuehelia nepalensis H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 7A) flabelliform to orbicular to dimidiate, 13 mm wide X 8 mm broad, dry, glabrous (not hairy), white or greyish white, dull yellow to straw yellow (3B2) or silver white (2B2) or ivory (4B3) or putty (4B2) or yellowish grey (3B2); margin upturned, crumpled, eroded, rimose, white at first, brownish on aging or maturity, pure white or brownish towards margin, dry; flesh thin, white or greyish white, slightly hard and horny when dry. Lamellae milk-white, shallow or not so broad, distant to medium distant, appearing frosted at 10 X; lamellulae present, some forked. Stipe absent or very short, as a continuation of lateral side of pileus at base of lamellae, densely hairy, white. Odour and taste not distinct.

Microscopic features

Pileus composed of pileipellis, gelatinous zone, and lamellar trama layers. Pileipellis 3-7 cell layers thick; hyphae very loosely interwoven, 3.5-5 µm diam, hyaline, smooth, branched, slightly thick-walled (wall up to 1 µm thick); clamp connections present, dilated up to 7.5 µm. Pileipellis hairs long, hyphoid, up to 250 µm long X 3.5-4 um diam, dense or crowded, arising erect or repent from pileipellis, hyaline, smooth, slightly thick-walled (wall up to 1 µm thick); tip

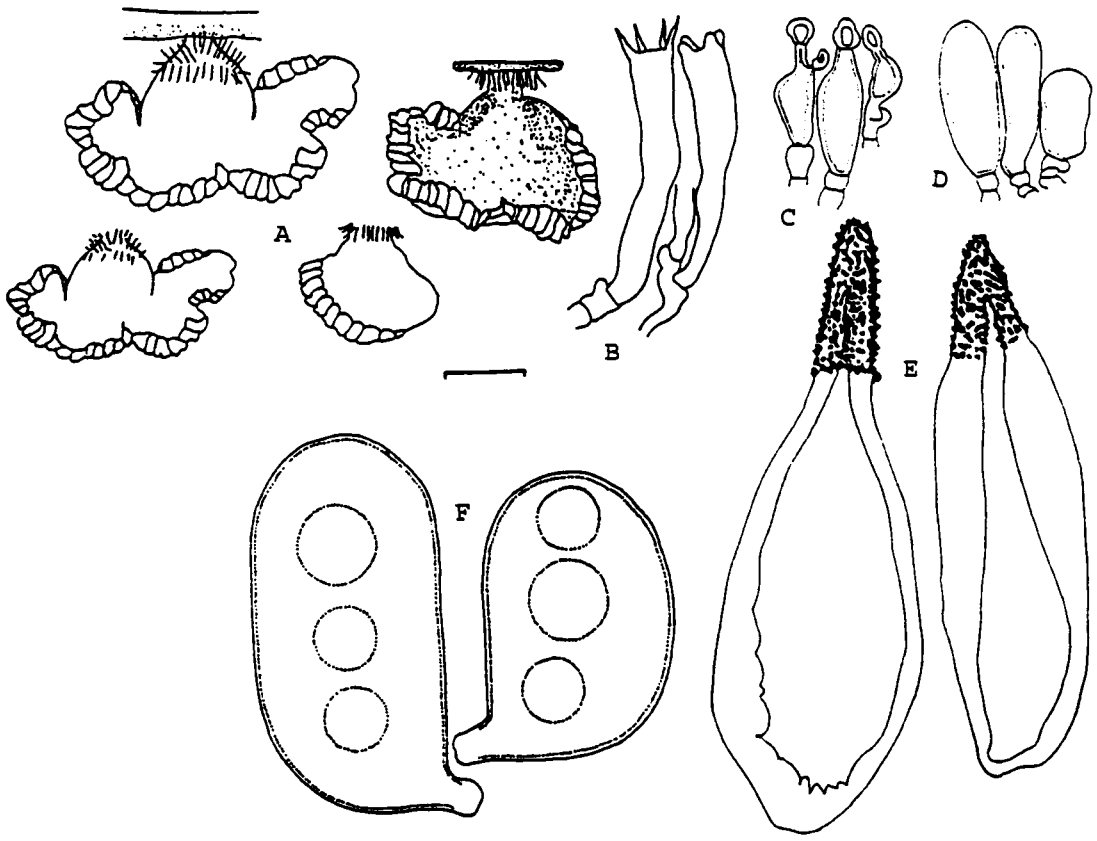


Figure 7 A-E. Features of Hohenbuehelia nepalensis. A. Basidiomata (TENN. 51827, holotype). B. Basidia. C. Gloeosphex cheilocystidia. D. Metuloids. E. Basidiospores. Standard bar = 3 mm for A; 10 µm for B-D; 1.5 µm for E.

often septate, occasionally possessing pileocystidia with gloeosphex apparatus; clamp connections present, dilated to 7.5 µm. Pileicystidia up to 7.5 X 30 µm, similar to cheilocystidia, capitate; gloeosphex apparatus (gloeosphex or mucoid drop + hour-glass cell) (3-)6(-10) µm, with or without neck, borne on the sides or tips of pileal pileal hairs. Gelatinous zone up to 680 um deep; hyphae (2-)2.5(-5) µm, very loosely arranged, mostly vertical or radial (subparallel), thick-walled (wall up to 1 µm thick), contents guttulate; clamp connections abundant, inflated to 7.5 µm diam. Lamellar trama up to 550 µm broad, parallel to subparallel; hyphae (3.5-)6.5(-11) µm, hyaline to greyish, smooth; wall hyaline, not staining in Congo red solution, thick (wall 1-5 µm thick), gelatinous; lumen appearing guttulate. Subhymenium 1-3 cell layers, hyaline, up to 15 um deep. Basidia (Fig. 7B) 32.5-56 X 7.5-11.5 µm, hyaline, clavate, 4-sterigmate (sterigmata up to 7.5 µm long), guttulate. Cheilocystidia of two types: 1) (Fig. 7C) 23.0-30.0 X 7.5-11.5 µm, projecting up to 10 µm, lageniform to fusoid-ventricose to lecythiform, capitate with gloeosphex or hour-glass secretory cell; hour-glass cell 3-4 X 3-5 µm, mostly with mucoid droplet; neck short, 2.5-4 um long, up to 2.5 µm wide, branched or unbranched, clamped at base; 2) (Fig. 7D) 15-31 X 8.0-12.5 µm, basidioliform or clavate or pyriform. Pleurocystidia of two types: 1) (Fig. 7E) 46-125 X 15-42.5 µm, present as metuloidal pseudocystidia, projecting up to 55 µm, mixture of fusiform or broadly-fusiform or obclavate or ventricose structures with or without median constriction, hyaline to yellowish grey in KOH solution, pallid to brownish yellow in Melzer's reagent,

with granular and hyaline encrustation at tip; wall thick (up to 11 µm thick); lumen wide; tip mostly mucronate and sometimes slightly elongated; 2) pyriform or basidioliform, similar to the 2nd type of cheilocystidia. Basidiospores (Fig. 7F) 5.7-7.6 X 3.4-3.8 µm (Lm = 6.63, Wm = 3.75, Em = 1.5-2.0, n = 23), white in prints (assumed), hyaline, inamyloid, smooth, elliptic-phaseoliform, distinctly curved, sometimes slightly thick-walled, prominently uniguttulate or multivacuolate.

Habitat: In a group on bark and dead twigs of Ficus religiosa (belonging to the Angiospermic family Moraceae), 5 ft off ground level in a lower temperate forest in Ranibari.

Specimen examined. Nepal, Kathmandu, [Mt.] Ranibari (4500 ft), coll. HRB, 4.VII.91, HRB 10, (TENN. 51827, HOLOTYPE).

Etymology: Nepal = the country from where this fungus was collected.

Comments: Hohenbuehelia nepalensis is accommodated in Hohenbuehelia because of its lecythiform cystidia (cheilo- as well as pileicystidia) with apical adhesive or mucoid drop, gelatinous trama, and metuloidal pleurocystidia. It can be identified in the field by its thin-fleshed (but horny on drying) small-sized yellow or brownish yellow basidiomata with upturned or crumpled margin, and growth preference on the bark of living Ficus tree. Microscopically, it can be distinguished by its gloeosphex pileicystidia and spore dimensions.

Hohenbuehelia spissifera H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 8A) up to 11 mm wide X 13 mm broad, petaloid, seminfundibuliform to dimidiate, sessile to stalked, snow white outward, cream (3A3) to pale ochraceous buff (4A2) inward, densely wooly, appressed hairy or finely frosted over entire pileus surface (especially when young) or at center and margin; cuticle moist, slimy-tacky; margin finely striate or not, minutely rimose, incurved; flesh thick (up to 1 mm). Lamellae decurrent, crowded, white at first, changing to cream (3A3), pale ochraceous buff (4A2) or pale yellow-orange (4A3) when bruised or on maturity, becoming greyish orange (6B5), caramel brown (6C6) or cinnamon brown (6D6) on drying, finely frosted at 10X. Pseudostipe 12 mm long X 4.5 mm broad, lateral, continuous with pileus, forming a distinct sterile area from base of lamellae, white, tomentose, with debris at base. Odor and taste not distinct.

Microscopic features

Pileus composed of pileipellis, gelatinous zone, pileus trama and lamellar tramal layers. Pileipellis or cuticle 3-4 cells deep, 15-20 µm thick; hyphae up to 4.5 µm diam, repent or interwoven, thick-walled (wall 1-1.8 µm thick), with clamp connections. Gelatinous zone up to 400 um thick, hyaline; hyphae loosely interwoven, near pileipellis horizontal as well as radial, near trama horizontal and obliquely radial, frequently branched, (2.5-3.5-)4.5(-9) µm diam, thick-walled (wall up to 1.5 µm thick); apex obtuse; clamp connections present, inflated up to 7 µm broad. Pileus trama homogeneous, up to

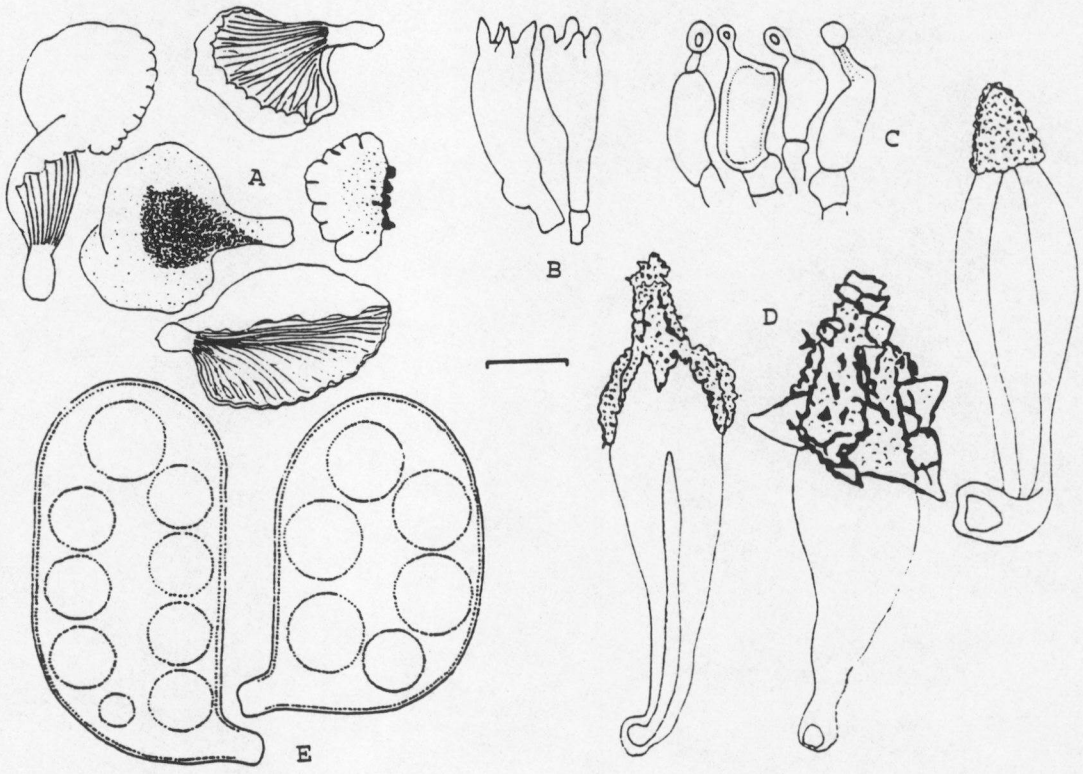


Figure 8 A-E. Features of Hohenbuehelia spissifera. A. Basidiomata (TENN. 51828, holotype). B. Basidia. C. Gloeosphex cheilocystidia. D. Metuloids. E. Basidiospores. Stndard bar = 3.5 mm for A; 10 µm for B-D; 1.5 µm for E.

900 μm deep; hyphae 7.5(-13.2) μm diam, compactly interwoven, horizontal, thick-walled (wall 2.6-4.5 μm thick), hyaline, smooth, with granular contents, descending to form lamellar trama. Stipitipellis hyphae loosely interwoven, somewhat inflated, hyaline, smooth, thick-walled (wall up to 1.7 μm thick); clamp connections abundant, inflated up to 6.6 μm broad. Stipe trama compactly interwoven; hyphae horizontally arranged, 5.3(-9.7) μm diam, thick-walled (wall 1.5-3.5 μm thick), smooth; clamp connections present, inflated up to 13 μm broad. Lamellar trama interwoven; hyphae (4.5-)5.3(-9) μm diam, smooth; wall undulate, thick (wall up to 2.5 μm thick); clamp connections abundant, inflated to 5.7 um. Basidia (Fig. 8B) 25-32.5 X 6.8-8.8 μm, 4-spored, hyaline, clavate, clamped. Cheilocystidia (Fig. 8C) 16.7-28 X 5.7-7.5 μm, lecythiform to clavate-rostrate, capitate, hyaline, neck usually short (up to 2.2 um long) and tapering; mucoid droplet 2.6-3.0 X 2.2-2.6 μm diam. Metuloids (Fig. 8D) 35.2-63.5 X 13.2-17.6 μm, hyaline or greyish yellow, lanceolate, apically encrusted; hyaline or greyish yellow, lanceolate, encrusted; encrustation hyaline or greenish or greyish yellow in KOH solution, yellow in Melzer's solution, walls up to 3.5 μm thick; metuloids of gill edge 12.0-13.7 X 9-9.7 μm, elliptical, yellowish in Melzer's reagent. Basidiospores (Fig. 8E) 5.7-8.0 X 3.8-5.3 μm (Lm = 7.0, Wm= 4.1, Em = 1.5-2.0, n = 25), white in prints (assumed), hyaline, inamyloid, smooth, elliptic-phaseoliform, multiguttulate.

Habitat: In a small group on bark (8 ft above ground) of living Schima wallichii (hardwood tree) in lower temperate secondary forest.

Specimen examined: Nepal, Kathmandu, Swayambhu (4600 ft), HRB,

4.VII.84, HRB s.n., TENN. 51828 (HOLOTYPE), NHMTU 2-2-02624 (ISOTYPE).

Etymology: Spissis = thick; fera = to possess (because of the comparatively thick-fleshed basidiomata).

Comments: This fungus has been accommodated in Hohenbuehelia because of its gelatinized tramal hyphae, lecythiform cystidia with apical mucoid or gloeosphex drop, and thick-walled metuloids. Hohenbuehelia spissifera can be identified in the field by its woolly or appressed hairy, semi-infundibuliform to dimidiate and thick-fleshed basidiomata. The thick-walled hyphae of stipe trama, stipitipellis, pileipellis, pileus trama, gelatinous zone, lamellar trama and cheilocystidia and spore dimensions are its distinguishing microscopic characters.

LACTARIUS

Lactarius Persoon. 1997. Tent. Disp. Meth. Fung. 63. (nom. orth. cons.).

Type species: L. piperatus (Linnaeus: Fries) Persoon [= Lactaria piperata Persoon (= Agaricus piperatus Linnaeus: Fries).

Persoon (1797) had even earlier published Lactaria [also as Lactarius (Persoon, 1801)] as a genus name [which he (1800, 1801) later reduced to a rank under the genus Agaricus sect. Lactifluus (Pers.)]. Persoon is regarded as the author of Lactarius by the International Code of Botanical Nomenclature (ICBN) although its alternative spelling (Lactaria) was reserved (Greuter et al, 1988: 136). Fries (1835) also had used the word Lactarius (instead of

Lactaria) without citing any author for a group of fungi which he (1821) himself had earlier named Gallorrheus.

Persoon (1801) accommodated Lactarius as sect. Lactifluus of Agaricus, a group of latex-bearing mushrooms. Gray (1821) placed Lactarius as a genus of the family Hymenotheceae, characterized by funnel-shaped fleshy basidiomata with lamellate hymenium producing milk on cutting. He accommodated Lactarius together with Micromphale, Mycena, and Russula in a group characterized by pileate, "juicy" (producing some kind of juice when broken) fungi with non-decolorizing gills.

Singer (1986) characterized Lactarius by latex-bearing pileate and stipitate fleshy basidiomata with lamellate hymenium, distinct sphaerocyst cells in the pileipellis, laticiferous hyphae in the trama, subregular to subirregular hymenophoral trama, and mostly terrestrial (mostly mycorrhizal) habit. Lactarius is placed in family Russulaceae (because of lamellate hymenium, heteromerous pileus trama, parasitic or saprophytic or ectotrophically mycorrhizal habit), suborder Russulineae (because of amyloid ornamentation in spores, heteromerous and or dimitic trama or trama with lacitiferous hyphae, absence of clamp connections and usual association either as parasitic or mycorrhizal symbiont with roots of higher plants) of Agaricales (because of non-thickening hymenium).

Bondarzewia, type genus of family Bondarzewiaceae (characterized by tubular or poroid hymenium, dimitic trama with generative and skeletal hyphae and root parasitic habit), also accommodated in suborder Russulineae, may resemble Lactarius by simply

possessing latex-bearing basidiomata. However, the latter is entirely different by possessing lamellate hymenium. Lactarius resembles confamilial Russula by possessing similar characters mentioned above for the family Russulaceae but differs by possessing latex (either milky or watery) and presence of sphaerocyst cells in the pileus (generally) but not in the hymenophoral trama. Some genera like Hydropus, Lactocollybia (see key to the world genera) and Mycena also possess latescent (which show colorless or milky juice when broken) fruitbodies (Singer, 1986) but they belong to the different family Tricholomataceae and are different from Lactarius by their smooth spores.

There is a debate about typification of Lactarius. Some mycologists (e.g. Donk, 1962) support lectotypification of Lactarius by L. piperatus. Singer (1986) believed L. torminosus should be the type species while others (e.g. Hesler & Smith, 1979) regarded L. deliciosus as the type species. Lactarius piperatus, however, has been conserved as the type species by ICBN (Greuter et al, 1988).

According to Singer (1989b), the more advanced obligatory ectomycorrhizal Lactarius species were derived from more primitive root-parasitic species like L. igapoensis. Of over 100 Lactarius species reported to date (Singer, 1986), all are agaricoid or mesopodal except four which are pleurotoid. Singer (1952) first described the pleurotoid L. panuoides from Trinidad and to accommodate this species, Singer (1957) erected sect. Panuoidei for Lactarius species with pleurotoid basidiomata and parasitic habit. Of the

pleurotoid Lactarius species reported heretofore, three are neotropical while one (L. uyedae) was reported from Japan (Singer, 1984). Lactarius pleurotoideus is another Lactarius species occurring in Asia and the first report of a pleurotoid, parasitic Lactarius from the Himalayan region.

Description of Nepalese species

Lactarius pleurotoideus H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 9A) convex, center raised at first, finally slightly depressed, flabelliform or spathulate, broadly striate-sulcate, up to 12 mm broad, 9 mm wide, milk white all over in the beginning, later white only between the furrow of striations, cream (4A3) or light yellow (4A4) or putty (4B2) or ivory (4B3) or champagne (4B4) or light blonde (4C3) or blonde (4C4) or orange white (5A2) or pale orange (5A3 or 5B3) or greyish orange (6D4) or greyish brown or tan (6E4 or 6E5) all over or mostly at the ridges and center; surface densely white hairy when young, remaining so towards margin and white frosted or wooly towards center; margin striate-sulcate, incurved at first, then straight, slightly lobed (sometimes rimose and much lobed), with erect and silky hairs all over; flesh thin (up to 0.3 mm thick at the center), white or greyish white, turning pink or pinkish brown on aging, brittle; milk or latex white, abundant (in larger specimen), unchanging in color. Lamellae decurrent or originating from a point, milk white, then yellowish white (4A2), broad (up to 1.5 mm), distant, forked up to one or two levels; lamellulae abundant. Stipe absent or

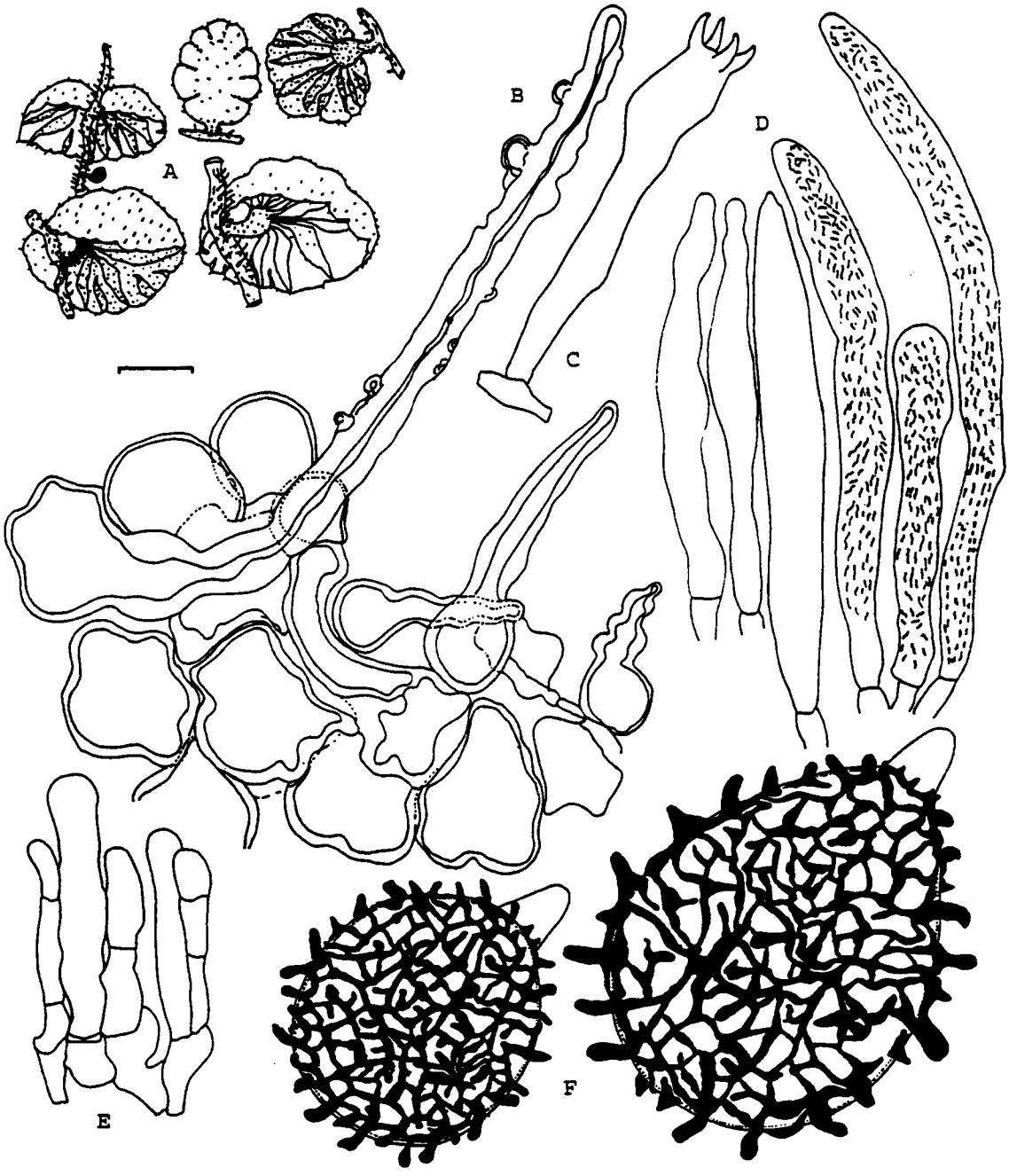


Figure 9 A-F. Features of Lactarius pleurotoideus. A. Basidiomata (TENN. 51830, holotype). B. Pileipellis with sphaerocyst cells and hairs. C. Basidium. D. Pseudo- or lacto-cheilocystidia. E. Pleurocystidia. F. Basidiospores. Standard bar = 5 mm for A; 10 µm for B-E; 1.5 µm for F.

when present cylindrical, strongly eccentrical or lateral, short, up to 1.5 mm long, 0.9 mm thick, white, often wholly effused or reduced into a globular densely hairy structure, white hairy all over, occasionally covered with scattered, thick (at base) hairs, up to 1 mm long, generally abundant in the basal tomentum or subicular area on the substratum; base white and covered with strigose hairy tomentum; basal tomentum or subiculum thinly or densely effused around the substratum, extending up to a distance of more than 60 mm from the carpophores, white or silky white, possessing erect hairs; hairs scattered, milk-white, scattered, erect, spiny, fascicled, sometimes bifurcate, with pointed and curved tips. Taste instantly acrid. Odor inconspicuous.

Microscopic features:

Pileus composed of pileipellis (with erect hairs), pileus trama and hymenophoral trama. Pileipellis with stratified (up to 4 cells layer) sphaerocyst cells, up to 30 μm deep; sphaerocyst cells at first compactly arranged, spherical (look polygonal in side view), up to 34.2 μm diam, thick-walled (wall up to 2 μm thick), giving rise to erect pileipellis hairs. Pileal hairs (Fig. 9B) 80-100(-200) μm long, 6.5(-9.5) μm diam, originating from sphaerocyst cells at the base, thick-walled (wall up to 3 μm thick), with continuous (sometimes not visible) lumen; tip round or obtuse. Pileus trama thin, only up to 30 μm deep (near center of the pileus), dimitic with compact and horizontally arranged generative hyphae and parallel and laxly arranged gleoplerous or laticiferous hyphae. Generative hyphae up to 4.2 μm diam, smooth-walled, hyaline, non-amyloid, not staining in

Sulfobenzaldehyde, without clamp connections. Gleoplerous hyphae black or dark greyish blue in Sulfobenzaldehyde, hyaline in KOH and Melzer's reagent, mostly vertical or parallel in pileus and hymenophoral trama but densely horizontally arranged around subhymenial layer, reaching and projecting from hymenial layer; hyphae 4.6-5.3(-11.4) µm diam, with banded contents; wall slightly thick (up to 0.8 µm), smooth, undulated; tip typically round, very slightly swollen and darkly staining in Sulfobenzaldehyde. Lamellar trama up to 20 µm broad, subregular to regular; hyphae of three types: 1) generative hyphae similar to those of pileus trama, compactly arranged, appearing gelatinized; 2) laticiferous or gleoplerous hyphae similar to those of pileus trama; 3) sphaerocyst cells occasional, similar to those of pileipellis. Subhymenium not so conspicuous, 8-10 µm deep, one or two cells thick. Basidia (Fig. 9C) 43.7-60.8 X 9.9-10.6 µm, 4-spored, clavate, slightly thick-walled (wall up to 0.8 µm thick), without clamp connections. Cheilocystidia of two types: 1) (Fig. 9D) 53.2-98.8(-120) X (3.8-)7.6-8.7(-20) µm, as pleudo- or lactocystidia, projecting up to 45 µm, continuations of laticiferous or gloeplerous hyphae of pileus and lamellar trama, cylindric, with banded contents positive in Sulfobenzaldehyde; tip mostly obtuse or round, occasionally acute or mamillate; contents generally absent towards tip; 2) (Fig. 9E), 25.5-26.6 X 3.8-4.9 µm, basidioliform, non-projecting, 2-3-times septate, with obtuse tip, originating from base of basidia. Pleurocystidia similar to 1) and 2) types of cheilocystidia. Basidiospores (Fig. 9F) 6.8-9.5 X 5.7-8.7 µm (Lm =

8.4, Wm = 7.5, Em = 1.0-1.5, n = 25), white, subglobose or short ellipsoid, with a densely warty and densely reticulate amyloid ornamentation; connecting lines of ornamentation thin or thick, with II or IIIa type of ornamentation (Singer, 1986), up to 1.5 µm long, without suprahilar amyloid spot; prominently one and very large guttule (best visible in KOH solution)hilar appendage prominent, (spore size including appendage 10.6-12.2 X 8.4-8.7 µm), distinctly observable in KOH rather than Melzer's reagent), triangular, up to 3.4 µm long, 1.1(2.8) µm thick at base.

Habitat: Gregarious, parasitic, on living roots of Castanopsis tribuloides, Myrsine semiserrata and M. capitellata but overgrowing on other closely associated leaf litter, soil, decaying sticks, stem base and roots of ferns and higher plants such as Daphne bholua, Myrica esculenta, Quercus leucotricophora, Q. lamellosa, etc.

Specimens examined: Nepal, Kathmandu, Shivapuri Watershed Management Area, Malpokhari (5500 ft), coll. HRB and K. Sunwar, 7.viii.90., [HRB 74(35), TENN. 51830 (HOLOTYPE), HRB 74(35), [NHMTU. s.n. (ISOTYPE)]; Kathmandu, Shivapuri, Coll. HRB, 9.vii.90, HRB 135(30), TENN. 51831; Kathmandu, Nagarjun (Raniban) forest, coll. HRB, 10.vii.91., HRB 58, TENN. 51829; Kathmandu, Nagarjun forest, coll. HRB, 15.vii.91., HRB 83, TENN. 51832.

Etymology: Pleurotoideus = pleurotus-like or pleurotoid.

Comments: Lactarius pleurotoideus can be identified in the field by its small, gregarious, white or blond or brown, finely hairy basidiomata with milky latex, root-parasitic habit and thinly effused and strigose white basal tomentum or subiculum. Microscopically, L.

pleurotoideus can be identified by pileipellis with sphaerocyst cells, erect and thick-walled pileipellis hairs, laticiferous hyphae in the pileus and hymenophoral trama, projecting pseudocystidia (both cheilo- as well as pleurocystidia), non-projecting and septate cystidia (both cheilo- and pleurocystidia) and spore measurements.

Lactarius pleurotoideus has been placed in Lactarius because of presence of latex from broken basidiomata, amyloid ornamented spores and presence of sphaerocyst cells and laticiferous (or gloeoplerous) hyphae in the pileus and (also) hymenophoral trama. It could not be accommodated in Russula because of these characters. It fits in sect. Panuoidei (Pegler, 1979, 1983a; Singer, 1952, 1986) because of pleurotoid basidiomata and parasitic habit.

Among the species in sect. Panuoidei, L. pleurotoideus is different from the three neotropical species (L. campinensis, L. igapoensis, and L. panuoides) because of its acrid taste, presence of sphaerocyst cells (other species possess occasionally swollen subisodiametric cells on the filamentous hyphae) in pileus and lamellar trama and its temperate distribution ([other species are neotropical: (Singer, 1986)].

Lactarius pleurotoideus strongly resembles L. uyedae by similar-sized white pleurotoid basidiomata with numerous sphaerocyst cells in the trama, dimitic hyphae, acrid taste, white latex, heavy spore ornamentation, and temperate Asiatic distribution. Lactarius pleurotoideus, however, differs because of its blond or brown colored pileus [white with ochraceous spots in L. uyedae (Singer, 1984)],

septate non-projecting basidioliform cystidia, different spore dimensions [8.5-10 X 7-8 µm (Singer, 1984)], lack of suprahilar amyloid plage and presence of prominent hilar appendage on the spores, spreading basal tomentum or subiculum with white erect hairs and parasitic habit on tree roots [L. uyedae is not parasitic and grows on soil or rotten wood or among mosses (Singer, 1984)].

LENTINUS

Lentinus Fries. 1825. Stirp. Agri Fems. 3: 57.

Lectotype species (Donk, 1949:314): Agaricus crinitus Linn.:Fr.

[= L. crinitus (Linn.:Fr.) Fr.].

Lentinus is a Friesian (1825) genus name descended from Lentiscyphi, proposed earlier by Fries (1821: 174) for fleshy but tough and coriaceous (not easily decaying) lignicolous mushrooms characterized by hairy or squamose or smooth fruitbodies with centrally or eccentrically stipitate stipe and lamellate hymenium. Since Fries (1825) described Lentinus entirely on the basis of morpho-characters, some distantly related species (from genera Lentinellus, Panellus, Pleurotus, etc.) also happened to be included.

Classification of Lentinus from the time of Fries (1836) to the early 19th century by Lloyd (1913), Petch (1916), and Pilàt (1936, 1941, 1946) was based on macroscopic characters.

After understanding the importance of microscopic features in fungal taxonomy, many mycologists tried to circumscribe Lentinus. Singer (1951) placed Lentinus in tribe Lentineae, close to tribes Panelleae, Resupinateae, Schizophylleae, etc., in the family

Tricholomataceae because all these tribes possessed pleurotoid habit, thick-walled (either thick-walled or gelatinized in other closely placed tribes) tramal hyphae, regular or irregular (but neither bilateral nor inverse) hymenophoral trama and white, inamyloid, smooth and elongated spores. Singer (1951) also recognized the importance of structure of hymenophoral trama and subhymenial layer in the taxonomy of Lentineae. Kühner and Romagnesi (1953) suggested the importance of spore size and shape (cylindrical against non-cylindrical), cystidial nature and condition of lamellar attachment. Kühner (1980) later gave emphasis to hyphal systems and placed Lentinus in the family Pleurotaceae. Pegler (1971) suggested that features such as stipe attachment, nature of lamellar edge, cystidiiform hairs, and degree of development of subhymenial layer previously considered important for generic delimitation of Lentinus, Panus, and Pleurotus were variable within a single collection or specimen ages and hence proposed that the hyphal construction of the pileus flesh were more important (which was already in use for the circumscription of Polyporus) and reliable way to sharply delimit these three genera. Pegler (1975) also drew attention to the trimitic hyphal system (see key to the world genera or Pleurotus) in Lentinus and proposed its importance to taxonomy. Results of independent works by Chang Kiaw Lan (1965), Romagnesi (1969) and Stankovicová (1973) further indicated the importance of hyphal construction in the taxonomy of Lentineae and their findings were employed later by Singer (1975a) and Corner (1981). Singer (1962a) recognised the resemblance of three genera of Lentineae to

Polyporus species (then considered to be Aphyllophorales) and finally transferred Lentineae from Tricholomataceae (see above) to a newly proposed family Polyporaceae under the order Agaricales. Most modern mycologists now support Singer's (1962a, 1986) placement of Lentinus together with Panus, Pleurotus, Phyllotopsis and Faerberia in tribe Lentineae under Polyporaceae, together with a sister tribe Polyporeae (with several poroid genera). Jülich (1982), however, placed Lentinus in a monotypic family Lentinaceae within the order Polyporales after after modifying Rea's [(1922): reprint 1968] Aphyllophorales established earlier by Gaüman (1926).

Tribe Lentineae is characterised by fungi with lamellate hymenophore and consists of five genera of which circumscription of three has been controversial (see Pleurotus). Singer (1986) characterised Lentinus by regular (at least towards the gill edge) or irregular hymenophoral trama, well-developed or totally absent subhymenium, mono- or dimitic (never tri- or amphimitic) trama, and serrate lamellar edge. Panus was characterized by irregular hymenophoral trama, inconspicuous or totally absent subhymenium, di- or trimitic hyphal system, entire lamellar edge, and strongly pilose or dotted fruitbodies. Pleurotus was characterized by irregular gill trama, well-developed subhymenium, mono- or amphimitic hyphal system, and entire lamellae.

Corner (1981) circumscribed Lentinus by dimitic trama as well as skeleto-binding hyphae, Panus by dimitic trama with skeletal hyphae but without skeleto-binding hyphae; and Pleurotus by either monomitic or dimitic trama with tapering (or rarely branched) terminal skeletal

hyphae. Pegler (1983c) considered Panus a synonym of Lentinus and treated the former as a subgenus of the latter. According to Pegler (1983c) Lentinus is dimitic with well-formed skeletal and skeleto-binding hyphae and Pleurotus is monomitic, without skeletal hyphae or dimitic with only inconspicuous or short skeletal hyphae. Kühner (1980) also did not recognize Panus as a separate genus, defined Lentinus as dimitic with regular trama and binucleate spores and Pleurotus as either mono- or dimitic with irregular trama and mononucleate spores.

There also exists a controversy amongst various mycologists about typification of Lentinus. Kühner (1980) and Singer (1986) regard L. lepideus (Fries: Fries) Fries as the type species, Pegler (1983c) considers L. crinitus (Linnaeus: Fries) Fries as the type species, and according to Corner (1981) either one of the above two species could be regarded as the type species.

With increasing numbers of reports on lentinoid mushrooms, several species were observed worldwide which did not fit any of the above circumscriptions. In the present work, the latest technique suggested by Redhead and Ginns (1985) for separation of lentinoid mushrooms (see Neolentinus) has been followed. It is believed that Redhead and Ginn's (1985) concepts of Lentinus, Neolentinus, Pleurotus and Heliocybe (= L. sulcatus) not only provide a convenient way to sharply distinguish the three controversial genera but also eliminate controversy over typification of Lentinus. This is also supported by a recent molecular study by Hibbet and Vilgalys (1991) which implies

that the brown rot-producing Lentinus species [regarded as Neolentinus by Redhead and Ginns (1985)] tested by them were closer to each other than to the white rot-producing species. In the present work, I have followed Pegler's (1983c, 1986) concept to classify Panus. Hence the species which may have been treated as Panus by other workers have been treated here under Lentinus. More on the circumscription of Lentinus has been taken up under Neolentinus and Pleurotus.

Including six Lentinus species (L. badius, L. polychrous, L. sajor-caju, L. squarrosulus, L. strigosus, and L. velutinus) previously reported by Pegler (1983c), altogether 10 Lentinus species are now known from Nepal. Lentinus chepangiana and L. rutus are newly reported. Lentinus species 1 and 2 could not be resolved to species level because of insufficient data.

Lentinus is a popular (next to Pleurotus) edible pleurotoid mushroom in central Nepal. Most of the species are called by the name Chaamrey or Kurkurey chyau (meaning leathery and coriaceous) in Nepali language but the names differ in other dialects (e.g. ramchi tiffo or ramchi sokali in Hayu; syaaknaa in Limbu; dharkur (see Lentinus species 1) in Majhi or Danuwar; sunaakokten or yaakhaa pitto in Rai; ottaai uut or uud or od in Satar etc.). Lentinus species are not sold in Kathmandu (4300 ft altitude) market because they are more common in lower altitudes. In other parts of rural central Nepal where Lentinus species are available, they are locally consumed and stored for latter use. Recognizing the tough, leathery, and not so readily putrifying qualities of Lentinus, in rural areas they are generally saved for later use after air-drying, a process which may not be possible for

Pleurotus as well as other common terrestrial species (because they putrify faster) because of very humid and cloudy conditions in monsoon (causing sun-drying impossible), lack of electricity and cost of fuelwood. In remote places where fuelwood is easily accessible, these mushrooms are dried in open fire in a kind of bamboo mat or basket (vaar or saraang or taangalaa in Nepali language) which is kept hung permanently above the cooking fire.

Key to Nepalese species

1. Tramal construction monomitic; distinct skeletal and skeleto-ligative hyphae absent; distinctly clamped, skeletalized generative hyphae present.....L. chepangiana
1. Tramal construction dimitic or trimitic; distinct skeletal or skeleto-ligative hyphae present; skeletalized generative hyphae not observed.....2
    2. Hyphal-pegs (see key to the world genera) present.....3
    2. Hyphal-pegs absent.....7
3. Annulus present.....4
3. Annulus absent (or ephemeral in young stage).....5
    4. Pileipellis with dark subpyramidal warts surrounded by pale areola.....L. badius
    4. Pileipellis without dark subpyramidal warts; (not treated here).....L. sajor-caju
5. Pileipellis hairs and tramal hyphae with ladder-like septation.....Lentinus sp. 1

5. Pileipellis hairs and tramal hyphae without ladder-like septation.....6

6. Skeleto-ligative hyphae forming short diverticulate tips; (not treated here).....L. polychrous

6. Skeleto-ligative hyphae not forming short diverticulate tips.....L. squarrosulus

7. Stipe rooting.....L. rutus

7. Stipe not rooting.....8

8. Either thick-walled metuloids or sclerocystidia present.....9

8. Both metuloids and sclerocystidia absent.....Lentinus sp. 2

9. Basidiomata cespitose; stipe very short; spores less than 6 µm long; (not treated here).....L. strigosus

9. Basidiomata not cespitose; stipe elongated; spores more than 6 µm long; (not treated here).....L. velutinus

Descriptions of Nepalese species

Lentinus badius (Berk.) Berkeley. 1847. in Lond. Journ. Bot. 6: 491.

Macroscopic features

Pileus (Fig. 10A) cyathiform, centrally or excentrically attached, up to 75 mm broad, nutria or greyish brown (5F3 or 5F4) toward center, fading to bay brown (9E5 or 9E6) or light orange (5A5 or 5A6) toward margin, covered by erect hairs and concentric zones of scales; hairs stiff, bronze brown or soot brown (5E5 or 5F5) all over the pileus when young, persistent only towards margin on maturity; scales at first subpyramidal, up to 3 mm broad, brownish grey (5F2) at first, finally ephemeral leaving brownish grey (6F2 or 7F2) or dark

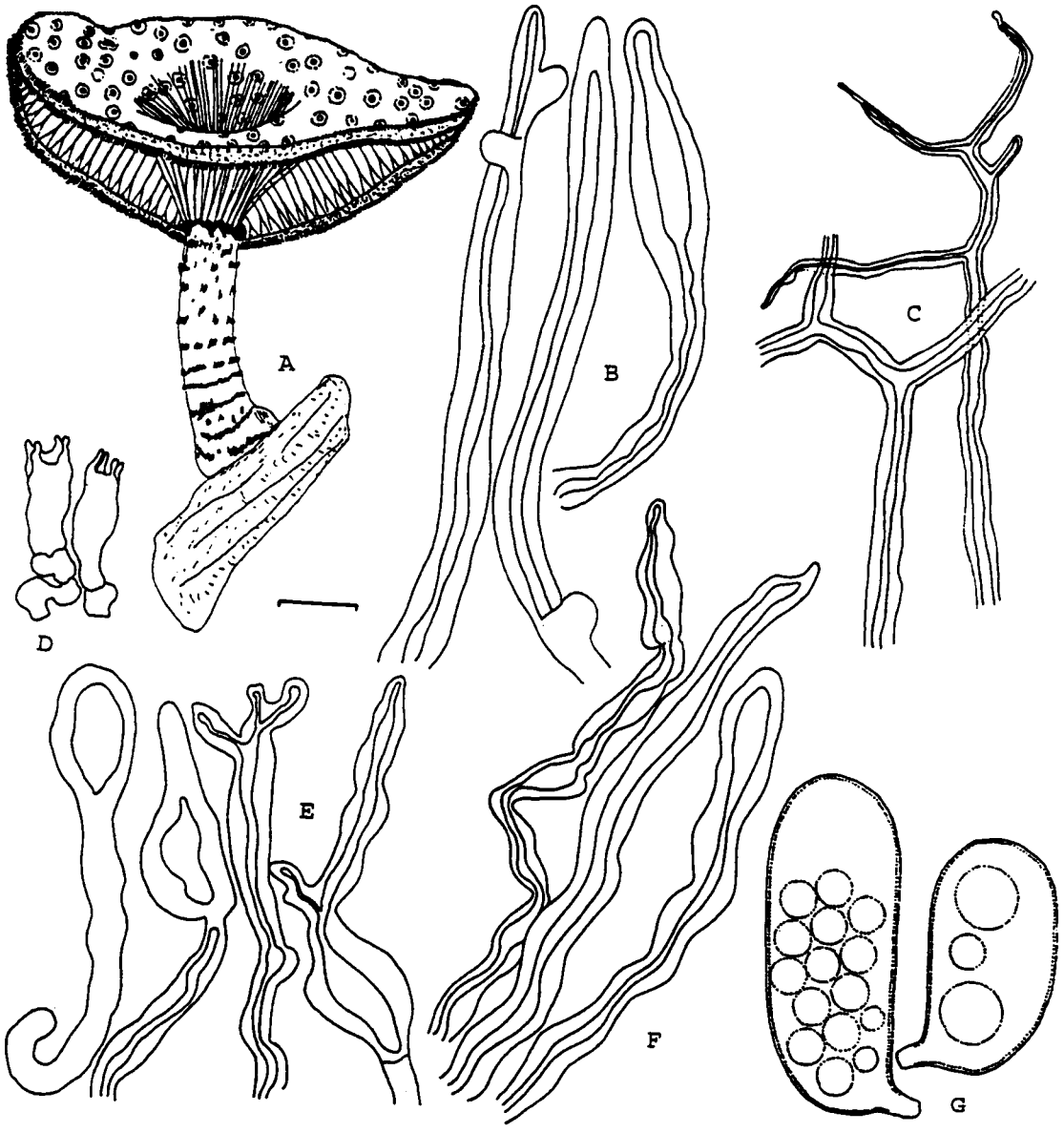


Figure 10 A-G. Features of Lentinus badius. A. Basidioma (NHMTU. 2-2-02168, TENN. 51833). B. Pileipellis hairs. C. Skeleto-ligative hyphae. D. Basidia. E. Cheilocystidia. F. Pleurocystidia. G. Basidiospores. Standard bar = 10 mm for A; 10 µm for B & D-F; 20 µm for C; 1.5 µm for F.

black circular spots (up to 4 mm diam) with a pale orange (6A3) or pariel red (7A4) areola around the black spot, much crowded toward center; margin thin, involute and finally expanded, slightly striate, rimose, densely hairy; flesh white, leathery, up to 4 mm thick at the disk, 0.5 mm toward the margin. Lamellae short-decurrent, pale orange to light orange (5B3 or 5B4), medium distant, broad (up to 6 mm), forked, furcate up to 5 levels of dichotomies, minutely densely spiny under 20X; edge entire, emarginate and pastel red (7F4 or 7F5) near the point of attachment with stipe. Stipe cylindrical, up to 36 mm long, 8 mm diam, concolorous to the pileus surface above, slightly darker towards the base, central to excentric, woody, tapering below, solid, covered with hair brown (5E4) or brownish grey (8F2) squamules with hairy tomentum; flesh white, tough; annulus persistent, shallow, thin, concolorous to stipe surface, coriaceous, warty or fused with decurrent end of lamellae.

Microscopic features

Pileus composed of pileipellis (with hairs), pileus trama and lamellar trama. Pileipellis a trichoderm layer giving rise to hairs scattered or fascicled into compact bundles; hairs (Fig. 10B) up to 106 µm long; hyphae 3.8-6.7 µm diam, thick- (wall up to 2.3 µm thick) and brown-walled in KOH solution; branched (bifurcately) or unbranched; tip obtuse, not differentiated; clamp connections present. Pileus trama made of two layers: upper gelatinous or mucilaginous layer up to 25 µm deep, not staining in Congo red; lower layer, about 30 µm deep (towards margin), made of compact and mostly horizontally aligned hyphae; tramal hyphae of two types: 1) generative hyphae up to

7.6 µm diam, uninflated, thin-walled, hyaline, with prominent clamp connections; 2) skeleto-ligative hyphae (Fig. 10C) up to 600 µm long, 9.5 µm diam, thick-walled (wall up to 3 µm thick), hyaline, smooth-walled, 4-5 times branched; branches short to very long, often abruptly tapering to filiform apex. Lamellar trama up to 350 µm deep, interwoven, hyaline, with hyphae similar to those of pileus trama. Subhymenium not distinct, 1-2 cell layers, up to 7 µm deep. Hyphal pegs abundant, projecting up to 80 µm, up to 85 µm long and 27 µm broad, cylindrical and tapering but apically slightly dilated; hyphae 2.6-3.4 µm diam, cylindrical, narrow, agglutinated, thin-walled, elongated, with rounded tips. Basidia (Fig. 10D) 16-19.1 X 4.9-5.7 µm, clavate, 4-sterigmate, clamped at base. Cheilocystidia (Fig. 10E) made of slightly emergent and inflated pseudocystidial tip of skeletal hyphae, 7-17.9 X 4.2-10.7 µm, sparse, projecting up to 10 µm, thick-walled (wall up to 3 µm thick); tip sometimes slightly swollen or branched. Pleurocystidia (Fig. 10F) similar to cheilocystidia but usually unbranched at apex. Basidiospores (Fig. 10G) 4.8-7.0 X 2.7-3.8 µm (Lm = 6.0, Wm = 2.9, E_m= 1.8-2.6, n = 25), white (assumed), cylindric or oblong-cylindric, hyaline, thin- and smooth-walled, non-amyloid, multiguttulate.

Habitat: Growing singly on fallen and decaying branches and stumps of Rhododendron species (either R. arboreum, R. barbatum, R. campanulatum or R. cinnabarinum).

Specimen examined: Nepal, Pipar [Thulokhopang (10,000 ft)], about 15 miles north west from Pokhara (2500 ft), Gandaki zone, coll. H. R.

Bhandary, 3.iv.82., HRB s.n. (NHMTU 2-2-02168), TENN. 51833.

Comments: Lentinus badius is recognizable in the field by its typical brown velutinate-hairy pileus spotted with brownish-grey warts, annulate stem and concolorous squamulose stipe. Thick-walled pileipellis hairs, gelatinous hypodermis, abundant hyphal pegs, branched skeleto-ligative hyphae, and spore dimensions are some of its microscopic features by which it can be distinguished from other related species.

Lentinus badius was described as the "most beautiful of all Lentini" by Berkeley (1842: 145) when he first described this fungus from the Philippine Islands. Berkeley (1854) reported its occurrence in Nepal after he obtained specimens collected by J. D. Hooker in 1848 from Mai Valley, eastern Nepal. Some mycologists (Singer, 1986) treat L. badius as a species of Panus but following Pegler's (1983) view of treating Panus as a subgenus of Lentinus, I have included it as a species of Lentinus.

The species with which Lentinus badius can be confused are L. araucariae and L. brunneofloccosus, distribution ranges of which are very different from L. badius (Pegler, 1983c).

Lentinus chepangiana H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 11A) dimidiate, flabelliform, cyathiform or infundibuliform, centrally or laterally attached, up to 55 mm diam, silky white towards margin, pale ochraceous buff (4A2) toward center [drying greyish orange (5B5 or 5B6) or tawny (6C6)], glabrous,

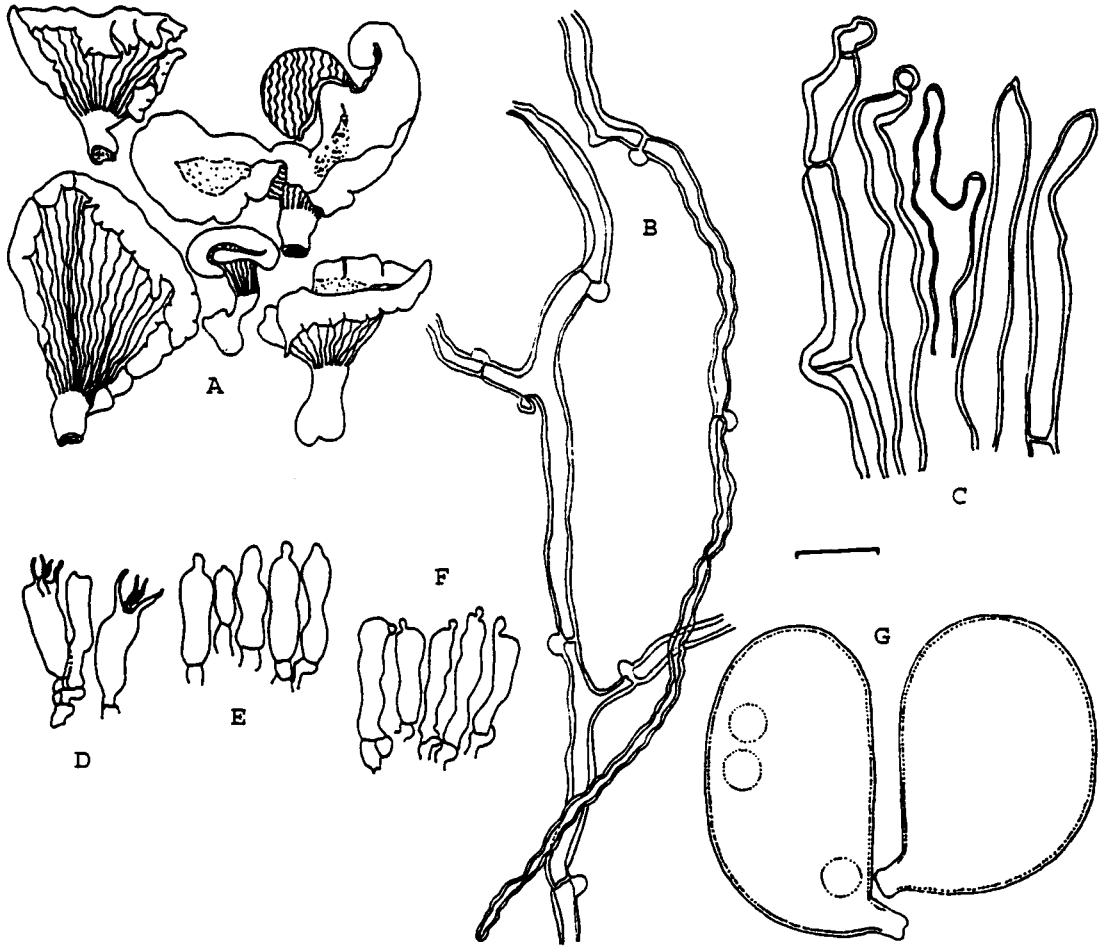


Figure 11 A-F. Features of Lentinus chepangiana. A. Basidiomata (TENN. 51834). B. Skeletalized generative hyphae. C. Stipitipellis hairs. D. Basidia and basidiole. E. Cheilocystidia. F. Pleurocystidia. G. Basidiospores. Standard bar = 13 mm for A; 20 µm for B; 10 µm for C-F; 1.5 µm for G.

delicately concentrically wrinkled at center; margin incurved at first, straight later, eroded, rimose, deeply lobed in some specimens, slightly transparent-striate; flesh white, 1.5 mm thick at center, gradually thinning outward, up to 0.5 mm at margin. Lamellae short-decurrent, not anastamosing at stipe apex, subdistant, narrow (up to 1.5 mm deep), white, finally concolorous to the pileus [drying white or pinkish buff (6A3) at the base, cinnamon brown (6B5 or 6C5) toward edge], not forked, with lamellulae of three ranks; edge entire, slightly emarginate and undulate when dry. Stipe central or lateral, short, cylindrical, 10 mm long, 5 mm thick, tomentose, white or finally concolorous with pileus, slightly swollen and woody at base in some specimens, solid, sometimes hollow at apex and porate with the infundibuliform pileus; flesh white, persistently soft and not woody. Odor and Taste not distinct.

Microscopic features

Pileus composed of pileipellis, pileus trama and lamellar trama. Pileipellis a cutis, 15 µm deep; hyphae 1.3-3.4 µm diam, smooth-walled; giving rise to sparse, erect, fascicled or non-fascicled hairs; hairs 30 µm long, mostly 3.8 µm diam, slightly thick-walled (wall up to 0.4-0.8 µm thick); tip round, undifferentiated; clamp connections present. Pileus trama up to 100 µm deep (towards margin), 1400 µm deep at center, interwoven, made of thick-walled or skeletalized generative hyphae, greyish yellow in KOH, sometimes lacunose. Skeletalized generative hyphae (Fig. 11B) 3.8(-5.3) µm diam, slightly inflated, unbranched or sparingly (4-5 times) branched, with clear lumen; wall generally less than 0.8 µm thick toward the base,

1.5-3 μm thick in the side branches or toward the apex, hyaline, smooth, sometimes appearing gelatinized; clamp connections prominent, abundant and distinct at the thin-walled as well as the thick-walled portion of the generative hyphae; tip undifferentiated, obtuse, not filiform or narrowly tapering. Stipitipellis (Fig. 11C) giving rise to hairs; hairs up to 45 μm long, 1.3-3.5 μm diam, undifferentiated, similar to the skeletalized generative hyphae. Skeletal hyphae absent. Lamellar trama up to 250 μm deep, irregular, composed of hyphae not distinguishable from those of the pileus trama. Subhymenium not conspicuous, up to 10.8 μm broad. Hyphal pegs absent. Basidia (Fig. 11D) 14.3-21.1 X 3.1-4.3 μm, 4-sterigmate, clavate, clamped at base. Cheilocystidia (Fig. 11E) 7.6-15.2 X 2.7-3.8 μm, clavate, nippled at tip (but without any reminescence of microdroplet or adhesive knob), projecting up to 3.0 μm. Pleurocystidia (Fig. 11F) 13.2-23.4 X 3.0-4.1 μm, mostly basidioid, sometimes similar to the cheilocystidia or sometimes asymetrically nippled once or twice (toward the same side) which may be due to asymetrical growth of the sterigmata. Basidiospores (Fig. 11G) 3.7-6.1 X 2.0-3.4 μm (Lm = 4.9, Wm = 2.9, E_m= 1.1-1.9, n = 25), white, ellipsoid to cylindric, hyaline, non-amyloid, thin-walled, uni- or multiguttulate.

Habitat: Cespitose on partly buried and decayed log of Shorea robusta tree on the forest floor.

Specimen examined: Nepal, Jugedi, Chitwan district, HRB, 12.vii.90., HRB s.n., TENN. 51834 (HOLOTYPE), NHMTU. s.n. (ISOTYPE).

Etymology: Chepang is a tribe in central Nepal (Tulloss and

Bhandary, 1992a) speaking a Tibeto-Burman dialect.

Comments: Lentinus chepangiana can be identified in the field by its non-coriaceous and Pleurotus like, pleuropodal to cyathiform, glabrous, white or ochraceous pileus with subdistant and shallow lamellae, thick and short wooly white stipe and cespitose habit. Monomitic tramal construction with distinctly clamped skeletalized generative hyphae, irregular hymenophoral trama, lack of skeletal hyphae, nippled (at center or at side of the apex) cheilo- and pleurocystidia (without any reminiscence of microdroplets), and spore dimensions are its microscopic characters.

Lentinus chepangiana, although lacking distinctly coriaceous fruitbodies and possessing monomitic trama (pileus and stipe) is here tentatively accommodated in Lentinus because of its non-amyloid white spores, Pleurotus-like fruitbodies (lignicolous, un-coriaceous habit and with decurrent gills) and irregular gill trama. Although it appears more like Pleurotus (because of its less coriaceous basidiomata, thick-walled or sclerified generative hyphae), L. chepangiana could not be a Pleurotus because of lack of capitate or lecythiform cheilo- or pleurocystidia in exsiccates (mycelial cultures not examined). It could not be placed in Neolentinus because of lack of regular hymenophoral trama (and lack of information on the white or brown rots it produces). The monomitic (presence of only thick-walled and prominently clamped generative hyphae) tramal system could align L. chepangiana to Heliocybe but the latter is characterized by lack of clamp connections in the tramal hyphae (Redhead and Ginns, 1985). The thick-walled generative hyphae observed in L. chepangiana possess

distinct clamps. Corner (1981: 15) defined such hyphae as transformed cells of generative hyphae, a characteristic feature of Pterula (Corner, 1970). Pterula is a group of filiform (branched or unbranched) clavarioid (non-gilled) fungi which cannot be confused with L. chepangiana.

Lentinus chepangiana resembles L. suavissimus, accommodated by Pegler (1983c) in Lentinus sect. Pleuroti, characterized by glabrous pileus surface, short stipe, and non-furcate hymenophore. Lentinus chepangiana, however, differs not only by lack of aniseed smell but also by microscopic features such as absence of hyphal pegs, skeletal hyphae and smaller spores [spore size for L. suavissimus is 6-9 X 2.5-3.5 µm (Pegler, 1983c)]. Lentinus chepangiana differs from L. hirtus by presence of distinct dimitic trama in the latter (Pegler, 1983c).

Lentinus rutus H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 12A) up to 90 mm diam, thin, very deeply cyathiform, centrally stipitate; surface smooth, yellowish white (4A2), pale yellow (4A3), or orange white (5A2) toward margin [drying light orange (5A5) to greyish orange (5B5) interrupted by thin fuscous or dark brown (7F5 or 7F6) striations], greyish brown (5D3 or 5E3) or yellowish brown (5D4 or 5E4) toward center [drying dark brown (7F5 or 7F6 or 8F5 or 8F6)], dry, glabrous; margin very thin, incurved, soon becoming rimose and lobed, finally lacerate, or eroded; flesh thin, leathery or coriaceous, fibrous, white to yellowish white, unchanging. Lamellae deeply decurrent, white or yellowish white (4A2) above

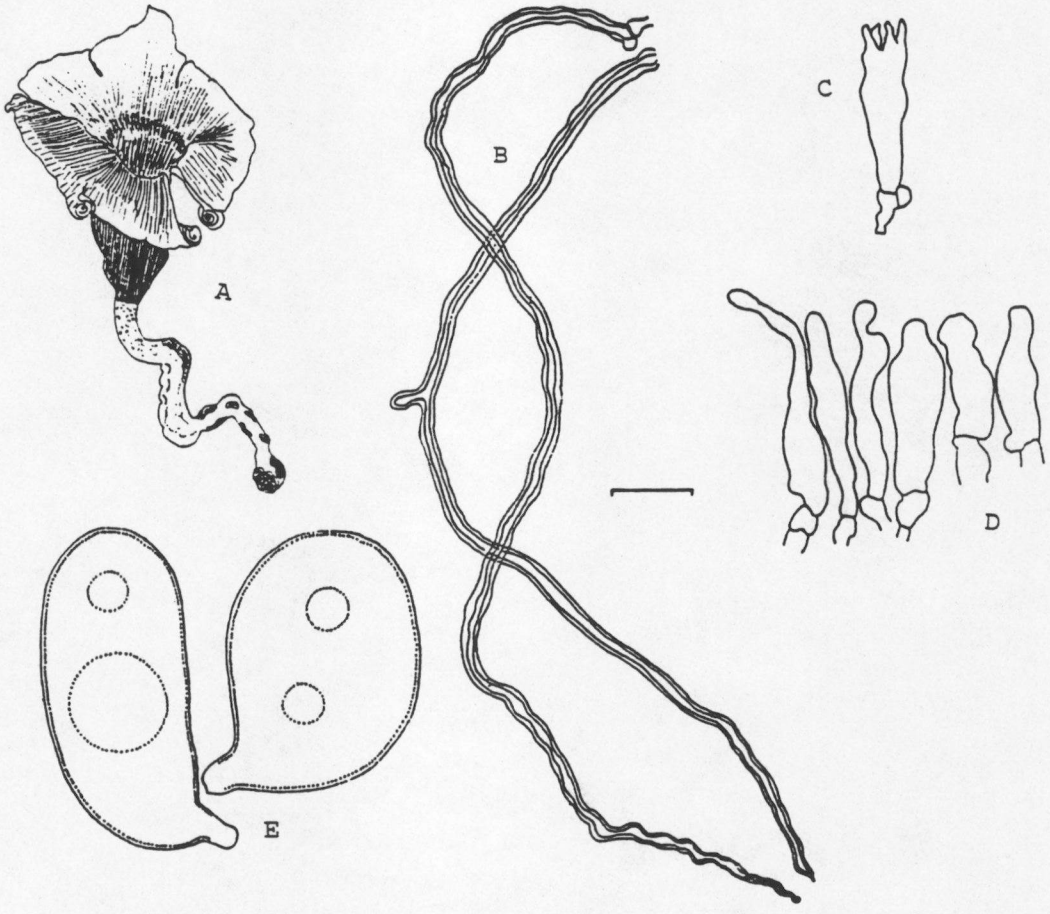


Figure 12 A-E. Features of Lentinus rutus. A. Basidioma (TENN. 51835, holotype). B. Skeletal hyphae. C. Basidium. D. Cheilocystidia. E. Basidiospores. Standard bar = 30 mm for A; 20 um for B; 10 µm for C & D; 1.5 µm for E.

[light brown (7D5 or 7D6) on drying], light brown near the stipe apex [brownish grey (7F2) to grey (7F1) on drying], densely crowded, very narrow (up to 1 mm); lamellulae up to 5 ranks; edge entire, minutely hairy and grey (7F1) under 10X. Stipe long, rooting, up to 100 mm long, 10 mm thick, central, erect, stout, solid; surface brown (7E6 to 7E5) [drying brownish grey (7F2) or grey (7F1)], finely striate; striations with minute erect greyish or dark greyish hairs under 10X; base deeply rooted, slightly irregularly swollen below. Odor and Taste not recorded.

Microscopic features:

Pileus differentiated into piliepellis and pileus trama. Pileipellis an epicutis; hyphae repent, 1.5-5.7 µm diam, smooth, thin-walled, hyaline; clamp connections present. Pileus trama up to 300 µm deep; dimitic with interwoven generative and skeletal hyphae. Generative hyphae 1.9-5.7 µm diam, not inflating in KOH solution, thin- or slightly thick-walled (wall up to 0.5 µm thick), frequently branched, hyaline, staining red in Congo red; clamp connections present and prominent, inflated up to 5.7 µm. Skeletal hyphae (Fig. 12B) 3.8-5.7 µm diam, arising from generative hyphae with clamp at base, some flexuous, rarely branched; wall hyaline, thick (up to 2 µm thick), smooth-walled; lumen continuous. Lamellar trama irregular, hyaline; hyphae dimitic, similar to pileus trama. Subhymenium 2-6 µm wide, interwoven. Hyphal pegs absent. Basidia (Fig. 12C) 20.9-25.5 X 4.6-5.7 µm, 4-spored, clavate, clamped at the base. Cheilocystidia (Fig. 12D) 13.3-30.4- X 3.8-6.8 µm, hyaline, fusoid or narrowly utriciform, constricted once or twice, sometimes narrowly lageniform

or cylindrical with slightly elongated tip. Pleurocystidia absent or basidioliform, clavate. Basidiospores (Fig. 12E) 4.2-6.8 X 2.7-3.8 µm (Lm = 5.8, Wm = 3.3, E_m= 1.3-2.3, n = 50) white in print, ellipsoid to subcylindrical, hyaline, smooth-walled, non-amyloid, mono- or bi-guttulate.

Habitat: On decaying fallen stumps and roots of Shorea robusta hardwood tree. Called Chaamrey chyau in Nepali language (by the local people) because of leathery texture, this mushroom is collected as edible.

Specimen examined: Nepal, Chitwan district, Jugedi (alt. 500 ft), coll. HRB, 15.vii.86., HRB s.n., TENN. 51835 (HOLOTYPE), NHMTU.2-2-02848 (ISOTYPE).

Etymology: Rut (t as "t" sound in French language) = a word meaning "root" in Chepang [a Tibeto-Burman language speaking tribe of Nepal (Tulloss and Bhandary, 1992a)] dialect.

Comments: Lentinus rutus is recognizable in the field by its long-rooted, infundibuliform, thin-fleshed, yellowish white to yellowish brown carpophores with shallow and crowded lamellae and minutely dark-brown hairy lamellar edge. Presence of a rooting stipe-base has been regarded as its diagnostic morphological feature. Occasional short-branched skeletal hyphae, narrowly utriciform or fusoid cheilocystidia and spore dimensions are the diagnostic microscopic features.

Lentinus rutus resembles L. connatus, a common southeast Asian [including Indian peninsula (Pegler, 1983c, 1986)] species, by

possessing similarly colored, deeply cyathiform, thin-fleshed pileus, shallow lamellae, elongated stipe, occasionally branched sinuous skeletal hyphae, constricted fusoid cheilocystidia and absence of hyphal pegs. Lentinus connatus, however, does not have a rooting base, possesses slightly larger spores [spore size for L. connatus is 6-8 X 2.5-3.5 µm (Pegler, 1983c, 1986)] and stipe sometimes arising from a pseudosclerotium. No pseudosclerotium was observed in L. rutus (based on a single specimen).

Lentinus squarrosulus Mont. 1842. Ann. Sci. Nat. Bot. sér. 2, 18: 21

Macroscopic features:

Pileus (Fig. 13A) convex with slightly depressed center to deeply infundibuliform, centrally or eccentrically stipitate, up to 60 mm broad, sometimes perforated at the center; surface white or cream white (3A3) or pale ochraceous buff (4A2) [drying pale yellow (3A3 or 4A3) or light yellow (3A4 or 4A3)], dry, faintly radially striate [(striations becoming light brown (6D5 or 6D6) on drying)] with persistent concolorous scales [drying light orange (6B4 or 6B5) or red-haired (6C4)] which are larger and distinct toward center, appressed toward margin; margin incurved, then downcurved, thin, rimose and finally lobed; flesh up to 2 mm thick, white, coriaceous or leathery, tough. Lamellae deeply decurrent, slightly interveined at the stipe apex, crowded, broadened up to 4 mm (2 mm on drying), white or off-white; edge entire, greyish orange (6B4) or red-haired (6C4), hence slightly emarginate; lamellulae present, usually of 4 ranks. Stipe up to 25 mm long, up to 8 mm broad, central or eccentric,

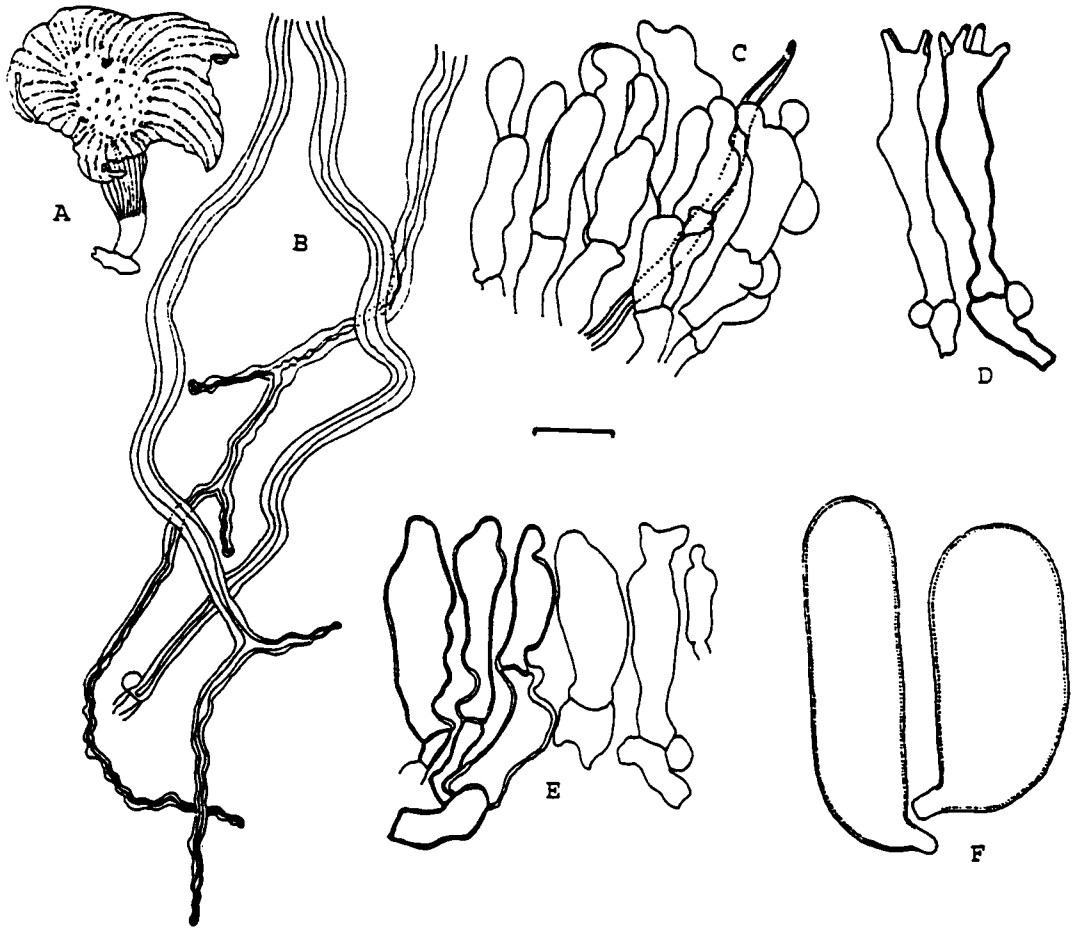


Figure 13 A-F. Features of Lentinus squarrosulus. A. Basidioma (TENN. 51838). B. Skeleto-ligative hyphae. C. Hyphal peg. D. Basidia. E. Cheilocystidia. F. Basidiospores. Standard bar = 20 mm for A; 20 µm for B; 10 µm for C-E; 1.5 µm for F.

curved, slightly tapering below, stout, solid, broadly ribbed in some specimens; surface concolorous with the pileus, turning pale orange when handled, black at the place of attachment with substrate, thinly floccose or velutinous with cream colored scales, finally glabrous, woody hard on maturity. Odor and taste agreeable.

Microscopic features

Pileus composed of pileipellis, pileus trama and lamellar trama. Pileipellis made of interwoven, longitidinally arranged hyphae; hyphae 2.7-5.7 µm diam; wall up to 1 um thick; hyphal tip dilated up to 7.6 µm diam; clamp connections present and prominent. Pileus trama up to 1100 µm deep (toward center), dimitic. Generative hyphae 1.5-15.2 µm diam, inflated (sometimes irregularly so), hyaline, staining red in Congo red, branched; wall smooth, thin or thick (up to 1.1 µm thick); clamp connections present, inflated to 11.4 µm (in 7.6 µm diam hyphae). Skeleto-ligative hyphae (Fig. 13B) up to 700 µm long, 2-7.6(-14.1) µm diam, hyaline, wavy or not, smooth- and thick-walled (wall up to 3 µm thick), flexuous, profusely branched, tapering at branch apex; apex filiform or tapering very gradually; lumen of the skeletal and ligative hyphae continuous. Lamellar trama irregular; hyphae loosely woven, hyaline, similar to those of pileus trama. Stipitipellis a cutis giving rise to triangular fascicles of compact hyphae (45-50 µm long, up to 15 µm broad at base) similar to generative hyphae.Subhymenium well-developed, with 1-3 layers of broad hyphae (up to 12.2 µ diam). Hyphal pegs (Fig. 13C) occasional, inconspicuous, broader than long, conical to truncate-cylindric, projecting up to 36 µm broad, made of about 30 clavate or basidioliform hyphal tips, 1.4-

7.6 µm diam; walls slightly thickened to 0.4 µm. Basidia (Fig. 13D) 11.4-31.2 X 3.8-8.4 µm, 4-sterigmate, clavate, slightly thick-walled (wall up to 0.4 µm), clamped at base. Cheilocystidia (Fig. 13E) 15.2-28.5 X 4.9-8.4 µm, clavate or cylindro-clavate, with tip round and slightly tapering, rarely ligative hyphal branch ends emerging as cheilocystidia, projecting up to 30 µm. Pleurocystidia undifferentiated. Basidiospores (Fig. 15F) 4.9-8.0 X 1.9-3.8 µm (Lm = 6.9, Wm = 2.4, E_m= 2.1-3.6, n = 50), white, hyaline, cylindrical, non-amyloid, with usually 2-3 guttules.

Habitat: Caespitose on fallen and decaying branch or log of Rhus wallichii (Kaag valaayo in Nepali language) and Shorea robusta (Sal) trees. This fungus is also called chaamrey chyaau (see Lentinus and L. rutus) in Nepali language because of its coriaceous texture especially on maturity. Generally immature basidiocarps are collected, air-dried and stored for future use as food.

Specimens examined: Nepal, Karuwa (alt. 4,560 ft), on the way to Pipar from Pokhara (2500 ft), coll. HRB, 26.V.82., HRB s.n., NHMTU 2-2-01060, TENN. 51838; Pisang (6000 ft), Tanahu district, coll. HRB (dry specimens obtained from local people who had collected, dried and saved it for later use as vegetable), 5.VII.84, HRB # A612, NHMTU 2-2-02395, TENN. 51839; Jugedi, Narayanghat, Chitwan district, coll. HRB, 12.vii.90., HRB s.n., NHMTU s.n., TENN. 51840.

Comments: Lentinus squarrosulus can be identified in the field by cespitose, white or creamy white, scaly, slightly depressed to deeply infundibuliform carpophores with lentinoid habit. Its readily

recognizable microscopic features are pileipellis hyphae with frequently inflated tips, profusely branched skeleto-binding hyphae, spore dimensions and inconspicuous or sparse hyphal pegs. Lentinus squarrosulus can be confused with L. polychrous because of deeply infundibuliform, scaly and similarly colored carpophores, similar skeleto-ligative hyphae, hyphal pegs and emergent skeleto-ligative hyphal tips on the gill edge (as cheilocystidia). Lentinus squarrosulus, however, differs by absence of short coralloid diverticulae formed by the skeleto-ligative hyphal tips and smaller spores [spore size of L. polychrous is 6-9 X 2.7-3.3 µm (Pegler, 1983c, 1986)].

Lentinus squarrosulus is a common palaeotropical fungus (Pegler, 1983c) found throughout the world. It was reported from central Nepal by Pegler (1983c). It can be confused with L. sajor-caju, an equally common fungus [also reported from Nepal by Pegler (1983c)], because both possess scaly and infundibuliform carpophores, similar skeleto-ligative hyphae and similar spore dimensions. Lentinus sajor-caju, however, is very distinct by annulate stipe, numerous much elongated hyphal pegs and coralloid branch tips of the skeleto-ligative hyphae.

Lentinus species 1

Macroscopic features (description from exsiccates)

Pileus (Fig. 14A) cyathiform, spathulate, dimidiate or infundibuliform, eccentrically or laterally attached, up to 90 mm broad, 55 mm wide, silky greyish orange (5B4 or 5B3), reddish-, golden-brownish-, or greyish-orange (5B4 or 5B5) or brown (7D6) toward

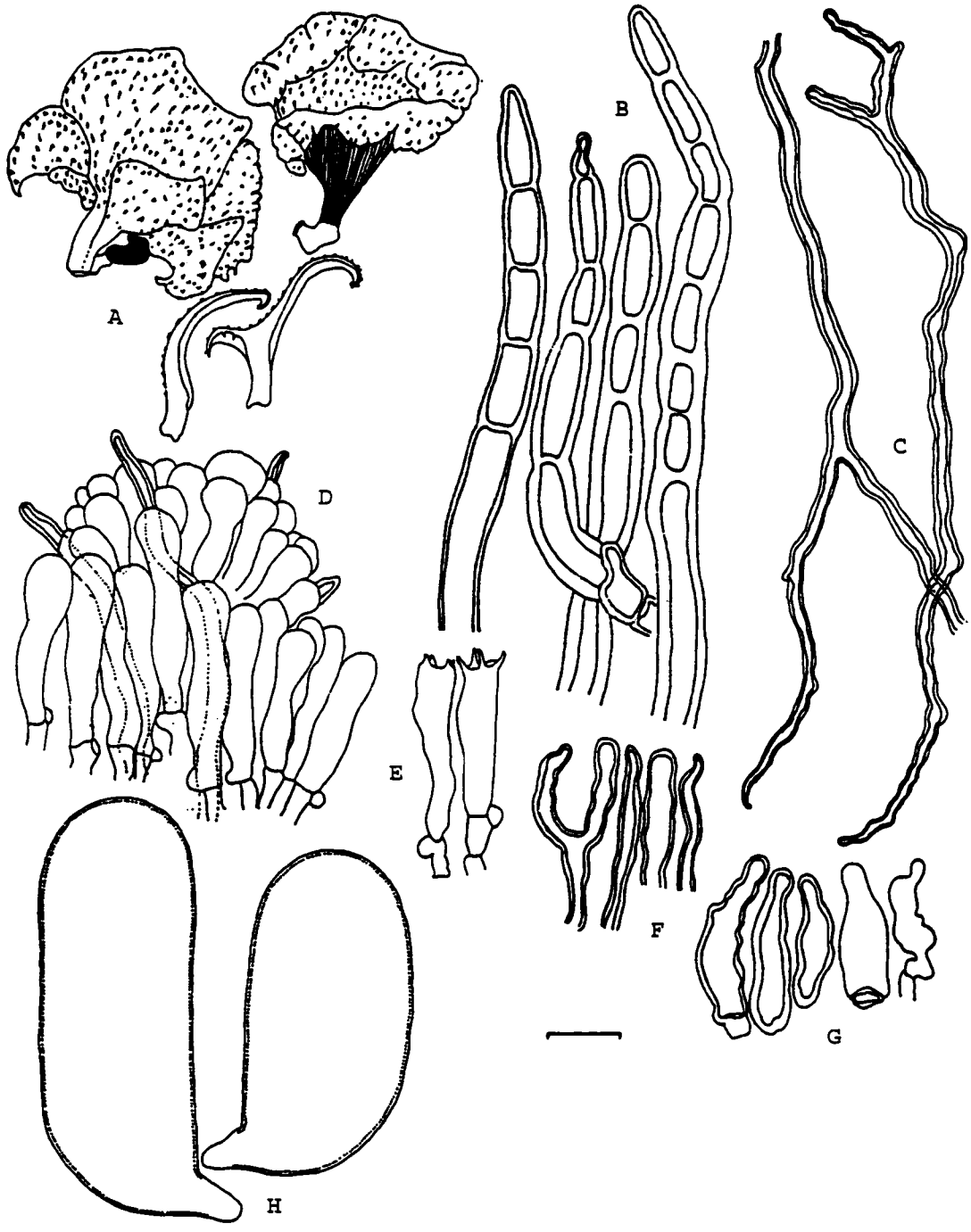


Figure 14 A-H. Features of Lentinus species 1. A. Basidiomata (TENN. 51836, NH 9009). B. Pileipellis hairs. C. Skeleto-ligative hyphae. D. Hyphal peg. E. Basidia. F. Cheilocystidia. G. Sclerocystidia. H. Basidiospores. Standard bar = 25 mm for A; 10 µm for B & D-G; 20 µm for C; 1.5 µm for H.

center, dark brown (7F4) toward margin, covered with fibrillous squamules all over; squamules brownish orange (5C3 or 5C4) or red-haired (6C3 or 6C4), dense and appressed, erect to suberect, minutely longitudinally striate, denser and light brown (6D5) toward center, greyish or faded greyish brown (5C3 or 5C4) toward margin; pileus center raised-convex or depressed and broadly bumpy in laterally attached forms, much depressed in cyathiform or infundibuliform specimens; margin strongly and persistently incurved, rimose, striate, crenate-eroded here and there, beset with concolorous but smaller appressed scales; flesh light ochraceous buff (5A4), topaz (5C5) or light topaz, tough, leathery, 2 mm thick toward stipe attachment, 0.2-0.3 mm thick toward margin (hence abruptly thinning). Lamellae short decurrent, walnut brown (7D6), emarginate to auburn (7E5) or vandyke brown (7E6), anastomosing at the stipe apex, subdistant, with up to 6 ranks of branching, 2 mm broad, slightly broader toward margin; edge entire, very minutely floccose-hairy in 20X. Stipe cylindric or fused-expanded at base, white or greyish orange (5B4), covered with Pompeian yellow (5C6) or honey yellow (5D6) velvety tomentum which may turn dark blonde (5D4) or olive brown (5E4) toward base, 8-20 mm long, 5-18 mm broad, solid, woody, tough, appressed or flat in laterally attached forms; flesh concolorous with that of pileus.

Microscopic features

Pileus composed of pileipellis, pileus trama and lamellar trama. Pileipellis made of radial hyphae; hyphae 5.7 μm diam, smooth-walled, giving rise to erect hairs; hairs (Fig. 14B) 5.7-7.6 μm diam, up to 160 μm long, smooth-walled, septate in ladder-like or bamboo node-like

fashion, unbranched, unfascicled; tip round or triangular; wall 1.1-2.3 µm thick. Pileus trama up to 400 µm deep toward margin, interwoven, composed of generative and skeleto-ligative hyphae. Generative hyphae up to 12.5 µm diam; thin- or thick-walled (wall up to 3.0 µm thick), frequently septate (as in pileipellis hairs), sparingly branched, hyaline, smooth-walled; lumen wide to narrow; clamp connections not observed. Skeleto-ligative hyphae (Fig. 14C) up to 900 µm long, 9.5 µm diam, thick-walled (wall 1.1-2 µm thick), undulate, gradually thinning (to 1.2 µm in a 3.8 µm diam hypha) toward tip, dichotomously branched once or twice; tip round and tapering but not filiform. Lamellar trama interwoven, mostly of skeleto-ligative hyphae. Subhymenium conspicuous, up to 30 µm broad, interwoven. Hyphal pegs (Fig. 14D) very inconspicuous, sparse and located only towardss the base of the gills, up to 40 um high, 32.3 µm broad, composed of basidiole-like elements and thick-walled tips of skeletal hyphae, up to 3.8 µm thick. Basidia (Fig. 14E) 13.4-27.2 X 4.2-6.8 µm, 4-spored, clavate, distinctly clamped at base. Cheilocystidia of two types: 1) (Fig. 14F), 11.4-60.0 X 2.7-3.8 µm, projecting up to 40 µm, long cystidiiform hairs, pseudocystidioid, clamped at base indistinctly, thick-walled (wall 1.1-1.5 µm thick), sometimes slightly constricted or strangulate; 2) (Fig. 14G) 19-27.3 X 5.7-7.2 µm, sclerocystidia, clavate to constricted fusoid, thick-walled (wall up to 1.5 µm thick), metuloidal, not projecting. Pleurocystidia not differentiated. Basidiospores (Fig. 14H) 6.8-9.5 X 3.4-3.8 µm (Lm = 8.3, Wm = 3.2, Em = 2.0-2.8, n = 20), white (assumed), cylindric, hyaline, non-amyloid,

thin-walled, uni- or multiguttulate.

Habitat: Information about habitat not available. It is an edible mushroom called Dharkur by the Danuwar people of Sindhuli district, central Nepal.

Specimen examined: Nepal, Sindhuli, Raniban, date unknown, coll. Mr. M. K. Adhikary, NH 9009, TENN. 51836.

Comments: This species has been asigned to Lentinus because of lentinoid habit, non-amyloid spores, generative and skeleto-ligative hyphae and interwoven lamellar trama.

Lentinus species 1 can be identified in the field by its typically colored fruitbodies (see macroscopic features) with concolorous appressed or suberect scales, cespitose habit, and spathulate or cyathiform shape. Ladder-like septate pileipellis hairs and generative hyphae, thick-walled (metuloidal) sclerocystidia, emergent skeleto-ligative cystidiiform hairs, spore-shape and dimensions, and inconspicuous hyphal-pegs are some of its microscopic features.

Pegler (1983c) reported some Lentinus species which possessed ladder-like septate pileipellis hairs. In this way, Lentinus species 1 may resemble L. atrobrunneus and L. villosus. However, Species 1 differs from the above species which possess basidiomes thickly covered with long hairs. Species 1 resembles L. swartzii with heavily squamulose and deeply infundibuliform pileus, cespitose habit, skeleto-ligative hyphae and ladder-like septate hyphae [squamule hyphae from pileus center of L. swartzii (Pegler, 1983c)]. Species 1 is distinguishable, however, by color of basidiomata and presence of

sclerocystidia, larger spores and appressed scales [L. swartzii has erect triangular scales at the pileus margin (Pegler, 1983c)].

Species 1 has not been specifically named because of lack of information on habit and habitat.

Lentinus species 2

Macroscopic features (description from exsiccates)

Pileus (Fig. 15A) cyathiform, deeply infundibuliform, applanate, spathuliform, flabelliform, or dimidiform, either laterally or centrally attached, up to 90 mm broad, 70 mm wide, fleshy, leathery, greyish brown (7F3) or dark brown (7F4) toward center, fading to light brown (7D7 or 7E8) or vandyke brown (7E6) or orange buff (5B5) toward the margin, finally white at the margin, covered all over with greyish (7E1) or greyish brown (7E3 or 7F3) minute patches of tomentum or appressed scales which are denser and concentrically arranged toward center, very finely and longitudinally dark brown striate all over; margin incurved, tending to be straight in some specimens, rimose, slightly to very deeply (up to stipe attachment) lobed; flesh leathery, less than 1 mm thick near stipe attachment, thinner toward margin. Lamellae deeply decurrent, sometimes undulate, white or pale orange (6A3) [amber brown (6D8), flushed pale orange (5A3) here and there and near stipe attachment area], staining reddish brown (7D4) around the margin, highly crowded, forked (forking up to 7-8 levels), not broad (less than 1 mm). Stipe very short, up to 50 mm long, up to 9 mm thick, curved or straight, cylindric, hollow, covered all over by persistent dense velvety tomentum toward base and minute dark grey

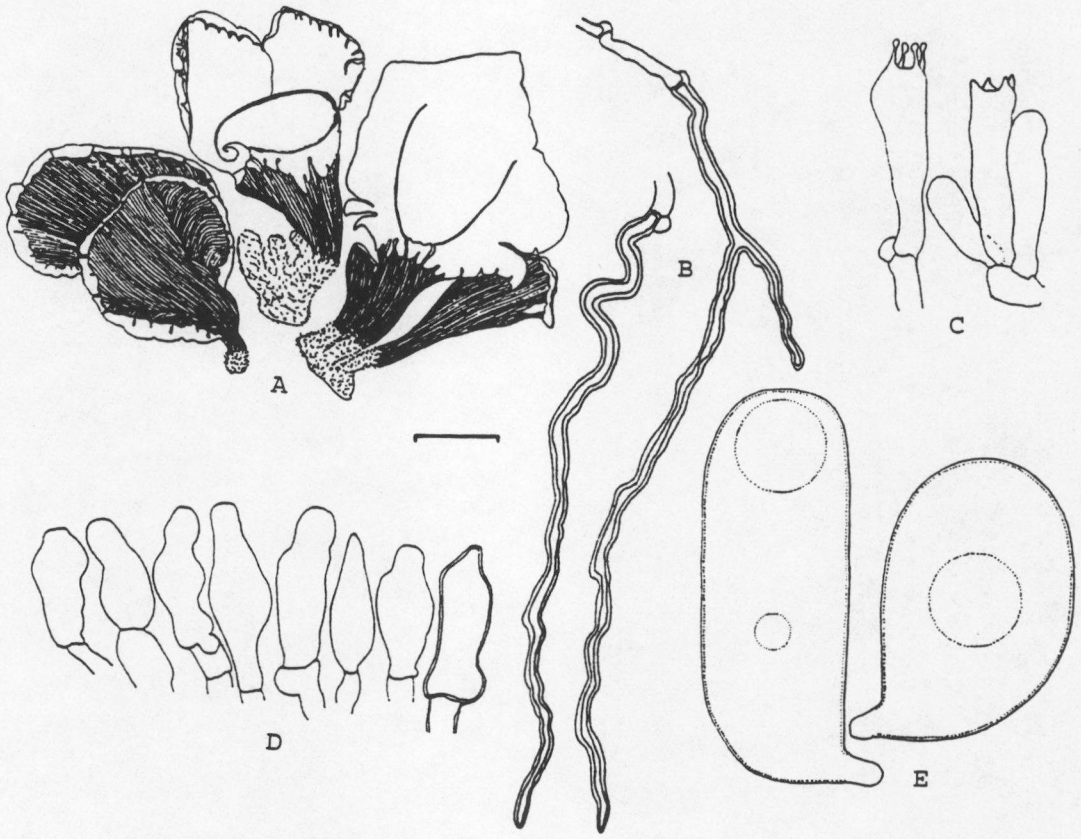


Figure 15 A-E. Features of Lentinus species 2. A. Basidiomata (NHMTU. 2-2-02707, TENN. 51837). B. Skeletal hyphae. C. Basidia & basidioles. D. Cheilocystidia. E. Basidiospores. Standard bar = 25 mm for A; 10 µm for B; 20 µm for C & D; 1.5 µm for E.

(7F1), dark brown (7F3) or greyish brown (7F2) dense pigments toward apex; base fused; flesh orange white (5A2), brownish in KOH solution, deep purple and then dark red in Congo red. Odor and taste not known.

Microscopic features

Pileus composed of pileipellis, pileus trama, and lamellar trama. Pileipellis of interwoven horizontal hyphae, up to 20 μm deep; hyphae 3.8 μm diam, dark brown or yellowish brown in KOH solution; wall up to 0.8 μm thick. Pileus trama up to 900 μm deep at the center of the cap; hyphae interwoven, yellowish to honey colored in KOH solution, dimitic. Generativfe hyphae up to 7.2 μm diam, thin- to slightly thick-walled (wall 0.4-0.8 μm), inflated, branched; branches irregularly undulate; tip obtuse; clamp connections prominent. Skeletal hyphae (Fig. 15B) 3.0-4.9 μm diam, thick-walled (wall up to 1.5 μm thick), produced from generative hyphae, rarely branched; wall hyaline, slightly undulated; tip rounded, not tapering to form binding hyphae; clamp connection present only at the base, inflated to 6.5 μm. Stipitipellis with interwoven hyphae, producing fascicles of erect hairs up to 456 μm long; hyphae 2.7-3.8 μm diam, thin- to slightly thick-walled (wall up to 0.8 μm thick); tip round, sometimes fused at the tip; clamp connection present, inflated up to 6.5 μm. Lamellar trama irregular, hyaline, composed of hyphae similar to those of pileus trama, not well-differentiated from the pileus trama. Subhymenium narrow (6-8 μm broad), not conspicuous. Basidia (Fig. 15C) 19.4-26.6(-36) X 4.-5.7 μm, clavate to almost cylindrical, 4-spored, slightly thick-walled (wall up to 0.5 μm thick), clamped at base. Cheilocystidia (Fig. 15D) 13.7-24.7 X 5.7-8.7 μm, projecting up to 17

µm, narrow or broadly utriform, sometimes clavate, strangulate or constricted once or twice, slightly thick-walled (wall up to 0.4 µm); clamped at base. Pleurocystidia not differentiated. Basidiospores (Fig. 15E) 5.3-8.0 X 2.7-3.8 µm (Lm = 7.0, Wm = 3.6, Em = 2.7-1.5, n = 50), white (assumed), hyaline, elongate-ellipsoid or cylindrical, thin-walled, non-amyloid, uni- or multiguttulate.

Habitat: Not recorded.

Specimen examined: Nepal, Dhangadhi (far-western development region, Seti Zone), locality of collection not known, collector not known, date of collection not known, NHMTU 2-2-02707, TENN. 51837.

Comments: This taxon belongs in Lentinus because of lentinoid habit (coriaceous habit with central or lateral attachment), presence of non-amyloid spores and dimitic trama with distinct skeletal hyphae. It could not be a Pleurotus species because of lack of capitate or lecythiform cystidia with mucoid drops.

Species 2 matches descriptions given by Pegler (1983d) for Lentinus anthocephalus by deeply infundibuliform or laterally attached, aplanate and thin-fleshed pileus, tomentose or velvety and connate stipe, utriform cheilocystidia, and similar skeletal hyphae. However, species 2 is different as follows: 1) different spore dimensions [(9-6 X 4-3.4 µm for L.anthocephalus: (Pegler, 1983c)]; 2) persistently hispid-tomentose stipe [glabrous on maturity in L. anthocephalus (Pegler, 1983c)]; and 3) distribution of L. anthocephalus in Africa and a few islands in Indian Ocean (Pegler, 1983c) but not reported from Southeast Asia, South Asia, China, Japan,

etc.

Species 2 resembles Lentinus tuberregium by cyathiform to deeply infundibuliform habit, tomentose stipe, similar unbranched skeletal hyphae and cheilocystidia. However, species 2 is different by its minutely striate pileus [pileus either squamulose or completely glabrous but not striate in L. tuberregium (Pegler, 1983c, 1986)], comparatively thin and hollow stipe [thick, robust, and solid in L. tuberregium (Pegler, 1983c, 1986)], and smaller spores [7.5-10.5 X 3-4.2 µm in L. tuberregium (Pegler, 1983d)]. Lentinus tuberregium always grows from a subterranean woody sclerotium (Pegler, 1983c, 1986): such a sclerotium is not known for species 2.

Species 2 resembles Lentinus hirtiformis, L. strigellus, L. strigosus, and L. torulosus by possessing similar shaped pileus, tomentose or strigose stipe and similar kind of skeletal hyphae. They, however, differ from Lentinus sp. 2 by their squamulose or hairy pileus (either on the center or margin or both), short stipe (in L. hirtiformis and L. torulosus), gloeocystidia (in L. hirtiformis and L. strigellus), both inflated cheilocystidia and metuloidal pleurocystidia (in L. torulosus) or only metuloidal pleurocystidia (in L. strigosus and smaller spores.

MARASMIELLUS

Marasmiellus Murrill. 1915. North American Flora 9(4): 243.

Type species: M. juniperinus Murr. ibid.

This epithet Marasmiellus [etymology = diminutive of Marasmius which means "to become dry or dead" in Latin (Donk, 1962)] was first

used by William Alphonso Murrill (1915) for a group of fungi with small, irregular, reviving, strongly eccentric or laterally attached or sessile and lignicolous basidiomata, adnate or adnexed lamellae, filiform, tubular, short stipe, and hyaline (white in print) spores. He placed Marasmiellus together with Pleurotopsis, Scytinotus (= Panellus), Resupinatus, Panellus, Tectella, Heliomyces (= Marasmius), Marasmius, Crinipellis, Lentinus, Lentinula, Lentinellus, Lentodium (= Lentinus) and Lentodiellum (= Pleurotus) etc., most of which were pleurotoid genera) in subtribe Lepiotanae of the Agariceae, characterized by putrescent or reviving, fleshy or tough basidiomata with lamellate hymenium.

Singer (1986) characterized Marasmiellus by marasmioid-collybioid, mycenoid or pleurotoid revivescent or putrescent basidiomata, lamellate and often intervenose (but not favoloid-anastomosing) or rarely strongly reduced hymenium, central or eccentric or lateral or sessile stipe, completely gelatinized or pockets or zones of gelatinized tissue (then always non-anastomosing lamellae and fusoid basidioles mostly seen in pleurotoid species), non-amyloid, tramal hyphae with or without clamp connections, distinct rameales structure (with knobs, diverticulae or short ramifications) or replaced by poor, unrecognizable construction of epicuticular hyphae, white to pale cream, inamyloid, acyanophilous, smooth (without any eccentric bulge or spur) spores and lignicolous habit.

It is obvious that Murrill (1915) had Marasmiellus originally proposed for membraneous pleurotoid species with white spores while

the centrally stipitate white spored, non-amyloid species were placed in Marasmius. Singer (1938) separated some centrally stipitate species of Marasmius and treated them under Hemimycena, also characterized by lignicolous basidiomata with non-amyloid spores. Later, Singer (1951) transferred all those Hemimycena species to Marasmiellus which did not possess sarcodimitic pileus (large-celled hyphae intermixed with filamentous hyphae) and lamellar trama, but possessed basidiomata with gelatinized and clampless tramal hyphae, diverticulate pellicular hyphae or rameales structure, and white basidiomata with setoid dermatocystidia in epicutis. Therefore, Marasmiellus may be confused with Hemimycena but the latter differs generally by possessing weakly pleurotoid white and putrescent basidiomata and clamped but not gelatinized hyphae. Pleurotoid Marasmiellus can also be confused with Pleuromycenula because of possession of laterally stipitate or sessile pleurotoid and lignicolous fruitbodies with smooth or venose hymenium, at least capitate or diverticulate pileocystidia (at least near the lamellar margin) or caulocystidia, and inamyloid spores. Pleuromycenula, however, is distinct by characters reviewed in the key to the pleurotoid genera of the world. Corner (1991) considered that all agaric species with sarcodimitic trama [hence both Hemimycena and Pleuromycenula sensu Singer (1986)] should be included in Trogia. Redhead (1982) transferred some of Singer's Hemimycena to Helotium and a Pleuromycenula to Flabellimycena (Redhead, 1984a). Pleurotoid Marasmiellus can be distinguished from Campanella (see taxonomic treatment of Campanella), Cymatella, Flabellimycena, pleurotoid species of Marasmius, Pleuromycenula, Tetrapyrgos, and Trogia by

various features mentioned in the world key. Marasmiellus (especially agaricoid ones) can be confused with Helotium which includes both lignicolous and muscicolous species with non-amyloid spores. Marasmiellus can be distinguished from Helotium by the former's lack of sarcodimitic construction and noduloso-diverticulate epicutis.

Pterospora, a former genus (Horak, 1968, 1983b) regarded later by Horak (1986) as an invalid synonym of Tetrapyrgos (see the world key) was considered a synonym of Marasmiellus by Singer (1986). Horak (1986) treated species of Marasmiellus with cruciate spores and gelatinous tramal hyphae [equivalent to Singer's (1986) Marasmiellus sect. Nigripedes] as new genus Tetrapyrgos. Horak (1968a) considered M. ramealis [Singer's (1986) type species of Marasmiellus sect. Rameales] as the type species of a new genus Collybiopsis.

Because of generally small and inconspicuous basidiomata (not useful as food) there have been no previous reports of any Marasmiellus from Nepal. Here, I have included only two common species which appeared prominently pleurotoid to me when I was collecting in central Nepal.

Key to Nepalese species

1. Hymenium distinctly cross-veined; basidiomata strongly to slightly excentric; habit not gregarious.....M. kathmanduus

1. Hymenium without cross-veins; basidiomata slightly eccentric; habit gregarious.....M. transluscentus

Descriptions of Nepalese species

Marasmiellus kathmanduus H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 16A) convex, orbicular or hemispherical or reniform, strongly eccentrically attached, up to 27 mm diam, snow white all over [remaining white or auburn (7E5) or greyish orange (6B6) with Sudan Brown (6E7) flushes here and there on drying, dried specimens turning primuline yellow (3A7) with KOH solution], purplish grey (13E2) or dark black or dark purple black (13F1) towards attachment area; surface dry, subtomentose or slightly velvety, minutely irregularly pitted or bumpy in 10X, sometimes faintly wrinkled; margin incurved, finally straight, broadly sulcate striate, faintly crenate and broadly lobed (one or two times); flesh very thin, unchanging white, membraneous, soft. Lamellae attached or weakly decurrent, white [drying pale orange (5A3) or Brussels brown (6F6) with cross-veins completely burnt umber (7E7) or dark brown (7F5) or brownish grey (6F2) or grey (7F1)], purplish grey (13F2) towards the attachment area under 10 X, pruinose, broad (up to 2 mm), distant and intervenose withf 9-10 primary lamellae. Stipe cylindrical, short and strongly curved, strongly eccentric (not lateral), 1-1.5 mm long, up to 0.4 mm thick, solid; surface dark black or concolorous to pileus, white or concolorous, pruinose (as pileus) all over, sometimes bulged at base or also at the apex. Odor and taste not distinctive.

Microscopic features

Pileus composed of pileipellis, pileus trama and lamellar trama.

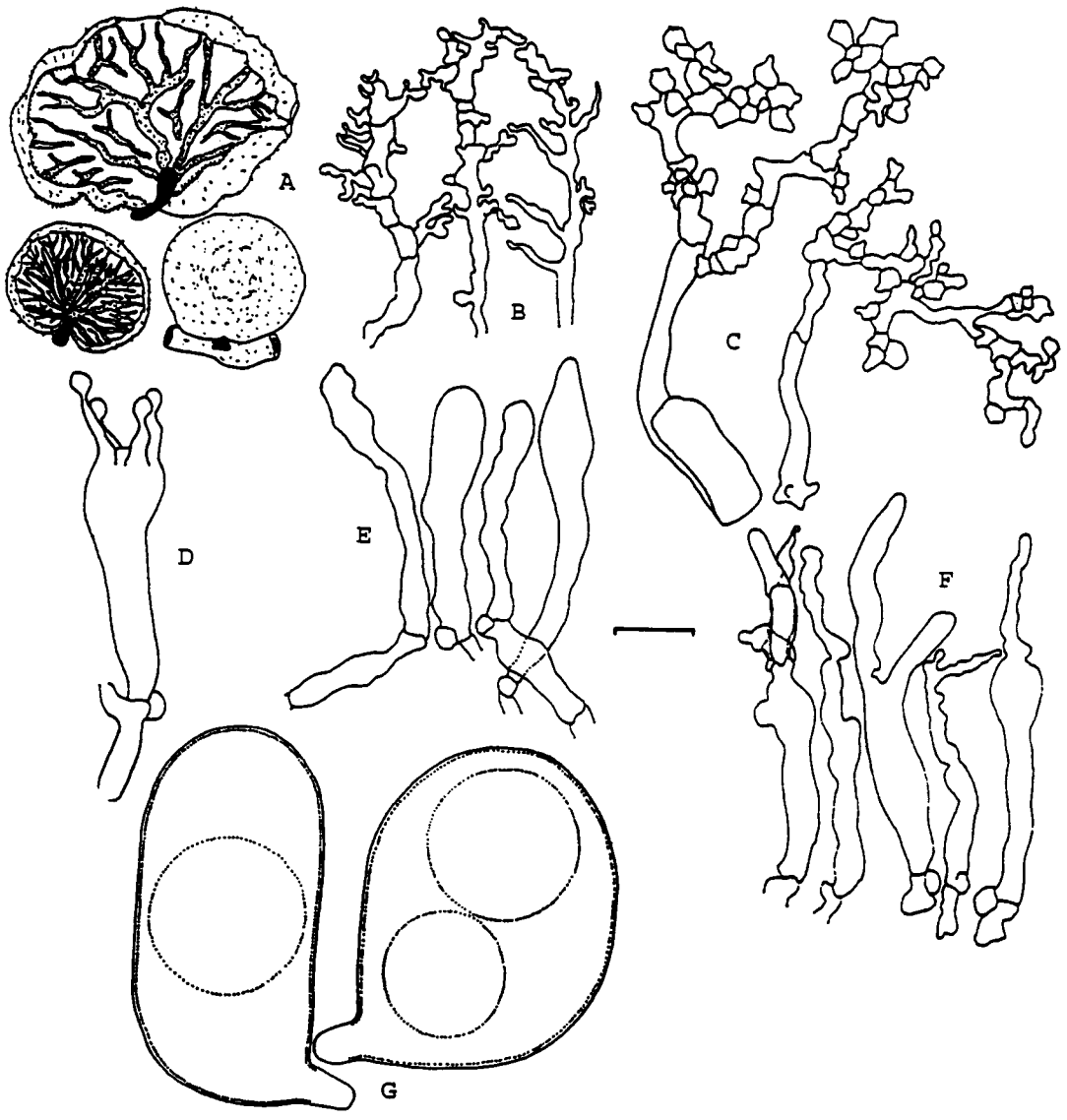


Figure 16 A-G. Features of Marasmius kathmanduus. A. Basidiomata (TENN. 51841, holotype). B. Rameales structure of peleicutis. C. Rameales structure of stipitipellis. D. Basidium. E. Cheilocystidia. F. Pleurocystidia. G. Basidiospores. Standard bar = 7 mm for A; 10 µm for B-F; 1.5 µm for G.

Pileipellis composed of loosely interwoven hyphae, up to 30 µm deep, giving rise to erect and well-developed rameales structures. Pileipellis hairs or rameales structure of pileicutis (Fig. 16B) up to 70 µm long, up to 2.3 µm diam, cylindric, erect, scattered, branched or diverticulate with numerous knobs at apex or at the side branches; wall slightly thick (up to 0.5 µm thick), smooth; clamp connections present; diverticula knob-like or linear (more common), irregular, branched, often with clamp connections. Pileus trama up to 110 µm deep (at the disc), greyish yellow or purplish or reddish brown in KOH solution, neither dextrinoid nor amyloid; hyphae loosely interwoven, branched, more laxly arranged near pileipellis, slightly more compact towards lamellar trama, 3.0-4.6 µm diam; wall smooth, slightly thick (up to 0.5 µm thick), gelatinized; clamp connections prominent, inflated up to 5.7 µm diam. Lamellar trama up to 100 µm broad (at the disc); hyphae interwoven or subparallel, brownish yellow in KOH, neither dextrinoid nor amyloid, gelatinized, similar but slightly more compactly arranged and more thick-walled (0.8-1 µm thick) than the hyphae of pileus trama. Stipitipellis hyphae similar to pileipellis, giving rise to erect rameales-structures (Fig. 16C); diverticula generally 1.9 µm broad, generally with knob-like rather than with linear diverticulate branches as in pileocutis. Stipe trama gelatinized; hyphae up to 7.6 µm diam; wall smooth and thick (up to 1.5 µm), neither dextrinoid nor amyloid. Subhymenium up to 22 µm deep, 3-4 celled layer, interwoven, conspicuous, dark reddish brown or brown in KOH solution. Basidia (Fig. 16D) 34.2-45.6(-68.4) X 6.5-9.5 µm, clavate, 4-sterigmate, clamped at base, slightly thick-walled (wall up

to 0.8 µm thick). Cheilocystidia of two types: 1) (Fig. 16E) 19-40.0 X 3.8-6.1 µm, clavate or cylindrical, not projecting at all or projecting up to 25 µm, with basal clamp; 2) (Fig. 16F) 36.1-60.0 X 2.3-7.6 µm, projected up to 20 µm, clavate rostrate or cylindrical, mostly septate leaving an empty non-staining (by Congo red reagent) apex; apex constricted once or several times, round or obtuse, thin and filiform to cylindrical; clamp connections present at base. Pleurocystidia similar to type 2) cheilocystidia. Basidiospores (Fig. 16G) 5.7-8.4 X 3.8-6.5 µm (Lm = 6.8, Wm = 4.8, E_m= 1.0-2.0, n = 25), white (assumed), ellipsoid to globular, smooth, non-amyloid, prominently uni- or biguttulate.

Habitat: Gregarious (but not cespitose) on decaying and fallen sticks of Viburnum erubescens shrub.

Specimen examined: Nepal, Kathmandu, Mt. Shivapuri Wildlife Reserve area (6400 ft), Coll. HRB and Kancha Sunar, 7.viii.90., TENN. 51841 (HOLOTYPE), (HRB 59(5), NHMTU. s.n. (ISOTYPE).

Etymology: Kathmandu = Capital city of Nepal where the fungus was collected.

Comments: Marasmiellus kathmanduus has been accommodated in Marasmiellus because of its distinctly diverticulate pileus and stipe pellicular hyphae, and inamyloid spores. It could not be accommodated in Marasmius because of presence of gelatinized tramal hyphae, absence of hymeniform broom cells in the epicutis and inamyloid tramal hyphae. It could not be acommodated in Campanella because of absence of cyphelloid habit, presence of distinct wiry excentric stipe, less

strongly ramified [or lack of consistently alveolate-anastomosing (Singer, 1973)] hymenium with less contrasting width between the primary and secondary lamellulae (unlike in Campanella). Marasmiellus kathmadauus can be identified in the field by its small (smaller than a dime) pleurotoid, milk white, thin and membraneous basidiomata growing on decaying sticks. Microscopically, it can be identified by highly diverticulate pilei- and stipitipellis hairs, non-diverticulate or weakly diverticulate, cylindrical, simple to branched cheilo- and pleurocystidia and spore measurements.

In the field, Marasmiellus kathmanduus appears similar to M. albuscorticis and other members belonging to Marasmiellus sect. Candidi (Singer, 1986) by possessing white pleurotoid basidiomata. Marasmiellus kathmanduus, however, is different from members of sect. Candidi by presence of gelatinized tramal hyphae (absent in sect. Candidi) and smaller spores [all members of sect. Candidi have spores larger than 10.4 µm (Singer, 1986)]. Marasmiellus kathmanduus can be confused with members of Marasmiellus sect. Distantifolii and sect. Nigripedes (= Tetrapyrgos) because of presence of pleurotoid habit and gelatinized trama. All species belonging to sect. Nigripedes (= Tetrapyrgos) can be distinguished from M. kathmanduus which has smooth instead of asymmetric [triangular (sometimes) or cruciate (Horak, 1983, 1986; Singer, 1986) spores. Marasmiellus kathmanduus can be distinguished from species of sect. Distantifolii which possess smaller spores [8.2-10.8 X 3-4 (9.5 X 3.5) µm for M. afer (Pegler, 1977); 10.5-12 X 4(-4.5) µm for M. cinereus; (6.5-)8-10(-11.2) X (3.7-)4-5.5 µm for M. corticum; (6.5-)8-13.2 X (3.5-)4-4.8 µm, mostly 9-

11.5 X ±4.5 µm for M. devenulatus; (8.5-)10.2-16 X 3.5-5(-6) µm, most frequently 11-13 X 3.5-4.3 µm for M. distantifolius; and 7.5-10 X 4.5-6 µm for M. merulius (Singer, 1973)]. Spore measurements of M. kathmanduus are similar to those of M. bambusicola [(= Leptoglossum bambusicolum) 6-8.5 X 3.7-4.7 µm (Corner, 1966)]. However, M. bambusicola differs by much reduced and un-ramified hymenophore (with only 1-4 rugulose veins), smaller pileus (3-11 mm broad), complete lack of cystidia and tropical distribution (Corner, 1966).

Marasmiellus transluscentus H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 17A) convex, then applanate, finally depressed or deeply infundibuliform, centrally or eccentrically attached, up to 13 mm broad, milk white or pale ochraceous buff (4A2), unchanging when bruised; surface minutely velutinous, white hairy or frosty at 10X; margin incurved, broadly sulcate-striate, undulate; flesh very thin, white, transparent-transluscent, gelatinous, soft, membraneous, white. Lamellae short decurrent, concolorous to pileus, medium-broad (up to 1 mm), distant or medium-distant, white pruinose under 10X, forked one or two times; lamellulae present; edge smooth, white pruinose to slightly white floccose in 10X, sharp. Stipe central or eccentric, cylindrical, up to 6 mm long, up to 0.5 mm thick, concolorous to pileus, curved, downy white especially at center (in 10X), solid, gelatinous; base slightly swollen with a white, strigose, hairy basal tomentum. Odor and taste not distinct.

Microscopic features

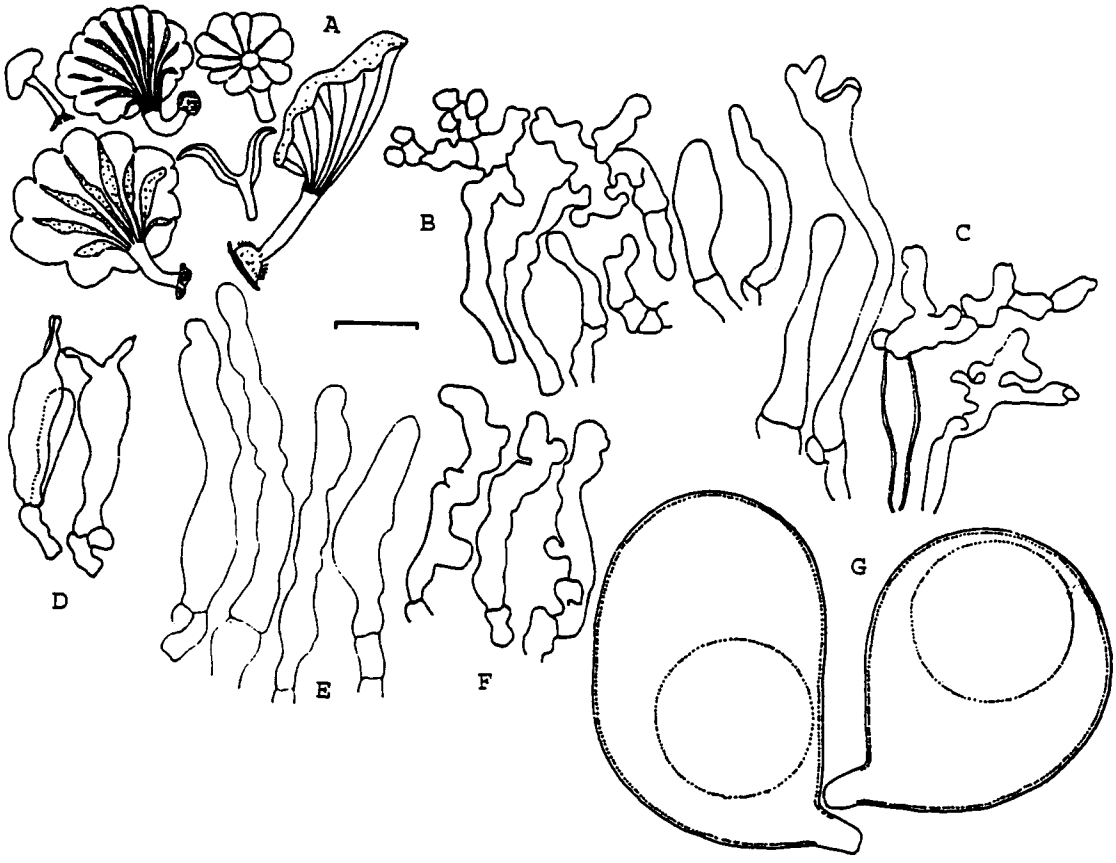


Figure 17 A-G. Features of Marasmius transluscentus. A. Basidiomata (TENN. 51842, holotype). B. Rameales structure of pileicutis. C. Rameales structure of Stipitipellis. D. Basidia & basidiole. E. Cheilocystidia. F. Pleurocystidia. G. Basidiospores. Standard bar = 6 mm for A; 10 µm for B-F; 1.5 µm for G.

Pileus composed of pileipellis (with clavate or occasionally diverticulate hairs), pileus trama and lamellar trama. Pileipellis a cutis, up to 15 µm deep, 3-4 cells deep, periclinally arranged; hyphae 3.0-3.8 µm diam, occasionally giving rise to erect or subprostrate hairs. Pileipellis hairs (Fig. 17B) up to 20(-70) µm long, (2.3-)3.8-4.9(-5.7) µm diam, with usually cylindrical or clavate or capitate or cystidiate apex (dilated up to 12.5 µm diam), occasionally branched or strangulate and coiled or diverticulated with a few knobs and branched protuberances, hyaline, with slightly thick wall (wall up to 0.4 µm thick). Stipitipellis hairs or caulocystidia (Fig. 17C) similar to cystidiate pileipellis hairs, occasionally with diverticulate or rameales structure possessing short knobs or coralloid branches; clamp connections prominent at base. Stipe trama gelatinized; hyphae transversely oriented, isodiametric, compactly arranged, up to 20.9 µm diam; wall thick (up to 2 µm thick), gelatinized. Pileus trama up to 250 µm deep, gelatinized; hyphae mostly radial or interwoven, up to 3.5-9.5(-22) µm diam, inflated, hyaline, neither amyloid nor dextrinoid, smooth and slightly thick-walled (wall up to 0.8 µm thick); clamp connections present. Lamellar trama up to 150 µm broad, parallel or subparallel, gelatinized; hyphae similar to those of pileus trama. Subhymenium not conspicuous, 2-3 cells thick. Basidia (Fig. 17D) 24.7-45.6 X 3.8-6.1 µm, 2-sterigmate, clavate or cylindric-clavate, clamped at base. Cheilocystidia (Fig. 17E) 30.4-60.0 X 4.6-5.7 µm, cylindrical or narrowly clavate, sometimes faintly strangulate, non-projecting. Pleurocystidia of two types: 1) 20.3-24.5 X 4.2-2.5 µm, basidioliform, clavate, or cylindrical, sometimes

slightly strangulate or flexuous, non-projecting; and 2) (Fig. 17F) 20.9-30.4 X 1.9-6.1 µm, cylindrical, flexuous-strangulate, occasionally weakly diverticulate with one or two subtle knobs at apex or base, non-projecting. Basidiospores (Fig. 17G) 5.3-7.6 X 3.8-5.7 µm (Lm = 6.45, Wm = 4.64, E_m= 1.16-1.56, n = 20), subglobose to ellipsoid, white (assumed), hyaline, inamyloid, smooth, thin-walled, uniguttulate or multiguttulate with one prominent guttule, hilar appendage prominent.

Habitat: Gregarious on dried and decaying standing stem and stilt roots of bamboo (Dendrocalamus species).

Specimen examined: Nepal, Kathmandu, Mt. Ranibari (4400 ft), coll. HRB, 6.vii.91., TENN. 51842 (HOLOTYPE), [HRB 33, NHMTU. s.n. (ISOTYPE)].

Etymology: Transluscent = the transluscent or gelatinous nature of basidiomata.

Comments: Marasmiellus transluscentus has been accommodated in Marasmiellus sect. Distantifolii (Singer, 1986) because of its gelatinized tramal hyphae, pleurotoid habit, presence of rameales structure in pilei- and stipitipellis, and non-amyloid, smooth-walled spores. It did not fit in Campanella because of non-ramified lamellate hymenium. Though M. transluscentus resembles Hydropus (Singer, 1982, 1986) by possessing inflated hymeniform epicuticular or pellicular hyphae, and eccentrically (not laterally) stipitate mycenoid-omphalioid basidiomata, it did not fit in Hydropus because it possessed white, non-blackening (when handled) and non-watery (or non-

milky) basidiomata, rameales structure in the epicutis, absence of sarcodimitic construction in stipe and pileus trama and absence of pseudocystidia or metuloids. Marasmiellus transluscentus can be identified in the field by its eccentrically stipitate, white and gelatinized or transluscent-appearing minute basidiomata growing gregariously on the dry and decaying bamboo stems and stilt roots. Microscopically, M. transluscentus could be identified by its hymeniform epicuticular cells with clavate or inflated apex, and occasional rameales structure, two-spored basidia, slightly diverticulate non-projecting cheilocystidia and spore measurements.

Marasmiellus transluscentus can be distinguished from most species of sect. Distantifolii by small-sized spores [10.5-12 X 4-4.5 μm for M. cinereus; (6.5-)8-13.2 X (3.5-)4-4.8 μm for M. devenalatus ; and 11-13 X 3.5-4.3 um for M. distantifolius; and 7.5-10 X 4.5-6 μm for M. merulius; (Singer, 1973)].

NEOLENTINUS

Neolentinus Redhead & Ginns. 1985. Trans. mycol. Soc. Japan 26: 357.

Type species: Lentinus kauffmanii Smith in Bier & Nobles. 1946. Canad. J. Res., Sect. C. 24: 118.

Neolentinus is a recently named genus (Redhead and Ginns, 1985) belonging to the Polyporaceae (= Pleurotaceae) tribe Lentineae. Redhead and Ginns (1985) gathered nine species, all of which had been placed earlier in Lentinus (Corner, 1981; Pegler, 1983c). Neolentinus is mainly characterized by: 1) production of brown rot; 2) binucleate spores; 3) bipolar mating system; and 4) regular hymenophoral trama.

Lentinus: 1) causes white rot; 2) produces uninucleate spores; 3) shows a tetrapolar mating system; and 4) has irregular hymenophoral trama. Redhead and Ginns (1985) were able to correlate a relationship between the orientation of hymenophoral trama and type of wood rot, thus reinforcing the importance of the type of rot in the taxonomy of these fungi. Earlier, Singer (1975a) and Kühner (1980) had attempted to delimit these fungi in the basis of structure of the lamellar trama but their method of classification could not suffice because there were a number of exceptional species. Corner (1981) and Pegler (1975, 1983c) emphasized hyphal construction (see Pleurotus) in order to sharply circumscribe these groups of fungi, but they also had to confront a number of exceptions.

According to Redhead and Ginns (1985), establishment of Neolentinus would not only homogenize Lentinus but also help solve the old problem of separating Lentinus from Pleurotus. Both Corner (1981) and Pegler (1983c) admitted that some species which they had treated as Lentinus [e.g. N. lepideus (= L. lepideus) and N. kauffmanii (= L. kauffmanii)] did not fit in Lentinus based on their hyphal systems, which more resembled Pleurotus than Lentinus.

Reijnders and Stalpers (1992) found that the ability to cause brown rot is indeed correlated with formation of a regular hymenophoral trama in Neolentinus adhaerens, N. cyathiformis, N. lepideus, N. suavissimus and N. tigrinus, thus supporting Redhead and Ginns (1985). Moreover, their studies showed that the texture of lamellae was also dependent on the developmental phase of the

fruitbodies. In the species mentioned above, although they invariably found a regular hymenophoral trama it occurred only in an early stage of hymenophore development in some species, while the regular trama showed up in much later stages in others. According to Reijnders & Stalpers (1992), some species classified in Panus and Pleurotus also exhibited regular hymenophoral trama which meant that the structure of hymenophoral trama alone [as proposed by Singer (1975) and Kühner (1980)] could not be a strong generic diagnosis for these pleurotoid groups.

Neolentinus can be confused with a number of Pleurotus species but the two genera can be separated very sharply in the basis of presence of nematophagous cheilo- or pleurocystidia and hyphal-pegs in Pleurotus absent in Neolentinus. Thorn and Barron (Redhead and Ginns, 1985) found that none of the Lentinus and Neolentinus species tested possessed nematotoxic properties, unlike Pleurotus.

Heliocybe, Hypsizygus and Ossicaulis may also be confused with Neolentinus. However, Heliocybe can be distinguished by its monomitic, thick-walled and clampless tramal hyphae, Hypsizygus (a brown-rot producing genus like Neolentinus) by absence of skeletal hyphae and Ossicaulis by possession of thick-walled monomitic tramal hyphae.

Singer (1986) considered Neolentinus a synonym of Lentinus while Watling and Gregory (1989) followed Pegler's (1983d) idea for classification of Lentinus, thus not agreeing with Redhead and Ginn's (1985) inclusion of L. adhaerens and L. lepideus in Neolentinus.

Including Neolentinus species 1 (see below) and N. tigrinus reported earlier by Pegler (1983c: as Lentinus tigrinus) there are two

species of Neolentinus now known from Nepal.

Key to Nepalese species

1. Hyphal pegs (fascicles of unbranched hyphae projecting from the hymenium) present; skeleto-ligative hyphae present; annulus present; (not treated here).....N. tigrinus

1. Hyphal pegs absent; skeleto-ligative hyphae absent; annulus not observed (in dry specimen).....N. species 1

Description of Nepalese species

Neolentinus species 1

Macroscopic features (description from exsiccates)

Pileus (Fig. 18A) convex, then applanate, attached subeccentrically with slight umbonate center, up to 50 mm diam, pale ochraceous buff (4A2), pale cinnamon pink (5A2), pale orange (5A3) with light brown (6D6) or faded light brown concentric appressed, triangular scales (made of tuft of hairs at 10X), dense, smaller, and slightly darker towards center, sparse and shining pale ochraceous buff (4A2) toward margin; surface glabrous, dry; flesh tough and woody, thick (up to 4 mm) toward center, 1 mm at margin, pale cinnamon pink (5A2), gradually thinning towards margin. Lamellae sinuate, decurrent by a tooth, interveining towards stipe apex, pale ochraceous buff (4A2) or greyish orange (5B4) towards margin, stained or flushed auburn (7E5) or vandyke brown (7E6) toward center, broad (up to 5 mm),

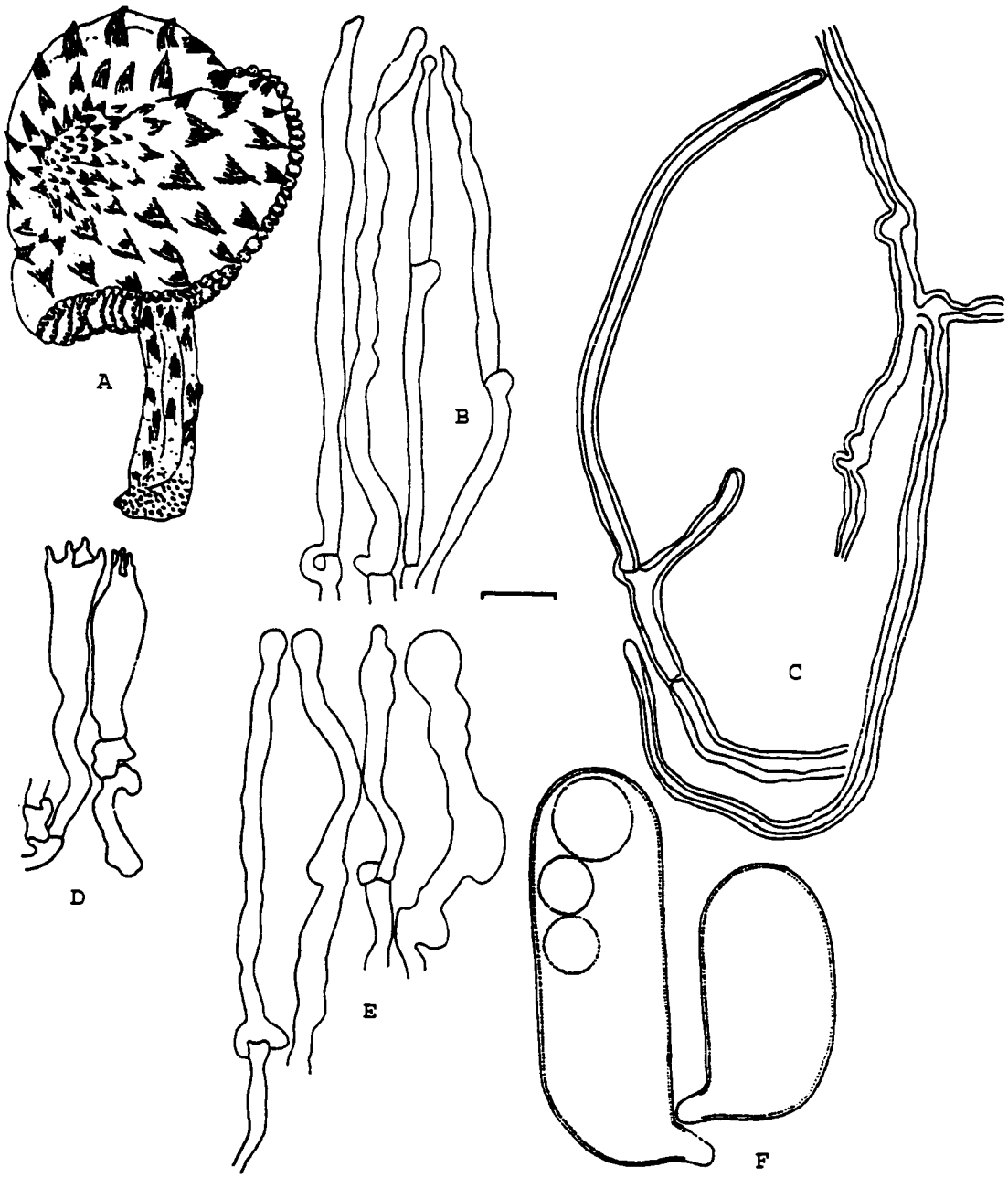


Figure 18 A-F. Features of Neolentinus species 1. A. Basidioma (TENN. 51849). B. Pileipellis hairs. C. Skeletal hyphae. D. Basidia. E. Cheilocystidia. F. Basidiospores. Standard bar = 10 mm for A; 10 µm for B, D & E; 20 µm for C; 1.5 µm for F.

subdistant, with lamellulae of three or four ranks; edge minutely crenate, rather eroded, minutely marginate (more distinct under 10 X) or lined or dotted with dark brown (7F5 or 8F5) or grey (9F1) pigments. Stipe up to 45 mm long, up to 8 mm thick, slightly eccentric, pale ochraceous buff (4A2) with minute dark grey (9F1) dots or pigments toward apex as well as base, cylindric and narrowing downward with a very slightly enlarged base, solid, woody, slightly ribbed longitudinally; pigments continuous from the lamellae edge downward to the stipe apex; base with sparse appressed, concolorous (to pileus) or dark brown (7F4 or 7F2 7F1) smaller and denser scales and also minute pigments. Odor and taste not known.

Microscopic features:

Pileus composed of pileipellis, pileus trama and lamellar trama. Pileipellis an epicutis of repent to radial hyphae, loosely interwoven, up to 35 µm deep, frequently giving rise to loose fascicles of repent to suberect hairs; base of the fascicles up to 34 µm diam. Pileipellis hairs (Fig. 18B) up to 46 µm long; hyphae 3.4-6.8 µm diam, slightly and irregularly dilated here and there and also at tip; tip round, sometimes slightly constricted; wall up to 0.4 µm thick; clamp connections present, inflated to 4.2 µm on a 2.7 µm diam hypha. Pileus trama loosely interwoven, up to 200 µm deep towards margin; hyphae dimitic, mostly generative. Generative hyphae up to 8 µm diam, hyaline, smooth-walled, inflated, branched, thin-walled (wall up to 0.4 µm thick); clamp connections present, inflated to 8.4 µm on a 6.1 µm hypha. Skeletal hyphae (Fig. 18C) 3.8-10.6 µm diam, mostly produced at septa of generative hyphae, hyaline, smooth-walled, thick-

walled (wall 1.5-5.3 µm thick), sparingly branched; branches not tapering and not filiform; clamp connections distinct, inflated up to 11.5 um; apex rounded. Lamellar trama slightly more densely interwoven than pileus trama, up to 600 µm thick, regular, mostly made of skeletal hyphae; skeletal hyphae similar to those of pileus trama. Gill edge brown or dark brown under KOH. Subhymenium distinct, up to three cells and 15.2 µm thick, interwoven. Hyphal pegs absent. Basidia (Fig. 18D) 17.1-41.8 X 2.7-8.4 µm, clavate, 4-sterigmate, clamped at base. Cheilocystidia (Fig. 18E) 32-114 X 3.0-8.7 µm, cylindrical, generally projecting up to 30 µm, hyaline, thin- or thick-walled (wall up to 1.2 µm thick); apex round, slightly constricted, sometimes septate; base clamped. Pleurocystidia not differentiated. Basidiospores (Fig. 18F) 5.7-10.6 X 3.8-3.0 µm (Lm = 8.2, Wm = 3.5, Em = 1.9-2.8, n = 51), white (assumed), cylindrical, hyaline, thin-walled, non-amyloid, mono- or multiguttulate.

Habitat: Unknown.

Specimen examined: Nepal, Around Jiri (6,000 ft), 5.X.88., M. K. Adhikary, NH 88046, TENN. 51843.

Comments: Neolentinus species 1 can be identified in the field by its convex or plane, squamulose pileus, sinuate-decurrent, crenate, emarginate (dark-brown or black pigmented gill-edge) gills and squamulose stipe. Presence of distinct dimitic trama (with skeletal and generative hyphae), regular gill-trama, spore dimensions and elongated cystidiiform hairs are some of its important microscopic features.

This fungus fits in Neolentinus because of lentinoid habit (coriaceous and eccentrically attached basidiome), non-amyloid white spores, dimitic trama with skeletal hyphae, and regular hymenophoral trama.

Neolentinus species 1 resembles N. lepideus reported by Pegler (1983c) from south Asian countries (neighboring Nepal). Common features shared by N. lepideus and Neolentinus species 1 are presence of squamulose and undepressed pileus, sinuate-decurrent lamellae with dentate-eroded edge, fibrillose-squamulose stipe, repent to erect pileipellis hairs, elongated cystidiiform hairs, skeletal hyphae, and close distribution range in South Asia. Neolentinus species 1, however, differs from N. lepideus by the former's dark brown or black line of pigment at the lamellar edge, thick-walled (up to 1.2 µm thick) emergent cystidiiform hairs and much smaller spores [8.5-12.5 X 4.7 µm for N. lepideus (Pegler, 1983d)].

Neolentinus tigrinus [= Lentinus tigrinus (Pegler, 1983d)] resembles Neolentinus species 1 by appressed squamulose pileus, squamulose and slightly eccentric (not lateral) stipe, regular gill trama and spore size. The two species are distinct, however, both macroscopically as well as microscopically. Neolentinus tigrinus has concave to deeply infundibuliform pileus, annulate stipe, hyphal pegs, skeleto-ligative hyphae and emergent skeleto-ligative cheilocystidia unlike Neolentinus species 1.

Neolentinus species 1 may look similar to N. ponderosus in possessing an undepressed to appressed-squamulose pileus, sinuate-adnate lamellae, regular gill-trama, absence of hyphal pegs,

unbranched skeletal hyphae and cystidiiform hairs in the lamellar-edge. Neolentinus ponderosus, however, is distinctly different, with large pileus, short, very thick, smooth stipe, and much larger spores [8.5-12.5(-14) X 4-5 µm (Pegler, 1983)].

In the absence of first-hand information on the type of rot Neolentinus species 1 produces in nature (or test of mycelial cultures for lignin or cellulose degradation), as well as on its morphological features (habit of the fresh specimens and habitat preference) the fungus could not be proposed as a new species.

OMPHALOTUS

Omphalotus Fayod. 1889. Ann. Sc. Nat. sér. VII. 9: 338.

Type species: Pleurotus olearius (D.C.: Fr.) Gillet. 1874. Hym. France 344.

Omphalotus was proposed by M. V. Fayod (1889) for a new genus characterized by excentrically or sublaterally attached basidiomata with parallel or regularly arranged, clamped tramal hyphae, coriaceous stipe and pileus flesh, distinct subhymenium, lack of cystidia, and obovoid spores with prominent hilar appendage. Fayod (1889) placed Omphalotus in tribe Pleurotés, characterized by persistent cuticle primordial cells, regular trama, and distinct subhymenium. Fayod (1889: 231) was aware that both mycelium and carpophores of Omphalotus olearius (type species) were phosphorescent.

Singer (1986) characterized Omphalotus by lignicolous, cespitose habit intermediate between pleurotoid and clitocyboid, fleshy and

always bright colored basidiomata, deeply decurrent and lamellate hymenium, white, subglobose to short-ellipsoid, hyaline, non-amyloid, and cyanophilic spores, 4-sterigmate as well 1-sterigmate (pseudoparaphysoid) basidia, clamped tramal hyphae, irregular to subregular lamellar trama with axillar trend (near the thin subhymenial layer) and lack of cyanic acid but producing thelephoric, atromentic, xerocomic and variegatic acids, gyroporin and atromentin.

Singer (1951, 1962a, 1975a) placed Omphalotus together with Lampteromyces and Clitocybe in tribe Clitocybeae of the Tricholomataceae because of white, non-amyloid, smooth spores and clitocyboid habit. The taxonomic position of Omphalotus, to this date, is mainly based on its chemical composition. As envisoned by Moser (1983), Singer (1986) transferred Omphalotus from the Tricholomataceae to the family Paxillaceae in the order Boletales because of close similarities of Omphalotus to Hygrophoropsis [a member of Paxillaceae (Moser, 1983; Singer, 1986)]. Both possess fruiting bodies with fleshy, involute margin, decurrent, yellow, orange or brown pigmented lamellae, cream-white to brown, subglobose, ovate or elliptical, cyanophilous non-amyloid spores, and various pigments and chemicals (which are not present in members of Tricholomataceae) namely atromentin (Singh and Anchel, 1971), variegatorubin, involutin and atromentic, xerocomic, and variegatic acids. On the other hand, unlike Omphalotus, Hygrophoropsis was found to be an unusual fungus which causes brown-rot on one hand and contrastingly also degrade cellulose in pure culture (cellulose degrading ability is a characteristic feature of white-rot causing fungi). Therefore, Nilsson & Ginns (1979)

segregated Hygrophoropsis into the family Coniophoraceae. Kämmerer et al (1985) placed Omphalotus in a new family Omphalotaceae together with Lampteromyces on the basis of presence of characteristic sesquiterpenes (illudan and illudalan type) and their ability to cause white-rot. They have placed the Omphalotaceae in the order Boletales (because of the presence of typical pigments and cyanophilous spores also found in other members of Boletales) together with the sister family Paxillaceae and Coniophoraceae (which also possess similar kinds of pigments characteristic of Boletales). Members of the Coniophoraceae have been verified to possess pulvinic acid derivatives also found in boletes and Paxillus species (Bresinsky, 1973, 1974; Kämmerer, 1983). Therefore, although a distinctly lamellate fungus, Omphalotus was proved to resemble poroid fleshy members having Boletales. Kühner (1980; 900) believed that the Boletales were related to the Tricholomatales (Agaricales) via Omphalotus and Hygrophoropsis.

Corner (1981) treated Omphalotus as a synonym of Pleurotus (see Pleurotus). Monoadelphus is an old name of Omphalotus and some Omphalotus species were treated as Clitocybe, Flammula, Panus, or Pleurotus species in the past (Singer, 1986).

Omphalotus can be confused with pleurotoid or non-pleurotoid lignicolous Clitocybe. The two genera resemble so much that the North-American forms of Omphalotus illudens (Bresinsky & Besl, 1985; Petersen, 1977) were popular as Clitocybe illudens and C. subilludens (= Monoadelphus subilludens; see below in O. olearius) for a long time until they were finally transferred to Omphalotus because of: 1)

anatomical-morphological and ecological point of view (Singer, 1962); 2) because of production of chemicals not found in Clitocybe (Bresinsky & Besl, 1985) e.g. illudin group of sesquiterpenes, compounds of the pulvinic acid group (Carey, 1974) and polyacetylenes (Anchel et al, 1962); 3) mating studies (Petersen, 1977). Omphalotus, therefore, can be distinguished from Clitocybe by the former's bright ochre or orange colored fruiting bodies, presence of pigments characteristic of family Boletales (see above), caespitose habit and globose, cyanophilic (rarely or slightly cyanophilic in Clitocybe) spores. Omphalotus can also be confused with its sister genus Lampteromyces and excentrically attached Lentinus and Pleurotus species, and other similar looking pleurotoid genera which can be distinguished by the features mentioned in the world key.

Omphalotus is a cosmopolitan genus (Singer, 1986). From Nepal it was first reported by Cotter (1987). It is also present in some of the neighboring countries to Nepal viz. China (Tai, 1979) and India (Manjula, 1983).

Description of Nepalese species

Omphalotus olearius (DC. ex Fr.) Sing. 1889. Ann. Sc. Nat. Bot. 338.

Macroscopic features

Pileus (Fig. 19A) clitocyboid, cyathiform or infundibuliform, deeply depressed, up to 78 mm broad, up to 35 mm wide, henna (7E8) or somalis-henna (7E7) at the center with concolorous or brick red (7D7) hairy or wooly tomentum, fading to burnt Sienna (7D8) or maize (4A6) or butter yellow (4A5) or light yellow (4A4) towards margin; drying

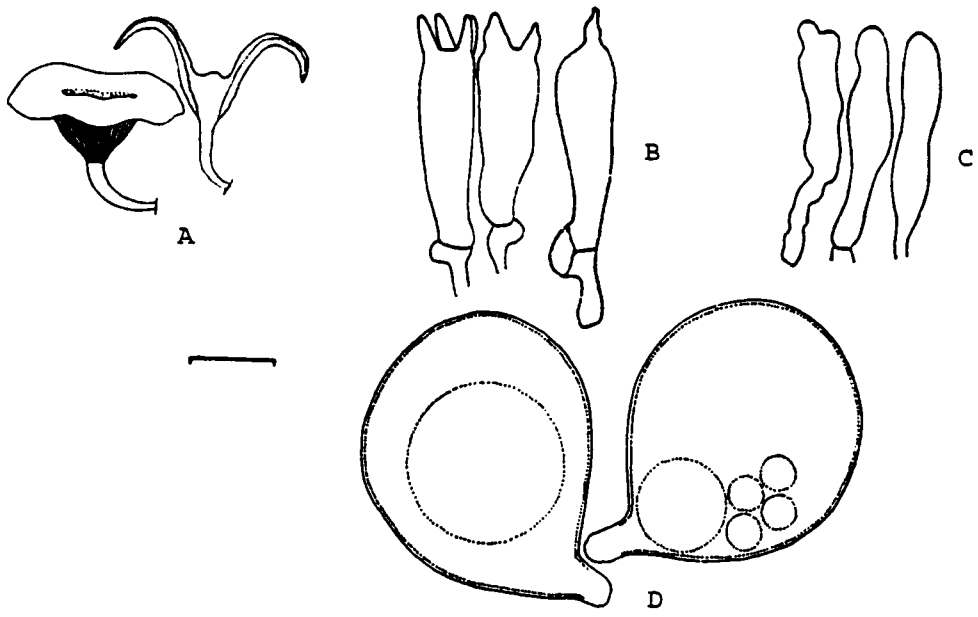


Figure 19 A-D. Features of Omphalotus olearius. A. Basidiomata (TENN. 51845). B. Basidia. C. Cheilocystidia. D. Basidiospores. Standard bar = 15 mm for A; 10 µm for B & C; 1.5 µm for D.

yellow ochre or oxide yellow (5C7) all over with violet brown (10F6) and dark greyish brown (11F3) coloration toward center and with occasional dark olive green (29F2) scattered patches here and there; center highly depressed (up to 25 mm deep in a 35 mm high pileus), papillate, appearing concentrically wrinkled-zoned after drying; surface smooth, glabrous, silky or glistening; margin incurved, finely eroded, finely striate, shortly rimose; flesh leathery, soft, pliant, fleshy, medium thick (up to 4 mm thick at the center), pale yellow. Lamellae strongly decurrent, butter yellow (4A5) or champagne (4A4), brownish orange (6C8) towards stem apex, medium broad (up to 4 mm), crowded or subdistant, undulate, forked up to 3 levels (especially near attachment to stipe), with abundant lamellulae; edge entire, sharp, concolorous to the pileus, slightly darker or raw Sienna (6D7) when drying. Stipe cylindrical, long, up to 65 mm long, 7 mm diam, slightly thinner towards base, concolorous to the pileus throughout or glistening brickred (7D7) or dark brown (7F8) towards tip, finely longitudinally striate; striations or ridges brick red (7D7); flesh fibrous, soft, glistening pale yellow towards apex, light brown (6D8) or raw Sienna (6D7) or dark brown at base. Phosphorescence not recorded. Odor agreeable. Taste mild.

Microscopic features

Pileus composed of pileipellis, pileus trama and lamellar trama. Pileipellis a loosely woven repent layer; hyphae 2.5-3.5 μm diam, cylindrical, hyaline, non-amyloid, smooth and slightly thick-walled (wall up to 0.4 μm thick); sometimes with orange ochre contents (in KOH solution); clamp connections present. Stipitipellis a cutis giving

rise to erect fascicled or solitary hairs, up to 30 µm long, 2.7-4.6 µm diam, similar to pileipellis hyphae; hyphal tip undifferentiated, round; clamp connections prominent, inflated up to 5.6 µm diam. Pileus trama up to 100 µm deep (at the pileus margin), somewhat loosely arranged or lacunose towards lamellar trama, pallid to brownish yellow in Melzer's reagent, yellowish in KOH solution; hyphae subparallel, up to 6.5 µm diam, hyaline, non-amyloid, branched; wall smooth, up to 0.8 µm thick; clamp connections prominent. Sarcodimitic construction absent. Lamellar trama up to 150 µm broad, subparallel; hyphae similar to those of pileus trama. Subhymenium narrow, 2-3 celled layer. Basidia (Fig. 19B) 24.7-34.2 X 7.6-9.5 µm, 4-spored, occasionally 1- or 2-spored, clavate, prominently guttulate and with yellowish contents, clamped at base. Cheilocystidia (Fig. 19C) 20.9-33.1 X 3.8-7.6 µm, as pseudocystidia, projected up to 15 µm, clavate, basidioliform, sometimes slightly knobbed at the apex, yellow in KOH solution, gttulate. Pleurocystidia similar to cheilocystidia. Basidiospores (Fig. 19D) 5.7-6.8 X 4.6-6.8 µm (Lm = 5.7, Wm = 5.0, E_m= 1-1.23, n = 25), subglobose or globose, yellowish white in print, smooth, thin-walled, non-amyloid, prominently appendiculate and uniguttulate or multiguttulate; contents glistening yellow in KOH solution.

Habitat: Cespitose (with numerous fruiting bodies) on dead or fallen old stump of Quercus glauca and other angiosperms.

Specimens examined: Nepal, Kathmandu, Nagarjun Ban (5540 ft), coll. H. Van T. Cotter and Penny Ellis, 23.ix.85., VC1400, NHMTU. 2-2-02940, TENN. 51844; Kathmandu, Suryabinayak (South slope of Karki

Danda, 4600 ft), coll. HRB, 15.vii.91., HRB 77, TENN. 51845.

Comments: This fungus has been tentatively identified as Omphalotus olearius because of its variously brown shaded and ochre-brown colored, dry, smooth, clitocyboid basidiomata, pseudoparaphysoid (presence of 1-, 2-, or 3-sterigmate) basidia, globose to subglobose and similar-sized spores (Bigelow et al, 1976; Bresinsky & Besl, 1985; Horak, 1968; Kämmerer et al, 1985; Miller, 1979; Singer, 1986; Watling and Gregory, 1989) and lack of prominent cystidia.

According to Watling & Gregory (1989), Omphalotus olearius is reported to exist in varying shades of yellow, orange or brown color and there is also the possibility of various taxonomic subunits. The bright ochre-brown or golden-brown specimens (especially TENN. 51845 from central Nepal) rather resembled the dark ochre-brown (with a slight orange tint) basidiomata with much elongated stipe from North America [specimens from Tennessee area (TENN. 51746 & TENN. 51750) and information from literature (Bresinsky & Besl, 1985)]. In fact, O. illudens is said to be another form of O. olearius (Arora, 1979; Bresinsky & Besl, 1985; Miller, 1979). According to Petersen (1977), both O. olearius and O. illudens, including O. subilludens [= (Monadelphus subilludens), another North American form believed to be a different species (Smith, 1975)], although morphologically different, were genetically similar and hence represented a single biological species ['syngameons' (Petersen, 1977)] because monokaryotic strains of all the above forms collected from Europe and North America were completely intercompatible. Since Nepalese specimens also possessed some features (much depressed and thin-fleshed basidiomata)

different from both European and North American collections, it would be interesting to carry out mating studies in order to understand the amount of genetical variability in Nepalese collections in relation to European and North American collections.

PANELLUS

Panellus Karsten 1879. Bidrag Kannedom Finlands NaturFolk 32: XIV, 96.

Type species: P. stypticus (Bull.: Fr.) Karsten

Panellus was first proposed as a genus by Karsten (1879). Kühner and Romagnesi (1953) regarded Fries's (1836) genus Panus to be separable into Panellus, characterized by amyloid spores, and Panus with inamyloid spores. Kühner and Romagnesi (1953) placed Panellus in the family Pleurotacées (Pleurotaceae), characterized by pleurotoid genera with lignicolous or epiphytic habit, and hyphae with clamp connections. They characterized Panellus by colorless (under microscope), amyloid, elongate spores, entire or non-serrate lamellae and lateral stipe. Leptoglossum (= Arrhenia), Lentinellus, Geopetalum (= Faerberia), Panus, Lentinus, Pleurotus, Pleurotellus and Crepidotus were sister genera.

According to Singer (1951, 1986), Panellus is characterized by sessile to short-stipitate pleurotoid basidiomata with gelatinized or thick-walled pileus tramal hyphae, thick-walled hymenophoral tramal hyphae, thin-walled cheilocystidia, amyloid, smooth, allantoid to narrowly elliptical, small, white to yellow spores and lignicolous habit. Singer (1951, 1986) placed Panellus in tribe Panelleae

(characterized by gelatinized or thick-walled tramal hyphae and amyloid small spores) close to tribes Schizophylleae, Resupinateae, Lentineae, Hemimyceneae, and Marasmieae, various genera of which can be distinguished from Panellus by features mentioned in the world key. Panellus was placed in the family Tricholomataceae (order Agaricales) because of proesence of bilateral-divergent hymenophoral trama, well-developed non-waxy lamellate hymenophore, amyloid or slightly amyloid spores, and monomitic tramal system. Pleurotoid members of Collybieae (Singer, 1986) resembled Panelleae but the former possessed non-amyloid spores.

Singer's (1986) recent classification of tribe Panelleae includes Tectella and Dictyopanus together with Panellus. Tectella is distinguished from Panellus by presence (in the former) of a veil that covers the lamellae and two-layered pileus trama, of which the upper layer alone is gelatinized. Dictyopanus is distinguished by having poroid or favoloid hymenophore. Burdsall and Miller (1975) had transferred Dictyopanus to Panellus subgenus Panellus because of the ovoid amyloid spores, well-developed lateral stipe, similar growth habit [with the exception of pores instead of gills in Dictyopanus pusillus (= Favolus rhipidium or Polyporus rhipidium) dry cuticle of densely entangled hyphae penetrated by pileocystidia with refractive contents, and bioluminescent nature of mycelial culture as well as the basidiomes.

Panellus can be confused with a number of genera like Lentinellus, Hohenbuehelia, Resupinatus, Sarcomyxa and other resembling genera which can be separated by diagnostic characters

mentioned in the world key.

Orientation of gelatinzed hyphae in Panellus appears similar to many other agarics (e.g. Campanella, Marasmiellus, Pleurotopsis, Sarcomyxa, etc.) except Resupinateae, that exhibit gelatinized fruitbodies. In Panellus, the gelatinous hyphae are arranged at right angle to the axis or plane of cross-section of the pileus. As a result, in an unsquashed cross-section mount, the gelatinized walls (observable as thickened hyphal-walls) of every individual hyphae can be observed in close contact with the gelatinized walls of neighboring hyphae. Therefore, the whole gelatinous trama looks like a honeycomb of closely packed cells with every individual cell surrounded on all sides by its thick or gelatinized walls (see key to the world genera). In members of the Resupinateae, however, gelatinous hyphae are arranged parallel to the axis or plane of cross section of pileus so that the gelatinized hyphae appear radially arranged and the thickened or gelatinized walls of individual hyphae do not appear distinct. As a result, in an unsquashed cross-section mount, the whole mass of hyphae appears immersed in a common gelatinous mass.

Of the two species of Panellus now known to occur in Nepal, P. stypticus was reported earlier (Adhikary, 1988a).

Panellus does not have popular edible species. In central Nepal, P. edulus (see below) is used as familiar food source in a small village of Kathmandu Valley.

Key to Nepalese species

1. Both cheilo- and pleurocystidia rostrate (with long or short pointed beak); branched cheilocystidia absent; pileus trama lacunose.....P. edulus

1. Neither cheilo- nor pleurocystidia rostrate; branched cheilocystidia present; pileus trama not lacunose.....P. stypticus

Descriptions of Nepalese species

Panellus edulus H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 20A) spathulate, dimidiate, cyathiform or cupulate, laterally attached, up to 32 mm broad, up to 22 mm wide,greyish orange (5B4 or 5B3) to light brown (7E6) towards attachment area, turning dark brown (6F6) on bruising or aging, walnut brown (7D6) or dark brown (7E6) when young; surface covered all over by silky appressed hairs (distinct under 10X) which are dense inward when young, remaining only at the margin when mature, finally thinly wrinkled longitudinally; margin incurved, dark reddish brown due to concolorous appressed hairs, not striate; flesh thin (up to 0.5 mm thick), in some abnormally fleshy specimens flesh up to 2 mm thick (as well as thicker and wider lamellae), snow-white, brittle, unchanging in colour. Lamellae radiating from a central point, crowded, 3-4 per mm, narrow to medium broad (in some specimens, up to 15 mm broad), white at first, then pale orange (5A3) or pinkish buff (6A3), slightly darker

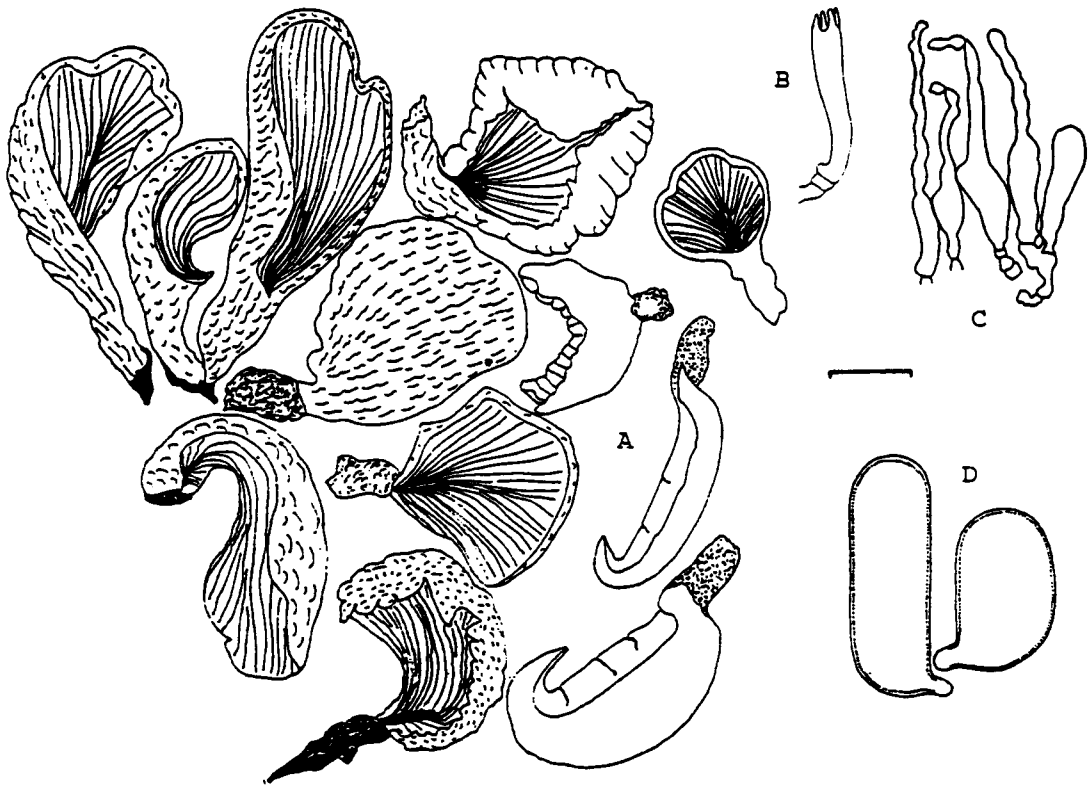


Figure 20 A-D. Features of Panellus edulus. A. Basidiomata (TENN. 51846, holotype). B. Basidium. C. Cheilocystidia. D. Basidiospores. Standard Bar = 6 mm for A; 10 µm for B & C; 1.5 µm for D.

towards base than towards edge, light orange (5A4 or 5A5) at first, finally dark brown (6F5 or 6F6) on bruising or staining; lamellulae abundant; edge entire or minutely dentate or eroded (only under 10X). Stipe or pseudostipe represented by a continuation of pileus, cylindrical, narrowing towards base (attachment area), short, up to 5 mm long, 4 mm diam, walnut brown or dark brown at base due to thick covering of hairs concolorous to the pileus, sparsely hairy toward pileus attachment, at first solid; surface indistinctly longitudinally rugose. Odor sharp and typically fungoid. Taste very slightly bitter at first with mild after-effect.

Microscopic features

Pileus composed of pileipellis with scattered hairs, pileus trama, and lamellar trama. Pileipellis 1-3 cells deep; hyphae horizontally interwoven, up to 5.7 µm diam, clamped, giving rise to short hyphal protuberances or long, scattered or more often fascicled (up to 130 µm long and 15 µm broad at base) erect hairs; hyphae of hairs 2.6-3.4(-6.0) µm diam, thick-walled (wall up to 1 µm thick), compactly arranged in the fascicles; hyphal tips obtuse, not differentiated; clamp connections present, inflated up to 6.9 µm diam. Pileus trama composed of three layers: 1) upper pileus trama gelatinous, about 60 µm deep (toward center of pileus); pallid in Melzer's reagent, deep red in Congo red; hyphae up to 4.8 µm diam, compactly interwoven, thick-walled (wall up to 0.8 µm thick and gelatinised); clamp connections present, inflated up to 6.0 µm diam; 2) middle pileus trama gelatinised, up to 250 µm thick, sometimes lacunose or honey comb-like; hyphae with thick and gelatinized wall,

similar to those of upper pileus trama; 3) lower pileus trama up to 50 µm thick, gelatinized, not lacunose; hyphae compactly woven and similar to those of upper pileus trama. Lamellar trama gelatinized, irregular, composed of compactly interwoven hyphae similar to those of upper pileus trama. Stipitipellis a cutis giving rise to fascicles of compact hairs similar to those of the pileipellis; clamp connections present; hyphae inflated up to 12.0 µm diam; wall thin or thick. Subhymenium no more than a 2-celled layer, 12.0 µm thick. Basidia (Fig. 20B) 12.4-17.6 X 3.4-4.1 µm, clavate to almost cylindrical, 4-sterigmate, sometimes 2-sterigmate and with unequal sterigmata. Cheilocystidia (Fig. 20C) 10.8-40.6 X 2.7-6.2 µm, projecting up 30 µm, clavate-rostrate or cylindrical-rostrate, with long or short apical beak, slightly thick-walled (wall up to 0.5 µm thick); beak up to 20 µm long, cylindrical, sometimes undulate, sometimes with slightly swollen apex. Pleurocystidia similar to rostrate cheilocystidia. Basidiospores (Fig. 20D) [2.7-5.5 X 1.3-2.0 µm (Lm = 3.8, Wm = 1.8, Em = 1.6-2.8, n = 50) including the hilar appendage], white (assumed), ellipsoid or cylindrical or somewhat allantoid, smooth, weakly amyloid, cyanophilous, guttulate, sometimes the appendage carrying a piece of sterigma.

Habitat: Growing gregariously on decaying standing or fallen stump of Quercus spp. or Lithocarpus pachyphylla.

Specimens examined: Nepal, Kathmandu, Shivapuri Watershed Management Area, close to Malpokhari (alt. 4900 ft), col. H. R. Bhandary, Uttam Manandhar, and Kancha Sunwar, 7.vii.90., TENN. 51846

(HOLOTYPE), [HRB 63, NHMTU. s.n. (ISOTYPE)]; Kathmandu, Shivapuri Watershed Management Area (Shivapuri Wildlife Reserve Area), below Mahadevsthan (alt. 5000 ft), coll. H. R. Bhandary, Kancha Sunwar and Gyanendra Karki, 11.viii.90., HRB 19, TENN. 51847.

Etymology: Edulus = edible.

Comments: This species has been accommodated in Panellus because of its lignicolous and pleurotoid habit, gelatinous trama, and amyloid, minute spores. Panellus edulus can be identified in the field by its minutely hairy, brown, pleurotoid basidiomata growing cespitosely on the decaying stumps of oak. In the field, P. stypticus can be distinguished from P. edulus by the latter's light brown or brown [pale yellow or ochraceous buff in P. stypticus (Miller, 1970; Adhikary, 1988)] fruitbody with shallow crowded gills and pseudostipe. A lacunose pileus tramal layer, rostrate cheilo- and pleurocystidia with extended beak, and spore dimensions are the microscopic features by which P. edulus can be distinguished from other Panellus species. In accordance with Singer (1986), P. edulus can be accommodated in subg. Serotinia because of presence of thin-walled pleurocystidia. In this subgenus there are three species (Singer, 1986) of which P. edulus differs from P. pteridophytorum by the latter's white pileus and growth habit on ferns (Libonati-Barnes, 1981; Singer, 1986). Panellus nubigenus ssp. australis and P. stenocystis are different from P. edulus by their growth habit on bamboo and absence of rostrate-clavate pleurocystidia with elongated beak (Libonati-Barnes, 1981; Singer, 1986). Panellus edulus resembles P. aureofactus in size, shape and laterally attached, dry, fibrillose basidiomata and spore dimensions

[spore measurements of P. aureofactus are 3.5-5 X 0.8-1.2 μm (Horak, 1980)] but the latter is different by submetuloid or occasionally encrusted fusoid to lageniform cheilocystidia. Panellus edulus resembles P. rupicola in size and color of basidiomata but the latter differs by having larger spores [5-6.3 X 2-2.7 μm (Singer, 1942)]. Both P. aureofactus and P. rupicola have been reported from Himalayan regions of India, close to Nepal.

Panellus edulus, so far only reported from the northern part of Kathmandu valley, is an edible mushroom for a small local community. It is called Kukur Kanney Chyau in Nepali language, meaning inferior Pleurotus or oyster mushroom because of its pleurotoid habit. Some local people reportedly bring the decaying stumps (on which it is found growing) to their home, leave it in a humid place, and water it regularly in order to get continuous harvest of gregariously growing fruitbodies.

Panellus stypticus (Bull.: Fr.) Karsten. 1897. Hattsvamper 1: 96.

Macroscopic features (descriptions from exsiccates)

Pileus (Fig. 21A) spathulate when young, then conchate to dimidiate to reniform, 11-15 mm long, 15-22 mm broad, convex to plano-convex, depressed at base, areolate when dry, somewhat scaly (Adhikary, 1988) concentrically zoned, yellowish when fresh (Adhikary, 1988a), pale yellow-orange (4A3) or greyish orange (5B5) or topaz (5C5) or tawny ochraceous (6C6) or walnut brown (7D6) or Rood's brown (7D5) towards base, greyish orange (6B5) or tawny ochraceous (6C5-6C6) or topaz (5C5) or amber brown (6D7) to walnut brown (7D6) towards

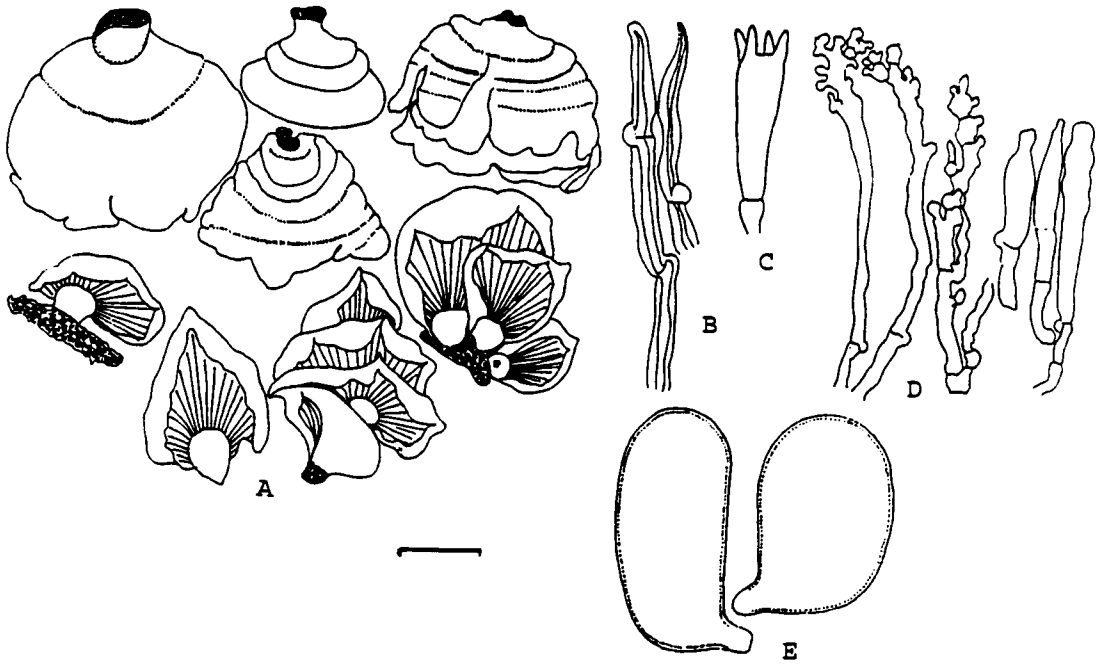


Figure 21 A-E. Features of Panellus stypticus. A. Basidiomata (TENN. 51849). B. Thick-walled (gelatinized) and clamped tramal hyphae. C. Basidium. D. Cheilocystidia. E. Basidiospores. Standard bar = 6.5 mm for A; 10 µm for B-E; 1.5 µm for F.

margin; tawny ochraceous (6C6) or Amber brown (6D7) at first, then Sudan brown (6E7) or Brussels brown (6E6) or mummy brown (6F8) or olive brown (6F5) or glistening brownish grey (6F2) or grey (6F1) with 3 % KOH solution; margin incurved, sometimes finely striate to 1 mm, slightly lobed; flesh tough, orange buff (5A5) to light ochraceous buff (5A4), 1 mm thick, gradually thinning towards margin. Lamellae close, narrow, often forked, brownish orange (7C5) to walnut brown (7D6) or Rood's brown (7D5); lamellulae present; edge even or sometimes eroded. Stipe 3-4 mm long, 3 mm broad, eccentric or lateral, minutely pale cinnamon pink (5A2) or pale orange (5A3) fibrillose, somewhat constricted at base. Odor, taste and bioluminesence not recorded.

Microscopic features

Pileus composed of pileipellis, upper trama, lower trama, and lamellar trama layers. Pileipellis a tangle of clamped hyphae with scattered pileocystidia; pileocystidia cylindrical, branched or unbranched, up to 80 um long, 2.4-5(-6) µm diam, slightly thick-walled (wall 0.2-0.9 µm thick); tip undifferentiated, obtuse, hyaline in KOH, yellowish in Melzer's reagent. Pileus trama obscurely divided into upper and lower trama. Upper trama gelatinous, up to 20 µm thick, dark tan or dark reddish brown in KOH, pallid ochraceous in Melzer's reagent; hyphae (Fig. 21B) interwoven, horizontal and mostly vertical or upright, 1-11 µm diam, smooth, thick-walled (wall up to 3.0 µm thick), clamped; clamp inflated to 6.6 µm. Lower pileus trama up to 150 µm deep, hyaline in KOH, pallid ochraceous in Melzer's reagent; hyphae similar to those of upper trama, not gelatinized. Lamellar

trama parallel; hyphae continious and similar to pileus trama, hyaline to yellowish in KOH, pallid ochraceous in Melzer's reagent; gill edge gelatinized, glassy in KOH. Stipitipellis with thick, triangular fascicles of compact hyphae; fascicles erect, acute, circum 33 µm long, 15 µm broad (at base); individual hyphae cyanophilous, gelatinous, 2.3-3.5 µm diam, thick-walled (wall up to 1.1 µm thick), smooth, inamyloid, clamped; clamps inflated to 4.2 µm. Basidia (Fig. 21C) 11.4-22 X 3.5-6.6 µm, clavate, clamped at base, 4-sterigmate, slightly thick-walled. Cheilocystidia of two types: 1) (Fig. 21D, at left) 11.5-55.5 X 2.2-4.4 µm, projecting up to 20µm, cylindrical with branched or coralloid or diverticulate apex, abundant, crowded; 2) (Fig. 21D, at right) 11-66 X 4.5-6.6 µm, projecting up to 20 µm, narrowly clavate or cylindric, clavate-rostrate, fusiformm or bifurcate at apex. Pleurocystidia similar to 2) type of cheilocystidia. Basidiospores (Fig. 21E) [3.4-4.0 X 1.7-2.4 µm (Lm = 3.4, Wm = 2.1, E_m= 1.2-1.8, n = 25), including the hilar appendages], white, minute, cylindrical, sometimes nearly allantoid, amyloid.

Habitat: Tightly packed in imbricate clusters on fallen stump of Quercus leucotricophora or Q. lamellosa or Q. semecarpifolia.

Specimens examined: Nepal, Langtang National Park, Rasuwa district, along trail between Ghora Tabela and Lama Hotel (8810 ft), coll. H. Van T. Cotter and Prem K. Rai, 9.VIII.85, VC. 1264; Nepal, Kathmandu, Thankot, Mt. Chandragiri (2220 ft), coll. M. K. Adhikary, 16.X.86; NH. 8611.1; Kathmandu, Mt. Shivapuri (6,500 ft), coll. HRB and Bhaiya Khanal, 20.XI.88, HRB s.n., NHMTU. s.n., TENN. 51849.

Comments: The above description of Panellus stypticus from Nepal corresponds to that by Miller (1970), and Burdsall and Miller (1975) from North America, and by Watling and Gregory (1989) from Britain. However, the following variations were observed in Nepalese collections: 1) spores slightly smaller than those reported for collections from USA and Britain (3-4.5 X 1-2.2 µm) and also reported by Horak (1968) for the type specimen (3.5-6 X 2-3 µm); 2) cheilocystidia longer than observed in collections from USA and Britain (17-45 X 3.5-6 µm); and 3) pleurocystidia slightly shorter than those reported in collections of USA and Britain (40-70 X 3-4.5 µm). Exsiccates (TENN 46056, 46207, 46211) from the Appalachian Mountain area had slightly larger carpophores (TENN 46211), pale yellowish color [also reported by Adhikary (1988) for Nepalese collections] and possessed only occasional branched cheilocystidia. Basidiomata (TENN 36011, coll. Moser) from Austria were rusty brown (also described from U.S. collections by Miller, 1970), possessed branched cheilocystidia more frequently and therefore looked more similar to the specimens from Nepal. Panellus stypticus was first reported from Nepal by Adhikary (1988a). Panellus stypticus var. stypticus differs from P. stypticus var. albido-tomentosus by the latter's yellowish white basidiomes and complete lack of cystidia (Bi et al, 1986).

Panellus stypticus, a cosmopolitan fungus. Its edible or toxic status in Nepal is unknown. Miller (1979) reported that North American P. stypticus (bioluminescent variety) is non-poisonous. According to Arora (1979), P. stypticus has a very unpleasant, astringent taste and

is not edible. Petersen and Bermudes (1992) found that unlike acrid (in taste) North American species, Asian collections of P. stypticus produced no sensation (but possessed nauseating taste) in the mouth when tasted. Both Arora (1979) and Miller (1979) agree, however, that the non-bioluminiscent P. serotinus (= Sarcomyxa serotina), which occurs also in Nepal (but information on edibility uknown), is edible.

Panellus stypticus is bioluminescent mushroom like a number of other genera viz. Armillariella, Lampteromyces, Mycena, Omphalotus and Pleurotus (O'Kane et al, 1990). Its bioluminescent form, however, occurs only in eastern North America, whereas P. stypticus found in Europe and Asia are not bioluminescent (Buller, 1924; Macrae, 1942). The intensity of bioluminescence in North American P. stypticus varies over fruitbody parts [lamellae and pileus surface (Ellis, 1886; Buller, 1924, Macrae, 1942); lamellar edge, pileus margin, pileus surface and stipe (O'Kane et al, 1990); growth stage (Calleja and Reynolds, 1970; O'Kane et al, 1990), substrate (O'Kane et al, 1990), and growth condition of mycelial cultures (Bermudes et al, 1990). According to Lingle et al (1986), O'Kane et al (1990: 605) and Petersen and Bermudes (1992a,b) a non-bioluminescent form of P. stypticus also occurs in North America. Petersen and Bermudes (1992a,b) have verified that mono- and dikaryotic mycelial cultures of P. stypticus from Asia (Japan, Russia, New Zealand) were non-luminescent. However, they showed that non-luminescent Japanese collections and luminescent North American collections were sexually compatible and hence belonged to the same biological species. Petersen

and Bermudes (1992a,b) also concluded that taste of fresh carpophores of P. stypticus is variable across the geographic range. The theory that bioluminescence is related with insect attraction and therefore to spore dispersal (Ewart, 1906; Sivinski, 1981) in P. stypticus has not been established. According to Miller (1970), luminescence in North American specimens of P. stypticus could be best observed in temperatures from 10-25 °C in a dark room and could be tested by observing negative results after exposing photographic film to the gills in complete darkness.

PLEUROTOPSIS

Pleurotopsis (P. Henn.) Earle. 1909. Bull. New York Bot. Gard. 6: 412.

Type species: Marasmius spodoleucus Berkeley et Broome. 1859. Ann. Mag. Nat. Hist. III. 3: 358: Notices on British fungi.

The name Pleurotopsis [etymology = appearance like Pleurotus (Donk, 1962)] was first used by P. Hennings (1898) as a section of Marasmius [adopted from Fries (1874), and Saccardo's (1887) Marasmius subg. Apus] characterized by fungi with sessile and resupinate, membranaceous, reviving, thin, basidiomata with decurrent (or radiating from a point) lamellae and white white spores. Subsequently, Berkeley and Broome (1859) and Rabenhorst (1862) placed Henning's Marasmius sect. Pleurotopsis under Marasmius. Earle (1909) finally treated Pleurotopsis as a separate genus characterized mainly by the pleurotoid habit.

Pleurotopsis could be circumscribed more clearly on the basis of its type species (Pleurotopsis spodoleucus = Marasmius spodoleucus) by

cyphelloid or pleurotoid habit, distinctly lamellate hymenium, gelatinous pileus and lamellar trama, inamyloid allantoid white spores and lignicolous habit (Horak, 1968). Horak's (1979, 1983a) inclusion of Pleurotopsis longinqua in this genus has extended the generic delimitation by eccentrically, laterally or dorsally attached pleurotoid basidiomata, gelatinized pileocutis (including pileus and gill trama), cylindrical to allantoid amyloid spores and often diverticulate cystidia.

Pleurotopsis most closely resembles Panellus through a number of common characters of which the most important are gelatinized tramal hyphae and amyloid spores. Moreover, Singer (1986) considered Pleurotopsis synonymous to Panellus and Singer (1952, 1986) treated a pleurotoid agaric (Panellus longinquus) as Panellus, now considered to be a Pleurotopsis (P. longinqua) by Horak (1983a) and Petersen (1992) on the basis of presence of gelatinous pileipellis (Horak, 1983a), diverticulate cystidia (caulo- and cheilocystidia) and much larger spores than Panellus.

Dennis et al (1960) and Singer (1986) regarded Pleurotopsis spodoleucus (type species of Pleurotopsis) a synonym of Resupinatus cyphelliformis (= Hohenbuehelia cyphelliformis) because of presence of gelatinous tramal hyphae and allantoid non-amyloid (only in the type species but amyloid in other species) spores in both genera. Hohenbuehelia and Pleurotopsis, however, are different from one another not only because of absence of nematophagous habit in the latter but also because of different orientation of the gelatinized

(see world key and Panellus) pileus and tramal hyphae. In Pleurotopsis arrangement of gelatinized tramal hyphae is similar to that of Panellus but not to Hohenbuehelia (see Panellus and Hohenbuehelia). Similarly, Pleurotopsis can be confused with Plicaturopsis, completely different from Agaricoid fungi by its merulioid hymenium (see Plicaturopsis below) and hyphae with non-inflated porate clamp connections. Because of similar looking pleurotoid, lignicolous basidiomata of the two fungi, Singer (1942) had transferred Pleurotopsis into Plicatura (Rea, 1968). Plicaturopsis is now regarded as a member of the Schizophyllaceae either under the Agaricales (Watling and Gregory, 1989) or the Aphyllophorales (Donk, 1964; Singer, 1986). Donk (1951) treated Pleurotopsis as a member of the Cyphellaceae because of the cyphelloid basidiomata of M. spodoleucus, but Donk (1962: 237) later supported M. spodoleucus as the type species of Pleurotopsis. Velenovsky (1939) described M. spodoleucus under the name Urceolus. For Singer (1986) Urceolus is a synonym of Hohenbuehelia.

This is the first report of occurrence of Pleurotopsis from Nepal Himalaya.

Description of Nepalese species

Pleurotopsis species 1

Macroscopic features (description from exsiccates)

Pileus (Fig. 22A) semiorbicular, orbicular or conchate, laterally attached, 30 mm broad, 27 mm wide, greyish brown or brownish grey or negro (9F2 or 9F3) at disc, pompeian yellow (5C6) towards margin;

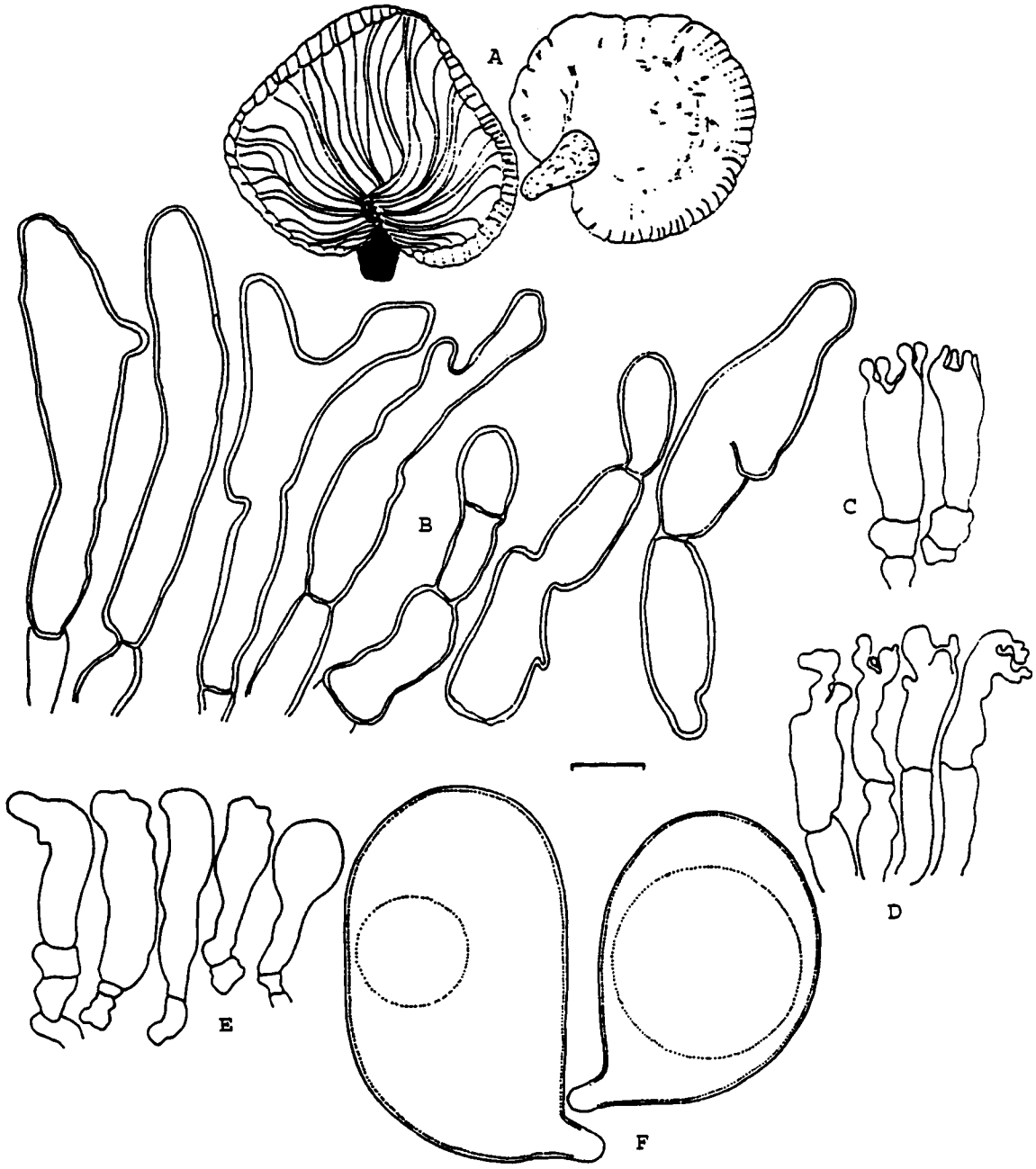


Figure 22 A-F. Features of Pleurotopsis species 1. A. Basidiomata (NH 88005, TENN. 51850). B. Stipitipellis elements. C. Basidia. D. Diverticulate cheilocystidia. E. Pleurocystidia. F. Basidiospores. Standard bar = 8 mm for A; 10 µm for B-E;1.5 µm for F.

surface minutely wrinkled, glabrous; margin glabrous, incurved, with distinctly reddish brown (8E4) medium-distant striations, transluscent; flesh gelatinous, pompeian yellow (5C5), thin (0.3 mm thick at center). Lamellae short or strongly decurrent, broad (up to 5 mm), dark brown (9F4) or greyish brown (9F3) or brownish grey (9F2), some light brown (6D5 or 6D6) towards edge, forked, glabrous; lamellulae of 2-3 ranks; edge entire, sharp, glabrous. Stipe lateral, distinct, thick, short, natal brown (8E6) to dark brown (9E5), narrow downward. Odor and taste not recorded.

Microscopic features

Pileus composed of pileipellis (with hairs), pileus trama and lamellar trama. Pileipellis a thin eroded layer, hyphae 3.8 µm diam, periclinally arranged, with gelatinized, smooth, thick wall (wall up to 2 µm thick). Pileipellis hairs trichomatous, single, scattered or fasciculate, erect to subrepent, up to 160 µm long, 3.8-7.7 (-22.8) µm diam, slightly inflated towards septa, sometimes strangulate or constricted several times; wall thick (1.1-2.7 µm), gelatinized, smooth; tip obtuse, not differentiated; clamps present, but not prominent because of thickening of hyphal wall. Stipitipellis hairs or caulocystidia (Fig. 22B) clustered, 15.7-60.1 X 8-19 µm, septate, 1-4 celled, terminal cell narrowly clavate to broadly clavate, with occasional nodular or knob-like short projections, sometimes bifurkate; cells constricted and easily separable at septa; apex round, sometimes bifurkate but no diverticulate branches observed; clamp connection indistinct. Pileus trama 170-400 µm deep (near center of pileus), composed of two gelatinized layers: 1) upper layer (close

to pileipellis) 120-300 μm deep, appearing lacunose; hyphae usually 5.7 μm diam, periclinally arranged; wall gelatinized, thick (up to 1 μm), smooth; 2) lower layer up to 50-100 μm deep; hyphae slightly more compactly and irregularly arranged than the previous layer, other features of the hyphae similar to those of the upper layer. Lamellar trama up to 150 μm broad, regular or parallel, gelatinized; mediostratum distinct, 60 μm thick; hyphae similar to those of pileus trama. Subhymenium up to 40 μm broad, several cell layers thick, gelatinized, conspicuous. Basidia (Fig. 22C) 19.8-32.6 X 5.7-8.7 μm, 4-sterigmate, clavate or narrowly clavate, multiguttulate, clamped at base. Cheilocystidia (Fig. 22D) 19-22.8 X 3.8-4.2 μm, clavate and mostly basidioliform, occasionally with one or two inconspicuous knobs or bulges at tip and inconspicuously constricted or strangulate below, very rarely branched or coralliform at tip. Pleurocystidia (Fig. 22E) similar to cheilocystidia but never branched or coralliform at tip. Gill edge fertile. Basidiospores (Fig. 22F) 6.5-9.5 X 4.9-5.7(-6.1) μm (Lm = 8.1, Wm = 5.5, E_m= 1.3-1.7, n = 25), short-cylindric to ellipsoid, white (assumed), smooth, hyaline, amyloid, multiguttulate to prominently uniguttulate.

Habitat: On wood (other information not known).

Specimen examined: Nepal, around Jiri (7000 ft), Dolkha district, coll. Mr. M. K. Adhikary, 3.X.88., MKA s.n., NH 88005, TENN. 51850.

Comments: This fungus has been accommodated in Pleurotopsis (and not in Panellus) mainly because of its gelatinized pileipellis (including pileipellis hairs, pileus trama, lamellar trama and

subhymenium), peeling pileipellis and amyloid spores larger than those of Panellus.

Pleurotopsis species 1 can be recognized in the field by its very short, laterally stipitate, thin-fleshed, lignicolous basidiomata and broad lamellae. Microscopically, it can be identified by gelatinized hyphae of epicutis, pileus trama, lamellar trama, and subhymenium, occasional coralloid cheilocystidia, clavate or broadly clavate, knobed or bulged or bifurcate caulocystidia and spore dimensions.

Pleurotopsis species 1 is different from P. spodoleucus by the latter's sessile, cyphelloid or resupinate basidiomata, and reniform or strongly curved, inamyloid spores [7-9 X 3-3.5 μm: (Horak, 1968)]. Pleurotopsis species 1 closely resembles P. longinqua (Singer, 1954; Petersen, 1992) and P. longinquus subsp. pacificus (Libonati-Barnes & Redhead, 1984) by similar size and thick-fleshed, membraneous, lignicolous, pleurotoid, short-stipitate basidiomata, peeling or flaking and gelatinized pileipellis, gelatinized pileus and lamellar trama (including subhymenium), occasional coralloid cheilocystidia, clavate or broadly clavate, occasionally knobbed or bulged caulocystidia, and ellipsoid or short-cylindric amyloid spores. Pleurotopsis sp. 1, however, is different by possessing broader spores than P. longinqua subsp. longinqua [6.8-8 X 2.7 μm (Singer and Digilio, 1952) or 6.8-9.7 X 2.7-4.5 μm (Singer, 1954)], slightly larger and broader spores with much lesser length/width ratio than P. longinqua [6.6-8.6 X 3.5-4.1 μmand E = 1.7-2.27 μm (Petersen, 1992)] and much smaller spores with similarly smaller length/width ratio than those of P. longinquus subsp. pacificus [6-11.5(-13.5) X 3-5.0(-6) μm

and E = 1.75-3.25 µm (Libonati-Barnes and Redhead, 1984)]. According to Petersen (pers. comm.) the Australian, New Zealand, and Pacific Northwest collections of P. longinqua are all one biological species and all infraspecific variation in P. longinqua can be seen in New Zealand populations (Petersen, 1992). Data on pileus coloration of fresh specimens of Pleurotopsis sp. 1 was not available.

PLEUROTUS

Pleurotus (Fr.) Quéllet. 1872. Champ. Jura Vosges p. 62.

Type species (typ. cons.): P. ostreatus (Jacquin: Fr.) Kummer. 1871. Der Führer in die Pilzkunde, 105, 1871.

Fries (1821) first adopted Pleurotus as Agaricus tribus Pleurotus, to a group of fungi with excentric or sessile white-spored basidiomata accommodated in series Leucospori of Agaricus. Kummer (1871) considered Pleurotus a separate genus characterized by soft or leathery, edible mushrooms with excentrically stipitate, sessile or resupinate fruitbodies. Although Kummer (1871) validly published Pleurotus as a genus name and antedated Quélet (1872) by one year, Pleurotus (Fr.) Quél. was conserved by the Paris Congress in 1954 (Donk, 1962).

By using the same basic concept as Fries, Quélet (1872, 1888) gave the name Pleurotus to a group of fungi placed in tribe Lenti, characterized by excentric stipe, adnate or sinuate or decurrent gills, white spores and lignicolous habit. He believed that Pleurotus was not only related to the pleurotoid (sometimes centrally stipitate)

Lentinus and Panus but also to Marasmius, characterized by inamyloid white spores, corticolous habit, central eccentric stipe and adnate to sinuate lamellae. Quélet put all these genera in tribe Lenti. Pleurotus included many white-spored shell-shaped fungi even after micromorphology became important in fungal taxonomy. Consequently, a large, artificial assemblage developed, members of which were later transferred to widely differing genera.

Singer (1951) characterized Pleurotus by pleurotoid habit (eccentric stipe, decurrent lamellae, lignicolous habit), light-colored, non-amyloid, cylindric spores, well-differentiated subhymenium and at first placed it with Asterotus, Geopetalum, Lentinus, Panus and Phyllotopsis in the family Tricholomataceae (Agaricales). Singer (1962a, 1986) later transferred Pleurotus along with Lentinus and Panus to the family Polyporaceae [(= Pleurotaceae) because of presence of irregular or regular, dimitic or amphimitic (also monomitic) hymenophoral trama] to the Agaricales (fungi with non-thickening hymenium). The newly placed Polyporaceae or Pleurotaceae (also see Lentinus) was characterized by fungi with poroid or lamellate hymenophore, irregular or regular hymenophoral trama, monomitic, dimitic or amphimitic hyphal system and rather elongated, non-amyloid spores. The family consists of two tribes Polyporeae and Lentineae.

Despite more carefully defined circumscriptions in recent years (Kühner, 1980; Singer, 1986; Corner, 1981; Pegler, 1983c) Pleurotus still provokes controversies as regards separation from the two traditionally close sister genera Panus and Lentinus (for more, see

Lentinus). Kühner (1980) emphasized hyphal construction of the lamellar trama for separation of the three genera and restricted Pleurotus to mono- or dimitic species with irregular lamellar trama and Lentinus to dimitic species with more or less regular lamellar trama and binucleate basidiospores. Corner (1981) tried to separate these three genera by hyphal characters: Pleurotus was monomitic with generative [thick-walled or sclerified (Bresinsky et al, 1976) or thin-walled hyphae possessing clamp connections at certan intervals] or dimitic [with generative hyphae plus skeletal hyphae (thick-walled tapering lateral branches of generative hyphae without clamp connections at certain intervals)]; Panus was dimitic with both terminal (as in Pleurotus) as well as intercalary skeletal hyphae but without skeleto-binding (tapering and ramifying laterals of skeletal hyphae); and Lentinus was dimitic with skeleto-binding hyphae (as in Polyporus). Redhead and Ginns (1985) opposed Corner's (1981) inclusion of a number of "unrelated genera" (e.g. Lampteromyces, Marasmiellus, etc.) in Pleurotus, none of which produced skeletal hyphae. If Pleurotus is strictly circumscribed by presence of nematophagous cystidia or hyphal microdroplets (see below) the above genera amalgamated by Corner would resume their previous positions.

Pleurotus and Panus appear to be a mixture of very similar groups of fungi which cannot be sharply differentiated by traditional means. Corner (1981) was aware that the distinction between Pleurotus and Panus was uncertain. He described two types of gill construction in the Lentineae: 1) descending (gill trama formed by gradual thickening

of the pileus trama along the gill lines by means of localized multiplication of the radiating hyphae); and 2) radiate, in which hyphae of the gill trama grow out more or less at right angles from the underside of the pileus along the extending paths of gills). This developmental distinction, also used by Pegler (1983c) was considered an artifact by Reijnders and Stalpers (1992). Corner (1981) also employed texture as important feature, thus putting more fleshy fruitbodies into Pleurotus, intermediately coriaceous fruitbodies in Panus and coriaceous fruitbodies in Lentinus.

Singer (1975a, 1986) separated Pleurotus from Lentinus and Panus because of monomitic, dimitic, or amphimitic hyphae, irregular lamellar trama and well-developed subhymenium in the former. According to Singer (1986), Panus was distinct from Pleurotus by the virtual absence of (or very reduced or very inconspicuous) subhymenium, and strongly pilose or dotted pileus and stipe.

Presence of capitate, or lecythiform cystidia (with without microdroplets), or hyphal microdroplets and nematophagy could be regarded as the latest developmental tool to sharply segregate Pleurotus from other genera of the Lentineae. Hence, all species of tribe Lentineae characterized by presence of glandular and capitate cystidia (cheilo- or pleurocystidia) or hyphal tips (in mycelial cultures or pileipellis hairs) with nematotoxic microdroplets could be confirmed as Pleurotus (Petersen, 1993a). Drechsler (1941) described the genus Nematoctonus which produced hyaline conidia and hour-glass secretory cells or microdroplets surrounded by a sticky, nemotoxic, adhesive knob or gloesphex drop (see Hohenbuehelia). Hilber (1982)

observed that Pleurotus species also possessed secretory cystidia and hyphal microdroplets as produced by Nematoctonus and Hohenbuehelia. Thorn and Barron (1984) found that microdroplets produced by cultures of Pleurotus were able to immobilise nematodes on contact. Therefore, they proposed that a similar nematophagous mode of nutrition occurs in Pleurotus as was proposed for Hohenbuehelia by Barron and Dierkes (1977) who had concluded that the secretory gloeosphex drops or adhesive knobs or microdroplets produced on cystidial apices or hyphae, the germinating basidiospores and the hour glass-shaped conidia of Hohenbuehelia and similar gloeosphex apparatus produced in the hyphal cultures of Nematoctonus were similar functionally. In fact, Thorn and Barron (1986) found that the toxin responsible for killing nematodes in Pleurotus acted more quickly (within one minute) than the toxin of Hohenbuehelia which acted after 24 hours (Giuma and Cooke, 1971) or 56 hours (Giuma et al, 1973). Hilber's (1982) observation implies that secretory cystidia and microdroplets of Pleurotus do not possess sharply defined hour glass-shaped apex (also evident in the present work) as observed in Nematoctonus and Hohenbuehelia (Barron, 1984; Thorn and Barron, 1986). According to Petersen (1993a), means of delivery of nematotoxic chemicals (produced in the mycelial cultures) is different in Pleurotus and other pleurotoid genera like Hohenbuehelia and Hypsizygus.

Diagnosis of Pleurotus by the presence of nematophagous, lecythiform or capitate cystidia or hyphal microdroplets may dictate three consequences: 1) exsiccates of all species described as

Pleurotus must be re-examined for presence or absence of lecythiform or capitate cystidia with or without mucilage droplets; 2) mono- as well as dikaryotic cultures must be established to confirm whether they produce microdroplets or not; 3) production or presence of lecythiform or capitate cystidia or hyphal microdroplets alone may not diagnose a member of tribe Lentineae as a Pleurotus unless it could be established that the cystidia or microdroplets are nematophagous (or become active in presence of nematodes) because inactive or non-nematophagous microdroplets or gloeosphex apparatus were reported to be produced in some species [e.g. Resupinatus striatulus and Stigmatolemma poriaeforme (Thorn & Barron, 1986)]. Therefore, in the present work, presence of cystidia or pileipellis or stipitipellis hairs with nematophagous microdroplets has been regarded as the main separating generic character of Pleurotus from Panus and Lentinus, rather than spore shape and size, presence or absence of skeletal hyphae, hymenophore construction, nature of subhymenium, texture of fruitbodies, etc.

Four species of Pleurotus [including an unidentified species (see key to Nepalese species of Pleurotus) reported by Singh and Nisha (1976) occur in Nepal. Pleurotus corticatus and P. circinatus reported by Singh and Nisha (1976) are synonymous to Pleurotus dryinus and Hypsizygus circinatus (Singer, 1986) respectively. Pleurotus djamor var. djamor is a new record for Nepal. Pleurotus platypus was reported by Pegler (1976) and P. ostreatus was reported by Singh and Nisha (1976).

Pleurotus species are found in abundance in central Nepal during

early summer as well as late monsoon. All species of Pleurotus being edible (Singer, 1986) and being familiar as edible throughout Nepal, they are mostly brought for sale in the market rather than locally consumed. Pleurotus species constitute about 10-15 % of wild mushrooms brought for sale in Kathmandu. Pleurotus species are called kathchenguwaa or kathcheu in Bhojpuri; kaa syumu (syaamu) in Gurung; hiu:dey mung in Limbu; sapyaa mugaan in Magar; kanney or kharsu or vujeu or thoseu or seto chyaau in Nepali; waa:u: or gwo or khichaa mhuka: (muka:) in Newari; mukkhai, saankawaay (Toba, 1975) or aangewaa or sannuvung or nwaamung in Rai; kaathe kundhuk in Ranbansi; gowaa syaamu in Sherpa; maarmo or marmu syaamu (Adhikary, 1975, 1981-82, 1987) or ghusya (Shrestha, 1988) or taak or taakpaa or lohaa syaamu in Tamang; kunni or kathcheu in Tharu; and fopaley syaamu in Tibetan languages.

Key to Nepalese species

1. Spores more than 6 µm long.....2
1. Spores up to 6 µm long (Singh and Nisha, 1976); not treated here.....Pleurotus sp.
    2. Spores 6-9 µm long 3
    2. Spores more than 9 µm long.....P. ostreatus
3. Pileus with brown shades; skeletal hyphae absent; (not treated here).....P. platypus
3. Pileus white to yellowish white; skeletal hyphae present.....P. djamor var. djamor

Descriptions of Nepalese species

Pleurotus djamor var. djamor (Fr.) Boedijn. 1959. Rumphius Memorial Volume, 292.

Macroscopic features

Pileus (Fig. 23A) spathulate to flabelliform, laterally stipitate, up to 50 mm broad, white to silky white, ochraceous buff (4A2) at center, drying light orange (5A4 or 5A5) to apricot yellow (5B5) towards margin, tawny ochraceous (6C6) to brownish orange (6C7) or pecan brown (7C6) at center, flushed light brown (7D6) here and there; center depressed, white, hairy; margin slightly striate, incurved, eroded, rimose at maturity; flesh up to 1 mm thick (on drying) near stipe, abruptly thin towards margin, white. Lamellae decurrent, crowded, 2 mm broad (when dry), white; margin entire, not darker; lamellulae present, usually bifurcating at base. Stipe up to 6 mm long, up to 5 mm broad, lateral, woody when dry, white, coarsely hairy.

Microscopic feature:

Pileus composed of pileipellis, pileus trama and lamellar trama. Pileipellis a trichoderm with radial hyphae, giving rise to erect hairs. Pileal hairs sometimes in fascicles, up to 60 µm long; hyphae mostly 4.7 µm diam, slightly thick-walled (wall up to 0.7 µm thick). Pileus trama up to 200 µm deep, interwoven, dimitic; 1) generative hyphae 2.6-5 µm diam, slightly thick-walled, septate, with clamp connections; 2) skeletal hyphae (Fig. 23B) 2.6-4.9 µm diam, hyaline in KOH, undulate, nodular here and there, thick-walled (wall 0.7-2.3 µm

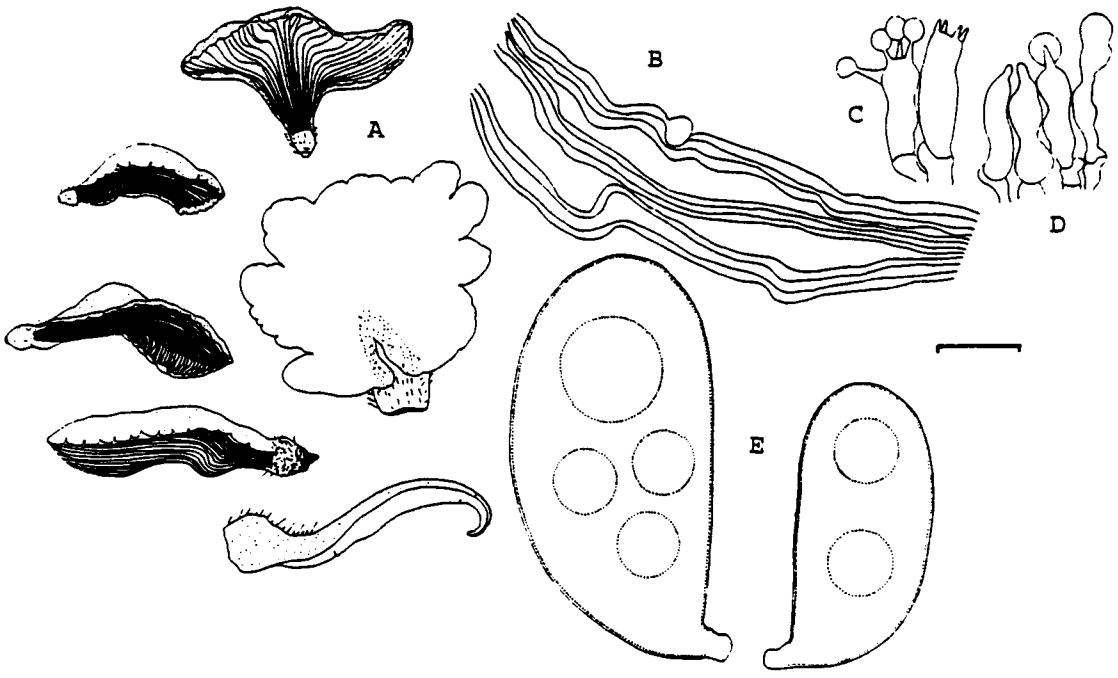


Figure 23 A-E. Features of Pleurotus djamor var. djamor. A. Basidiomata (NHMTU. 2-2-02858, TENN. 51854). B. Skeletal hyphae. C. Basidia. D. Lecythiform and beaked cheilocystidia. E. Basidiospores. Standard bar = 13 mm for A; 10 µm for B-D; 1.5 µm for E.

thick). Lamellar trama 50 µm broad; hyphae similar to pileus trama, interwoven, slightly more compact than pileus trama. Subhymenium distinct, up to 8 µm thick. Basidia (Fig. 23C) 12.7-23.4 X 4.3-5.7 µm, clavate, 4-spored, clamped. Cheilocystidia (Fig. 23D) 11.7-16.7 X 3.7-5.0 µm, lecythiform, capitate at the tip, projected up to 5.3 µm; capitate or glandular-apex 3.8-4.9 X 3.0-4.9 µm. Pleurocystidia similar to cheilocystidia. Basidiospores (Fig. 23E) 5.7-8.4 X 2.7-4.2 µm (Lm = 7.5, Wm = 3.4, E_m= 1.5-3.0, n = 40), white (assumed), cylindrical, hyaline, smooth, thin-walled, non-amyloid, multiguttulate.

Habitat: Imbricate on fallen hardwood stumps of Shorea robusta in tropical forest of terai.

Specimen examined: Nepal, Chitwan, Jugedi (alt. 500 ft), 12.vii.90. HRB s.n., NHMTU. 2-2-02858, TENN. 51854.

Comments: The entirely white imbricate pileus, presence of distinct skeletal hyphae in the trama, emarginate gills, similar spore dimensions [(5.5-)6-8.7 X 3-4 µm (Corner, 1981); 6-10 X 3-4 µm (Petch, 1924)] and occurrence in subtropical forest confirms that this is P. djamor var. djamor as described by Corner (1981).

Pleurotus djamor var. djamor can be confused with P. pulmonarius [expected in Nepal because of its occurrence in western China and India (Petersen and Hughes, 1993)] by presence of laterally attached white or yellowish white (Watling and Gregory, 1989) fruitbodies, and similar spore range [6-10 X 3-4 µm for P. pulmonarius (Petch, 1924)]. The two, however, can be distinguished by presence of skeletal hyphae, tropical habit and slightly smaller fruitbodies in P. djamor.

Pleurotus djamor may resemble both the European and Japanese varieties of P. cornucopiae by presence of skeletal hyphae and spore measurements [8-9.5 X 3.5-4 µm in European variety (Kühner and Romagnesi, 1953); 6.5-8.5 X 2-3 µm in Japanese variety (Corner, 1981)]. Pleurotus cornucopiae (= P. citrinopileatus), however, can be separated by yellow or honey yellow (in Japanese variety; Corner, 1981) to buff or clay-buff colored (European variety; Watling and Gregory, 1989) and subcentrally stipitate fruitbodies (never lateral like P. djamor var. djamor).

Pleurotus ostreatus (Jacquin: Fries) Kummer, 1871. Der Führer in die Pilzkunde, 105, Figs 34-35, 38.

Macroscopic feature

Pileus (Fig. 24A) dimidiate, flabelliform, spathulate, orbicular, convexo-umbonate or infundibuliform, 18-40 mm wide, 25-100 mm broad, inward putty (4B2), greyish ivory (4B3), pale orange (5A3), greyish orange (5B4), pinkish (5C4), dark blonde (5D4), red haired (6C3-6C4), camel (6D4), sunburn (6D5), greyish brown (6E4) or dark brown (6F5-6F6 or 7F4-7F5), outside yellowish white (4A2), cream or pale yellow (4A3), pale orange (5A3), orange grey (5B3), pinkish orange grey, nougat (5B3), reddish blonde (5C4), dark blonde (5D4), light brown (5D5), camel (6D4), dark brown (6F6), or pale brown (7E4); center papillate to depressed to deeply infundibuliform; margin broadly transparent-striate to slightly rugulose, incurved, eroded to rimose (sometimes up to center) on maturity; surface silky-glabrous to white hairy or white wooly, moist; cuticle slightly wrinkled on maturity,

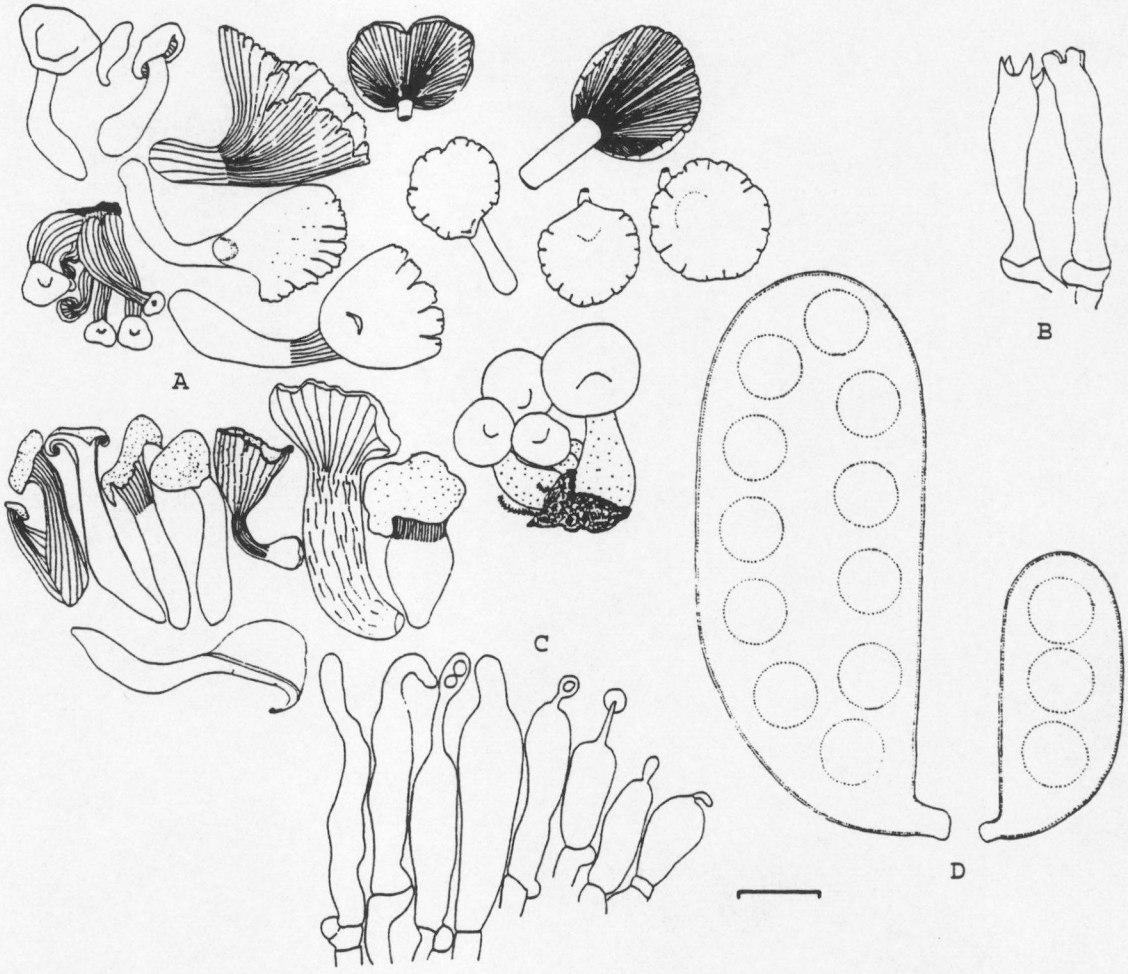


Figure 24 A-D. Features of Pleurotus ostreatus. A. Basidiomata (TENN. 51855 & other specimens). B. Basidia. C. Lecythiform and beaked pleurocystidia. D. Basidiospores. Standard bar = 38 mm for A; 10 µm for B & C; 1.5 µm for D.

peeling easily up to center, leathery; flesh white, 1.5-6 mm thick, soft, brittle, gradually (sometimes abruptly) thinning towards margin. Lamellae deeply decurrent, close to somewhat distant, up to 4 mm broad, thick at middle, milk white then yellowish white (4A2), pale yellow (4A3), greyish yellow (4B3), or champagne (4B4); edge entire, sometimes much crumpled, eroded on handling or maturity, brittle. Stipe excentric to lateral, curved, 15-82 mm long, dilated below, 7-9 mm thick at apex, 10-18 mm thick at middle or base, milk white, with brown (6D4) to sooty or dark brown (6F5) longitudinal or reticulate striations (sometimes inconspicuous) which turn greyish orange (5B4) or dull brown or brownish (6E4) on handling or aging; flesh white, silky-cottony, dry or moist, compact, leathery, stuffed, sometimes marbled with greyish yellow (4B3) fibers; base much dilated or not, with white or greyish white hairy or wooly covering, tufted, dull brown on bruising or handling.

Microscopic feature

Pileus composed of pileipellis, pileus trama, and lamellar trama. Pileipellis a radially arranged cutis; terminal cells up to 40 µm long, with round or obtuse tip, erect to suberect, clamped; hyphae 2.4-3 µm diam, honey yellow to brownish yellow in KOH solution. Pileus trama up to 100 µm deep, sometimes lacunose, honey yellow to brownish yellow in KOH, monomitic; hyphae compact, interwoven, inflated, 2.6-12.0 µm diam; wall thin or slightly thickened (wall 0.3-0.7 µm thick); clamp connections present and distinct. Lamellar trama up to 300 µm broad, sometimes lacunose; hyphae interwoven, slightly less compact than the pileus trama; hyaline, honey, or brownish yellow in KOH

solution, similar to the pileus trama. Skeletal hyphae absent. Oleiferous hyphae present in pileus as well as lamellar trama; hyphae up to 8.8 µm diam, branched, rotate, nodulose, without distinct septa and clamp connections. Basidia (Fig. 24B) 15.4-28.4 X 3.7-5.4 µm, clavate, 4-sterigmate, clamped. Cheilocystidia similar to pleurocystidia. Pleurocystidia (Fig. 24C) 11.4-40 X 2.7-7.6 µm, capitate, lecythiform, cylindrical to narrowly lageniform, clavate (with short beak or neck-like projection), projecting up to 18.5 µm, with or without distinct mucoid drops; neck 2.2-4.9 µm long, 1.5 µm thick; mucoid drop globular, 2.3-3.3 X 2.0-2.3 µm. Basidiospores (Fig. 24D) 5.7-11.8 X 2.3-4.6 µm (Lm = 8.4, Wm = 3.2, Em = 1.8-4.6, n = 65), white (assumed), hyaline, elongate-ellipsoid or cylindrical, thin-walled, non-amyloid, multiguttulate.

Habitat: Growing in tufts (caespitose) on the moss-covered stumps of Quercus glauca (Falaa:t in Nepali) and Q. leucotricophora (Khasru in Nepali) in the lower temperate forest.

Specimens examined: Kathmandu, Ason vegetable market, 24. VII.90., coll. HRB, HRB 92(1), HRB 94(2), HRB 95(3), HRB 98(5); Kathmandu, Ason vegetable market, 13.IX.90., coll. HRB, HRB 138(1), HRB 138(2), HRB 139(3); Kathmandu, Ason vegetable market, 11.X.91., coll. HRB, [HRB 143(1A), TENN. 51851], HRB 143(1B), HRB 144(2A), 144(2B), 146(3); Kathmandu, New Road, coll. HRB, NHMTU. 2-2-02743. [The above first eight specimens were brought for sale from Bhedunga (alt. approximately 5000 ft) and the last specimen from Leley (7000 ft) (both in peripheries of Kathmandu valley) by the local mushroom

collectors. Information on habitat may be inaccurate, therefore].

Comments: These specimens of Pleurotus have been identified tentatively as P. ostreatus (Jacquin: Fries) Kummer based on brown to almost black, shell-shaped and strongly eccentric (some laterally attached) pileus, absence of tapering skeletal hyphae in the pileus trama and spore size [(8-)9-11(-12) X 3-3.7(-4) µm: (Corner 1981)]. The occasional centrally or subcentrally attached greyish pileus, larger spore range [6.5.-8.5 µm for Japanese specimens of P. cornucopiae: (Corner, 1981) and 8-9.5 X 3.5-4 µm: (Corner, 1981) or 7.5-11 X 3.5-5 µm: (Kühner and Romagnesi, 1953) in European collections)] and occurrence in late monsoon (September-October and not in May-June or early summer as for P. ostreatus) suggest that the species involved is P. cornucopiae. Pleurotus cornucopiae, which exists in European and Japanese varieties, however, would possess distinct skeletal hyphae unlike P. ostreatus.

The brownish and rimose, sublaterally attached pileus without any skeletal hyphae may align this species to P. pulmonarius which has slightly smaller, laterally attached fruitbodies, and slightly smaller spore dimensions [(7.5-)8-9(-10) X 3-4 µm: (Watling and Gregory, 1989)]. Fruitbodies of Pleurotus pulmonarius and P. ostreatus are so similar that morphological characters alone are insufficient to distinguish the two species (Petersen and Hughes, 1993). In fact, change in various environmental conditions (e.g. substrate, light intensity, temperature, humidity etc.) could also influence on some macro- and microtaxonomic criteria (color and shape of basidiomates, length of stipe, presence or absence of sclerified generative hyphae,

spore dimensions, etc.) of Pleurotus species complex as observed in laboratory conditions by Bresinsky et al (1976). Monokaryotic mycelium mating, however, was found highly useful in identifying Pleurotus species monospore cultures (Bresinsky et al, 1976; Petersen and Hughes, 1993). Petersen (1993b) also found neohaplont mating possible for identification of Pleurotus cultures by neohaploidization technique (a mechanism to obtain monokaryotic from dikaryotic mycelial cultures).

Nepalese specimens also resembles P. platypus by exhibiting eccentrically to subcentrally stipitate brownish pileus. Pleurotus platypus, however, is different by smaller (10-40 mm broad) and constantly excentric (lateral in P. ostreatus) fruitbodies, lack of thick-walled tramal hyphae and pleurocystidia, and spore dimensions (6-8.5 X 2.5-3.5 μm; Pegler, 1976).

The author of Pleurotus ostreatus (type species) is Kummer because Agaricus ostreatus Jacq.: Fr. [Fries (1821) ascribed A. ostreatus to Jacquin)] was fixed as the type species of Pleurotus by ICBN and automatically changed to Pleurotus ostreatus as a result of conservation of Pleurotus as a genus name. Donk's (1949) proposition to ascribe Kummer as the authority of P. ostreatus [hence P. ostreatus (Jacq.: Fr.) Kummer] has been supported by many mycologists.

RESUPINATUS

Resupinatus S. F. Gray. 1821. A natural arrangement of British plants 1: 617.

Type species: Resupinatus applicatus (Batsch: Fries) S. F. Gray. 1821. Nat. Arr. Brit. Pl. 1: 617.

The epithet Resupinatus (etymology = turned-over or flat) was first proposed by S. F. Gray (1821) while describing the type species Resupinatus applicatus. Gray (1821) characterized Resupinatus by sessile, veil-less, membranaceous fruitbodies with orbicular shape attached by its back. This name was not used for a long time, until Murrill et al (1915) revived it again by describing thirteen species of Resupinatus from North America. Murrill placed Resupinatus together with other genera with gelatinized trama viz. Marasmiellus, Panellus, Pleurotopsis, Tectella etc. in tribe Agariceae of Agaricaceae characterized mostly by pleurotoid basidiomes with lamellate hymenium.

Since Pleurotus Kummer (1871) included R. applicatus (= Agaricus applicatus) when originally described, the latter could have been obligate typonym of the former. Donk (1949) eventually secured the name Resupinatus by conserving Pleurotus against Resupinatus and also showed that the latter was validly published.

Singer (1951, 1986) treated Resupinatus as the type genus for tribe Resupinateae of Tricholomataceae. Because Resupinatus and Hohenbuehelia closely resembling contribal genera [characterized by similarly gelatinized basidiomata (see Panellus) and inamyloid smooth spores], the main basis of their separation followed by Singer (1986)

was possession of apically encrusted thick-walled metuloidal cystidia, lecythiform cheilo- or pleurocystidia and lack of incrusted epicuticular hyphae as well as lack of diverticulate cheilocystidia in Hohenbuehelia.

Miller (1984) emended the concept of the Resupinatus to include only those species with gelatinized trama (as in Hohenbuehelia or other members of Resupinateae) characterized by absence of gloeosphex apparatus and diverticulate epicuticular hyphae. Using this concept, Miller (1984) transferred three Resupinatus species to Hohenbuehelia because they were found to possess gloeosphex or lecythiform cystidia and metuloids which were not detected earlier (for more see Hohenbuehelia). Therefore, according to Miller's concept, Resupinatus is strictly characterized by absence of gloeosphex cystidia and metuloids (Thorn, 1986; Thorn & Barron, 1986).

Since gloeosphex cystidia are associated with nematophagous habit and ability to produce an asexual Nematoctonus anamorph (Barron and Dierkes, 1977; Thorn and Barron, 1986: also see Hohenbuehelia), Resupinatus is strictly circumscribed by species with lack of nematophagous habit as well as lack of production of Nematoctonus asexual state. It was observed that although R. applicatus produced secretory gloeosphex apparatus like structures on hyphal tips in cultures, the did not possess any nematotoxic effect (Thorn & Barron, 1986).

From Nepal there have been no previous reports of occurrence of Resupinatus. Resupinatus nepalensis represents a new genus record for Nepal. Resupinatus applicatus was reported from neighboring countries,

China (Tai, 1979), India (Manjula, 1983) and Sri Lanka (Manjula, 1983).

Description of Nepalese species

Resupinatus nepalensis H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 25a) dry, cupulate, orbicular, dimidiate, or reniform, up to 7 mm wide, 5 mm broad, laterally attached, at first chocolate brown (6F4), then dark brown (7F4) or dark sooty brown or eye brown (7F5) at raised central disk or at middle, faded brownish or brown (7E7) or chocolate brown (6F4) or teak brown(6F5) or dark brown (7F4) toward margin; margin incurved or cuticle upturned, slightly striate, black, appressed hairy or white mealy, appearing white hoary or frosted under 10X when dry; flesh brown. Lamellae radiating, narrow (up to 1 mm broad), widely spaced, forked or divided, milk- or snow-white at first, then orange-white (5A2) or marble white to greyish orange (5B3); white, off-white or black with edge remaining white on drying; edge white to greyish white, crenate; lamellulae present. Stipe up to 0.3-0.5mm long, up to 0.3 mm thick, lateral, very short, thick, white. Odor and taste indistinct.

Microscopic features

Pileus composed of pileipellis, distinct gelatinous zone, pileus trama and lamellar trama. Pileipellis and pileipellis hairs (Fig. 25B) 20-30 um thick, dark brown or dark greyish in KOH, with dark reddish brown incrusted pigments, composed of loosely arranged interwoven horizontal hyphae, 3-8 cells thick; hyphae (2.5-)5(-6) µm diam, dark

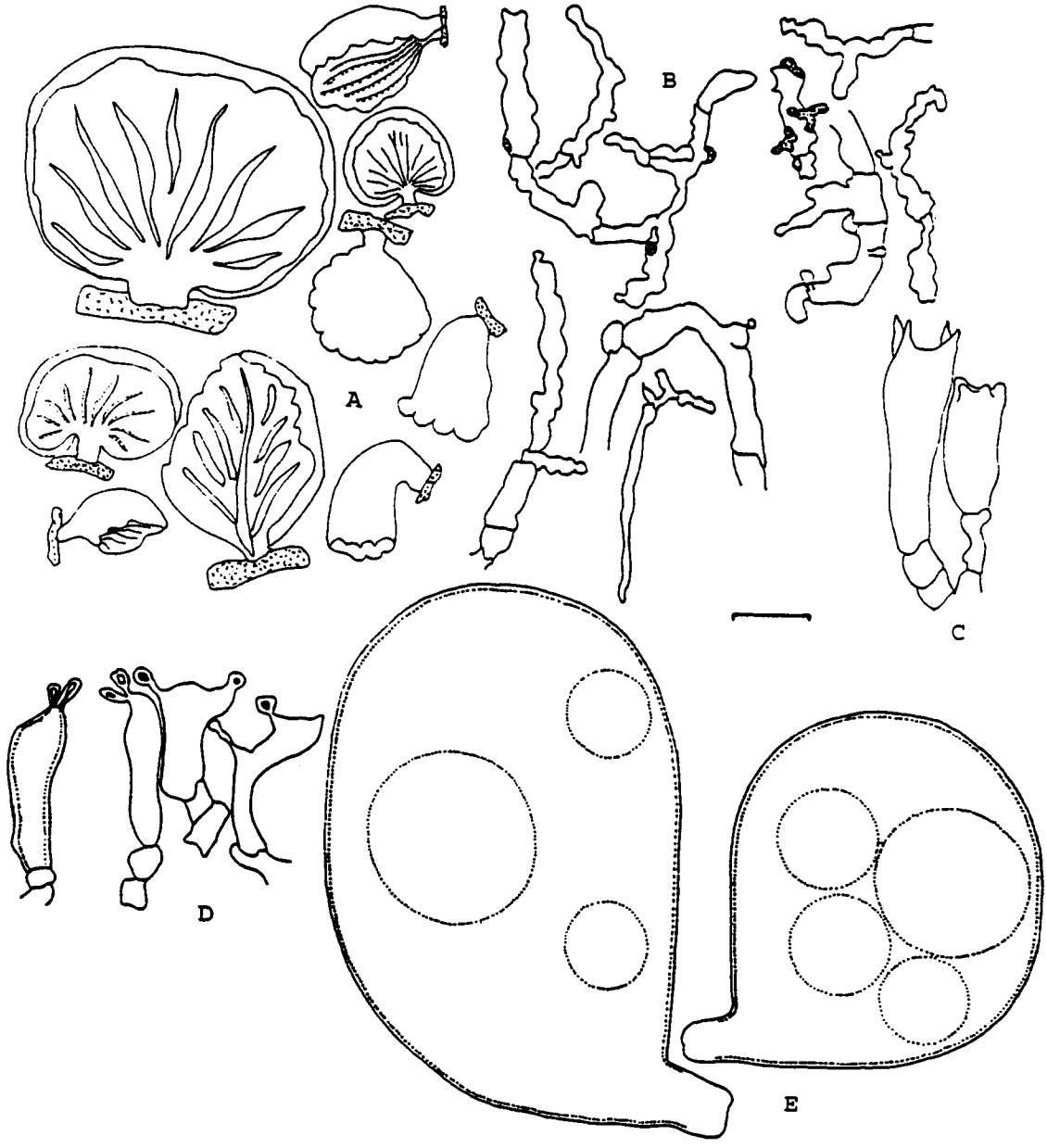


Figure 25 A-E. Features of Resupinatus nepalensis. A. Basidiomata (TENN. 51855, holotype). B. Diverticulate epicuticular hyphae. C. Basidia. D. Diverticulate or knobbed cheilocystidia. E. Basidiospores. Standard bar = 1.6 mm for A; 10 µm for B-D; 1.5 µm for E.

brown, heavily incrusted (with coarse brown pigments), thick-walled (wall up to 1 μm thick), frequently terminated with short diverticulate ends or occasionally giving rise to thinner (2 μm diam, 30 μm long) erect to repent (Fig. 25B) terminal or lateral diverticulate branches (possessing knobs and tapering ends); clamp connections abundant, inflated up to 6.5 μm broad. Gelatinous zone up to 450 μm deep; hyphae (2.5-)3.5-5(-6) μm diam, predominately radial and parallel, very loosely arranged (maximum distance between two juxtaposed hyphae 25 μm), thickly to sparsely encrusted; clamp connections abundant, inflated up to 8 μm wide, distinctly metachromatic (staining purple red in cresyl blue). Pileus trama subsequently below the gelatinous zone, up to 350 μm deep; hyphae 3-6 μm diam, compactly arranged, vertical radial; wall encrusted as well as smooth, slightly thickened (wall up to 1 μm thick); clamp connections present, inflated up to 7 μm. Lamellar trama parallel, staining less in Congo red solution than pileus trama; hyphae 3.5-(-6.5) μm diam, thick-walled (wall up to 1mm thick), encrusted; clamp connections present. Basidia (Fig. 25C) 30-50 X 11-15 μm, clavate, 4-sterigmate, slightly thick-walled (wall up to 1.5 μm thick), clamped at base; sterigmata up to 7 μm long; contents guttulate, metachromatous (staining red in cresyl blue). Cheilocystidia (Fig. 25D) 23-34 X 6.5-10 μm, projecting up to 26 μm; clavate to fusoid-ventricose to cylindrical, subcapitate, with single or often branched (up to 3 branches) neck or finger like diverticulae (some of which look like distorted or decapitate or shrivelled neck or thick-walled finger like knobs), thick-walled (wall up to 2 μm thick); base

clamped; neck short or up to 7.6 um long, cylindrical or acuminate, with or without dilated apex; apex globular or cylindrical or finger like, sometimes shrivelled or undilated swellings, thin- or thick-walled, 1.9-2.3 µm long, 2.3-4.9 µm broad. Pleurocystidia absent. Metuloids absent. Basidiospores (Fig. 25E) 7.6-11.4 X 6.5-8.7 µm (Lm = 10.0, Wm = 7.3, Em = 1.17-1.5, n = 25) ovate to ellipsoid, white (assumed), hyaline, inamyloid, acyanophilous, smooth, multiguttulate, with one or two dominant guttules.

Habitat: On bark of living Pyrus sylvestris (crab-apple) tree and mossy or putrifying bark of living Schima wallichii in lower temperate forest.

Specimens examined: Nepal, Kathmandu, [Mt.] Ranibari, 4.VII.91, coll. HRB, (TENN. 51855, HOLOTYPE), [HRB 8, NHMTU. s.n. (ISOTYPE)]; Kathmandu, [Mt.] Swayambhu, coll. HRB,9.VII.91, HRB 48, TENN. 51856.

Etymology: Nepal = the country where this fungus was first collected.

Comments: This fungus has been accommodated in Resupinatus because of its gelatinized tramal hyphae (as found in all members of tribe Resupinateae), lack of gloeosphex or lecythiform but rather diverticulate (with one or two finger-like knobs with or without shrivelled or indistinct apical swellings) cheilocystidia, lack of metuloidal cystidia and presence of non-amyloid smooth spores. The fungus could not be placed in Hohenbuehelia because of absence of metuloids and lecythiform or gloeosphex cheilocystidia. Resupinatus nepalensis can be recognized in the field by its brown or black,

fibrillous resupinate or sessile or laterally attached corticolous basidiomata with milk white, distant lamellae. Microscopically, R. nepalensis can be identified by its diverticulate brown incrusted epicuticular hyphae, incrusted gelatinized tramal hyphae, cheilocystidia with short finger-like branches and spore dimensions.

Resupinatus nepalensis resembles R. alboniger by shape, size, color, and habit of the glaucous or fibrillous basidiomes, narrow subdistant lamellae, encrusted and diverticulate cuticular hyphae, and cheilocystidia with irregular digitate projections. Resupinatus nepalensis, however, differs in having completely white lamellae [dull brown, blackish brown or black or occasionally white emarginate in R. alboniger (Thorn & Barron, 1986)] and different shaped [elliptic-phaseoliform or cylindric phaseoliform or often curved in R. alboniger type specimen (Thorn & Barron, 1986)] larger spores [(5.5-)5.8-8.2 X (2.5-)2.7-3.5(-4.0) μm or (5.8-)6.0-7.5(-8.0) X (2.5-)2.8-3.2(-3.5) μm: for type specimen of R. alboniger (Thorn & Barron, 1986)].

RIMBACHIA

Rimbachia Patouillard in Patouillard & Lagerheim. 1891. Bull. Soc. Mycol. Fr. 7: 158-184.

Type species: Rimbachia paradoxa Patouillard in Patouillard & Lagerheim. 1891. 159.

The name Rimbachia was first used by Narcisse-Théophile Patouillard (1891) for an upturned cup-shaped (attached to substrate with elongated stipe) tropical fungus (type species: R. paradoxa). Patouillard (1891, 1900) characterized Rimbachia by white spores,

auriculoid, reticulate or ridged hymenium, concave upward facing membraneous or delicate basidiomata with thin, long (relative to the basidiomatal size) usually upright stipe, and terricolous habit. He accommodated Rimbachia in family Agaricacées (characterized by typically superior or inferior lamellate or sublamellate hymenium) of the Homobasidiomycetes (Homobasidiés). Agaricacées was further divided into tribe Bolétés, tribe Cantharellés and tribe Agaricés. Rimbachia was accommodated in Tribe Cantharellés characterized by ridge-like or venose hymenial surface.

Redhead (1984a), after reevaluating a number of closely resembling species of bryophillous agarics, characterized Rimbachia by stipitate or sessile, cupulate or flabelliform basidiomata with smooth, rugose or lamellate, up-turned or nutant hymenium; clamped, inflated, inamyloid and always smooth-walled (i.e. never incrusted) tramal hyphae; weakly or strongly diverticulate, coralloid, capitate or simply bifurcate epicuticular hairs, and association (either directly growing on or around) with bryophytes. Redhead (1984a) broadened the circumscription of Rimbachia after uniting another-preexisting bryophilous genus, namely Mniopetalum. Therefore, Mniopetalum is an invalid synonym of Rimbachia sensu Redhead (1984a).

In accordance to Singer's (1986) circumscriptions, Rimbachia sensu Singer is different from Mniopetalum sensu Singer by the latter's pseudoamyloid stipe trama (occasional), cylindric or relatively narrow and larger spores and parasitic habit. Rimbachia sensu Redhead includes all bryicolous agarics included by Singer

(1986) in Rimbachia as well as Mniopetalum.

Rimbachia sensu Redhead closely resembles Arrhenia sensu Redhead [(1984a) = Leptoglossum sensu Singer (1986)] by possessing bryicolous habit, cyphelloid or pleurotoid basidiomata, smooth or auriculoid or lamellate hymenium, and clamped, inamyloid, inflated tramal hyphae. Since both Rimbachia sensu Redhead and Arrhenia sensu Singer possess weak or strongly differentiated pellicular hyphae, the two genera are virtually identical and distinguishable only by means of incrusted hyphae (present in Arrhenia). In Redhead's (1984a) view, Arrhenia may (usually) or may not have incrusted hyphae and clamp connections but it always lacks rameales like or capitate structures on pellicular hyphae.

Rimbachia resembles another bryophilic genus, Cyphellostereum [regarded as an agaric of the Tricholomataceae by some mycologists (e.g. Singer, 1986; Watling & Gregory, 1989) or some as a member of the family Corticiaceae of the Aphyllorales [e.g. Eriksson and Ryvarden (1975), Redhead (1984a), Breitenbach and Kränzlin (1986)]. Cyphellostereum is different from Rimbachia by possessing clampless tramal hyphae (also see key to the world genera). Rimbachia can be confused with bryophilous Omphalina but the latter has omphalioid-agaricoid (not cyphelloid or pleurotoid) habit, some species lichenized, and pigment-incrusted tramal or epicuticular hyphae.

Rimbachia and Arrhenia sensu Redhead include a number of previously separately treated pleurotoid or cyphelloid genera of basidiomycetes or even ascomycetes of which Campanella, Chaetoscypha, Cyphella, Pleurotellus, Pleurotus are lignicolous but not bryicolous

and can be distinguished by features mentioned in the key to the world genera; Helvella and Peziza are ascomycetes; Cantharellus is a terricolous (non-bryicolous) and truly stipitate genus; Merulius is a lignicolous (non-bryicolous), resupinate and merulioid genus; and Thelephora is terricolous, mostly mycorrhizal and with semipileate, reflexed or resupinate basidiomata and brownish verrucose-spinose spores. The latter three genera including Cyphellostereum (also see above) are members of the Aphyllophorales.

Cantharellotus, Corniola, Dictyolus, Leptotus, Mniopetalum, and some species of Pleuromycenula sensu Singer (1986) are synonyms of Rimbachia (Redhead, 1984a). Rimbachia can be confused with a number of pleurotoid bryicolous (e.g. Flabellimycena, Pleurotellus, etc.) as well as lignicolous (e.g. Helotium, Campanella, Marasmiellus etc.) species by the features mentioned in the key.

Five species of Rimbachia have been described from central Nepal, previously there were no reports of occurrence of any species from this genus. Mniopetalum distinctum, first described by Horak (1980) from Sikkim Himalayan state of India (eastern neighbor of Nepal) and Mniopetalum furfuraceum reported by Pegler (1986) from Sri Lanka have been treated as synonyms of R. furfuracea by Redhead (1984a). Rimbachia furfuracea was reported previously from southeast Asia (Vietnam and Malaya) by Corner (1966: reported as Cantharellotus furfuraceus) who concluded that this fungus was restricted to the higher montane areas.

Key to Nepalese species

1. Basidiomata pleuropodal, distinctly lamellate.....R. lamellata
1. Basidiomata pleuropodal or cupulate, with smooth or venose hymenium.....2
    2. Basidiomata usually nutant with long, thin, and upright stipe; hymenium smooth.....R. kaaliya
    2. Basidiomata cupulate or pleuropodal; hymenium smooth.....3
3. Basidiomata pleuropodal, with distinct stout stipe; hymenium reticulate, with veins or lamellae.....R. leleya
3. Basidiomata cupulate or campanulate; hymenium smooth.....4
    4. Basidiomata persistently campanulate; growing on epiphytic mosses on tree barks.....R. campanulata
    4. Basidiomata cupulate; growing on terrestrial mosses.....R. gujesoria

Descriptions of Nepalese species

Rimbachia campanulata H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 26A) deeply campanulate, sometimes slightly curved at the middle at one side,inverted, up to 2.5 mm broad, up to 3.5 mm high white or slightly greyish white (lighter than 1B1), with uniform coloration throughout; margin slightly striate, straight, thin, eroded-crenate, shortly rimose (appearing widely lobed on aging or after drying). Hymenial surface completely smooth, concolorous to pileus surface, faint orange on young basidiomata after drying.

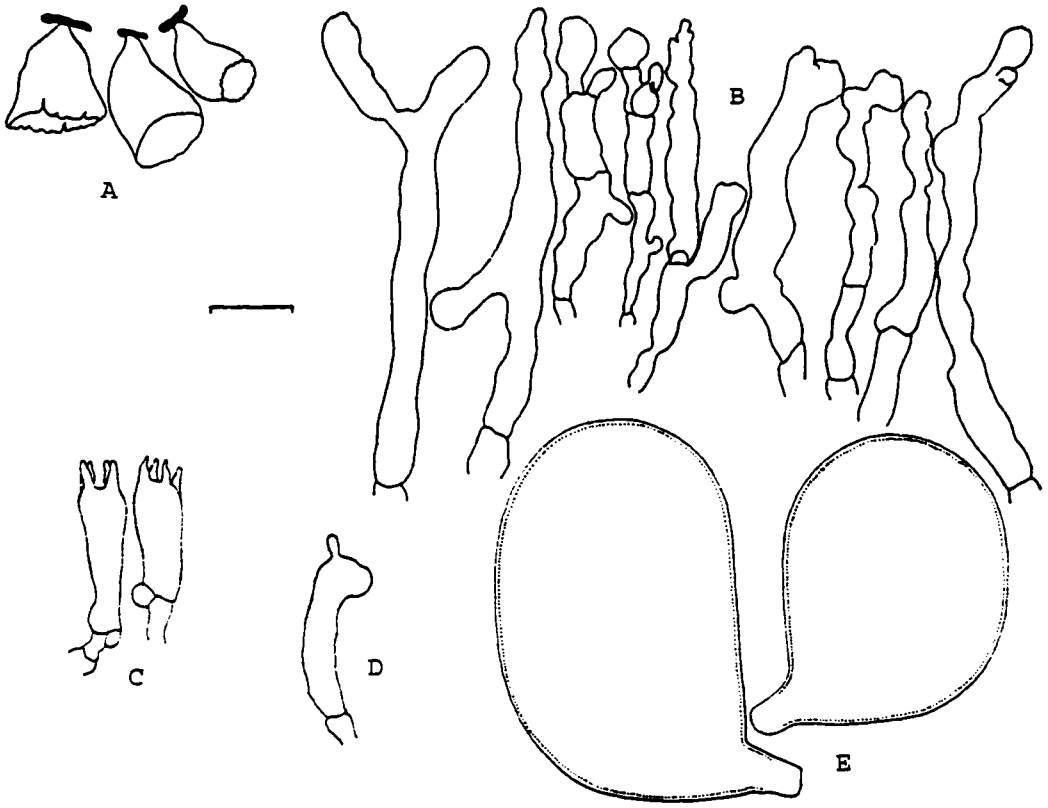


Figure 26 A-E. Features of Rimbachia campanulata. A. Basidiomata (TENN. 51857, holotype). B. Pileipellis or epicuticular elements. C. Basidia. D. Knobbed cheilocystidium. E. Basidiospores. Standard bar = 2 mm for A; 10 µm for B-D; 1.5 µm for E.

Abhymenial surface concolorous to the above, white strigose-hairy to appressed tomentose all over at 10 X, densely wooly towards base on young specimens; flesh very thin, white, drying greyish or yellowish white or light ochraceous salmon, soft, fragile, brittle. Pseudostipe very short (but distinct at 10 X), dorsal, cylindrical, thickly white tomentose towards base. Basal tomentum or subiculum present occasionally. Odor and taste inconspicuous.

Microscopic features

Pileus composed of pileipellis (with hairs), pileus trama, and subhymenium layer. Pileipellis a trichoderm layer giving rise to erect hairs. Pileipellis hairs (from the margin of the pileus) fascicled (Fig. 26B), up to 70 µm long, 3.0-7.6 µm diam, hyaline; wall smooth, slightly thickened (wall up to 0.8 µm thick); apex branched or slightly swollen (up to 7.6 µm) or with capitate or slightly lobed tip. Pileus trama up to 480 µm deep; hyphae transversely arranged, 3.4-5.7(-13) µm diam, branched, inflated, inamyloid, sometimes irregularly inflated to produce occasional short, thick, irregular branches; wall smooth, hyaline, slightly thick (wall up to 1 µm thick); tip round, occasionally swollen or constricted below. Subhymenium distinct, up to 25 µm broad, cellular to interwoven; hyphae slightly thinner and more compact than those of pileus trama. Basidia (Fig. 26C) 21.0-22.8 X 6.5-6.9 µm, 4-sterigmate, clavate, clamped at base. Pleurocystidia (Fig. 26D) 21.5-22.8 X 6.5-7.2 µm, non-projecting, clavate or mostly basidioliform, occasionally weakly diverticulate, with one small protuberance at the apex. Basidiospores (Fig. 26E) 4.6-7.6 X 3.4-4.9 µm (Lm = 5.7, Wm = 4.0, E_M= 1.21-1.55, n

= 20), subglobose to ellipsoid, white (assumed), inamyloid, smooth, thin-walled, with prominent hilar appendage.

Habitat: Gregarious (but not fascicled) or solitary on or around epiphytic mosses growing on the thick bark of living Schima wallichii tree about 6-7 ft from the ground level.

Specimen examined: Nepal, Kathmandu, Godavari (4700 ft), coll. HRB and Mr. Bhaiya Khanal, 2.viii.92., TENN. 51857 (HOLOTYPE), HRB 111, NHMTU. s.n. (ISOTYPE).

Etymology: Campanulata = campanulate or bell-shaped (Greek).

Comments: Rimbachia campanulata is accommodated in Rimbachia and not in Arrhenia because of its lack of incrusted epicuticular or tramal hyphae but presence of marginal epicuticular hyphae with capitate or bifurcate or cystidiate apices, bryophilic habit and inamyloid, smooth spores. Rimbachia campanulata can be identified in the field by its bell-shaped, inverted, white basidiomata on or around epiphytic mosses growing on the bark of living trees. Microscopically, it can be identified by slightly capitate or variously swollen or lobed marginal pileipellis hairs, occasional pleurocystidia and spore dimensions.

Rimbachia campanulata resembles Rimbachia neckerae subsp. neckerae by delicate, white, campanulate basidiomata, smooth hymenium, slightly clavate to capitate pellicular hyphae and non-amyloid spores. Rimbachia neckerae, however, is different by occasional rugose hymenium (at center) and much larger spore size [8-10.5 X 4.5-7 µm (Redhead, 1984a)]. Rimbachia neckerae subsp. megalospora is different

from R. campanulata by the former's of shallower basidiomata, reticulate-rugose hymenium (toward the center) and spore dimensions (see below in R. gujesoria). Rimbachia campanulata may look similar to Mniopetalum miniatum but the latter has minute basidiomata [0.2-0.3 mm (Zang, 1986)], distinct central stipe with white basal tomentum and larger spores (7-10 X 5.5-6 µm: Zang, 1986). Rimbachia campanulata may also resemble R. arachnoidea subsp. arachnoidea but the latter occasionally has a slightly rugose hymenium and has different spore dimensions [4-5(-6) X 4-5 µm: Redhead, 1984].

Rimbachia gujesoria H. R. Bhandary, sp. nov.

Macroscopic features

Pileus or basidiomata (Fig 27A) cupuliform, deeply infundibuliform, finally cyathiform, with attenuated pseudostipe and with upward directed hymenophore, some finally discoid, up to 4 mm broad, 6 mm wide (or tall); hymenial surface completely smooth, occasionally minutely and closely bumpy (thus appearing aerolate), milk white, pale ochraceous buff (4A2) at center at maturity and on drying, concave, center strongly depressed at first (depressed center sometimes not corresponding with the tip of the pseudostipe), finally broadly concave, glabrous, but slightly tomentose under 10 X; abhymenial surface concolorous to the hymenial surface, tomentose or smooth at the base; margin not striate, smooth, upturned at first, finally remaining straight at right angles or rarely completely rotated to face downward; edge very thin, slightly lobed and very finely crenate; flesh very thin (0.2 um thick), white, fragile or

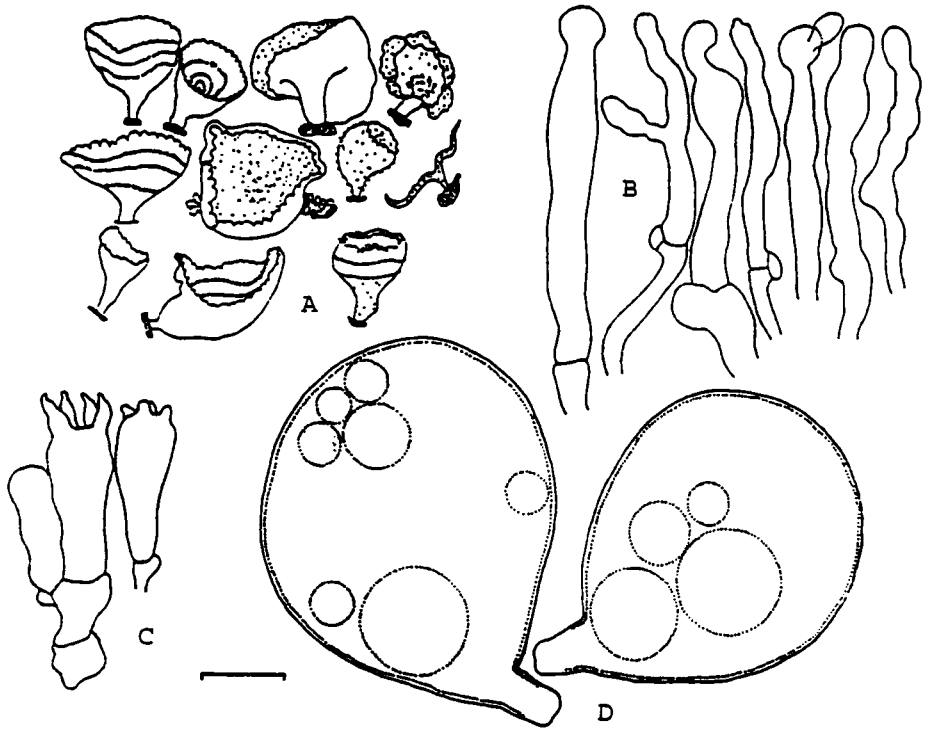


Figure 27 A-D. Features of Rimbachia gujesoria. A. Basidiomata (TENN. 51858, holotype). B. Pileipellis or epicuticular elements. C. Basidia. D. Basidiospores. Standard bar = 3.5 mm for A; 10 µm for B & C; 1.5 µm for D.

brittle, soft, uniformly thick toward the margin from the middle. Pseudostipe up to 5 mm long, hollow above, solid below, white or concolorous to the hymenial layer, hairy-tomentose under 10 X, stout, tapering below. Subiculum white, occasionally scattered also on the substrate. Odor and taste inconspicuous.

Microscopic features

Pileus composed of pileipellis, epicuticular hairs and pileus trama. Pileipellis a cutis, up to 7 µm deep; hyphae 3.0-4.5 µm diam; wall smooth, hyaline, slightly thick (up to 0.8 µm thick); clamp connection present, prominent. Pileipellis hairs (Fig. 27B) up to 30(-45) µm long, 3.8-5.3 µm diam, single or fascicled, cylindrical; tip cell strangulate, or capitate (swollen up to 7.6 µm) or unequally dichotomously branched or with 1-2 short knob-like branches. Pileus trama up to 150 µm deep, interwoven; hyphae up to 3.0-7.6 µm diam, inflated, hyaline, inamyloid, branched, septate; wall smooth, slightly thick (up to 1 µm thick); tip slightly swollen, round; clamp connections distinct. Subhymenium up to 10 µm broad, inconspicuous, 1-2 celled, with polygonal cells. Basidia (Fig. 27C) 21.5-31.0 X 6.2-8.60 µm, 4-sterigmate, clavate, clamped at base. Cystidia at pileus margin up to 55 X 7.3 µm, similar to pileipellis hairs. Pleurocystidia (Fig. 27 D) basidioliform or not differentiated. Basidiospores (Fig. 27E) 5.3-7.2 X 4.2-5.7 µm (Lm = 6.23, Wm = 5.75, E_m= 1-1.26, n = 20), globose, subglobose or ellipsoid, white (assumed), inamyloid, smooth, thin-walled, distinctly appendiculate (hilar appendage up to 1.9 µm long, 1.1 µm thick), multiguttulate.

Habitat: Scattered on living (or necrotic) branches of trailing

mosses on ground.

Specimen examined: Nepal, Kathmandu, Gujeswori (north of Pashupati temple), coll. HRB, 19.vii.92., TENN. 51858 (HOLOTYPE), [2HRB 102, NHMTU. s.n. (ISOTYPE)].

Etymology: Gujeswori = name of a locality in Kathmandu where the fungus was collected.

Comments: Rimbachia gujesoria has been accommodated in Rimbachia because of its bryophilic habit, slightly capitate or branched pellicular hyphae and inamyloid smooth spores. Rimbachia gujesoria can be identified in the field by its white, minute, fragile, cup-shaped, bryogenous basidiomata. Microscopically, R. gujesoria can be distinguished by its pellicular hyphae with slightly swollen or bluntly branched apices and spore dimensions.

Rimbachia gujesoria resembles a number of below mentioned cupuliform Rimbachia species but it differs by: 1) different spore dimensions of R. bryophila [5-7 X 4.5-7 µm (Redhead, 1984a)]; 2) 1- or 2-spored basidia of R. arachnoidea subsp. bispora and R. paludosa (Redhead, 1984a); 3) different shaped (globose to subglobose) and smaller spores of R. arachnoidea subsp. arachnoidea [= Mniopetalum globisporium: (Donk, 1962)] with spore measurements 4-5(-6) X 4-5 µm (Redhead, 1984a) or [5.4-6 X 4.2-5.1 µm (Donk, 1962)]; and 4) larger spores of R. neckerae subsp. megalospora [Redhead (1984a) (= Mniopetalum megalosporum) with larger spores [8.5-10 X 4-5.5 µm (Singer, 1969)].

Rimbachia kaaliya H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 28A) pseudostipitate with spathulate, cup-, saucer- or goblet-shaped upturned or nutant (some seminutant or downward faced) basidiomata, up to 13 mm diam, up to 3 mm wide, yellowish white (3A2 or 4A2); abhymenial surface directed downward, convex, white furfuraceous or frosted (in 10 X), smooth, yellowish white; margin of the cupulate disc straight, smooth and not striate; edge crenate, white frosted in 10 X; flesh very thin (0.1-0.2 mm), white, soft, brittle. Hymenial surface concave, curved semi-ovoid or saucer-like manner, completely upward or sideward or some (rarely) downward facing, completely smooth, concolorous to abhymenial surface; center sometimes much depressed but never porate. Stipe or pseudostipe elongated, cylindrical, dorsal or lateral, 3-4 mm long, very thin (0.1-0.2 mm thick), solid, stout, mostly erect and straight, occasionally slightly curved, uniformly thick throughout, white frosted or furfuraceous like the hymenophore, base olive buff (3A2) or yellowish grey (4B2) toward base. Odor and taste inconspicuous.

Microscopic features

Pileus or hymenocarp composed of pileipellis (with hairs) and pileus trama. Pileipellis originally made of agglutinated cutis, giving rise to fascicled or singly scattered erect hairs. Pileal hairs (Fig. 28B) up to 80 µm long, 3.8-4.6(-8.8) µm diam, smooth and slightly thick-walled (wall up to 0.8 µm thick), hyaline, not branched, inflated, weakly diverticulate with one or two occasional, short, lateral as well as apical globular protuberances or

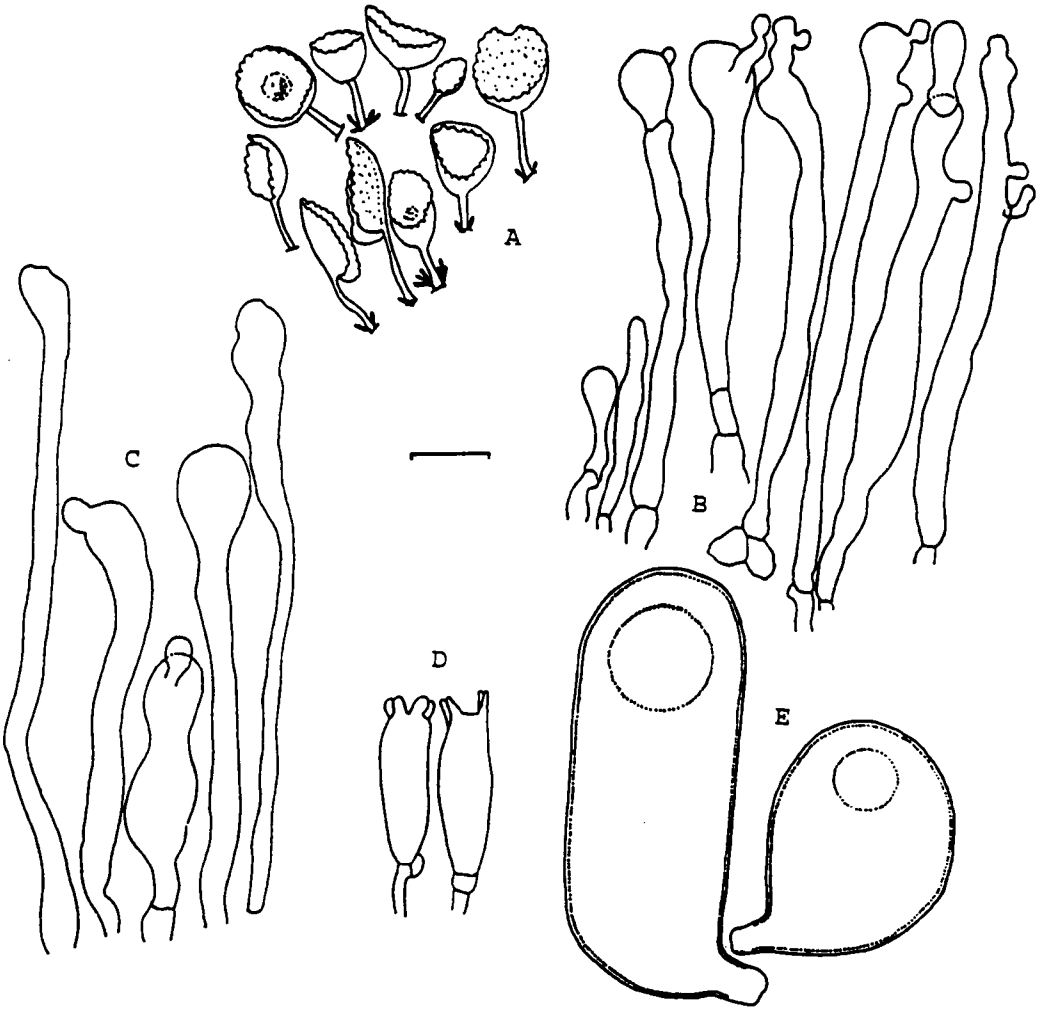


Figure 28 A-E. Features of Rimbachia kaaliya. A. Basidiomata (TENN. 51859, holotype). B. Pileipellis or epicuticular elements. C. Stipitipellis elements. D. Basidia. E. Basidiospores. Standard bar = 9 mm for A; 10 µm for B-D; 1.5 µm for E.

projections, sometimes variously constricted; apex occasionally cylindrical, mostly subcapitate to capitate (swollen at tip up to 8.4 µm) or clavate, with globular knob-like projections or occasionally bifurkate and irregularly dilated; tip round. Caulocystidia or stipitipellis hairs (Fig. 28C) similar to pileipellis hairs but much longer (up to 120 µm); wall up to 1.5 µm thick; clamp connections distinct and inflated up to 4.6 µm. Pileus trama up to 250 µm deep at center of the pileus appearing gelatinized; hyphae 3.8-6.1 µm diam, hyaline, smooth and slightly thick-walled (wall up to 0.8 µm thick), interwoven, septate, slightly inflated at tip and also around septa, also with occasional diverticulae or knob-like projections as in the pileipellis hairs; clamp connections present. Subhymenium conspicuous, up to 15 µm broad, 3-4 cells thick, appearing gelatinized. Basidia (Fig. 28D) 15.2-29.6 X 3.4-5.7 µm, 4-sterigmate, clavate, distinctly clamped at base. Cheilocystidia and pleurocystidia not differentiated. Basidiospores (Fig. 28E) with 4.9-8.7 X 3.0-4.2 µm (Lm = 6.45, Wm = 3.83, E_m= 1.29-2.56, n = 25), white (assumed), subglobose to ellipsoid, with prominent hilar appendage, smooth- and thin- walled, hyaline, inamyloid, mono- (mostly) or multiguttulate.

Habitat: Gregarious on rough cemented floor (concrete top of outdoor stair walls) where only small mosses (less than 2 mm tall) were growing.

Specimen examined: Nepal, Kathmandu, Dakkhinkali (around Dakkhinkaali temple), coll. HRB, 17.vii.91., TENN. 51859 (HOLOTYPE), HRB 92, NHMTU. s.n. (ISOTYPE).

Etymology: Kaali = the Kaali Hindu goddess of Dakkhinkaali temple

premises where the fungus was collected.

Comments: Rimbachia kaaliya has been accommodated in Rimbachia because of its bryogenous habit, capitate or weakly diverticulate epicuticular hairs (of pileus as well as pseudostipe), and inamyloid, smooth- and thin-walled spores. It could not be classified in Arrhenia because of the absence of incrusted but presence of weakly diverticulate epicuticular hyphae. Rimbachia kaaliya can be identified in the field by its typical cupulate, nutant basidiomata with elongated and erect or upright pseudostipe, and growth-habit associated with mosses. Microscopically, it can be identified by its occasionally capitate epicuticular hairs with one or two knobs or protuberances and spore dimensions.

Rimbachia kaaliya is similar to R. paradoxa (type species of Rimbachia) by possessing upturned cup-shaped and nutant basidiomata with elongated stipe and bryophilous habit. The two, however, are distinguishable because R. paradoxa [= Arrhenia auriscalpium (Corner, 1966: 26)] has anastomosing ridges in the hymenium (Patouillard, 1900), larger spores [9-9.3 X 5.5-6 µm (Corner, 1966) or 9-12 X 4.8-6 µm (Redhead, 1984a) or 10.5-11 X 3.8-6 µm (Singer, 1945)] and is tropical in distribution (Patouillard, 1900; Singer, 1945).

Rimbachia lamellata H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 29A) spathulate, flabelliform or dimidiiform, laterally or dorsally attached, sessile, up to 6 mm broad, up to 4 mm wide, milk white; surface dry, bumpy, appressed hairy in 10 X; margin

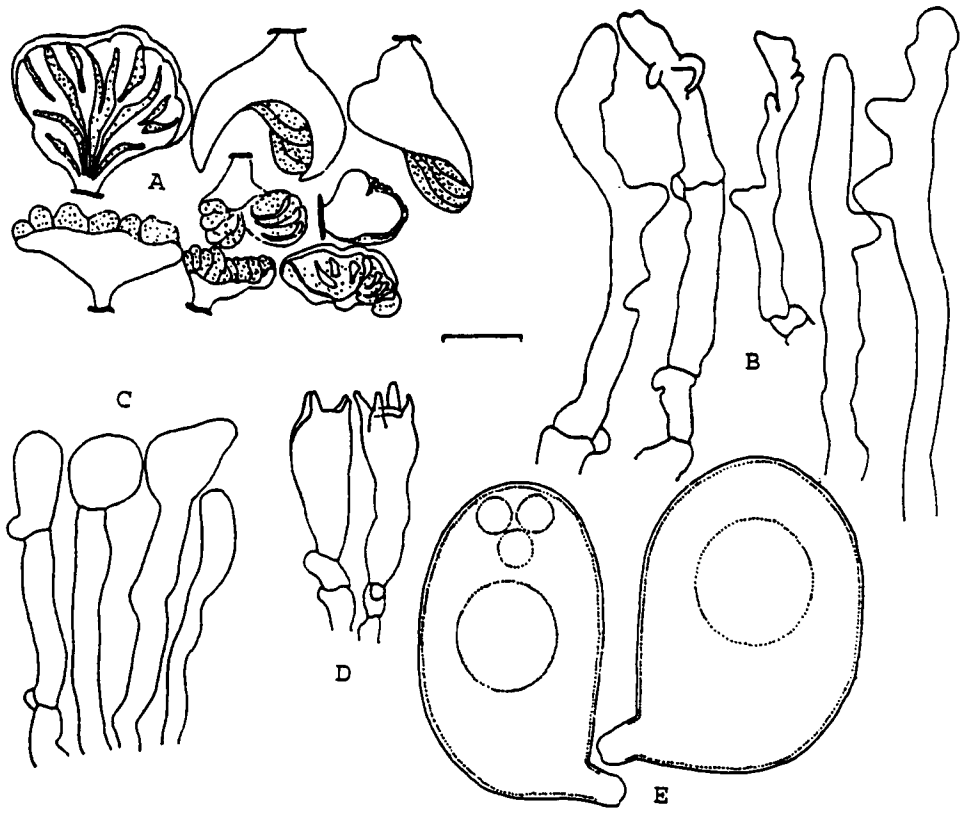


Figure 29 A-E. Features of Rimbachia lamellata. A. Basidiomata (TENN. 51860, holotype). B. Pileipellis or epicuticular elements from basidiomata margin and disc. C. Tramal hyphae. D. Basidia. E. Basidiospores. Standard bar = 11 mm for A; 10 µm for B-D; 1.5 µm for E.

persistently incurved, white erect or appressed hairy, slightly striate, undulate, crenate (in 10X), lobed shallowly; flesh very thin (0.1-0.2 mm thick), white and unchanging, soft, leathery, not brittle. Lamellae originating from a single point, medium broad (1.3-1.5 mm deep), white, medium-distant, up to 3-7 primaries, branched up to 2-4 times; lamellulae abundant, present up to 4 ranks; edge sharp, entire, very minutely mealy or white frosted at 20 X. Stipe totally absent or highly reduced, represented by a short and thick lateral or dorsal continuation of pileus, thickly covered with white wooly tomentum especially at the base, white tomentum also spread in the substrate sparsely. Odor and taste not distinctive.

Microscopic features

Pileus composed of pileipellis (with hairs), pileus trama and lamellar trama. Pileipellis a loosely woven ixocutis, up to 25 μm deep; hyphae 4.2-6.5 μm diam. Pileipellis hairs (Fig. 29B) fascicled or not, up to 60 μm long, 4.9-8.4 μm diam, clavate or capitate or branched one or two times or with a few oblique finger- or knob-like branches; clamp connections distinct. Pileus trama up to 150 μm deep (toward center); hyphae (3.0-)6.1-6.8 μm diam, compactly interwoven, hyaline, inamyloid, inflated, septate, occasionally abruptly swollen around the septa; wall smooth, thin or slightly thick (up to 0.4 μm thick); tip cells occasionally abruptly inflated (Fig. 29C); clamp connections distinct, inflated up to 7.6 μm diam. Lamellar trama regular, narrow, with hyphae similar to those of pileus trama. Subhymenium inconspicuous, up to 7.6 μm deep, 1 or 2 cells deep. Basidia (Fig. 29D) 24.6-31.2 X 6.5-9.5 μm, 4-sterigmate, clavate,

clamped at base. Cheilocystidia and pleurocystidia not differentiated. Basidiospores (Fig. 29E) 5.7-7.6 X 3.8-5.7 µm (Lm = 6.46, Wm = 4.56, Em = 1.24-1.55, n = 20), subglobose to ellipsoid, white (assumed), inamyloid, smooth- and thin-walled, prominently uni-, bi- or few-guttulate, sometimes with a very shallow lateral or posterior bulge.

Habitat: Gregarious on soil amongst mosses (mostly Polytrichum species) and moss protonemas.

Specimen examined: Nepal, Kathmandu, Nagarjun (near the east entrance) preserved forest, coll. HRB, 10.viii.91., TENN. 51860 (HOLOTYPE), HRB 57, NHMTU. s.n. (ISOTYPE).

Etymology: Lamellata = possessing distinct lamellae or gills.

Comments: Rimbachia lamellata has been accommodated in Rimbachia and not in Arrhenia because of absence of incrusted hyphae and presence of clavate, capitate, or weakly diverticulate pellicular hyphal hairs, bryophilous habit and inamyloid, smooth and thin-walled spores. Rimbachia lamellata can be identified in the field by its white, laterally attached, and broadly lamellate flabelliform basidiomata growing on soil at the base of mosses. It can be distinguished microscopically by the presence of weakly diverticulate, capitate or cystidiate, simply branched or knobbed pileipellis hairs, tramal hyphae with swellings at the tip or around the septal regions, and spore dimensions.

Rimbachia lamellata resembles Mniopetalum flabelliforme (Zang, 1986) in having spathulate or fan-shaped whitish basidiomata and bryophilous habit. Mniopetalum flabelliforme, however, is different by

possessing venose to reticulately nerved and often dichotomously forked hymenium, distinct lateral stipe, and much larger spores [7-10 X 5-6 µm (Zang, 1986)]. Rimbachia lamellata may also resemble R. bryophila by possessing similarly colored bryophilous basidiomata with lamella-like folds (Redhead, 1984a). Rimbachia bryophila, however, is different by its pendant, conchate, conical or cupulate basidiomata and different spore size [5-7 X 4.5-7 µm (Redhead, 1984a)].

Rimbachia leleya H. R. Bhandary, sp. nov.

Macroscopic features

Pileus (Fig. 30A) convex, spathulate, flabelliform or reniform, laterally attached, 7-40 mm diam, milk white or sulphur yellow (1A2) or pale ochraceous buff (4A2) or pale cinnamon pink (5A2 or 5A3), on aging light ochraceous buff (5A4) or light orange (5B4) specially toward margin; surface smooth or minutely scurfy (under 20 X), dry, occasionally faintly bumpy and wrinkled concentrically; margin incurved, silky glistening, minutely scurfy (at 10 X), not striate, lobed slightly, occasionally faintly eroded-crenate; flesh thicker than hymenial folds (up to 1 mm thick), white, unchanging, leathery, hard, brittle. Hymenium of shallow veins, distinctly long-decurrent or radiating from stipe apex, concolorous to pileus, sometimes also pinkish buff (6A3) or flesh (6B3), medium-thick, shallow (up to 0.8 mm deep), subdistant; primary veins 3-7, forked or branched irregularly 2-6 times, branching interconnected by shallow wrinkles or veins; edge entire, blunt, white frosted under 10 X. Stipe sometimes completely absent or more elongated, cylindric, slightly curved, always lateral,

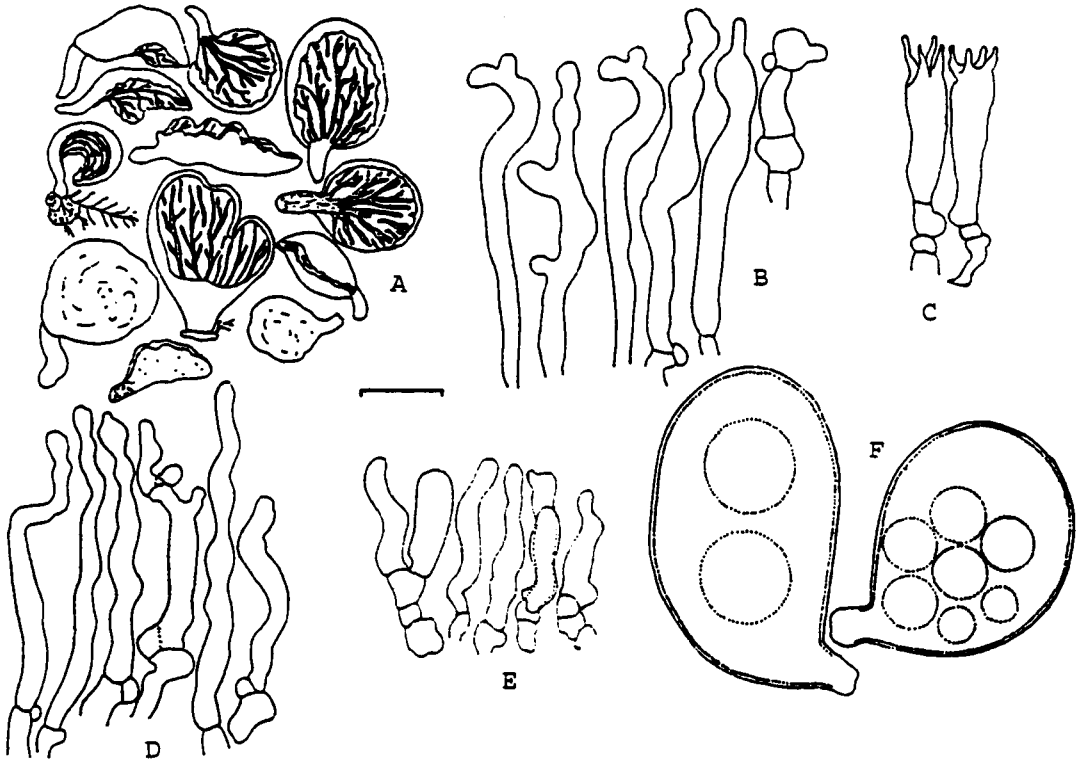


Figure 30 A-F. Features of Rimbachia leleya. A. Basidiomata (TENN. 51861, holotype). B. Pileipellis or epicuticular elements. C. Basidia. D. Cheilocystidia. E. Pleurocystidia. F. Basidiospores. Standard bar = 2.5 mm for A; 10 µm for B-E; 1.5 µm for F.

stout, up to 3 mm long, 1 mm diam, white, minutely subtomentose or scurfy, concolorous to the pileus, slightly enlarged and compressed or applanate above, curved, occasionally with white basal tomentum. Odor indistinct. Taste none or sometimes (HRB 120) slightly sweet.

Microscopic features

Pileus composed of pileipellis (with hairs), pileus trama and lamellar trama. Pileipellis an interwoven cutis; hyphae mostly 3.8 µm diam; clamp connections present. Pileipellis hairs (Fig. 30B) erect, single or fascicled; hyphae 19(-70) µm long, 3-4.2 µm diam, variously swollen, slightly knobbed, strangulate or shortly branched, hyaline, inamyloid; wall smooth, slightly thick (wall up to 0.8 µm thick); tip round. Caulocystidia up to 100 µm long, up to 4.3 µm diam, slightly swollen, apically clavate or capitate. Pileus trama 200-250 µm deep (at the pileus margin); hyphae interwoven, 3.4-7.6 µm diam, inflated, hyaline, inamyloid, septate, slightly swollen around the septa; wall smooth, slightly thickened (wall up to 1 µm thick); tip round, slightly swollen (up to 11 µm); clamp connections prominent. Lamellar trama circum 150 µm thick, interwoven, with hyphae similar to those of pileus trama. Subhymenium inconspicuous, up to 13 um broad, 3-4 celled. Basidia (Fig. 30C) 19.8-30.1 X 5.3-6.9 µm, 4-sterigmate (sterigmata up to 7.5 µm long), clavate, clamped at base. Cheilocystidia (Fig. 30D) 22.8-49.4 X 2.8-4.6 µm, projecting 11-25 µm, cylindrical, with round tip, sometimes flexuous and with 2-3 short branches or knobs, clamped at base. Pleurocystidia (Fig. 30E) 12.3-26.7 X 2.3-4.6 µm, basidioliform or cylindrical, sometimes undulate or stranguliform. Basidiospores (Fig. 30F) 4.2-6.1 X 3.0-4.6 µm (Lm =

4.91, Wm = 3.85, E_m= 1.16-1.61, n = 25), subglobose or ellipsoid, white (assumed), inamyloid, smooth and thin-walled, prominently uni- to multiguttulate, acyanophilic, with prominent hillar appendage, sometimes with a shallow posterior bulge.

Habitat: On soil or on Polytrichum or other mosses growing around recently exposed and eroded areas and roadsides.

Specimens examined: Nepal, Kathmandu, Mt. Shivapuri (5000 ft), coll. HRB and Bhaiya Khanal, 24.vii.90., HRB 133, TENN. 51862; Kathmandu, Bhardeo (5500 ft), on the way to Leley, coll. HRB and Ram Bahadur Tamang (Gomba), 15.vii.91., TENN. 51861 (HOLOTYPE), [HRB 120, NHMTU. s.n. (ISOTYPE)]; Kathmandu, Shivapuri, Sadhubas (6500 ft), coll. HRB, Bhaiya Knanal, Mahendra Shrestha, and Nima Sherpa, 24.viii.91., HRB 133, TENN. 51863.

Etymology: Leley = a place, popular in Kathmandu Valley for supplying edible wild mushrooms to the markets of Patan and Kathmandu).

Comments: Rimbachia leleya has been accommodated in Rimbachia and not in Arrhenia because of the lack of incrusted epicuticular or tramal hyphae and presence of subcapitate or slightly knobbed or bifurcately divided epicuticular hyphae, inamyloid smooth-walled spores and bryophilous habit. Rimbachia leleya can be identified in the field by its laterally attached, whitish, distinctly stipitate basidiomata with reticulately venose hymenium and bryophilous habit. Microscopically, it can be distinguished by irregularly swollen or knobbed (one or two times) or shortly bifurcate, erect, pellicular

hyphae, distinct cylindrical and projecting cheilocystidia, non-projecting basidioliform or slightly undulate, strangulate, cylindrical pleurocystidia and spore dimensions.

Rimbachia leleya resembles R. furfuracea by pleuropodal, reniform-flabelliform or spathulate-obovate whitish basidiomata with rather thick, anastomosing and venose hymenium, terricolous habit associated with bryophytes and similar spore dimensions [4.5-6 X 3-4 µm as Mniopetalum distinctum (Horak, 1980) or 5-6.5 X 3.5-4.3 µm as Cantharellus furfuraceus (Corner, 1966)]. Rimbachia furfuracea, however, is distinguishable by its putrescent flesh and lack of projecting cheilocystidia in (Corner, 1966).

SARCOMYXA

Sarcomyxa Karsten. 1891. Medd. Soc. Fauna fenn. 18: 62.

Type species: Agaricus serotinus Fries. 1821. Syst. Myc. I. 187.

The name Sarcomyxa was first used by Peter Adolf Karsten (1891) for Sarcomyxa serotinus, originally named Agaricus (Pleurotus) serotinus by Fries (1821) who acknowledged Schrader as its author. Karsten (1891) characterized Sarcomyxa by laterally stipitate basidiomata with viscid cuticle, fibrous stipe, lack of veils, decurrent lamellae, cylindrical, curved, white spores and cylindrical-clavate cystidia.

Sarcomyxa, on the basis of the type species, can be characterized by basidiomes with viscid cuticle, lateral stipe, gelatinized and hyaline tramal hyphae, thin-walled pleuro- and cheilocystidia (sometimes appearing metuloidal by possessing amorphous, yellowish

resinous exudations) and cylindric-curved (at one side), white, inamyloid [Horak, 1968: (in type specimens); Breitenbach and Kränzler, 1992)] or amyloid (Singer, 1986) spores.

Controversies occurred about spore amyloidity of the type species of Sarcomyxa (S. serotina). Singer (1975a, 1986), Miller (1970), Watling and Gregory (1989) treated Sarcomyxa as a synonym of Panellus because they found that the spores of Panellus serotinus (= Sarcomyxa serotina) were amyloid as reported earlier by Kühner and Romagnesi (1953) and not inamyloid as reported by Horak (1968a) and Breitanbach and Kränzler (1992). However, Horak (1980) again reported his collections from the Indian region of Sikkim Himalaya (close to east Nepal) as Panellus serotinus (not as Sarcomyxa) and with amyloid spores. In the present work, although I have found the spores of S. serotina (TENN. 51864 collected in Nepal and exsiccates TENN. 34843 from Kootenai Co., Idaho State) to be amyloid, I have rather preferred to accommodate my collections in Sarcomyxa because Panellus is strictly characterized by amyloid spores (Singer, 1986) and cannot accommodate those collections which reportedly (Horak, 1968a) have inamyloid spores.

Sarcomyxa differs from a number of genera with gelatinous tramal hyphae e.g. Hohenbuehelia, Panellus, Pleurocollybia, Pleurotopsis, Resupinatus, and Troqia, by features mentioned in the world key. Acanthocystis, Scytinotus, Urospora, and Urosporellina are some of the synyonyms of Sarcomyxa while Sarcomyxa also used to be treated as Agaricus and Pleurotus in the past.

This is the first report of occurrence of Sarcomyxa species in Nepal. It was reported from Sikkim (east himalayan part of India), close to eastern Nepal, by Horak (1980). Sarcomyxa is found on hardwood (oaks, etc.) and sometimes on conifers (Horak, 1980) in the temperate belt of the northern hemisphere.

Description of Nepalese species

Sarcomyxa serotina (Fr.) Karsten. 1891. Medd. Soc. Fauna fenn. 18: 62: Symbolae ad Mycologiam fennicam.

Macroscopic features (description from exsiccates)

Pileus (Fig. 31A) spathulate or flabelliform, laterally attached, up to 42 mmm broad, 36 mm wide, greyish orange (5B4 or 5B5) towards disc, pale orange towards margin, vandyke brown (7E6) flushed here and there, depressed at disc; surface glabrous, broadly wrinkled; margin incurved, straight in some specimens, finely striate up to 5 mm; flesh concolorous to pileus (i.e. 5B5), hard, up to 1.5 mm thick, gradually thinning towards margin. Lamellae short decurrent, Rood's brown (7D5), very crowded, medium broad, broader towards margin (up to 2.5 mm towards margin, 0.5 mm toward disc); edge entire, white frosted at 10 X; lamellulae of 2 or 3 ranks, not forked. Stipe thick, short, cylindrical, up to 10 mm long, 0.9 mm thick, concolorous to pileus disc, rugose, swollen below, woody. Odor and taste not recorded.

Microscopic features

Pileus composed of pileipellis (with hairs), pileus trama and lamellar trama. Pileipellis a cutis of loosely interwoven, periclinally arranged, filamentous hyphae; hyphae up to 150 µm long,

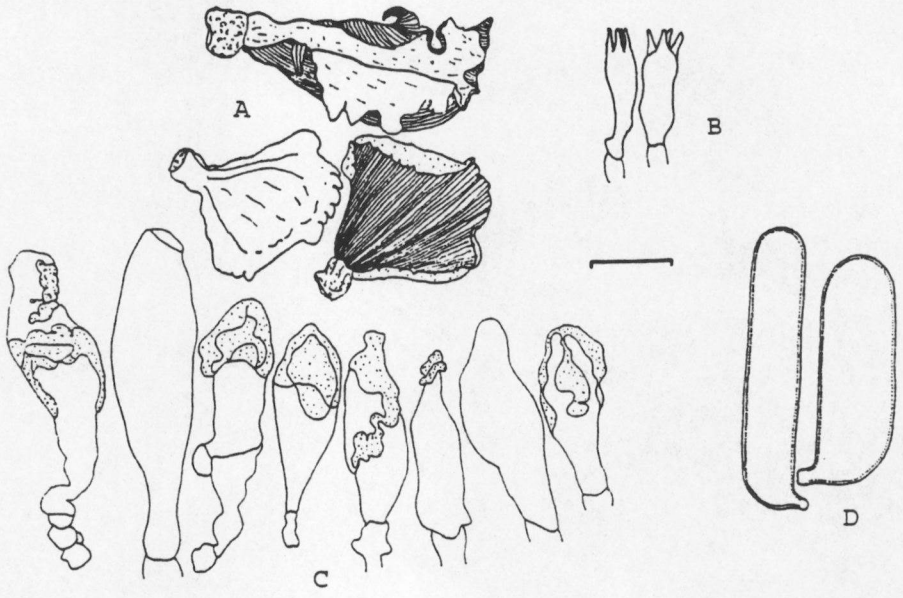


Figure 31 A-D. Features of Sarcomyxa serotina. A. Basidiomata (NH. 88102, TENN. 51864). B. Basidia. C. Cheilocystidia. D. Basidiospores. Standard bar = 12 mm for A; 10 µm for B & C; 1.5 µm for D.

2.6-4.4(-6.2) μm diam, brownish yellow in Melzer's reagent. Pileipellis hairs dense, erect or prostrate, cylindrical with undifferentiated or clavate end; wall smooth, slightly thick (up to 0.8 μm thick); clamp connections present, inflated up to 4.4 μm diam. Caulocystidia cylindrical, dense, similar to the pileipellis hairs. Pileus trama up to 700 μm deep (near the disc), three layered: 1) upper gelatinous layer up to 100 μm deep, highly gelatinized; hyphae 2.6-7.7 μm diam, compactly arranged, occasionally inflated, periclinally arranged, hyaline; wall smooth, gelatinized, thick (wall up to 1 μm thick); clamp connections distinct, inflated up to 5.4 μm. 2) lower gelatinous trama up to 200 μm deep; hyphae similar to the above layer but less compactly arranged, interwoven, continuous with the subsequent lacunose and ungelatinized tramal layer; 3) lower ungelatinized layer up to 400 μm deep; hyphae similar to the upper above layers but non-gelatinized and laxly arranged, occasionally lacunose. Lamellar trama up to 400 μm thick, interwoven; hyphae similar to the above mentioned layers; edge gelatinized. Subhymenium up to 9.5 um broad, inconspicuous. Basidia (Fig. 31B) 13.3-16.3 X 3.8-4.2 μm, 4-spored, clavate, clamped at base. Cheilocystidia (Fig. 31C) 11.4-44.5 X 3.8-9.5 μm, projecting up to 20 μm, cylindric, fusiform or narrowly to broadly clavate, with or without amorphous slightly dextrinoid resinous deposition at the tip or base (resinous depositions visible only in Melzer's reagent, but not in Congo red reagent). Pleurocystidia similar to the cheilocystidia. Basidiospores (Fig. 31D) [3.2-4.9 X 1.0-1.3 μm (Lm = 4.2, Wm = 1.1, E_m= 2.63-4.45, n = 25), including hilar appendages], cylindrical, allantoid, curved to

one side, white (assumed), amyloid, aguttulate to multiguttulate.

Habitat: Growing scattered on tree trunks of Quercus species.

Specimen examined: Nepal, Kinja-Goyam [10000 ft (Solukhumbu district ?)], coll. Mr. M. K. Adhikary, 8.X.88., MKA s.n., NH 88102, TENN.51864.

Comments: Despite lack of information on morphological features in fresh stage, this fungus has been identified as Sarcomyxa serotina because of its distinctly lamellate and pleurotoid basidiomata, cylindric pileipellis and stipitipellis hairs, gelatinized and slightly thick-walled hyphae of upper pileus trama, metuloid-like cheilo- and pleurocystidia, cylindric-allantoid amyloid spores and spore dimensions [4-5.5 X 1-1.5 μm: (Watling and Gregory, 1989); 4-5 X 1-1.5(-2) μm: (Horak, 1968); 3.7-6.5 X 1-1.5 μm: (Breitenbach and Kränzlin, 1991); 4.0-5.5 X 1.0-1.5 μm for Panellus serotinus: (Miller, 1970; Horak, 1980)], growth habit on trunks of hardwood tree (oak in this case) and occurrence in temperate climate (at upper temperate forest of Nepal at 10,000 ft elevation).

SCHIZOPHYLLUM

Schizophyllum Fr: Fr. 1821. Syst. mycol. 1: 330.

Type species: Schizophyllum commune Fr: Fr.: ibid.

Schizophyllum is a Friesian (1821) name characterized by pleurotoid basidiomata with corky-tough or coriaceous texture, involute margin, longitudinally bifurkate lamellae, lack of veil, and white spores. Fries (1821) placed Schizophyllum in order Pileati of

Hymenomycetes (together with Agaricus, Cantharellus, Merulius, Boletus, Polyporus, Hydnum, etc.) characterized by basidiomata with distinct hymenial layer. Kühner amd Romagnesi (1953) placed Schizophyllum in the family Pleurotacées and characterized the genus by lamellae with longitudinally divided and oppositely recurved margins, and inamyloid pinkish spores. Murrill (1915) placed Schizophyllum in tribe Agariceae of Agaricaceae together with other tough, woody or reviving genera like Lentinellus, Lentinus, Marasmiellus, Marasmius, Panellus, Pleurotopsis, Resupinatus, Tectella, etc.

Singer (1951) erected a separate tribus Schizophylleae to accommodate Schizophyllum in the Tricholomataceae, close to tribus Panelleae and Lentineae because of their common characters also envisioned by the earlier mycologists. Singer (1962) transferred Schizophyllum to the family Polyporaceae, erecting a separate subfamily Schizophylloideae. Singer (1975a, 1986) later supported Donk's (1964) view that Schizophyllum is not an agaric but a member of cyphelloid Aphyllophorales and hence should be placed in a separate family Schizophyllaceae of Aphyllophorales [as visualized much earlier by Quélet (1888)].

According to Donk (1964), basidiomata of Schizophyllum can be visualized as compound mass of several cups, developing on a common stroma. Therefore, each split gill actually represents two adjacent pilea margins (of two closely juxtaposed cyphelloid basidiomata because there are abhymenial hairs between the so-called split gills) which roll in opposite directions in dry weather to cover their

respective smooth hymenium. Therefore, according to Donk (1964) an entire basidioma with a number of split gills of Schizophyllum commune is an aggregation of a number of cupulate fruitbodies growing in such a manner that they finally look like an agaric with split gills.

Schizophyllum's close resemblance to cyphelloid aphyllophoraceous fungi has been supported by almost all modernday mycologists (Pegler, 1986; Watling and Gregory, 1989; Breitenbach and Kränzler, 1991; Reijnders and Stalpers, 1992; etc.). Stalpers (1988) had concluded that Schizophyllum and Auriculariopsis, a member of the family Corticiaceae of Aphyllophorales, are very close to each other in observations made from pure cultures, basidiomata ontogeny, and macro- as well as micromorphology.

Schizophyllum can be distinguished from other similar looking white spored pleurotoid agarics e.g. Hohenbuehelia, Lentinellus, Lentinus, Panellus, Resupinatus etc. by features provided in the world key. Apus, Hyponeuris, Rhipidium, Schizonia, Schizophyllus etc. are some of the synonyms of Schizophyllum.

Though now regarded as a member of the Aphyllophorales, Schizophyllum has been included here because it is always confused as a white-spored pleurotoid agaric.

Description of Nepalese species

Schizophyllum commune Fries. 1821. Systema Mycologicum 1: 330.

Macroscopic features

Pileus (Fig. 32A) convex, spathulate, reniform or dimidiiform, up

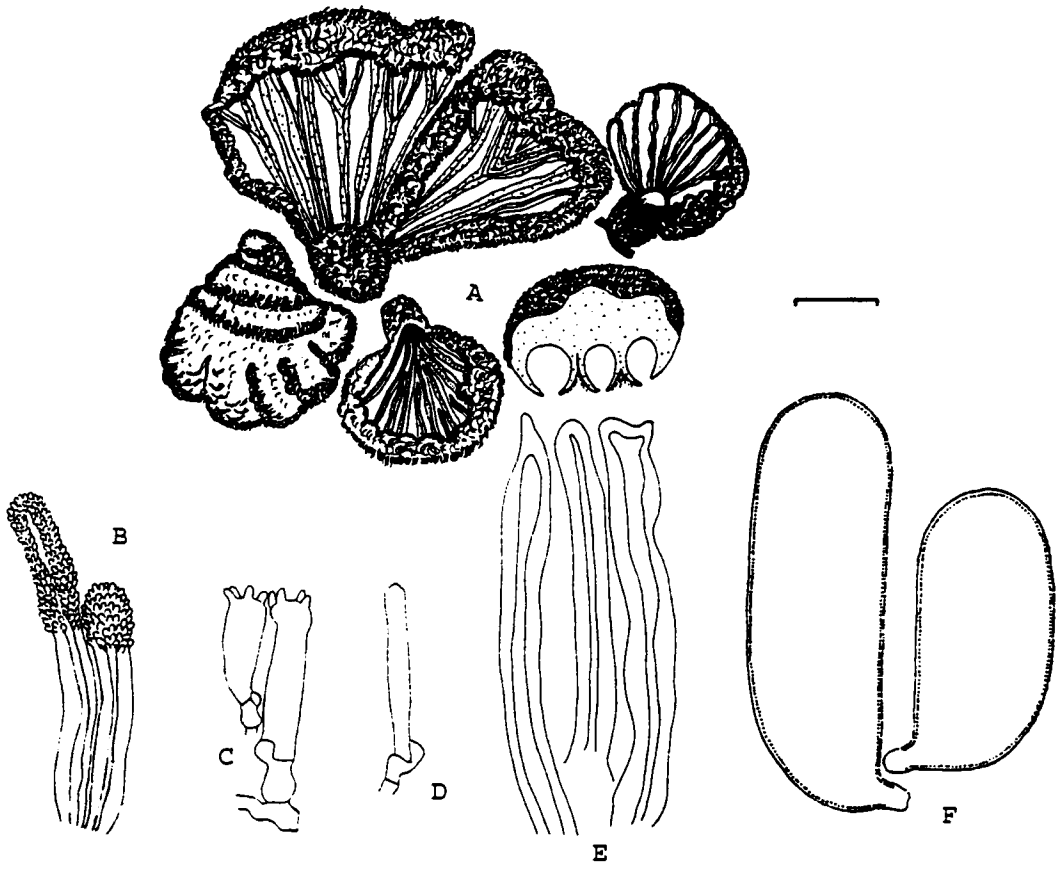


Figure 32 A-F. Features of Schizophyllum commune. A. Basidiomata (TENN. 51865 and other specimens). B. Detritus encrusted apex of tramal hyphae. C. Basidia. D. Basidioliform cheilo- or pleurocystidia. E. Hyphoid or projecting cheilo- or pleurocystidia. F. Basidiospores. Standard bar = 11 mm for A; 10 µm for B-E; 1.5 µm for F.

to 35 mm broad, 11 mm wide, milk white or pale yellow (4A3) or yellowish grey (4B2 or 4C2) or orange white (5A2 or 5A3); surface longitudinally rugulose, dry, completely covered with dry silky hairs, tomentose then strigose; margin striate, lobed (sometimes deeply), rimose, persistently incurved; flesh tough, hard, leathery, 0.5-0.6 mm thick, dry, silky greyish orange (6B3) or orange white (6A2) or brownish orange (6C4), unchanging on bruising. Lamellae originating from a point, longitudinally split, pale orange (5A3 or 6B3) or brownish grey or orange (6C2 or 6C3 or 6C4) or finally brown (6E4 or 6E5), crowded, shallow (up to 0.5 mm broad), white scurfy under 10X; edge entire, appearing as if split longitudinally and the edges rolling back on drying, blunt, grooved and densely white hairy or scurfy between the two split lamelae (in 10X). Stipe absent or lateral portion of pileus extended to form a short stipe-like base, up to 3 mm long, 2 mm diam, concolorous and similary densely hairy as the pileus. Odor and taste indistinct.

Microscopic features

Pileus composed of pileipellis (with hairs), pileus trama and lamellar trama. Pileipellis a trichoderm, giving rise to long thick-walled hairs. Pileipellis hairs up to 680 µm long, (2.3-)3(-5.7) µm diam, cylindric, unbranched, hyaline, uninflated, smooth- and thick-walled (wall up to 2.0 µm thick), with undifferentiated to round tip; clamp connections prominent. Pileus trama up to 500 µm deep (towards the base of pileus); hyphae 2.7-4.6(-8.4) µm diam, monomitic, interwoven, thick-walled [wall (0.8-)1.9(-3.8) µm thick], hyaline, smooth-walled, neither amyloid nor dextrinoid, some coiled towards the

tip, slightly branched; clamp connections prominent, inflated up to 7.6 μm broad; apex sometimes encrusted with granular detritus (Fig. 32B). Subhymenium inconspicuous. Basidia (Fig. 32C) 13.3-20.9 X 3.4-4.9 μm, 4-sterigmate, elongate-clavate, clamped at base. Cheilocystidia of two types: 1) (Fig. 32D) 14.0-22.5 X 4-5.2 μm, non-projecting, basidioliform, clavate, clamped at base; 2) (Fig. 32E) 21.6-51.3 X 3.0-5.3 μm, as pseudocystidia, projecting up to 15 μm, hyphoid or cylindrical, thick-walled (wall up to 2.3 μm thick). Pleurocystidia similar to both types of cheilocystidia. Basidiospores (Fig. 32F) 5.3-8.2 X 2.3-2.7 μm (Lm = 6.31, Wm = 2.5, E_m= 2.11-3.0, n = 20), elliptic oblong to cylindrical, straight or slightly curved, hyaline in KOH solution, inamyloid, smooth, thin-walled, uni- or biguttulate.

Habitat: On decaying sticks (of Pyrus malus) or decaying or discarded logs or timbers (Schima wallichii, Castanopsis indica, C. tribuloides, Shorea robusta).

Specimens examined: Nepal, Kathmandu, Ason and Basantapur vegetable market, exact origin unknown (kept for sale by local vendors who gathered the specimens from primary collectors probably from Terai or from other subtropical mountainsides), coll. HRB, 28.viii.86., HRB s.n., NHM s.n., TENN. 51865; locality unknown, coll. Mr. M. K. Adhikary, date unknown, MKA 020, NH s.n., TENN. 51866; Kathmandu, Mt. Shivapuri (specimens growing on logs of Shorea robusta, probably transported from Terai as fuelwood or construction material), coll. HRB and Mr. Bhaiya Knanal, 4.viii.90., HRB 122(15), TENN. 51867;

Kathmandu, Nagarjun forest, Coll. HRB, 6.vii.91, HRB 32, TENN. 51869; Kathmandu, Mt. Swayambhu, coll. HRB, 8.vii.91, HRB 42, TENN. 51868.

Comments: The above mentioned fungus specimens have been identified as Schizophyllum commune (type species of Schizophyllum). Schizophyllum commune is readily recognizable in the field by its typical, dry, tough, coriaceous, densely hairy whitish or greyish, sessile, lignicolous, pleurotoid basidiomata with white to pinkish lamellae which appear longitudinally divided. Microscopically, Schizophyllum commune can be identified with the help of its clamped, thick and brown-walled cylindrical as well as coiled hyphae with end-cells ornamented with granular detritus, hyphoid thick-walled cheilo- and pleurocystidia, elongated spores and their dimensions [3.5-5 X 1-1.5 µm (Horak, 1968) or (5-)6-7 X 2-2.5 µm (Watling and Gregory, 1989) or 5.6-7 X 1.8-2.3 µm (Breitenbach and Kränzler, 199).

Schizophyllum commune is widely used as a common mycological research tool for understanding biology, genetics, enzymology, cultivation etc. of wide varieties of basidiomycetous fungi (Watling & Gregory, 1989) because it is small (hence needs little space to grow), has a short life cycle, its spores germinate easily in high percentage, dikaryotic mycelium fruits in culture without difficulty (unlike many mushrooms), and easily grows in simple and chemically defined medium (Chang & Miles, 1989).

In Nepal, Schizophyllum commune is widespread especially in tropical and subtropical regions. From Nepal, it was reported for the first time by Balfour-Browne (1955). Schizophyllum commune is very popular as a vegetable throughout central parts of Nepal specially for

Newar, Chepang, Gurung, Sherpa, Rai, and Limbu communities. Use of Schizophyllum commune by Newar, Chepang and Gurung communities of central Nepal was reported by Bhandary (1991a, 1991b). Especially in Newar people of Kathmandu Valley, during their religio-cultural ceremonies this mushroom is used as a raw or cooked vegetable. Some people also believe that this mushroom possesses a medicinal effect as appetizer or as a cure for various stomach troubles and prepare several recipes from it. On the other hand, in Europe it is regarded dangerous to eat S. commune because it reportedly causes basidioneuromycosis, a disease characterized by presence of mycelium in cerebrospinal fluid (Svrcek, 1983). Schizophyllum commune is called baangrey moo in Chepang; dhey syaamu in Lama; senj naakmaa in Rai; miju or taarey or gundruk chyaau in Nepali; and chhogewaa mung in Limbu languages.

WHITE-SPORED PLEUROTOID FUNGAL ELEMENTS OF CENTRAL NEPAL

Approximately 150 collections of pleurotoid mushrooms were examined from central Nepal (15 collected by Mr. M. K. Adhikary, 132 by HRB, two by Dr. H. V. T. Cotter and one from far-western Nepal). Sixty-four collections (five by Mr. Adhikary, 56 by HRB, two by Dr. Cotter and one by anonymous collector) were found to belong to white-spored pleurotoid agarics while remaining collections belonged to pink- (Claudopus, Entoloma, Phyllotopsis, etc.) or brown-spored (Crepidotus etc.) mushrooms and some species of Lenzites, Polyporus etc. Among the 15 genera and 40 species (including those described in

this thesis and also those described by earlier workers) of white-spored pleurotoid agarics occurring in Nepal, Lentinus was found to possess the highest number of species (ten), followed by Hohenbuehelia (seven), Rimbachia (five), Pleurotus (four), Marasmiellus, Neolentinus and Panellus (two), and Campanella, Chaetocalathus, Lactarius, Omphalotus, Pleurotopsis, Resupinatus, Sarcomyxa, and Schizophyllum (one). Except the monotypic Pleurotopsis, Sarcomyxa, and Schizophyllum, all other genera possessed varied number of species world-wide [e.g. over 15 in Chaetocalathus, 30 in Campanella, 30 in Hohenbuehelia, four in Lactarius, 50 in Lentinus, over 160 in Marasmiellus (Singer, 1986), six in Neolentinus (Redhead and Ginns, 1985), three in Omphalotus, 15 in Panellus, over 25 in Pleurotus, 11 in Resupinatus (Singer, 1986), and ten in Rimbachia (Redhead, 1984a)].

In general, the pleurotoid agarics of central Nepal can be categorized into various types in the basis of their global geographical distribution: 1) cosmopolitan elements or species ubiquitously found all over the world e.g. Hohenbuehelia petalodes, Lentinus strigosus (Pegler, 1983c), Omphalotus olearius (Singer, 1986), Panellus stypticus (Breitenbach & Kränzlin, 1991), Pleurotus ostreatus (Watling and Gregory, 1989), and Schizophyllum commune (Watling, 1978; Cotter, 1987); 2) Pantropical elements found throughout the tropical (paleotropic as well as neotropic) regions of the world e. g. Lentinus velutinus (Pegler, 1983c) and Pleurotus djamor var. djamor (Corner, 1981); 3) Holarctic (Müller, 1986) elements found throughout the temperate regions of North America (nearctic), north Europe, North Africa, West Asia, and Mediterranean

regions e.g. Neolentinus tigrinus (Pegler, 1983c) and Sarcomyxa serotina (Breitenbach & Kränzlin, 1991); 4) Nearctic (Müller, 1986) as well as Australian (Müller, 1986) element found in North America and South Pacific Region e.g. Pleurotopsis sp. (Horak, 1983); 5) Paleotropical (Müller, 1986) elements found in tropical regions of Africa (Ethiopian), Madagascar (Madagascan) and oriental (Indian and SE Asian) regions e.g. Lentinus sajor-caju (Pegler, 1983c); 6) Indo-Malayan and South-east Asian elements reported from Indian Peninsula and SE Asian regions represented by Lentinus badius, L. polychrous, and L. squarrosulus (Pegler, 1983c); 7) element similar to Japanese elements represented by Lactarius pleurotoideus; 8) elements so far only reported from Nepal Himalaya e.g. Campanella himalensis, Chaetocalathus skeletiformis, Hohenbuehelia albifunicula, H. herbicola, H. kathmandua, H. mucrometuloidea, H. nepalensis, H. spissifera, Marasmiellus kathmanduus, M. transluscentus, Neolentinus species 1, Panellus edulus, Pleurotus platypus (Pegler, 1976), Resupinatus nepalensis, Rimbachia campanulata, R. gujesoria, R. kaaliya, R. lamellata, and R. leleya (temperate Himalayan elements) and Lentinus chepangiana, L. rutus, Lentinus sp. 1 and Lentinus sp. 2 (tropical Himalayan elements).

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VITA

Hemanta Ram Bhandary was born on 6 June, 1954, in Thamel Galko Pakha, Kathmandu, Nepal. He obtained elementary and lower secondary school education at Bijaya Memorial School and Padmodaya High School and matriculated from Shanti Vidya Griha High School, in 1969. After receiving Intermediate of Science from Anandakuti Science college and Bachelor of Science in biology and chemistry from Tri-Chandra college, he received Master of Science in Botany, in 1978, from Kirtipur Multiple Campus, Tribhuvan University, Kathmandu.

After graduation, Mr. Bhandary worked for a few months as a Nepali Language Instructor in American Peace Corps Volunteers program in Kathmandu. From July 1979 to November 1990, he was an Assistant Lecturer (later promoted to Lecturer) of Tribhuvan University, taught chemistry for a few months in Sanothimi Agriculture Campus, taught botany as a part-time (1979-1980) teacher (1979-1982) in Amrit Science Campus and Kirtipur Multiple Campus (6 months), and worked as a mycologist cum naturalist (1980-1990) in the Natural History Museum, Kathmandu. During his tenure in the Natural History Museum, Mr. Bhandary travelled widely in Nepal for mushroom and other plant collections.

Mr. Bhandary was awarded His Royal Highness Crown Prince Dipendra Science and Technology First National Youth Award in 1985 and National Education Award in 1988, and has published about 18 papers in professional Nepalese as well as international journals.

In December 1990, Mr. Bhandary received an assistantship to enter

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Mr. Bhandary is married to Shova Bhandary and has two children, Abijit and Aichhya.