

MUSHROOM FLORA OF KHASI HILLS (MEGHALAYA), INDIA

BY

Md. SHAJAHAN, N. ROY CHOUDHURY, A. K. SAHA AND N. SAMAJPATI
Mycology Laboratory, Department of Botany, University of Calcutta.
Calcutta-700 019

Key words : Survey, Mushrooms, Khasi Hills, India

Fourteen species of Basidiomycetous fungi have been collected from Shella, Shillong and adjacent area of Khasi hills and described here, out of which eleven species are reported for the first time from India. Seven of the collected specimens have been reported as edible by the local people.

INTRODUCTION

The available records on Indian mushrooms show that there are about five hundred species of Agaric reported so far (Sathe *et al* , 1975, 1977 ; Natarajan, 1977 ; Roy and Samajpati, 1978, 1979 ; Roy and Samajpati, 1979 ; Watling and Gregory, 1980). These records are mostly from northern, western and southern parts of India. Since the study of Barkeley (1856), there is no scientific and systematic record of mushroom flora of eastern India. In order to prepare a scientific account of the mushroom flora of eastern India studies are being continued in this laboratory. The present report is presented as an initial step to prepare a complete list of this area and has been undertaken in the area of Shella, Shillong of the Meghalaya state, India.

Meghalaya is one of the smallest state in the eastern part of India with an area of 22,429 sq km lies between approximately 25°34'N and 91°53'E and is known as Shillong or Assam plateau which is divided into Garo, Khasi and Jaintia hills. The plateau is a detached block of the peninsula about 241×97 km with summit level at 1370-1830 m. The bulk of the plateau is formed by Archaean (Dharwarian) quartzites, shales and schists, with granite intrusions and some basic sills ; but in the south these are overlain by horizontal cretaceous and eocene sand stones, which on the outer flank dip steeply southwards and is extremely straight and precipitous, rising over 1525 m in 16-19 km. This area is the highest rainfall area in the world (2,118 cm). Much of the plateau is under heavy forest with pines on the higher ridges and with a mixture of woodland and secondary

bush in which *Rhododendron* and Orchids are prominent. The collecting sites were as follows :

1. Shillong 65 km from Guwahati is a mountaineous area at an altitude of nearly 1800 m with sub-temperate climate. The area possesses a special type of climate where diurnal fluctuation in temperature is very sharp. Humidity and monsoon rainfall are very high. The area is cheaply covered by *Pinus khasya* forest. Besides, there are isolated patches of coniferous and other trees, such as *Abies webbiana*, *Picea spinulosa*, *Larix griffithiana*, *Tsuga brunoniana*, *Rhododendron arboreum*. Ferns and Orchids are chief epiphytes on them.
2. Shella is situated at the border are of Sylhet, Bangladesh at an altitude of 700m, 40 km down from Shillong. The area possesses mainly tropical and subtropical climate. High temperature and high humidity are prevalent. The soil is clay loam which stimulates the luxuriant growth of broad-leaved trees. The undergrowth of large grasses inside the forest is the characteristic

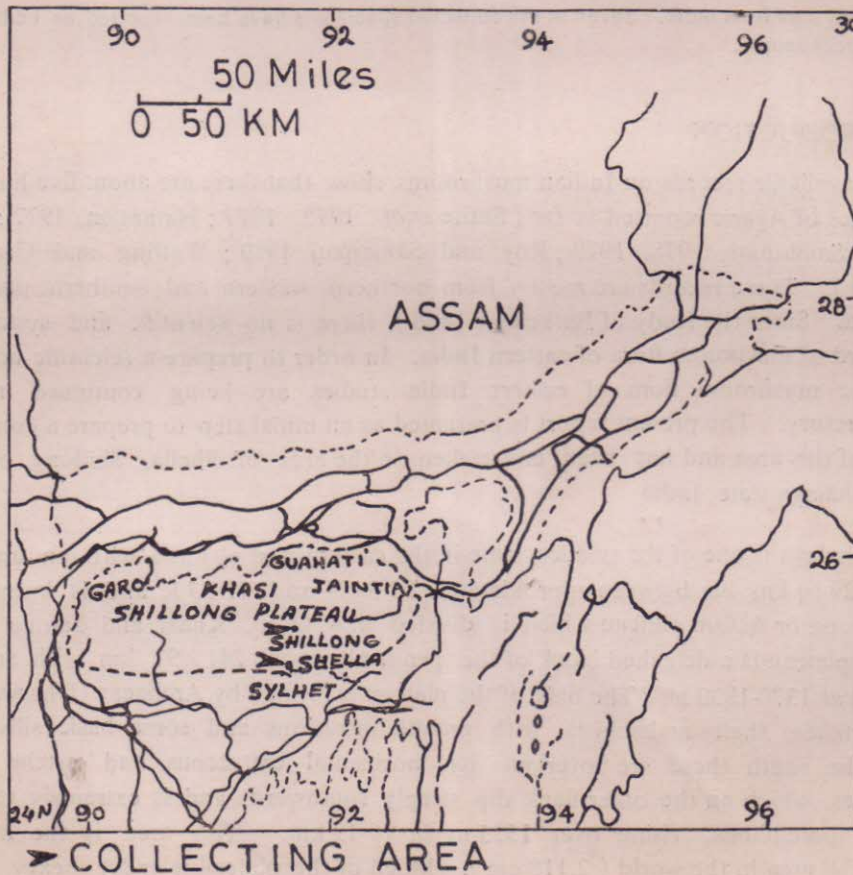


Fig. 1. Map of khasi hills area (Meghalaya) showing the area of collection.

feature of the vegetation. The dominant species at the upper part of this area are *Quercus lamellosa*, *Q. lineata*, *Michelia excelsa*, *Pyrus symplocos*, *Eurya*, *Meliosna*, *Castanopsis* etc. The lower region is covered by mixed deciduous forest consisting of *Shorea robusta*, *Sterculia villosa*, *Lagerstroemia perviflora*, *Terminalia* sp., *Anthocephalus kadamba*, *Toona ciliata*, *Bauhinia stercosperma*, etc.

MATERIALS AND METHODS

The collected specimens were brought to the laboratory and worked out scientifically. Detail spore morphology and other morphological and anatomical peculiarities of the specimens were observed macroscopically and microscopically following the methods of Singer (1975). Several chemical tests were also performed. The classification of Agaricales as proposed by Singer (1975) was followed in the present case. All these specimens are deposited in the herbarium of Botany Department, Calcutta University. The colour terminology used during working out of the specimens has been taken from Colour Identification Chart to the flora of British Fungi : Her Majesty's Stationary Service, Edinburgh.

ENUMERATION

Agaricaceae

1. *Cystoderma carcharias* (Pers. ex Secr.) Fayod ex auct. (Fig. 2)
Shillong 16 VII 1986, MH No. 8;86.

The fungus grows on decayed wood, caespitose; Basidiocarp convex, 1.5-2.0 cm, white, fragile, dry, cuticle granular, peels easily, margin regular; Gills clay pink at bud but white at maturity, adnate, 0.5 cm thick, crowded, number of lamellulae many, edge entire, ended gradually; Stipe central, cylindrical, white, solid, fragile, rough and dry, annulate, evolvate; Flesh white; Sporeprint white, Basidiospore ovate, $6.3-7.0 \times 4.2-5.1 \mu\text{m}$, amyloid, non-apiculate, thin-walled; Basidium clavate, $32.5-36.8 \mu\text{m}$, tetrasterigmate, holobasidium, thin-walled; Gill trama regular, homoiomerous, consisted of filamentous hyphae; Cystidium (peliocystidium) $67.5-72.6 \mu\text{m}$ long.

Amanitaceae

2. *Amanita pantherina* (D.C. ex Fr.) Schumm. (Fig. 3)

Shella and Shillong, 15 VII 1986 MH No. 1/16

The fungus grows on soil having mycelial connection with the root of *Pinus khasya*. solitary; Basidiocarp 4.0-6.0 cm, flat at maturity, mouse gray at the bud stage and becomes smoke gray with white periphery at maturity, surface warty, fleshy,

cuticle peels easily, moist margin regular and striated; Gills free, white crowded, edge entire, lamellulae many, fleshy and brittle; Stipe central, 3.0-5.0×1.0-1.5 cm, base bulbous, fleshy, smooth, dry, exannulate, evolvate; Flesh white, upto 0.5 cm thick at the middle; Sporeprint white; Basidiospore ovoid, 8.5-9.2×6.5-7.2 μm, slightly thick-walled at the base, hyaline, non-amyloid apiculate; Basidium clavate, upto 32.0 μm long, tetrasterigmate, holobasidium; Gill trama bilateral with hyaline and broad mediastratum upto 3.5-4.2 μm; Pleurocystidium fusiform, 42.5 μm long; Pileal surface regular, cystidium not found.

3. *Amanita rubescens* (Pers ex Fr.) S.F. Gray (Fig. 4)

Syn. *A. venenarius rubens* (Scop. ex Murr).

Shella and Shillong 15 VII 1986, MH No. 2/86

The fungus grows on soil and associated with *Pinus khasya* roots, solitary; Basidiocarp 7.0-12.0 cm in diameter convex fleshy, white, cuticle peels easily, smooth with clay buff squamules, margin slightly striated, entire and regular; Gills free, white, thin, crowded, number of lamellulae nine, edge entire, upto 1.0 cm breadth at the middle; Stipe easily detachable from the pileus, 6.0-7.0×1.0-1.5 cm, stout with bulbous base, central, hollow, fibrillar surface, fragile, annulus membranous, pendant, volva deeply situated in the soil and remains entire; Flesh white; Sporeprint egg yellow colour; Basidiospore 4.2-7.5×3.0-3.5 μm, ovoid, thick walled at the base, apiculate, nonamyloid; Basidium clavate, 28.3-32.5 μm, tetrasterigmate, holobasidium; Gill trama divergent, hyaline consisted of thin-walled hyphae of 3.2-4.5 μm in diameter, homoiomerous, pileal surface made up of mixed cells, pigmented cells and oleiferous hyphae often seen in the pileal surface.

4. *Amanitopsis vaginata* (Bull ex. Fr.) Vitt. (Fig. 5)

Shella and Shillong 15 VII. 1986, MH No. 3/86

The fungus grows solitarily on soil and associated with *Pinus khasya* roots; Basidiocarp 4.0-6.0 cm, convex to flat, delicate and fragile, rusty tawny with white margin, smooth, polished, glabrous, cuticle peels easily, margin striated, entire, moist; Gills free, white, 0.3 cm. width, moderately crowded, with many lamellulae, entire, brittle; Stipe central, cylindrical, 5.0-9.0×0.4-0.6 cm, hollow, white, exannulate, volvate, volva free from the stipe, membranous, white and bilobed; Flesh very thin, white, Sporeprint white; Basidiospore 5.0-8.0×2.5-5.0 μm, globose, thin-walled hyaline non-apiculate, inamyloid; Basidium clavate, 25.5-30.2×6.5-8.2 μm, tetrasterigmate, holobasidium; Gill trama typically bilateral with a broad mediastratum consisted of 2.5-3.3 μm hyphae; Pileal surface consisted

of thin walled tubular hyphae and some thick walled pigmented spherical cells upto $4.2\mu\text{m}$ in diameter and a slime layer outside.

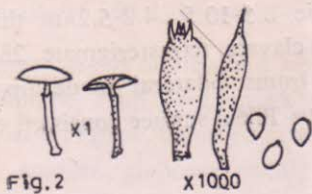


Fig. 2
Cystoderma carcharius

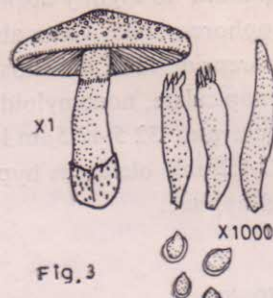


Fig. 3
Amanita pantherina

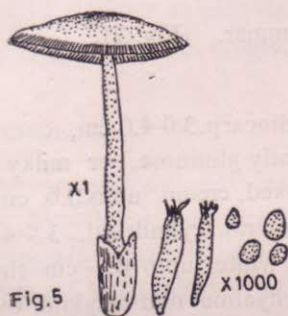


Fig. 5
Amanitopsis vaginata

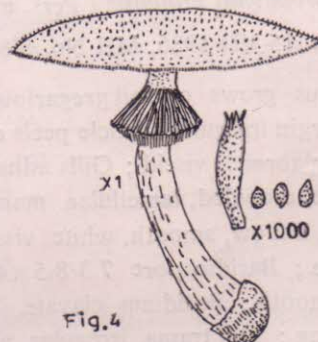


Fig. 4
Amanita rubescens



Fig. 6
Boletus elegans



Fig. 7
Camarophyllus pratensis

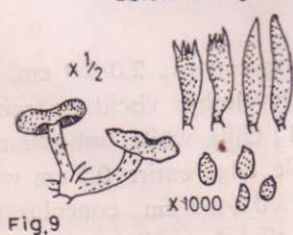


Fig. 9
Pleurotus flabellatus



Fig. 8
Hygrophorus coccinea

Boletaceae

5. *Boletus elegans* (Schus. ex Fr.) (Fig. 6)
Shillong, 15 VII, 1986, MH No. 4/86

The fungus grows on soil solitarily; Basidiocarp convex, 6.0-12.0 cm, orange to apricot, slimy, leathery, smooth polished, viscid, cuticle peels easily, margin,

irregular, slightly incurved; Hymenophore tubes buff, openings four per mm., 0.1 cm deep, angular, adnate; Stipe 4.0-5.0 × 1.0-1.5 cm., central cylindrical, leathery, smooth to slightly fibrillar, buff in colour, annular ring concolourous to the hymenophores, solid, volva absent; Flesh lemon chrome, 0.5 cm. thick at the middle; Sporeprint buff; Basidiospore elliptic 8.5-10.5 × 4.2-5.2 μm thick walled, smooth, nonapiculate, nonamyloid; Basidium clavate, tetrasterigmate, 28.5-30.5 μm; Cystidium clavate, 32.5-42.5 μm long; Gill trama bilateral made up of tubular hyphae (3.2-4.2 μm), oleiferous hyphae present; Pileal surface consisted of spherical thick-walled hyphae.

Hygrophoraceae

6. *Camarophyllus pratensis* (Pers. ex Fr.) Kummer. (Fig. 7)

Shella, 15 VII 1986, MH No. 5/86

The fungus grows on soil gregariously; Basidiocarp 3.0-4.0 cm, convex to flat, white, margin irregular, cuticle peels easily, slightly glutinose, or milky granular, smooth, glabrous, viscid; Gills adnate to adnexed, cream, upto 0.6 cm width at the middle, crowded, lamellulae many; Stipe central, cylindrical, 3.5-4.0 × 0.4-0.5 cm, equal, hollow, smooth, white, viscid; Flesh white, upto 0.2 cm thick; Spore print white; Basidiospore 7.3-8.5 × 4.2-5.3 μm, hyaline, non-amyloid, ovoid, thin-walled, smooth; Basidium clavate, tubular, tetrasterigmate, holobasidium upto 32.0 μm long; Gill trama irregular with interoven hyphae; Pileal surface with thin-walled hyaline parallel hyphae, of 4.5-6.2 μm in diameter; Clamp connexions often present.

7. *Hygrophorus coccinea* (Fris.) Kummer (Fig. 8)

Shillong, 16 VII 1986, MH No. 9/86

The fungus grows on soil in groups; Basidiocarp convex, 2.0-3.0 cm, blood red, or scarlet at maturity, smooth, papery to slightly fleshy, viscid, margin entire or lobed, cuticle peels easily, moist and polished; Gills white, subdistantly formed, thick, free, number of lamellulae three, separable, edge entire, 0.3 cm width at the middle; Stipe central, cylindrical 2.0-2.5 cm × 0.2-0.3 cm, concolorous with the pileal surface, smooth, hollow, brittle, moist, slightly swollen base, evolvate and exannulate; Sporeprint white; Basidiospore elliptical, thin-walled, hyaline, smooth, nonapiculate nonamyloid, 1.2-3 × 3.9-4.6 μm; Basidium upto 32.6 μm, clavate, tetrasterigmate; Gill trama homioimerous, irregular, consisted of filamentous cells; Pileal surface made up of filamentous cells with distinct clamp connexions; Cystidium absent.

*Pleurotaceae*8. *Pleurotus flabellatus* (Berk. & Br.) (Fig. 9)Syn. *P. leptograme* (Berk. & Br.) Sacc.

Shella, 15 VII 1916, MH No. 12/86.

The fungus grows on decayed wood, caespitose ; Basidiocarp umbilicate, depressed at the centre, 2.0-5.0 cm., creak white, fleshy or slightly squamulose, cuticle peels easily, dry, regular, incurved ; Stipe 2.0-3.0 × 0.5-1.0 cm, concolorous to the pileus, fleshy, smooth, glabrous, solid, dry, central to slightly eccentric, cylindrical to slightly tapering towards base, exannulate, evolvate ; Gills decurrent, crowded, white, 0.2 cm width at the middle, lamellulae five in number, edge entire ; Flesh white, upto 0.7 cm thick, Sporeprint white ; Basidiospore elliptic, 6.5-7.8 × 3.5-4.2 μm, thin-walled, nonamyloid, nonapiculate, hyaline.

*Tricholomataceae*9. *Clitocybe cyathiformis* Kummer. (Fig. 10)Syn. *Pseudoclitocybe cyathiformis* (Bull. ex Fr.) Singer,*Cantharellula cyathiformis* Singer

Shella, 15 VII 1986, MH No. 6 86

The fungus grows on soil solitarily ; Basidiocarp 5.0-7.0 cm, infundibuliform or deeply umbilicate, hazel-sepia colour, slightly leathery, cuticle smooth to squamulose, peels easily, slightly moist, margin thin, incurved ; Gills decurrent, white, subdistantly formed lamellulae many, edge entire, 0.3 cm width ; Stipe 20.0-22.0 × 1.0-1.5 cm, attenuated towards the base, cylindric, smooth, solid, exannulate, evolvate ; Flesh white, 0.2 cm. thick ; Sporeprint white ; Basidiospore 7.0-9.0 × 3.0-4.5 μm, ellipsoid, hyaline, thin and smooth walled, apiculate amyloid ; Basidium 25.5-28.0 μm long, clavate, tetrasterigmate ; Cystidium not found ; Gill trama intermixed consisted with thin-walled hyaline hyphae ; Pileal surface consisted of thin walled branched septate hyphae with distinct clamp connections, some spherical pigmented cells are also found ; Pleurocystidium 22.5-26.0 μm long.

10. *Collybia radicata* (H Relh ex Fr.) Berk. (Fig. 11)Syn. *C. superbiens* Berk.*Oudemansiella radicata* (Relh ex Fr.) Singh.

Shella, 15 VII 1986, MH No. 7/86

The fungus grows on soil, solitary ; Basidiocarp umbonate, 6.0-8.0 cm, milky coffee, viscid and polished, papery, margin striated, cuticle peels easily, regular ; Gills adnexed to free, number of lamellulae many, papery, moderately formed, 0.8 cm width at the middle, pliable, edge entire ; Stipe central, 10.0-12.0 × 0.6-0.8 cm

tapering towards base, white hollow scaly, brittle, exannulate, evolvate; Flesh white, 0.2 cm thick; Sporeprint white; Basidiospore ovate, $14.2-15.8 \times 8.5-9.2 \mu\text{m}$, nonamyloid, apiculate, thin-walled, tetrasterigmate, holobasidium; Gill trama bilateral made up of tubular cells, homoimerous; Cystidium not found.

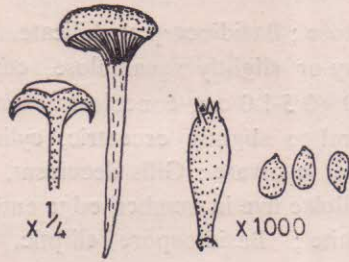


Fig.10 Clitocybe cyathiformis

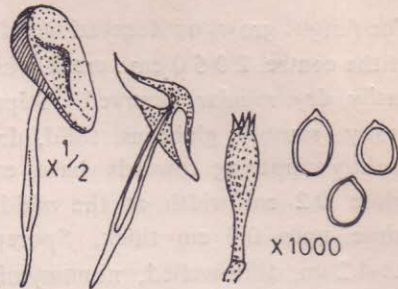


Fig.11 Collybia radicata

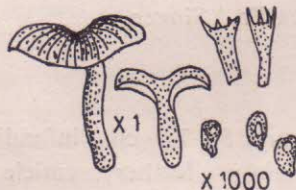


Fig.13 Omphalina pyxidata



Fig.12 Laccaria laccata

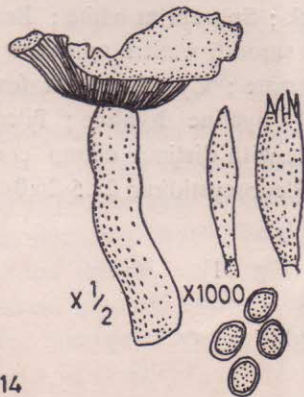


Fig.14 Tricholoma columbetta

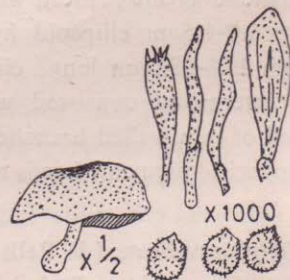


Fig.15 Russula emetica

11. *Laccaria laccata* (Scop. ex Fr.) Berk & Br. (Fig. 12)
Shillong, 16 VII, MH No. 10,86

The fungus grows on soil gregariously ; Basidiocarp irregular to flat at maturity, 3.0-5.0 cm fulvous to rusty tawny colour, slightly leathery, cuticle not peels easily, moist, polished margin irregular ; Gills milky coffee or white at bud condition, 0.8 cm thick at the middle, number of lamellulae many, free, wavy, edge entire, brittle, distantly formed, not interveined ; Stipe central, cylindrical, solid but becomes flattened at maturity, white vinaceous, evolvate, exannulate ; Sporeprint white ; Basidiospore globose, upto $10.5\mu\text{m}$ in diameter, surface finely granular, apiculate, nonamyloid, thin-walled ; Basidium clavate, $25.8-30.0\mu\text{m}$, holobasidium, tetrasterigmate, thin-walled ; Gill trama regular.

12. *Omphalina pyxidata* (Bull. ex Fr.) Quel (Fig. 13)
Shella, 15 VII, 1986, MH No. 11/86.

The fungus grows on decayed wood, gregariously ; Basidiocarp umbilicate 2.0-3.5 cm, light buff or brick at maturity, smooth, glabrous, dry, papery to coriaceous, margin striated regular, cuticle not easily separable ; Gills white, 0.1 cm width at the middle, distantly formed, lamellulae four in number, not interveined, edge entire, ended sharply, decurrent ; Stipe 3.0×0.5 cm, central, slightly clavate, hollow, smooth and polished, white, sometimes concolorous to the pileus, exannulate, evolvate ; Flesh thin, white, 0.1 cm at the middle ; Spore print white ; Basidiospore thin-walled, ovoid, semi-elliptic, $8.2-9.3 \times 4.5-5.2\mu\text{m}$, apiculate, smooth, nonamyloid ; Basidium fusiform to tubular, $24.9-26.3\mu\text{m}$ long, tetrasterigmate hoiobasidium, thin-walled ; Gill trama irreguiar, homoiomerous, composed of filamentous cells ; Pileal trama composed of thick-walled spherical cells and apicutis lacking.

13. *Tricholoma columbetta* (Fr.) Kummer. (Fig. 14)
Shella, 15 VII 1986. MH No. 14,86

The fungus grows on soil, solitary ; Basidiocarp flat to reflexed, 9.0-11.0 cm, white, fleshy, glutinous, glabrous, cuticle peels easily, margin irregular ; Gills free, white, crowded with many lamellulae, 0.6 cm wide at the middle, brittle, edge entire ; Stipe central, stout, cylindrical smooth to slightly fibrillar, brittle, solid, white, upto 13.0×2.5 cm ; Flesh white, upto 0.6 cm thick at the middle ; Spore print white ; Basidiospore $5.6-6.3 \times 3.9-4.6\mu\text{m}$, ovoid to slightly spherical, thin and smooth-walled, nonamyloid and nonapiculate ; Basidium clavate, $30.5-35.0\mu\text{m}$, tetrasterigmate, holobasidium ; Gill trama regular, with thin-walled hyaline hyphae, $4.5-5.5\mu\text{m}$ in diameter ; Pleurocystidium $25.5-32.5\mu\text{m}$ long ; Pileal surface with interwoven hyphae, $2.5-3.5\mu\text{m}$ in diameter with pigmented cells.

*Russulaceae*14. *Russula emetica* (Saccardo) Berk. (Fig. 15)

Shillong 16 VII 1986, MH No. 13/86

The fungus grows on soil associated with pine roots, solitary ; Basidiocarp 3.0-4.0 cm ; Scarlet, with light brown patch at the margin, umbilicate, and depressed at the centre, smooth, viscid, fragile, cuticle, peels easily, margin entire ; Gills white, crowded, adnate, number of lamellulae single, fragile, without latex, edge entire ; Stipe 2.5 x 0.5 cm, central, cylindrical to slightly clavate, fleshy, solid, white, evolvate, exannulate ; Sporeprint white ; Basidiospore spherical, echinulate, 8.5-9.2 μ m in diameter apiculate, amyloid ; Basidium clavate upto 24.5 μ m long, tetrasterigmate. holobasidium ; Gill trama heteromerous, consists of spherical and tubular cells ; Oleiferous hyphae and spherocysts present ; Cystidium frequently present and fusiform, upto 68. μ m long.

DISCUSSION

The present findings from the study of mushroom of Khasi Hills of Meghalaya have revealed that *Russula emetica* (Saccardo 1887, Berkeley 1956), *Pleurotus flabellatus* (Bose 1920), *Collybia radicata* (Berkeley 1856, Bose 1919), *Amanita vaginata* (Saccardo, 1887) and *Russula rosacea* (Butler and Bisby 1931) are already reported from India. The species of *Russula* and *Amanita* are known to form mycorrhizal association with sal and pine trees. It is also evident from the information supplied by the local people that *Tricholoma columbetta*, *Clitocybe cyathiformis*, *Russula emetica*, *Collybia radicata*, *Laccaria laccata*, *Amnitopsis vaginata* and *Pleurotus flabellatus* are edible.

ACKNOWLEDGEMENT

The authors are thankful to Department of Agriculture, Government of West Bengal for financial assistance and to Prof. S. Mukherjee, Head of the Department of Botany, University of Calcutta for necessary facilities provided for carrying out the work.

REFERENCES

- Berkeley, M. J. (1844-1856). Decades of fungi Decas 1-62. In Hooker's *London J. Bot.* 3-8 : 1844-1856.
- Bose, S. R. (1919). Description of fungi in Bengal II. Proc. Sci. Convention Indian Assoc. Cult. Sci. for the year 1918 : 136-143.
- Bose, S. R. (1920). Records of Agaricaceae from Bengal. *J. Asiatic Society Bengal N. S.* 16, 347-354.
- Butler, E. J. and Bisby, G. R. (1931). *The fungi of India*. Imp. Colln. Agric. Res. India Sci. Monogr. 1, 87-175.

- Natarajan, K. (1977). South Indian Agaricales III. *Kavaka* 5, 35-39.
- Roy, A. and Samajpati, N. (1978). Agaricales of West Bengal II *Indian J. Mushrooms.*, 4, 17-23.
- Roy, A. and Samajpati, N. (1979). Agaricales of West Bengal I *Bull. Botan. Soc. Bengal* 33, 139-147.
- Roy, S. and Samajpati, N. (1979). Agaricales of West Bengal-IV *Indian J. Mycol. Res.*, 17, 65-69.
- Saccardo G. A. (1987). Agaricineae. *Sylloge Fungorum*. V. Patarii.
- Sathe, A. V. and Rahalkar, S. R. (1975). Agaricales from South West India I. *Biovigyanam* 1 75-78.
- Sathe, A. V. and Sasangan, K. C. (1977). Agaricales from South West India III. *Biovigyanam* 1, 119-121.
- Singer, R. (1975). *The Agaricales in modern taxonomy*. J. Cramer. 3rd Edition.
- Watling, R. and Gregory, N. M. (1980). Larger fungi from Kashmir. *Nova Hedwigia* 32, 403-564.

(Accepted for publication February 25 1988)