MONOGRAPHIC STUDIES ON *AGARICUS* SPECIES OF KERALA

By
SUSHA, S. THARA

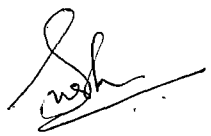
THESIS
submitted in partial fulfillment of the
requirement for the degree
DOCTOR OF PHILOSOPHY
Faculty of Agriculture
Kerala Agricultural University

Department of Plant Pathology
COLLEGE OF AGRICULTURE
Vellayani, Thiruvananthapuram

2001

DECLARATION

I hereby declare that this thesis entitled "**Monographic studies on *Agaricus* species of Kerala**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.



Vellayani,

31-12-2001

Susha. S. Thara
(97-21-12)

CERTIFICATE

Certified that this thesis entitled "**Monographic studies on *Agaricus* species of Kerala**" is a record of research work done independently by Ms. Susha. S. Thara (97-21-12). under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

Vellayani,
31-12-2001

Dr. S. Bhavani Devi
(Chairman, Advisory Committee)
Professor
Onattukara Regional Agricultural
Research Station, Kayamkulam

APPROVED BY:

CHAIRMAN

Dr. S. BHAVANI DEVI,
Professor,
Onattukara Regional
Agricultural Research Station,
Kayamkulam.

31-8-02

MEMBERS

1. **Dr. C.K. PEETHAMBARAN,**
Professor and Head,
Department of Plant Pathology,
College of Agriculture, Vellayani,
Thiruvananthapuram-695522.

31.8.02

2. **Dr. M. SUHARBAN,**
Associate Professor,
Instructional Farm,
College of Agriculture, Vellayani.

31/8/02

3. **Dr. S. DEVANESAN,**
Associate Professor,
Department of Agricultural Entomology,
College of Agriculture, Vellayani.

31/8/02

4. **Dr. P. SARASWATHI,**
Professor,
Department of Agricultural Statistics,
College of Agriculture, Vellayani.

31/8/02

EXTERNAL EXAMINER

Dr. R. P. TEWARI,
Director,
NCMRT, Solan

31/8/02

ACKNOWLEDGEMENT

This thesis will be incomplete without expressing my gratitude to :

God Almighty for the blessings showered upon me all throughout.

Dr. S. Bhavani Devi, Professor Onattukara Regional Agricultural Research Station, Kayamkulam and Chairman of my Advisory Committee for her valuable guidance, constant encouragement and unfailing patience throughout the course of this research work and preparation of thesis.

Dr. C.K. Peethambaran, Professor and Head, Department of Plant Pathology for his sustained interest, timely suggestions and invaluable advice.

Dr. S. Devanesan, Associate Professor, Department of Agricultural Entomology for his valuable suggestions, wholehearted help and constructive perusal of manuscript.

Dr. M. Suharban, Associate Professor, Instructional Farm for her valuable advices and constant encouragement.

Dr. P. Sarawathi, Professor and Head, Department of Agricultural Statistics has contributed so much to my thesis especially in the statistical analysis and interpretation of the results.

Dr. S. Balakrishnan, Professor, Research Co-ordinator for his timely help and co-operation during the course of the study.

Dr. D. Geetha, Associate Professor, Instructional Farm for the extent of moral support and affection rendered whole heartedly by her.

Dr. K.B. Vrinda, Scientist, TBGRI and Dr. Leelavathi, Professor (Rtd.), Department of Botany, Calicut University for their valuable help and advices during the course of research work.

All the teaching, non-teaching staff and all my senior and junior friends of Department of Plant Pathology for their help and assistance.

Sri. C.E. Ajithkumar, Junior Programmer, Department of Agricultural Statistics for the assistance rendered during the statistical analysis of the data.

I acknowledge Manoj, S. for taking photographs and drawings.

Biju. P. of ARDRA for prompt and timely help rendered in typing the thesis.

'A' One Infotech, Neyyattinkara for scanning the photographs.

ICAR for awarding me the S.R.F. fellowship.

I am deeply indebted to my husband, daughter, parents and other family members for their encouragement and help which made me possible for the completion of this study.

Susha. S. Thara

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES Contd...

LIST OF PLATES

LIST OF PLATES Contd...

Introduction

1. INTRODUCTION

Fungi form a major component of tropical ecosystem and are involved in innumerable interactions with plants, animals and man. Kerala, the Southernmost part of India, with its congenial climatic conditions, is found to be the abode of a vast variety of mushrooms and fleshy fungi. Mushrooms provide an excellent source of protein and it is realised that mushroom protein can make significant contribution in solving protein malnutrition problems.

Although preliminary efforts have been made to record the highly priced mushroom of Genus *Agaricus* of the state, no detailed floristic studies and cataloguing have been made. Systematic collection, identification, detailed description and documentation of each species along with mycogeography of each locality, seasonal occurrence of mushrooms, their medicinal value and properties are inevitable for the exploitation of the flora. Present study aims at collection, identification, preservation, documentation and cataloguing of *Agaricus* spp. from the twenty agroclimatic zones of Kerala during South West and North East monsoon seasons; isolation in to pure cultures of collected species, studying the physiological aspects like role of carbon, nitrogen, temperature, light and pH.

Like *Agaricus bisporus*, which is popularly known as button mushroom, *A. bitorquis* (temperature tolerant species) has got widest acceptability in the world market among the cultivated mushroom. Due to its ability to grow and fruit at relatively higher temperature (26-30^{0}C) it stands

out as a promising species for large scale production in Kerala. Tewari and Sohi (1976) attempted the cultivation of this mushroom at Bangalore and subsequently Guleria (1985) reported incubation temperature of 30^0C for both spawn growth on grains and in compost. Present study also includes cultivation of *A. bitorquis* under natural conditions of Kerala.

Review of Literature

2. REVIEW OF LITERATURE

2.1 Nomenclature

The genus *Psalliota* was renamed as *Agaricus* by the international Botanic congress in Paris in 1954. Singer (1962) classified Agaricales along with Polyporales and the family Agaricaceae include *Clarkeinda, Chlorophyllum, Volvolepiota, Macrolepiota, Leucoagaricus, Leucocoprinus, Agaricus, Melanophyllum* and *Cystoagaricus.* Donk (1971) indicated that the name of the genus Agaricus came from Agarica, the region of Sarmatia. The old synonyms for the genus *Agaricus* L. Fr. were *Pratella* (Pers. Fr) S. F. Gray and *Psalliota* Kumm, (Wasser, 1988).

2.2 *Agaricus* from India

A review of mycological research in India reveals that mushrooms are the least studied group of fungi. The earliest work on Indian Agaricus were invariably done by Europeans. Most of the knowledge of Agaricales of the Indian subcontinent was based up on Berkeley's description (1856) of the collection made by Hooker and Hooker, mostly in Sikkim and Khasi hills. This included five species of *Agaricus* and Berkeley was considered to be the first person to have reported species of *Agaricus* from India. Berkeley (1856) reported *A. exaltatus* Berk. from clay and earth banks in Darjeeling, *A. flaviceps* Berk. from ground of Sikkim *and A. latipes* Berk. from the Khasi hills of Assam: Henning (1901) described *A. comosus* P. Henn. Sacc and D.

Sacc., *A. creataceus* Fr., and *A. elevensis* from the ground of Botanic gardens of Sharanpur, Uttar Pradesh.

Other important early studies on Indian *Agaricus* were those by Mc Rae (1910) who reported *A. campester* from Pusa, Bihar and Massee (1912) who first described *A. burkilli* (Massee) Sacc and Trott from the ground under the wall in Calcutta, West Bengal.

Bose (1921) studied the Agaricaceae of Bengal and was one of the earliest Indian mycologists to work on agarics of this country. In his studies he came across only a single species of *Agaricus, A. campestris* Fr.

Butler and Bisby (1931) published the monograph of Fungi of India including 235 fungal species of India, Pakistan and Burma, of which only 18 species belong to the genus Agaricus.

Bose and Bose (1940) worked on edible mushrooms of India and described *A. arvensis* Schaeff. and *A. campestris* Fr. from meadows and pastures of North West Himalayas, Bihar and West Bengal. *A. arvensis* Schaeff. was reported from the meadows and grassy pastures of Calcutta by Banerjee (1947) who studied the fungi flora of Calcutta and Suburbs.

Smith (1949) reported *A. silvaticus* Schaeff. from Darjeeling and suspected about its edibility, not recommended for consumption. He also reported *A. campestris*. Fr. Bhattacharya *et al.* (1952) reported *A. pratensis* Schaeff. from Gouhati, Assam.

A new edible species of mushroom of genus *Agaricus; A. basianuloses* Paracer and Chahal was reported from soils of Ludhiana (Paracer and Chahal, 1962). Pandotra (1966) studied the fungi of Jammu and Kashmir and reported *A. campestris* L. ex. Fr. for the first time from Jammu and Kashmir. Saxena *et al.* (1969) observed *Agaricus* sp. in the dung of spotted and eland deers and Nilgai, but the species level identification was not done . Trivedi (1972) reported *A. arvensis* Schaeff. from Nagpur, Maharashtra.

Ghosh *et al.* (1974) studied on Indian Agaricales and collectecd *A. placomyces* Peck from Ludhiana. From Satara districts of Maharashtra Chavan and Barge (1977) observed *A. arvensis* Schaeff. during their survey. Sharma *et al.* (1978) reported *A. subrufescens* Peck from Chambaghat, Solan and *A. placomyces* Peck. from Lucknow, Uttar Pradesh. Garcha (1981) collected *A. bisporus* (Lange) Imbach and *A. bitorquis* (Quel.) Sacc. from natural habit from Ludhiana.

South Indian Agaricales were studied by Natarajan and Manjula (1981) and only *A. trisulphuratus* Berk. was collected from the genus *Agaricus*. *A. lasiophrys* Berk and Br, was first time reported in India from open grassy lawn of Chandigarh (Rawla *et al* ., 1982). Manjula (1983) prepared an updated list of agaricoid and boletoid basidiomycetes from India and Nepal and in it she recognized 19 species in the genus Agaricus. They are : *A. arvensis* Schaeff. ex. Fr, *A. basianulosus* Paracer and Chahal, *A. campestris* L. ex. Fr., *A. comosus* (P. Henn.) Sacc. and D. Sacc., *A. crocopeplus* Berk. and Br., *A. exaltatus* Berk, *A. fulviceps* Berk., *A. heterocystis* Heinem. and Gooss., *A. latipes* Berk., *A. placomyces* Peck.,

A. purpurellus (Mull.) Mull., *A. rimosus* (P. Henn.) Sacc and D. Sacc., *A. silvaticus* Schaeff. ex. Secr., *A. squalidus* Massee, *A. trisulphuratus* Berk., *A. variegans* (Mull.) Mull, *A. woodrowii* Massee and *A. xanthosarcus* Heinem. and Gooss. Heinem.

Saini and Atri (1983) reported *A. woodrowii* Massee from Patiala and grassy soil among *Cynadon dactylon.* Roy and Sampati (1986) collected *A. trisulphuratus* Berk for the first time from West Bengal. *Agaricus cylindriceps* was reported from Kashmir and was very similar to the collection from Singapore (Abraham and Kaul, 1988). *A. diminutives* Peck reported to occur scattered in open grassy lands of Punjab University campus, Patiala (Saini and Atri, 1989).

Abraham (1991) conducted a study to ascertain the fungal wealth and fungal components of Kashmir, their mode of introduction and distribution and collected *A. cylindriceps*, Murril, *A. campestris* (L), *A. bitorquis* (Quel). Sacc., *A. fuscofibrillosus* Moll (Pillat). *A. abruptibulbus* PK, *A. silivicola* (Vitt) Peck.

Atri *et al.* (1991) studied the systematic of *A. campestris* L. Fr and reported different varieties of field mushroom, *A. campestris* var *fusco - pilosella* Moller, *A. campestris* var. *indica* Atri *et al.*, *A. campestris* var. *isabellinus* Moller, *A. campestris* var. singeri Atri *et al.* from Punjab University campus. Manoharachary (1991) reported *A. campestris* L.ex . Fr and *A. trisulphuratus* Berk from Adilabd forest of Andra Pradesh.

Saini *et al.* (1991) listed eleven species of the genus *Agaricus* L. Fr. viz., *A. aestivalis* Moller Pilat, *A. altipes* (Moller) Pilat, *A. sulphureiceps* (Murrill) *A. alachuans* Murrill., *A. fusco-fibrillosus* (Moller) Pilat *A. decoratus* (Moller) Pilat, *A. rhoadsii* Murrill, *A subalachuanus* Murrill, *A. pratensis* Schaeff, *A. placomyces* Peck and *A. trisulphuratus* Berk. collected from various localities of Punjab plains. Out of these the first eight species were new records for India.

Atri *et al.* (1992) reported *A. comtulus* Fr., *A. cylindriceps* var. cylindriceps Murr., *A. mealgris* Schaeff., *A. subareades* Murr., and *A. xanthodermus* Genev. from Patiala, Punjab. *A. lanipes* var. *macrosporus* var. nov., *A. edulis* (Vitt.) Mull. and Schaeffer were first recorded in India by Saini *et al.* (1992) from Patiala.

Saini *et al.* (1993) recorded *A. dulcidulus* Schulz., *A. rodmani* Peck., *A. roadsii* Murrill, *A. sylvaticus* var. *rubribrunescens* (Murr.) Heinem, *A. spissicaulis* Moller from India. Lakhanpal (1995) reported *A. augustus* among conifers and broad leaved trees and found to be mycorrhizal with *Quercus incana*. He also worked on systematics of *A. arvensis* Schaeff. and reported *A. arvensis* var. *indica* Atri *et al.* and *A. arvensis* var *singerri* Atri *et al.*

Patil *et al.* (1995) worked on agaric flora of Maharashtra and reported four different species of *Agaricus*. *A campestris* L.ex . Fr., *A. crocopeplus* Berk. and Br., and *A. silvaticus* Schaeff. ex. Krombh. were reported from Meghalaya and Manipur (Verma, *et al.*, 1995).

Kalitha *et al.* (1997) reported *A. campestris* from grasslands throughout Assam and *A. squamuliferus* Moell. from garden soils of Jorhat. Saini *et al.* (1997) recorded seven taxa of the genus *Agaricus* L. Fr. subgenus *Agaricus* Fr, section Sanguinolenti Schaeff. et Moller from various localities of North West India. One species viz., *A. silvaticus* var. *silvaticus* Schaeff. was a new report for North-West India. Besides key to their identification, taxonomic details and culinary characteristics of individual taxa was also studied.

2.3 *Agaricus* from Kerala

Most of the reports of the genus Agaricus were made from the Northern parts of India and very few work was done in this genus in Kerala. *A. campestris* L. Ex. Fr. was reported from Cochin (Sathe and Sasangan, 1977). Bhavani Devi (1982) while surveying the edible flora of Kerala reported the occurrence of three species of Agaricus (*A. arvensis, A. campestris, A. placomyces*). Heinamann and Little flower (1984) conducted a general survey of subgenus Hymenagaricus of which southern India probably represent a dispersal centre. The key contain 18 species collected in Kerala as well as some old collection from Sri Lanka. *H. cylindrocystis, H. luteolosporus, H. chrysosporus, H. rubrescens*, and *H. erinaceus* were new species. *H. subaeruginous, H. epipastus, H. myriostius* and *H. flavidorufus* were new combinations. The basionym for all new combinations were *Agaricus* which *Xanthoagaricus* and *Hymenagaricus* were subgenus. Bhavani Devi (1995) reported nine species of *Agaricus* and from which *A. diminutivus* Peck and *A. iodolens* Heim were the first report for the country.

	Species	Common name	Habit and Habitat	Season and Distribution	Edibility
1	*A. arvensis* Sech. ex.Sec	Horse mushroom	Sporophores solitary or scattered on the ground in fields, lawns and grassy woods	S.W& N.E monsoon, College of Agriculture, Vellayani	Excellent
2	*A. augustus* Fries	The Prince	Sporophores solitary or scattered on the ground under trees	N.E. Monsoon, Mavelikkara	Excellent
3	*A. campestris* L. ex. Fr.	Field mushroom	Sporophores solitary or scattered on the ground or form fairy rings on pastures and lawns	S.W & N.E. monsoon, Seen in fairy rings on lawns on College of Agriculture, Vellayani	Edible
4	*A. diminutivas* PK	-	Sporophores scattered on ground	S.W monsoon, Neyyatinkara	Edible
5	*A. iodolens* Heim	-	Sporophores caesipitose or scattered under trees	N.E. Monsoon, Karamana	Said to be edible but disagreeable due to odour of idoform
6	*A. langei* (F. H. Moller) Moller	-	Sporophores gregarious or scattered, grows under the trees	S.W. Monsoon, collected from Museum, Thiruvanantha puram	Good
7	*A. placomyces* Peck	-	Sporophores in scattered groups on the ground	S.W. Monsoon, between heaps of rock, College of Agriculture, Vellayani	Good
8	*A. silvaticus* Schaffer. Ex.Secr.		Sporophores solitary or scattered groups on the ground near casuarina	S.W. monsoon, Museum, Thiruvanantha puram	Edible
9	*A. xanthodermus* Gen.	Yellow stainer	Sporophores scattered on the ground, meadows and garden	S.W. monsoon, Chirayinkizh	Poisonous causing allergic symptoms.

Vrinda *et al.* (1997) studied the agaric flora of Western Ghats of Kerala state and described *A. johnstonii* Mum. for the first time in India from Tropical Botanical Garden and Research Institute campus. In 1999 Vrinda *et al.*, described *A. volvatus* Heinem. et. Gooss. from the Western Ghats of Kerala. This distinctive species of Agaricus was characterized by a strongly marginate bulbous stipe base and a rimose pileal surface. The specimen was originally described from the Zaire Republic by Heinamann.

2.4 Edibility

The cultivation of *A. bisporus* started around 1650's in France, where the melon growers observed spontaneous appearance of *A. bisporus* on used compost of melon crops. Apart from the cultivated mushrooms of this genus, viz., *A. bisporus* and *A. bitorquis* a number of species were recommended as edible, *A. campestris* was recommended as edible and the possibilities of this mushroom for cultivation was studied (Mc Rae, 1910; Bose, 1921; Bose and Bose, 1940; Smith, 1949; Pandotra, 1966; Bakshi and Puri, 1978; Kalitha *et al.*, 1997; and Rai, 1997).

A. arvensis, horse mushroom was reported as edible by Bose and Bose (1940). Smith (1949) and Butler and Bisby (1960) observed *A. silvaticus* as edible but not recommended for consumption. Paracer and Chahal (1962) reported *A. baisanuloses* as a new edible species of genus *Agaricus* from Punjab.

Saxena *et al.* (1969) observed an Agaricus species in dung of spotted and eland deers and Nilgai which cause allergic diseases. The antibiotically

active 4- hydroxy benzene diazonium ion was isolated in the form of its stable sulphate (agaridin) from fruiting bodies of the poisonous mushroom *A. xanthodermus* (Dornberger *et al* . 1986)

Mushroom flora of Kerala was studied by Bhavani Devi (1995) and reported *A. arvensis* and *A. augustus* as excellent. *A. langei* and *A. placomyces* as good. *A. campestris, A. silvaticus, A. iodolens* and *A. diminutivus* as edible and *A. xanthodermus* as poisonous causing severe symptoms, resulting comma in some people.

Patil *et al.* (1995) reported *A. abruptibulbus, A. arvensis, A. bitorquis. A. brunnescens, A. campestris, A. essettei and A. silvicola* as edible and *A. bresadolianus, A. placomyces. A. praeclarosquamosus, A. xanthodermus* and *A. xantholepis* as toxic *Agaricus* spp., from Maharashtra.

A. campestris and *A. silvaticus* were reported as edible and *A. crocopeplus* as non-edible by Verma *et al.* (1995).

2.5 Physiological studies

2.5.1 Culture media

Humfeld and Frank (1949) described a process for the production of edible mycelium of *A. campestris* by agitation and aeration in the medium containing soluble carbohydrate as a source of energy, source of nitrogen and definite concentration of various mineral elements. Fritsche (1968) recommended malt extract agar and compost agar as the best media for culture maintenance of *A. bitorquis*.

Hayes (1972) reported a range of natural media viz., malt extract, potato extract, and extracts of compost that can support good growth.

Raper *et al.* (1972) reported that *A. bisporus* can be grown on complete yeast extract medium and minimal media. Kaul and Kachroo (1976) reported the production of fruiting body primordia on solid and liquid malt extract media. Wood (1976) also reported the primordial production of *A. bisporus* in solidified and liquid malt extract medium.

Submerged culturing of *A. bisporus* was done by Dirtsch (1978) in a synthetic medium containing inorganic salts, a hexose and vitamins. The study reveals that thiamine was found to be essential and Tween-80 had a strong growth promoting effect.

Vasser *et al.* (1980) studied the cultural characteristics of four species of *Agaricus* Fr. emend Karst, viz., *A. campestris* Fr., *A. sylvaticus* Schaeff. ex. Secr., *A. arvensis* Schaeff. ex. Secr., A, *bitorquis* (Quel) Sacc. in different nutrient media, two per cent and eight per cent beer wort, molish, deggar and Czapek's media and reported that the growth rate for species and different strains of the same species in the same nutrient media was individual and may serve an additional taxonomic criterion.

Martin *et al.* (1984) presented a review of fundamental process aspects to produce mushroom mycelium in submerged culture with peat as the main nutrient source.

Iqbal *et al.* (1988) tested a complete medium, a malt extract medium and a potato dextrose medium for the linear growth of the fungus. Of the

three media tested, complete medium gave maximum radial colony diameter of the fungus followed by the malt extract agar and potato dextrose agar.

Siwulski (1990) used six media to study the mycelial growth of *A. bisporus* and potato dextrose agar was found to be the best and next best as Hansen's medium, however on potato dextrose agar some malformations were observed and the Hansen's medium was considered as best.

Malt extract medium was commonly employed for culturing Agaricus, and the malt extract is an imported and very expensive material. Bahukhandi and Kapoor (1991) suggested Bournvita, as a substitute for malt extract, which is a popular malt containing beverage which in many times cheaper than the malt extract. They also reported that the colony appearance and growth rate were also comparable.

Khan *et al.* (1991) studied the factors affecting the growth of *A. brunnescens* Peck on three culture media, viz., malt extract agar, potato dextrose agar and wheat extract agar and found that the optimum linear growth of mycelium was on malt extract agar. Mycelial growth on different growth media and under different cultural conditions was investigated with *A. bitorquis* by Furlan *et al.* (1997) and observed that mycelial growth rates were higher on potato dextrose agar or malt soya peptone agar medium.

2.5.2 Carbon

Dirtsch (1978) reported that *A. bisporus* can be grown on synthetic medium containing hexose, viz; fructose, glucose and mannose. Stanek *et al* (1983) studied the source of nutrition of mushroom, *A. bisporus* in a

fermented substrate and found that the mycelia of mushroom utilized the polysaccharides more efficiently than glucose.

Martin *et al.* (1984) worked on the nutrition of *A. campestris* and in the study the liquid substrate based on peat extracts with the carbohydrate content of 29 g/l were supplemented with glucose 0-10g/l and yeast extract 1-10g/l on which *A. campestris* NRRL 2334 culture, previously adapted for growth in peat extract was aseptically introduced. Final dry biomass concentration and nitrogen content of mycelium were highest with 10g glucose and 5 g yeast extract and lowest in non-supplemented peat extract.

Protein utilization by basidiomycetous fungi were studied by Kalisz *et al.* (1986). *A. bisporus* was grown on defined liquid media in presence of protein as a sole source of carbon, nitrogen and sulphur. It was found that protein was utilized as effectively as glucose when provided as a sole source of carbon. When protein and glucose was supplied together, growth was greater than protein and glucose alone.

Khan *et al* (1991) reported starch as the best source of carbon for the mycelial growth of *A. bisporus*. *A. bisporus* showed good growth in a defined buffered medium on glucose as a carbon source (Baurs *et al.*, 1994).

2.5.3 Nitrogen

A. bisporus can utilize protein as the sole source of carbon and nitrogen where catabolite repression was observed when media were supplemented with ammonium chloride and protein (Kalisz *et al.*, 1986). Khan *et al.* (1991) reported peptone as the best source of nitrogen. Baurs *et al.* (1994) studied

the nitrogen assimilation in white button mushroom by growing *A. bisporus* in a defined buffered medium with a number of organic nitrogen compound or ammonia. No growth was observed using nitrate as the nitrogen source and the fungus cannot utilize organic nitrogen containing substance as a sole nitrogen and carbon source.

2.5.4 Temperature

Losel (1964) reported that the germination and growth of *A. bisporus* was promoted when the plates were incubated at 25^0C. Fritsche (1968) reported about different temperature requirements of *A. bitorquis* and *A. bisporus* as 20-30^0C and 24^0C respectively. Limited growth of *A. bisporus* can be obtained at 3^0C but the maximum limit for most strains was 30^0C with an optimum at 24-25^0C (Hayes, 1972). At prolonged exposure at 33-34^0C mycelium of *A. bitorquis* was killed.

Dirtsch (1978) reported that at a temperature of 28^0C *A. bisporus* produce homogenous filamentous growth on submerged culture. Guleria (1985) studied about the cultivation of *A. bitorquis* in Bangalore and found an incubation temperature of 30^0C as optimum for mycelial growth.

Iqbal (1988) reported best mycelial growth of *A. bitorquis* in all media studied when incubated at 25^0C. Khan *et al* (1991) also observed optimum linear growth of mycelium on malt extract agar at 25^0C. Furlan *et al.* (1997) studied the temperature requirement of *A. bitorquis* and found that these have higher growth rates at 30^0C than at 20 or 25^0C.

2.5.5 pH

Growth of *A. bisporus* was possible over an extended range of pH from 3.5-9.0, for an optimum growth most media require a pH of 6.8 - 7.0 (Hayes, 1972). Song (1976) reported pH of 4-10 as minimum and maximum for *A. bitorquis* growth. Dirtsch (1978) observed maximum growth of *A. bisporus* when the organism was grown at pH of 5.3. Furlan *et al.* (1997) found higher growth of *A. bitorquis* at pH 5.0.

2.5.6 Light

Alteration in the competitive force of certain basidiomycetous ground fungi including *A. edulis* and *A. campestris* were studied (Gramss, 1984) by transferring them to substrates in moderate day light and in the dark and found that the dry matter production was uninfluenced by light. Furlan *et al.* (1997) reported that the absence of light favoured rapid mycelial development of *A. bitorquis*.

2.6 Cultivation

Agaricus bitorquis was first isolated and selected in 1971 and later in 1972 it was cultivated by Poppe (1972). Raper (1976) investigated its sexuality and reported that this mushroom was four spored agaric, unifactorial, heterothallic species and single spore isolates are homokaryotic and non-self fertile.

In India *A. bitorquis* cultivation was attempted by Tewari and Sohi (1976) at Bangalore and subsequently Guleria (1985) reported that incubation temperature of 30°C as good for both spawn growth on grains and on compost.

2.6.1 Composting

Short method of composting which is followed to date by most of the growers around the world was introduced by Sinden and Hauser (1950, 1953). He suggested that composting will kill the harmful diseases and pest and also condition the compost for better selectivity. Hayes (1969) suggested that carbohydrate nutrients such as molasses, brewer's grain, potato waste etc., will correct C/N ratio and are also required for the establishment of the bacterial flora in the compost.

Long method of composting was first advocated in India by Mantel *et al.* (1972) which is an out door process, takes around 20 days for its completion. Seth and Shandilya (1975) recommended the use of muriate of potash, super phosphate and other trace elements can be added to compost in addition to carbon and nitrogen source. Shandilya (1976) suggested chicken manure as best for short method of composting.

Tewari and Sohi (1976) tried combinations of paddy straw and maize stalks for the preparation of compost. Paddy straw was used by Kachroo *et al.* (1979) for compost preparation under Kashmir condition. Vijay and Gupta (1992) tried combination of wheat and paddy straw for compost preparation. Pre composting supplementation of wheat or rice bran, dried brewer's grain,

seed meals of cotton, castor etc. will result in significant increase in yield (Gupta and Vijay, 1992).

2.6.2 Growing System

The earlier method of cultivation in wooden trays has become obsolete due to prohibitive cost of wood and difficulty in disinfecting these trays. Polythene bags could easily replace wooden trays for cultivating white button mushrooms (Shandilya, 1988). Upadhyay and Vijay (1988) worked on standardisation of depth of compost in these polythene bags and found that compost depth of 30-37.5 cm was better for maximum returns and concluded that compost depth plays an important role in total yield than the exposed surface.

2.6.3 Spawning

Cooke and Flegg (1962) reported about the beneficial effect of in creased spawning rate which resulted in yield increase. Edwards (1973) reported the advantages of high spawning rate which facilitated early casing, Vedder (1975) reported about the use of 0.5 per cent spawn rate for optimum crop growth of *A. bitorquis*. Fati *et al.* (1977) tried spawn rate ranging from 250 to 700 g/m^2 bed area and found 550 g/m^2 bed area resulted in maximum mushroom yield. However, Van Zaayen and Pol Luiten (1977) reported about the use of 0. 8 per cent spawn rate as appropriate in *A. bitorquis*. Patil and Shinde (1983) have evaluated different methods of spawning and through spawning in which spawn was mixed thoroughly in the compost while filling the compost was found to be the best. Patil and Shinde (1983) worked out the

optimum rate of spawn for mixing in the compost as 0.5 to 0.75 per cent of fresh weight of compost.

2.6.4 Crop Management after Spawning

San Antanio and Thomas (1972) observed that higher concentration of carbon dioxide is desirable and ventillation is kept at the minimum for spawn run. As a thumb rule, about 20 m^3 fresh air is required per tonne of compost per hour during spawn run. (Herman,1988).

Vedder (1975) reported that at a prolonged exposure at 33–34^{0}C mycelium of *A. bitorquis* was killed. Hayes (1972) reported about the optimal p^H requirement of 7-7.5 for primordial formation.

2.6.5 Casing

Mantel (1973) developed a casing material based on one year old spent compost, sand and lime (4 : 1 : 1) after treating it with steam, nemagon or formalin. Tschierpe (1973) reported about the use of 2-6 cm casing thickness for casing soil, 3.8-5.1 cm for peat and 1-1.5 cm for lime stone in caves.

Shandilya *et al.* (1976) recommended treatment of casing materials with benlate and steam (60^{0}C for one hour). Hayes and Shandilya (1977) tried different casing mixture based on locally available materials, such as farmyard manure, spent compost and soil; and mixture of farmyard manure and loam soil (1:1) proved to be the best. Shandilya and Agarwala (1983) reported increase in yield with use of 2-3 years old spent compost.

Saxena and Gupta (1986) studied different methods of treatment of casing soil and best results were obtained with formalin treatment. Sharma (1991) reported occurrence of less numbers of fungal colonies in steam pasteurized casing soil compared to formaldehyde fumigated samples. Sharma and Vijay (1992) however, reported better results with untreated casing mixture than with the casing soil treated in various ways including sterilization, steam pasteurisation and bavistin treatments.

Materials and Methods

3. MATERIALS AND METHODS

3.1 Collection

3.1.a Occurrence and distribution of *Agaricus* spp. in different agroclimatic zones of Kerala

In order to study the natural distribution of different species of *Agaricus*, a preliminary survey was carried out in the 20 agroclimatic zones of the State (Table 1, Fig. 1) during the South West and North East monsoon periods of 1998-2000. The periodicity of occurrence, nature of substrate, soil type, locality, habit of occurrence and date of collections were noted in data sheet (Appendix I). Relative humidity and temperature on the date of collections were also noted.

Table-1 Agroclimatic zones of Kerala

Sl. No.	Agroclimatic zones	Location surveyed
1	Dry forest loam	Chinnar
2	Semi Dry Red loam	Isolated pockets in Thiruvananthapuram and Neyyattinkara
3	Semi Dry laterite	Kollam, Chirayinkil, Thiruvananthapuram, Neyyattinkara and Nedumangad
4	Semi dry alluvium	Coastal areas of Kollam, Chirayinkil, Thiruvananthapuram, Neyyattinkara, Ottapalam & Palakkad
5	Semi dry black soil	Eastern most parts of Chittur and Palakkad
6	Semi dry forest loam	Kumily

7	Sub humid Red loam	Parts of Kasargod, Thaliparamb, Hosdurg
8	Sub humid laterite	Tirur, Parur, Trichur, Alwaye, Kanayannur, Ernad, Palakkad, Kottarakkara, Pathanapuram, Neyyatinkara and Nedumangad
9	Subhumid alluvium	Coastal areas and river beds in the regions under item 8.
10	Sub humid saline	Pokkali lands in the coastal parts of Kanayannur, Parur and Kochi taluks
11	Sub humid forest loam	Parts of Ernad, Pathanapuram
12	Humid laterite	Tellichery, Quilandy, Kozhikode,Kanjirappally, Pathanamthitta, Chengannur, Mavelikkara and Nedumangad
13	Humid alluvium	River beds of Chengannur and Mavelikkara, coastal areas of Shertalai and Karunagappally.
14	Humid greyish Onattukara	Parts of Mavelikkara, Karunagapally
15	Humid saline	Around Vembanad lake
16	Humid forest loam	Parts of Ernad, Pathanapuram, Neyyattinkara
17	Per humid laterite	Quilandy, Ernad, Thodupuzha, Kothamangalam
18	Per humid forest loam	Vythiri, Thodupuzha
19	Wet laterite	Ernad, Pathanamthitta
20	Laterite forest loam	Parts of Thodupuzha, Kanjirappally

Fruiting bodies of the mushrooms were collected very carefully from the ground without disturbing the underground mycelial system, as the stipe base is often a crucial identification feature. Collections were then wrapped

Fig. 1 Locations surveyed in twenty agroclimatic zones of Kerala

1. Neyyattinkara
2. Thiruvananthapuram
3. Nedumangad
4. Chirayinkil
5. Kollam
6. Karunagapally
7. Kottarakkara
8. Pathanapuram
9. Mavelikkara
10. Chengannur
11. Pathanamthitta
12. Kanjirappally
13. Shertalai
14. Thodupuzha
15. Kothamangalam
16. Kochi
17. Kanayannur
18. Alwaye
19. Parur
20. Vembanad Lakeside
21. Thrissur
22. Kumily
23. Palakkad
24. Tirur
25. Ernad
26. Kozhikode
27. Quilandy
28. Thaliparambu
29. Hosdurg
30. Kasargod

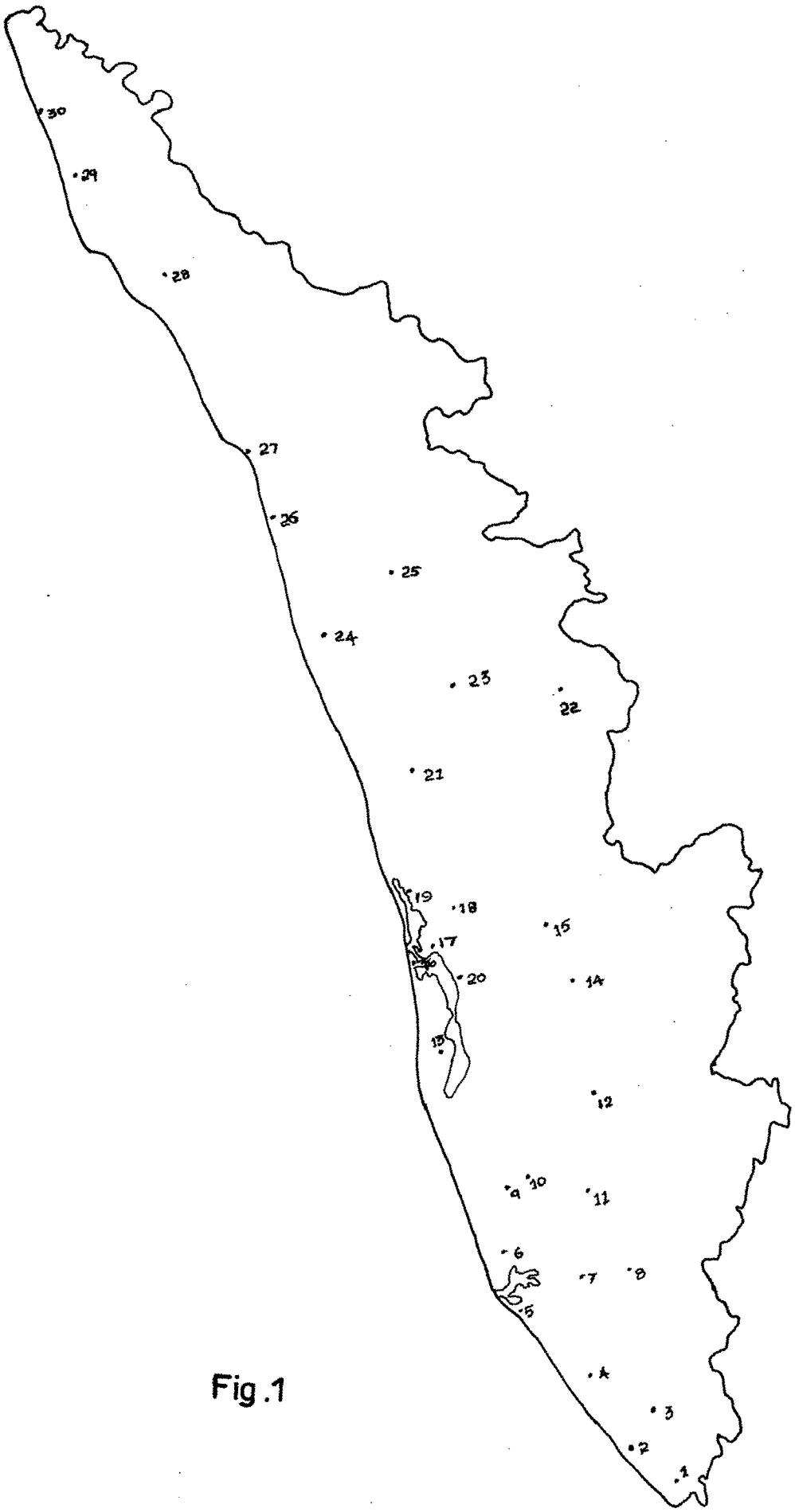

N
30
29
28
27
26
25
24
23
22
21
19
18
17
16
20
15
14
13
12
9
10
11
6
7
8
5
4
3
2
1

Fig .1

in ready cut squares of new papers - to retain adequate moisture, colour and stiffness of the fungus and also to prevent the specimen from crushing. Specimens collected from the field were brought to the laboratory as quickly as possible and subjected to various morphological observations and tissue isolation for obtaining their pure culture.

Morphological and microscopical characters of all the specimens collected were studied and recorded in the data sheet prepared by Nair and Devi (1984). Details of fruiting bodies like measurements of pileus, cap shape, texture, colour, presence of marginal veil, gill spacing, attachment of gill to stipe, gill colour stipe size, colour, stipe base were recorded. Colour of the pileus was noted as per Munsell's colour chart.

In order to differentiate *Agaricus* spp. cross reaction (Schaeffer's cross reaction) was carried out by drawing a streak of concentrated nitric acid over that of aniline and observing the colour changes at the point of intersection (chrome yellow to orangish) as positive or (no colour change) negative.

Spore prints of the pileus were taken on white sheet of paper from freshly collected mature fruit bodies. The stipe was cut off just beneath the pileus and was placed on a white paper, facing the gills downwards. This was kept undisturbed for 4-5 hr to get clear spore prints.

A part of the mature fresh specimen was subjected to microscopic analysis and rest dried in hot air oven at 40 - 50^0 C. Dried specimens with collection numbers were kept in paper bags and stored in a refrigerator to avoid the attack of moulds and mites. Specimens were also preserved by wet

method using formalin solution and the type specimens were deposited in KAU herbarium unit (Macrofungi) maintained at Onattukara Regional Agricultural Research Station, Kayamkulam.

Microscopic details of various parts of the fruiting body were studied either by free hand sections or by the tissue maceration. For this mature fresh specimens were used as far as possible. Then free hand sections of lamellae were made directly with the materials in between two halves of pith. These were mounted in water after staining with 3% congo red. In the case of dried specimens, sections were first revived using 5% KOH, stained in congo red and mounted in KOH. For tissue maceration, the stain was allowed to act for about 2-3 min and the specimens mounted in KOH. The tissue was macerated by keeping the same on glass slides and gently tapping with the blunt end of needle. Measurements of all microscopic structures were made using stage and ocular micrometers. Drawings of microscopic structures were made using camera lucida in 1000 X magnification.

The mushrooms were identified using the details available in the different published papers (Moller, 1950; Pilat, 1951; Singer, 1961, 1962, 1969; Pegler, 1977, 1983, 1986; Wasser, 1988; Arora, 1989). Ethnic information and edibility were recorded from the country folk at the place of collection. Information on edibility was also gathered from various literature and verified with Tanaka's encyclopedia of edible plants (Tanaka, 1976).

3.1.2 Isolation and purification of the fungus

Tissue isolation was used for obtaining the pure culture from various mushroom species. Medium sized sporocarps of late button stage were selected for tissue culture. The fresh mushroom was split length wise, small bits of context from the joining region of stipe and pileus were cut from the split surface with an inoculation needle and planted on sterile malt extract Agar slants. These slants were incubated at room temperature (26 ± 4^0C) and on 5^{th} or 6^{th} day the mycelial growth was transferred to fresh slants and the culture were purified by two or three subculturing by hyphal tip transfer method. Type cultures were deposited at Type culture collection unit at ORARS, Kayamkulam.

3.1.3 Moisture content of the substrate

Fifty gram of the soil from where the collections were made was taken in a petridish and was kept in an oven at 70^0C. The weight of the soil was recorded at one day interval until a constant weight was obtained. Moisture per cent of the soil was calculated using the formula.

$$\text{Moisture percentage} = \frac{\text{Wt. of soil before drying} - \text{Wt. of soil after drying}}{\text{Wt. of soil after drying}} \times 100$$

3.1.4 pH of the substrate

pH of the soil measured by mixing ten gram of sieved soil in 25 ml of distilled water. The mixture was stirred for 30 min. and contents were allowed to settle before reading the pH.

3.2 Physiological studies

3.2.1 Growth of *Agaricus* spp. in liquid media

In order to find out best media for growth of *Agaricus* spp. five different media broth were used, viz., malt extract, potato dextrose, oats, Czepak's Dox and complete medium (Appendix –2). The liquid media were prepared and 50 ml of each medium was dispensed in 250 ml Erlenmayer conical flasks and autoclaved at 1.02 kg/cm^2 for 15 min. The media were inoculated by 5 mm culture disc of the fungi, cut out from an actively growing culture of seven days old and incubated at room temperature (26 $\pm$ 4^{0}C). After ten days mycelial mat were filtered through Whatman No.1 filter paper and dried in an oven at 70^0 C. The dry weight was taken until a constant weight was obtained. Three replications were maintained.

3.2.2 Growth of *Agaricus* spp. in solid media

In order to find out the best medium for radial growth of *Agaricus* spp., the following eleven solid media were tried (Appendix II). Malt extract agar, potato dextrose agar, oats agar, yeast extract agar, complete medium, Coon's medium, Richard's medium, Sachh's medium, glucose mineral medium, Czepak's Dox medium and Hendrix medium. The sterilized media were taken in nine centimeter petri dish and inoculated with five millimeter diameter culture disk cut from an actively growing seven day old culture. The petri dish was incubated at room temperature (26 $\pm$ 4^{0}C). Colony diameter of the fungus was recorded for nine days at three days interval. The experiment was replicated three times.

3.2.3 Influence of different temperature on growth of *Agaricus* spp.

The effect of temperature (10, 15, 20, 25, 30 and 35^0C) on the growth of *Agaricus* spp. was tested using complete medium broth. The experiment was conducted as described under 3.2.1.

3.2.4 Influence of different pH on growth of *Agaricus* spp.

Complete medium broth was used to study the effect of pH on the growth of *Agaricus* spp. Initial pH of the broth was adjusted to 4.5, 5.0, 6.0, 7.0 and 8.0 by adding 0.1 N HCl or 0.1 N NaOH. The growth of the fungus was estimated as discussed under 3.2.1.

3.2.5 Influence of light and darkness on growth of *Agaricus* spp.

The experiment was conducted as described under 3.2.1. One set was kept under laboratory condition (normal day and night) and the other set was kept in a dark chamber. The growth of the fungus in the two sets was measured after ten days as 3.2.1. Six replications were maintained for each treatment.

3.2.6 Influence of different carbon sources on the growth of *Agaricus* spp.

Experiment was conducted as described under 3.2.1. The carbon source in the complete media (dextrose) was substituted with equivalent quantities of glucose, fructose, sucrose, xylose and mannose. Three replications were maintained in each case.

3.2.7 Influence of different nitrogen sources on the growth of *Agaricus* spp.

Experiment was conducted as described under 3.2.1. Different nitrogen source mainly ammonium nitrate, ammonium chloride and sodium nitrate were added in equal amount (2 g/l of media) to the complete media broth. Three replications were maintained in each case.

3.3 Cultivation

3.3.1 Comparative efficacy of different spawn substrates in supporting the mycelial growth

The following five grain substrates viz., paddy, maize, ragi, sorghum and wheat were tried for spawn production.

The grains after repeated washings were boiled with sufficient quantity of water till the grains absorb enough moisture to swell and become soft. Boiling was stopped just before splitting of the grains. The excess water was drained off, and grains were surface dried in shade for 30 min. Five to six per cent calcium carbonate on dry weight basis of the grain was mixed well with the boiled grains and filled in 500 ml saline bottles to its 2/3 rd capacity (200 g dry grain / bottle), plugged with cotton and sterilized for 1.5-2 hr at 1.02 kg /cm^2 pressure. The sterilized grains were then inoculated with 5 mm diam culture disc from an actively growing seven day old cultures of *A. bitorquis* and *A. squamuliferus* and incubated at room temperature (26 $\pm$ 4^{0}C). Mycelial growth of the fungus on the grains were graded on the 20th day of inoculation using the grade chart given below :

Visual observation	Grade
Very good growth	+ + + +
Good growth	+ + +
Moderate growth	+ +
Poor growth	+
No growth	---

3.3.2 Effect of temperature on mycelial growth of *Agaricus* spp. in wheat grain

Wheat grain was boiled and filled in 500 ml saline bottle as above and inoculated with 5 mm culture disc of seven days old actively growing cultures of *A. bitorquis* and *A. squamuliferus*. These were maintained at different temperature viz., 15, 20, 25 and 30^{0}C for 20 days. At the end of the incubation period, the mycelial growth was visually graded and recorded.

3.3.3 Production technology

Standard method used for growing *A. bisporus* was used for the production of *A. bitorquis*. There are different steps in the cultivation *viz.*, (1) preparation of compost (2) spawning and spawn run (3) casing and (4) cropping and crop management.

3.3.3.1 Compost preparation

Three types of compost viz., coir pith compost, vermicompost and traditional compost prepared by short method (Sinden and Hauser, 1953) were used. The formulations recommended by Indian Institute of Horticulture Research, Bangalore was used for composting and the materials include paddy straw, chicken manure, wheat bran and gypsum. For every 30 kg paddy straw,

15 kg of chicken manure, 1.25 kg of wheat bran and 900 g of gypsum were added. There were two phases in compost preparation. During the Phase I, prewetting and out door composting were done while pasteurization and conditioning of the compost followed in Phase II.

Phase - I

Paddy straw, chicken manure and wheat bran were mixed thoroughly and wetted properly till they absorb sufficient water. After thorough wetting the materials stacked to encourage aerobic fermentation. After two days the stack was broken.

Day - 0 - The stack was opened and an aerobic stack was made.

Day - 2 - First turning

Day - 4 - Second turning

Day - 6 - Third turning (gypsum was added)

Day - 8 - The compost was filled in poly bags of size 50 x 30 cm.

Phase - II

Pasteurization - Compost was pasteurized at 57 ^{0}C for 6 - 8 hours

Conditioning - During conditioning, compost was cooled down to 25 –28^{0}C by introducing more fresh air.

Vermicompost and coir pith compost were obtained commercially. Water was added to keep them moist. These were filled in polypropylene bags of size 50 x 30 cm and autoclaved at 1.02 kg / cm^2 for 20 min.

3.3.3.2 Spawning and spawn run

Fresh and good quality grain spawn of three weeks old was used for spawning. Through spawning (Shandilya *et al.*, 1974) was followed in which spawn was thoroughly mixed in the compost while filling containers. The grain spawn was mixed with compost at 0.5 per cent of compost weight (Patil and Shinde, 1983) and the seeded compost was levelled in the bag and slightly compressed. The seeded compost in bags were incubated at a temperature of 26 ± 1^0C.

3.3.3.3 Casing

When the mycelial run was completed casing was done to the beds. Casing layer of 4 - 5 cm depth was required to retain enough moisture. The material used for casing was Farm yard manure and garden soil in 1 : 1 proportion. This material was sterilized for 2 hrs at 1.05 kg/cm^2 after addition of enough water and applied above spawn run compost at a thickness of 4 - 5 cm. Case run was done at 28^0 C and Relative humidity of 80 per cent.

3.3.3.4 Cropping

Harvesting was done when the fruiting body attained button shape (6th day after pin head appearance).

3.3.4 Developmental morphology of fruiting body

Fruiting bodies from pin head emergence to the fully opened sporocarp were used for the study. The morphological features, macroscopical as well as the development of basidia, cystidia and basidiospores were also studied and the observations were noted.

3.4 Statistical analysis

The data obtained during the study were analysed statistically by applying the techniques of analysis of variance and correlation and regression analysis (Panse and Sukhatme, 1967).

Results

4. RESULTS

4.1 Collection

4.1.1 Occurrence and distribution of *Agaricus* spp. in different agroclimatic zones of Kerala

In order to study the natural occurrence and distribution of different species of *Agaricus* in Kerala, a preliminary survey was carried out in the twenty agroclimatic zones of the state (Table 1, Fig 1) during the South West and North East monsoon seasons of 1998-2000. Forty two *Agaricus* species were collected, identified and recorded from different localities of the above zones are given below :

1. *A. abruptibulbus* PK.
2. *A. actinorachis* Berk. and Br.
3. *A. altipes* (Moell.) Pill.
4. *A. annae* Pilat
5. *A. arenicolus* Wakefield et Pearson
6. *A. arvensis* Schaeff. Secr.
7. *A. augustus* Fr. var. *albus* Mos.
8. *A. benesi* Pilat
9. *A. bernardii* (Quel.) Sacc.
10. *A. bulbosus* sp. nov.
11. *A. campestris* var. *floccipes* (L.) Fr.
12. *A. caroli* Pilat
13. *A. chloroconius* Berk. and Br.

14. *A. endoxanthus* Berk. and Br.
15. *A. haemorrhoidaria* (Kalchbr. et. Schulzer.) Fr.
16. *A. ingrata* Moeller
17. *A. livido nitidus* Moeller
18. *A. mediofuscus* (Moell.) Moeller
19. *A. meleagris* (J. Schaeff.)
20. *A. microflavus* sp. nov.
21. *A. micromegethus* PK.
22. *A. microrubescens* sp. nov.
23. *A. moelleri* S. Wasser
24. *A. nivescens* Moller
25. *A. ochraceous* sp. nov.
26. *A. ochroflavus* sp. nov.
27. *A. phaeolepidotus* (Moell.) Moeller
28. *A. pseudopratensis* (Bohus.) S. Wasser
29. *A. purpurellus* Moeller
30. *A. rubicolus* sp. nov.
31. *A. rusiophyllus* Lasch.
32. *A. semotus* Fr.
33. *A. silvaticus* Schaeff. Secr.
34. *A. silvicola* (Vitt.) Sacc.
35. *A. simulans* Hooker
36. *A. spissarufosa* sp. nov.
37. *A. squamuliferus* Moeller
38. *A. stadii* (Petch.) Pegler. Comb. nov.

39. *A. subperonatus* (Lange.) Lange.

40. *A. trisulphuratus* Berk.

41. *A. xanthodermus* Gen.

42. *A. xantholepis* (Moell.) Moeller

Idetnification of the species

Genus *Agaricus*

***Agaricus* L. Ex. Fries**

Syst. Mycol. 1:5; 1821

Synonym

Pratella (Pers. ex) S. F. Gray. Nat. Arr. Brit. pp. 1:626, 1821

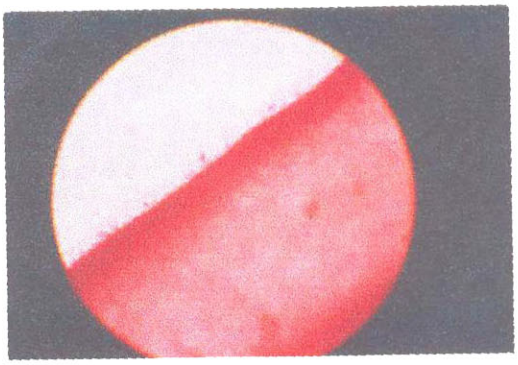
Psalliota (Fr.) Quel. Champ. Jura. Vosg. 139.1872

Fungus Adans. Ex. O. Kuntze, Rev. Gen. pp. 3: 477, 1898

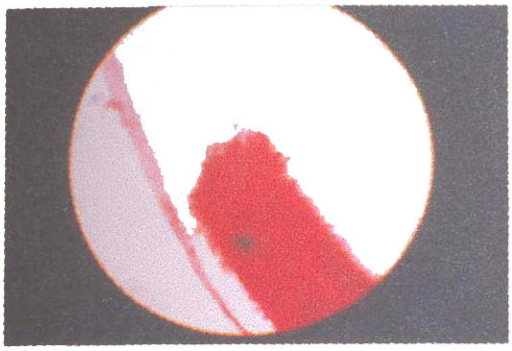
The species usually grow on soil, on dung, humus and on ant hills in and outside woods. Pileus white or coloured, naked or squamulose and also with warts or smooth dry. Stipe central. Annulus almost fleshy and sometime doubly annulate, and the lower annulus representing a volva which is adpressed and not cup shaped near the base. Gills free but without a collarium, white to pink when young but becoming deep coloured because of the attached spores. Context inamyloid often becoming reddish when bruised or changing to yellow when touched. Hyphae usually without clamp-connections. Hymenophoral trama regular then irregular. Basidia normal but often consistently two spored. Only cheilocystidia present. Cheilocystidia are moderately numerous, vesiculose, inflated or cylindric, at times catenulate, or absent. Spore print purplish brown to sepia. Spores smooth without

Plate 1 *Agaricus* sp. showing the general characters of genus *Agaricus*

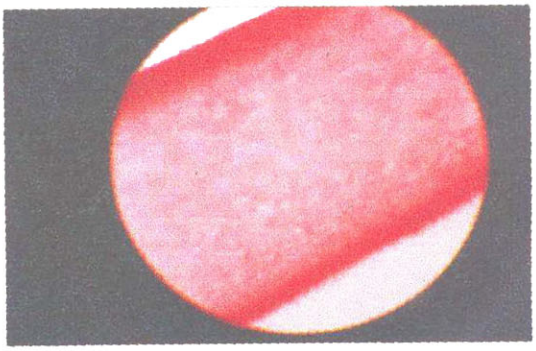
Free & pink gills, annulus present



Pleurocystidia absent



Cheilocystidia present



Regular trama

ornamentation, brown under microscope. Surface and context of the fruiting bodies often strongly react with ordinary reagents and with combination of anilin and nitric acid (Plate 1).

Key to the identification of Genus *Agaricus*

1a. Context of the carpophore, when fresh unchanging or staining pinkish or reddish on handling or on exposure. Schaeffer's cross reaction, as a rule negative. 2

1b. Context of the carpophore, when fresh becoming pale yellow, lemon yellow or intensely bright chrome yellow. In some eventhough the carpophore on handling become yellow, context on exposure stains pink.3

2a. Pileus glabrous or innately squamose, lacking a woolly universal veil. 4

2b. Pileus and stipe base covered by a brightly coloured woolly universal veil

A. trisulphuratus

4a. Cheilocystidia present, pleurocystidia absent 5

4b. Both cheilocystidia and pleurocystidia absent 6

5a. Pileus white at least in youth 7

5b. Pileus not white, either in youth or later 8

7a. Pileus almost glabrous, stipe taller even double that of pileus diameter.

A. benesi

7b. Pileus with adpressed white squamules more on periphery.

A. squamuliferus

7c. Pileus with sharply cut, pointing squamules more crowded in the centre.

A. caroli

7d. Pileus glabrous, with narrow cheilocystidia, long stipe deeply buried in soil *A. arenicolus*

7e. Pileus thin, strongly convex, pure white, becoming dark reddish brown on bruising. Cheilocystidia cylindric often subapically constricted. *A. simulans*

8a. Pileus brownish with brownish black squamules, stipe with dense brownish black squamules. *A. mediofuscus*

8b. Pileus whitish or greyish with yellowish brown squamulose scale 9

9a. Medium to large sized, short stiped species. Cheilocystidia clavate and spores roundish ovate. 10

9b. Medium sized, short stiped species, context turning greyish red. Cheilocystidia large, inflated broadly clavate. *A. spissarufosa*

9c. Medium to large sized, cheilocystidia balloon shaped to broadly clavate. Context on exposure turn pinkish red. 11

9d. Medium to large sized, cheilocystidia broadly clavate. Context on exposure turn deep red. 12

10a. Pileus 8-10 cm coarsely areolate-squamose, scales thick, grow in fairy rings. *A. bernardii*

10b. Pileus 6-8 cm. radially floccose-squamose, scales thin, do not grow in fairy rings - *A. ingrata*

11a. Pileus 5-7.5 cm, stipe slender, hollow with a small bulbous base. *A. ochroflavus*

11b. Pileus 6-8cm, stipe cylindrical enlarging towards base with a prominent bulbous base. *A. bulbosus*

11c. Pileus 5-6cm, stipe obclavate or cylindrical and gradually enlarging towards base. Cheilocystidia of variable shape. *A. ochraceous*

11d. Pileus 6-7.5 cm, greyish white with minute fuscous brown squamules, radially fissile to expose the underlying white context. *A. actinorachis*

11e. Small species, pileus 1.5-2 cm. Cheilocystidia cylindric. Spores ovoid. *A. chloroconius*

12a. Pileus 5-7cm. Stipe with a slightly enlarged base, cheilocystidia clavate to globose. Spores ovoid, small, 4.5 - 6 x 3.75-4µm. *A. silvaticus*

12b. Pileus 7-8cm, adpressed fibrillose scales arranged radially, spores roundish to ovate, 5.25-6x4 µm *A. subperonatus*

12c. Pileus 4-12 cm thick, fleshy, brownish yellow firmly adpressed fibrillose to squamulose scales, highly floccose lower stipe. Gills and context turn dark red on bruising. Cheilocystidia of variable shape. Spores ovoid. *A. rubicolus.*

12d. Pileus 2-4cm, small species, short stipe, cheilocystidia broadly clavate to piriform, large Spores large, ovoid 6-7 x 4.5 µm. *A. microrubescens*

12e. Pileus 8-9 cm, centre brown surrounded by brown squamulose scales. Spores ovate, 4.5-6 x 3-3.75 µm. *A. haemorrhoidaria*

6a. Pileus 5-6cm, white, glabrous, pink discolouration absent in context. *A. stadii*

6b. Pileus 4-7cm, convex to aplanate, yellowish white have a wide umbo in the centre. Stipe slightly enlarging towards base. *A. altipes*

6c. Pileus greyish 5-6 cm, convex with flattened centre. *A. livido nitidus*

6d. Pileus 4-5 cm, white, floccose on pileus and lower shape *A. campestris* var. *floccipes*

12a. Context when broken becoming yellow, yellowish pink. Schaeffer's cross reaction positive. 13

12b. Context when broken becoming bright chrome yellow at the base of stipe. Schaeffer's cross reaction negative. 14

13a. Medium to large sized pileus > 6cm in diameter spores medium to large. 15

13b. Small species Pileus 2-6 cm in diameter. Spores small. 16

14a. Pileus whitish, whitish grey, smooth, glabrous, on handling becoming yellow. 17

14b. Pileus with yellowish brown, ochraceous brown or blackish brown fibrillose or squamulose scales. 18

17a. Pileus 4-8 cm, white, silky fibrillose. *A. xanthodermus*

17b. Pileus 3-7 cm whitish grey. *A. pseudopratensis*

18a. Pileus 5-10 cm, black centre, fibrillose scaly towards edge, stipe white with small bulb *A. moelleri*

18b. Pileus 7-10cm, blackish brown centre, towards edge fibrillose scaly, stipe brownish without bulbous base. *A. endoxanthus*

18c. Pileus 8-10 cm with adpressed fibrillose dark brown scales on whitish grey back ground. Cheilocystidia piriform, 15-16.5 x 8-10 mm. *A. meleagris*

18d. Pileus 5-8cm, centre dark brown, surrounded by diffusely squamose scales in whitish background. Cheilocystidia broadly clavate, 18-22 x 12-15 mm *A. phaeolepidotus*

15a. Pileus white, without coloured scales 19

15b. Pileus conical-companulate with low fleshy umbo, centre reddish brown. Cheilocystidia long; broadly clavate. *A. annae*

14c. Pileus off white with yellowish brown scales arranged more or less concetrically. Cheilocystidia of variable shape. *A. augustus*

19a. Pileus silky white and break radially when mature. Stipe white with a prominent roundish bulbous base. Cheilocystidia of varying shape and size. A. *abruptibulbus*

19b. Pileus white, convex to aplanate with small umbo. Stipe white, floccose towards base with slightly swollen base. Cheilocystidia short, clavate *A. arvensis*

19c. Pileus semiglobose with a flattened centre, glabrous, stipe fistulose, without bulbous base. *A. nivescens*

19d. Pileus convex to aplanate, white to off white. Stipe long, solid with a bulbous base. Context on exposure turn pink. *A. silvicola*

16a. Pileus yellowish white, centre with pinkish tinge. Stipe enlarged towards base Cheilocystidia absent. *A. rusiophyllus*

16b. Pileus whitish pink with reddish-pink centre *A. semotus*

16c. Pileus whitish with golden yellow to clay yellow adpressed squamules. *A. xantholepis*

16 d. Pileus pinkish white with purple brown centre and adpressed purple brown fibrills. *A. purpurellus*

16 e. Pileus cream with yellowish brown centre and small fibrillose to squamulose scales *A. micromegethus*

16 f. Pileus greyish white with small orangish brown squamules, more crowded in centre *A. microflavus*

Agaricus abruptibulbus Pk. (Plate 2, Fig. 2)

N.Y State Mus. Bull., 1905, 94: 35

Synonym

Psalliota abruptibulba (PK) Kauffn. Agar. Mich. 1918: 237

Agaricus silvicola (Vitt.) S. PK., NY. State Mus. Rept., 46, 1893: 135

A. arvensis Schaeff Fr. var. *abruptus* PK. N.Y State Mus Rept. 48, 1895:239

A. abruptus Pk. NY. State Mus. Memb. 4; 3, 1900:163

P. arvensis Schaeff. Fr. var. *silvicola* (Vitt.) Fr. S.J. Lge, Dan Bot. Ark. 1926:7

P. silvicola (Fr.) (Vitt.) Fries sensu J. Lange., Dan Bot. Ark. 1938 : 89

Pileus 4-7 cm in diameter, companulate when young, at maturity aplanate with a small umbo; silky white, (10YR 8/2), when bruised become yellow. Pileus radially break when mature. Stipe 6-8 x 1-2 cm, white, slender, cylindric, with a roundish bulbous base. Annulus thin, white. Context moderately thick with slightly pink colour. Gills free, crowded 18 nos/cm, pale coloured, turns to greyish pink, at ageing blackish brown. Gill trama regular. Basidia tetra spored, clavate, 20 x 6μm. Pleurocystidia absent. Cheilocystidia globose, balloon shaped to varying size and shape 21-30 x 10.5 -18 μm. Spores dark brown, oval, 6 x 4.5 μm. This species was found solitary on sandy soil in coconut basin.

Schaeffer's cross reaction-positive

Season and distribution : Collected from Kayamkulam during November 1999.

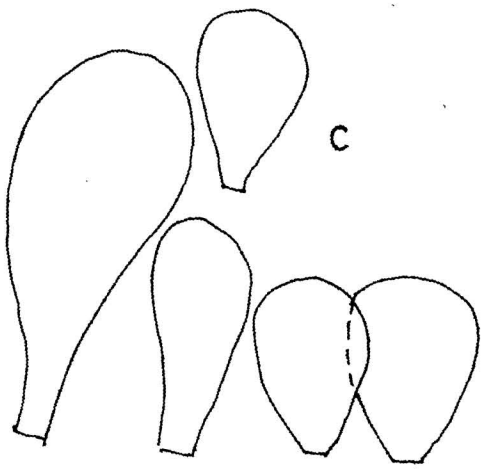
Edibility: Not edible

A. abruptibulbus is closely related to *A. silvicola* but differ because of the varying shape of cheilocystidia.

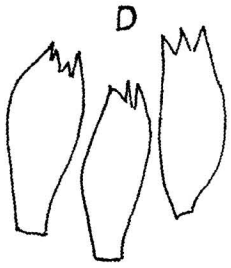
Fig. 2 *A. abruptibulbus*

A

B



C



D

A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

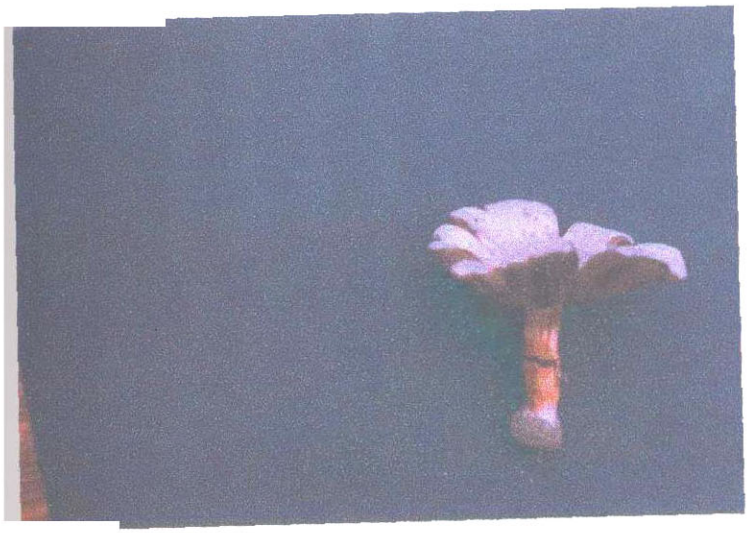


Plate 2 *A. abruptibulbus*

Plate 3 *A. actinorachis*

Agaricus actinorachis Berk. and Br. (Plate 3, Fig. 3)

Journ. Linn. Soc., Bot. 1871; 11 : 548

Synonym

A. lepiotoides Berk. and Br. loc. cit. 551

A. endoxanthus var. Berk. and Br. loc. cit: 548.

Pileus 6-7.5 cm in diameter, fleshy, convex to campanulate often with slight depression, greyish white (10 YR 7/1) covered with minute fuscous brown (10 YR 3/2) squamules, more crowded and darker towards centre, radially fissile to expose the underlying white context. Stipe 7-9 x 1-1.5 cm, cylindrical, fistulose then hollow, white, glabrous, slightly enlarged towards base. Annulus white, membraneous, large, pendulous, attached to upper quarter of stipe. Context white, becoming faint pink on exposure. Gills free, crowded, 18 nos/cm, purplish brown. Gill trama regular. Basidia clavate, four spored, 14-15 x 6 µm. Pleurocystidia absent. Cheilocystidia subglobose to piriform, 14-16.5 x 10-12 µm. Spores dark brown, elongate ellipsoid, smooth, 6-7.5 x 3.5-4.5 µm. Grows in group in forest area.

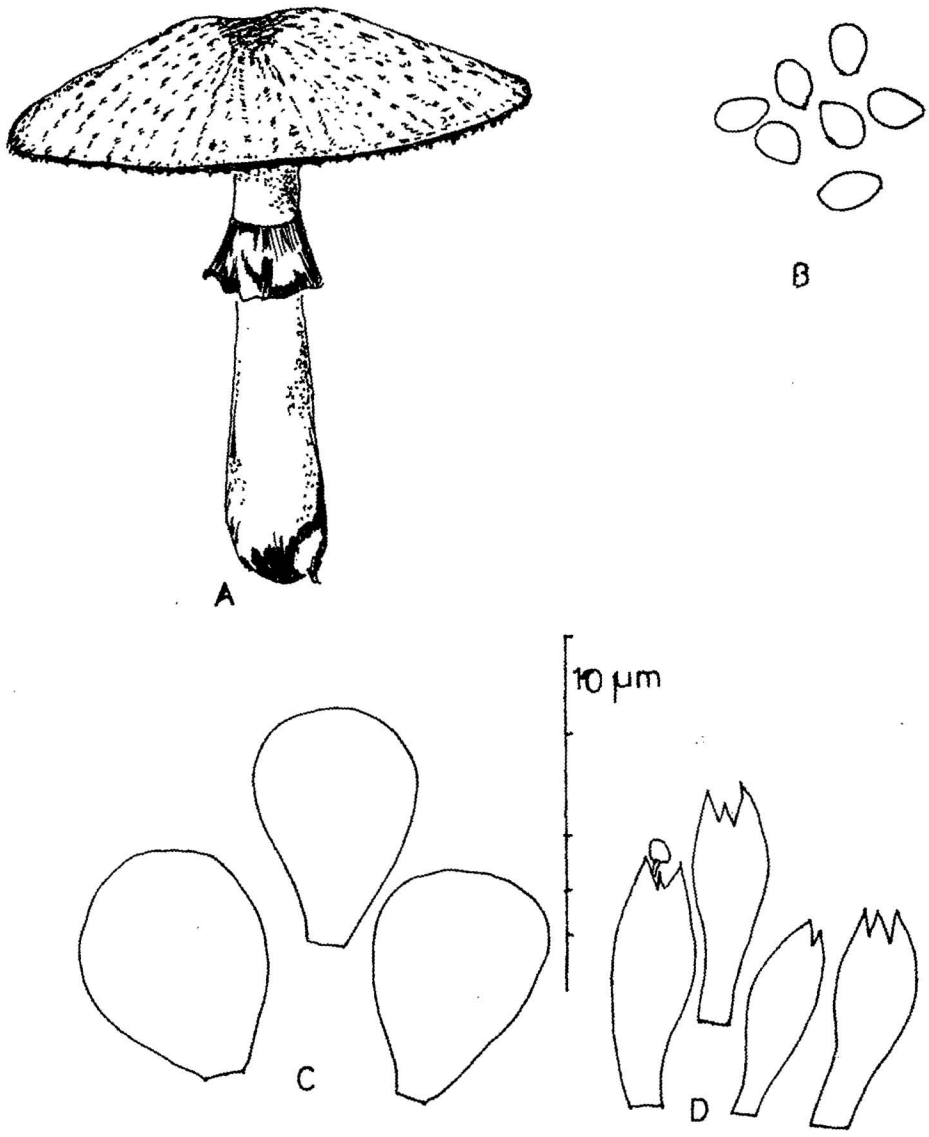
Schaeffer's cross reaction-negative.

Season and occurrence - Collected from silent valley during October 2000.

Edibility : Unknown

- This species is characterised by the distinctive radial splitting of pileus.

Fig. 3 *A. actinorachis*



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus altipes (Moel) Pill. (Plate 4, Fig. 4)

Acta Mus. Nat. Prag. VII B, 1951 : 12

Synonym

Psalliota altipes Moller Friesia IV 1950 : 46

Pileus 4-7 cm in diameter, semiglobose when young and on maturity turn convex to convex-aplanate, yellowish white (2.5 Y 8/4) in the centre, thick, fleshy in the centre and thin along the margin and have a wide umbo in the centre. Stipe 5-8 x 1-2 cm, white, central, cylindric with slighlty expanding towards base, yellowish brown at the base. Annulus superior, thin, sheathed above. Context white, on exposure especially in the upper part of the stipe and near the gills becoming reddish. Gills free, crowded, 20 nos/cm, fairly broad, rosy pink when unfolding and later blackish brown. Gill trama subregular. Basidia clavate, four spored, 24-26 x 8-10 μm. Pleurocystidia and cheilocystidia absent. Spores ovate, blackish brown, 6-7.5 x 4.5-5.2 μm. Smell disagreable. Seen as solitary among grass on roadside

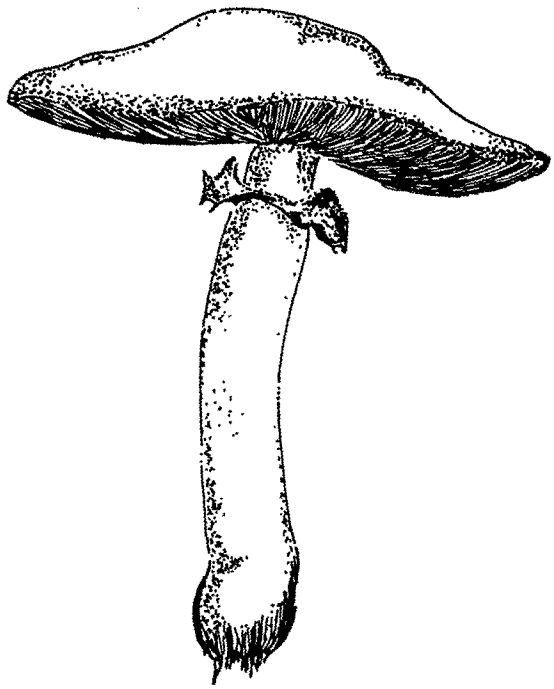
Schaeffer's cross reaction-negative.

Season and distribution- Collected from Kozhikode during June. 2000

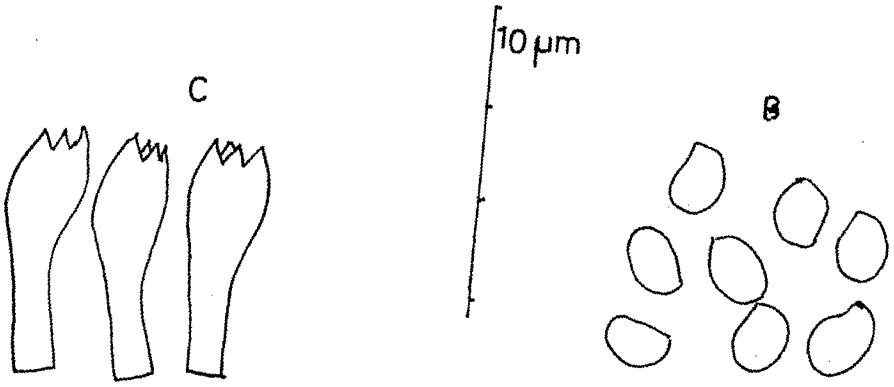
Edibility-Edible

This species is characterised by its stipe which is tall gradually enlarging base, the pileus with broad umbo and absence of cheilocystidia.

Fig. 4 *A. altipes*



A



A. Sporophore

B.Basidiospore 1000x

C. Basidia 1000x

Plate 4 *A. altipes*

Plate 5 *A. annae*

Agaricus annae Pilat (Plate 5, Fig. 5)

The Bohemian species of the Genus *Agaricus* 1950: 73

Pileus 7-9 cm in diameter, conical companulate when mature and then aplanate on ageing with low fleshy umbo, centre reddish brown, (2.5 YR 5/4) rest of pileus whitish (10YR 8/2) with small adpressed reddish brown squamules. Stipe tall, 8-10 x 1-1.5 cm central, cylindrical often with a little bent, smooth, off white. Annulus white, superior. Context white, becoming light pink when bruised. Gills crowded, 20 nos/cm, free, pale pink when young turn greyish pink and choclate brown on ageing. Gill trama regular. Basidia 15-19.5 x 7.5 µm clavate, tetraspored. Cheilocystidia abundant, long, piriform, 21-36 x 13.5-15 µm. Pleurocystidia absent. Spore rusty brown, ovoid, 6-6.75 x 3.75 µm. Gregariously growing, scattered under trees like Acacia, oil palm etc.

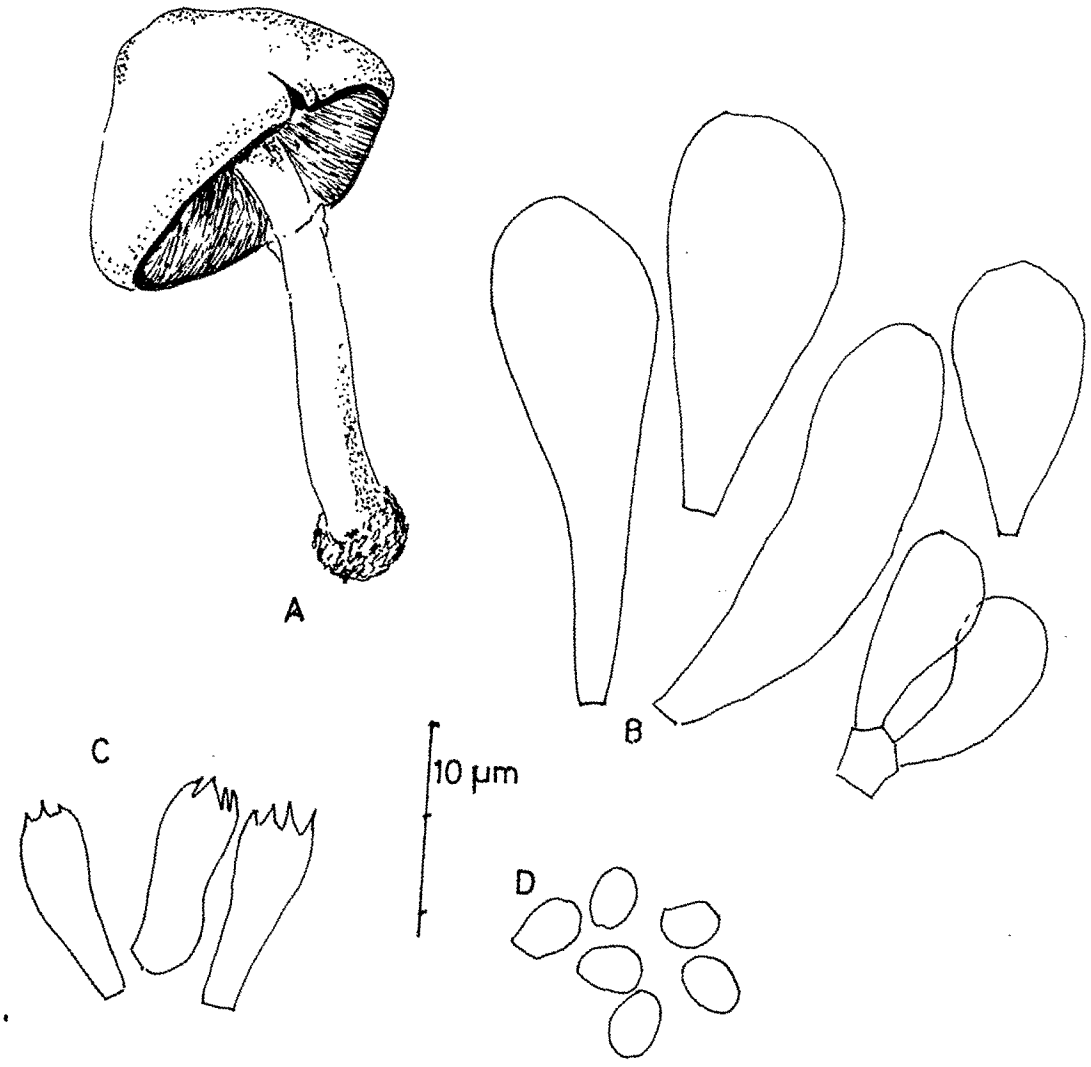
Schaeffer's cross reaction – negative

Season and distribution: Collected from Vellayani and Museum of Thiruvananthapuram district during May 1999.

Edibility : Unknown

A. annae is characterised by shape and colour of pileus, long abundant Cheilocystidia and positive reaction with Aniline oil and Nitric acid.

Fig. 5 ***A. annae***



A. Sporophore

B. Cheilocystidia 1000x

D. Basidiospore 1000x

C. Basidia 1000x

Agaricus arenicolus Wake field et Pearson (Plate 6a, 6b and Fig. 6)

Trans. Brit. Myc. Soc. 1946. 29:205

Pileus 4-5 cm in diameter, silky white (5YR 8/1), convex in younger stage and later become aplanate. Stipe 5.6 x 1-1.5 cm, comparatively long, slender, deeply buried in sand, slightly thinner towards base with a small bulb, densily pithy with a small tube, lower stipe pure white and upper stipe slightly pink in colour. Annulus white, narrow, superior sheathed below. Context thin, white turn slightly pink on cutting. Gills free, crowded, 18 nos/cm, pale pink later turns dark brown. Gill trama regular. Basidia tetra sporic, clavate, 21 x 6 µm. Pleurocystidia absent. Cheilocystidia numerous, clavate, 23-25 x 7.5 µm. Spores brownish black, roundish-oval, 6 x 4.5 µm. Growing gregariously in sandy loam soils along with grass on the sides of Kayal.

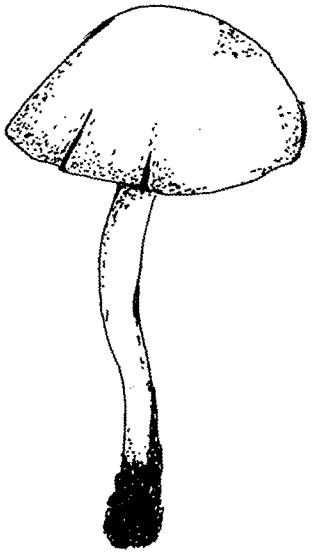
Schaeffer's cross reaction-negative

Season and distribution- Collected from Vellayani lake side during October 1999.

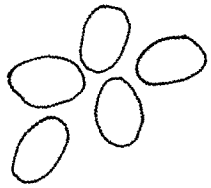
Edibility - Good

This species is very much similar to *A. stadii* but differ by its long stipe which was deeply buried in soil and presence of numerous cheilocystidia.

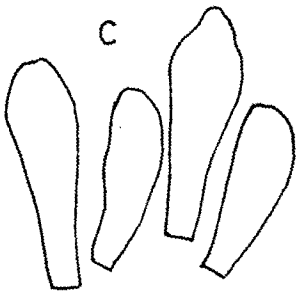
Fig. 6 *A. arenicolus*



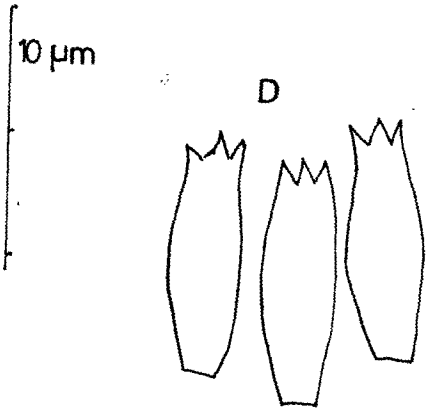
A



B



C



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Plate 6a *A. arenicolus*in natural habitat

Plate 6b *A. arenicolus*

Agaricus arvensis Schaeff. Secr. (Plate 7, Fig. 7)

Friesia, 1951, 5: 61-62

Synonym

Psalliota arvensis (Schaeff. Secr.) Kumm. Der. Fuhrer in die Pilzkunde. 1871:67

P. cretacea Fr. Deutsch lands 1915: 236

P. arvensis sub sp. *exquiseta* (Vitt.) Moell. Ann. Myc. 1938: 78

Pileus 5-8 cm diameter, convex at younger stage and then become aplanate with a slight umbo, silky white (10 YR 8/2), on touching, pressure and on old age changes to dark lemon colour. Stipe 6-8 x 1.5-2 cm white, glabrous, hollow, slightly swollen at base, on touching colour changes to yellow, floccose towards base. Annulus white, turns light yellow, superior. Gills free, narrow, crowded, 18 nos/cm, light coloured on button stage and become greyish pink coloured when opened and later become dark blackish brown. Context moderately thick, white with ageing become gradually ochraceous. Gill trama regular. Basidia clavate, four spored, 21-24 x 6-9 µm. Pleurocystidia absent. Cheilocystidia short, clavate, balloonshaped to ovate, hyaline, numerous, 10.5-15 x 7.5-12 µm. Spore powder dark brown. Spore ovate 6.75-7.5 x 4.25-4.5 µm. Growing in groups on soil in coconut plantation, also in roadside and among fodder grass.

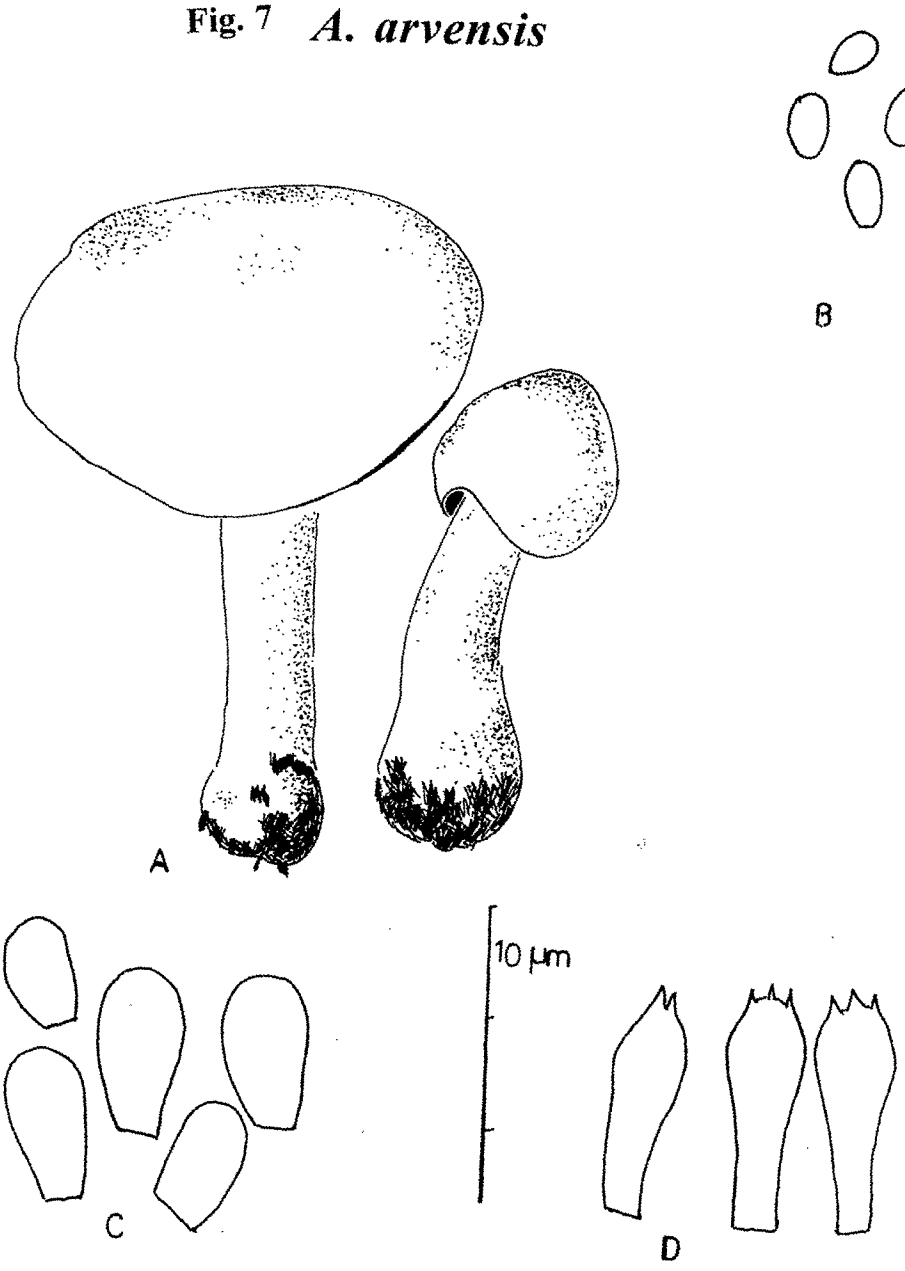
Schaeffer's cross reaction – Positive

Season and distribution: Collected from Vellayani of Thiruvananthapuram district during April 2000 and June 2000.

Edibility : Good

This species is similar to *A. nivescens* but differ by its enlarged stipe base and shape of pileus, size of cheilocystidia and spores and differ from *A. stadii* and *A. campestris* by the yellowing of context, positive Schaeffer's reaction.

Fig. 7 ***A. arvensis***



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Plate 7 ***A. arvensis***

Plate 8 ***A. augustus*** **var.** ***albus***

Agaricus augustus Fr. var. albus Mos. (Plate 8, Fig. 8)

Syst. Myc., 1836: 212

Synonym

Psalliota augusta (Fr.) Quel. Les Champ. du Jura et des Vosges 1872. 1: 255

Pratella augusta (Fr.) Gillet. Les Champ. de la Hymen. Fr. 1878 : 561

A. perrarus Schulz. Verh. Zool. Bot. Ges. Wein. 1829, 79: 493

A. peronatus Massee, Brit. Fung. Fl. 1892. 1 : 415

Psalliota peronata (Massee) Rea., Brit. Basid. 1922: 83

Pileus 6-8.5 cm in diameter, at first almost globose then becomes convex to aplanate. The cuticle covered with brownish yellow (10YR 6/6) adpressed squamules, crowded and concentric scales arranged against a pale (10 YR 8/3) background, on handling become yellow. Stipe 6-7 x 1-1.5 cm, white, on handling become light yellow, central, cylindrical, slightly enlarged towards base, solid and later become fistulose. Annulus white, simple, superior, pendulous. Gill free, crowded 20, nos/cm. Context white on exposure staining pinkish red. Gill trama regular to irregular. Basidia 20-25 x 7.5-10 µm, clavate. Cheilocystidia abundant, variable in shape (chains of globose, ovate or piriform), 15-25 x 7.5-18 µm. Spores ovate, broadly ellipsoid, 7-8 x 4.5-5.25 µm. Grows solitarily in open field and roadsides.

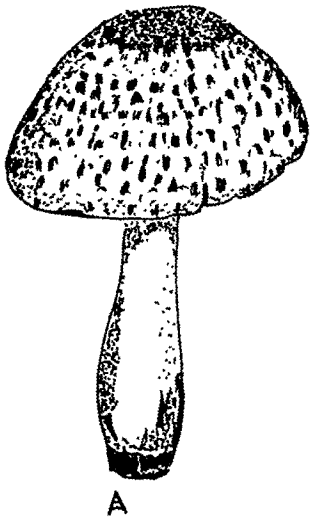
Schaeffer's cross reaction -positive.

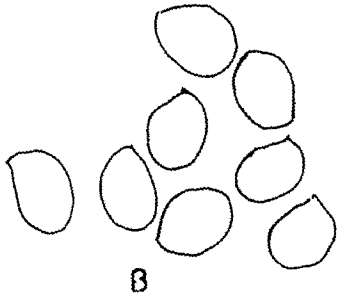
Season and distribution – Collected from Alwaye during June 2000.

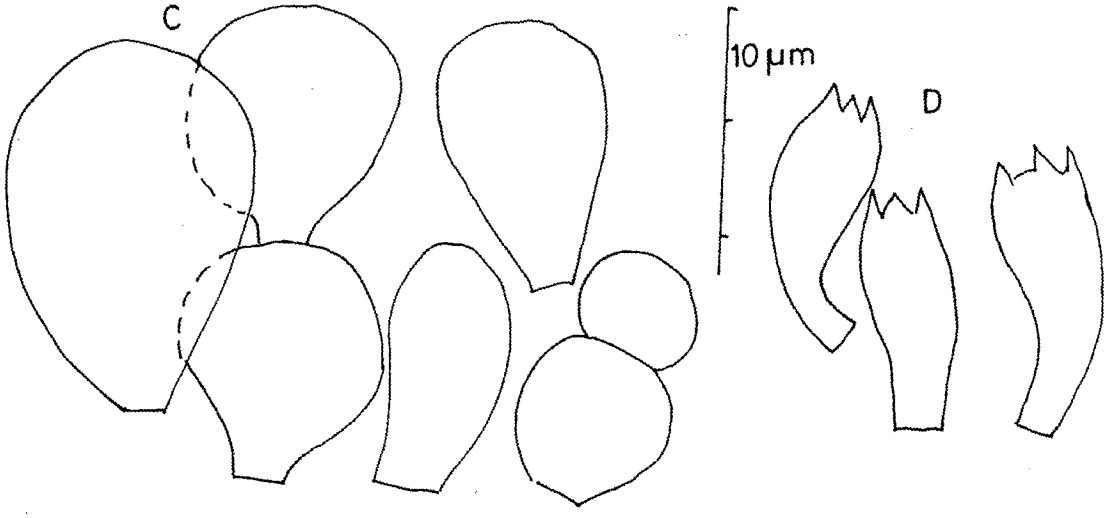
Edibility – Excellent

There is another variety of *A. augustus*, i.e., *A. augustus* var. *augustus* which has brown or dark orange pileus with broad brown fibrillose scales.

Fig. 8 *A. augustus*







A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus benesi Pilat. (Plate 9, Fig. 9)

The Bohemian species of the genus *Agaricus:* 1951

Synonym

Psalliota benesii Pilat, Mycologia : 1925: 47-49

P. bernardi Ricken, Vademecum ed. I. : 136

P. bulbosa Velenovsky. Novitates Mycologicae 1939 : 153

Agaricus albosanguineus Hobson et Stuntz, The Agaricus in Western Washington Mycologia: 1938 : 217

Pileus 5-7 cm diameter, fleshy, subglobose when young, become convex or convex-aplanate at maturity; white (2.5 Y N8) with small, white, adpressed squamules. Stipe 8-10 x 1.5-2 cm, white, long, often double that of pileus, central, cylindrical, solid with a narrow tube, slightly thickened below to a small bulb; when bruised the stipe changes to wine red to reddish brown, especially when cut in the upper part. The base of the stipe and the context of pileus do not redden on cutting. Annulus large, simple with bifurcate edge; above smooth and floccose below. Gills crowded, 18 nos/cm, free, broad, light rose when young then light pink which later turn chocolate brown. Gill trama regular to subregular. Basidia clavate, tetra spored, 19.5-20 x 6-7.5 μm. Pleurocystidia absent. Cheilocystidia clavate to piriform, 19.5-24 x 12-15 μm. Spores brown, 6 x 4.5 μm in size, ovate to ellipsoid in shape. Found solitary as well as in groups in garden soil near ornamental plants like Hibiscus, croton etc.

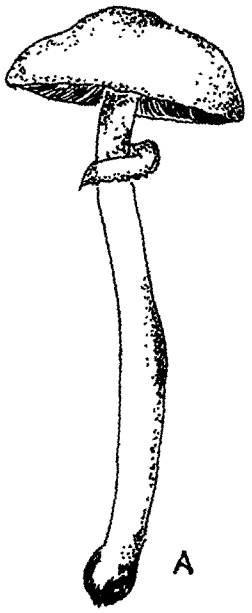
Schaeffer's cross reaction- Negative

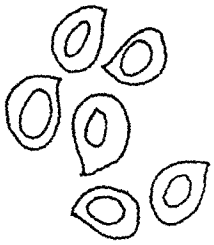
Season and distribution- Collected from CRS, Balaramapuram during October 1999.

Edibility - Good

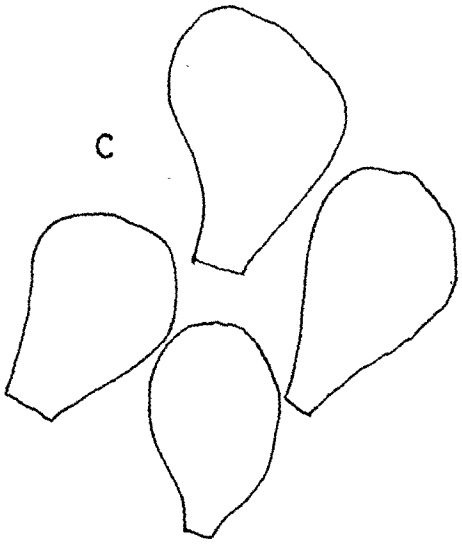
This species is allied to *A. squamuliferus* and *A. caroli* in appearance and colour. But differ from them by the presence of very long stipe even double that of the size of pileus, squamules are also less and small.

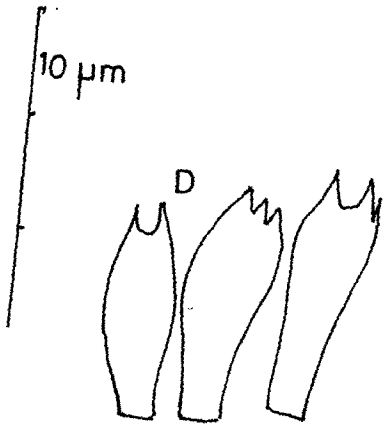
Fig. 9 *A. benesi*





B





A. Sporophore

B.Basidiospore 1000x

C. Chetlocystidia 1000x

D. Basidia 1000x

Plate 7 ***A. benesi***

Plate 10 ***A. bernardii***

Agaricus bernardii (Quel.) Sacc. (Plate 10, Fig. 10)

The Bohemian species of genus *Agaricus* : 1951

Synonym

Psalliota bernardii Quelet. Friesia 1950. 4: 14

Pileus 8-9 in diameter, firm, thick fleshed, at first semi globose then convex to flattened with a slightly depressed centre, surface scaly. At maturity the pellicle breakup into large, thick, dark brown (5YR 4/4), aerolate, concentric scales. Stipe 5-7 x 2-2.5 cm, short, white, cylindrical with pointed base, solid. Annulus superior, permanent, white, thick. Context white, thick, firm, turn purplish when bruised. Basidiocarp have an unpleasant fishy smell. Gills crowded, 18 nos/cm, free greyish pink turn to brownish grey. Gill trama regular to subregular. Basidia tetrasporic, clavate, 20-28 x 8.85 µm. Pleurocystidia absent. Cheilocystidia clavato-fusiform, 24-28 x 8-12 µm. Spore print dark blackish brown. Spores ovately round, thick walled, 5.5-6 x 4-5µm. Seen as well developed fairy ring on cowdung heap.

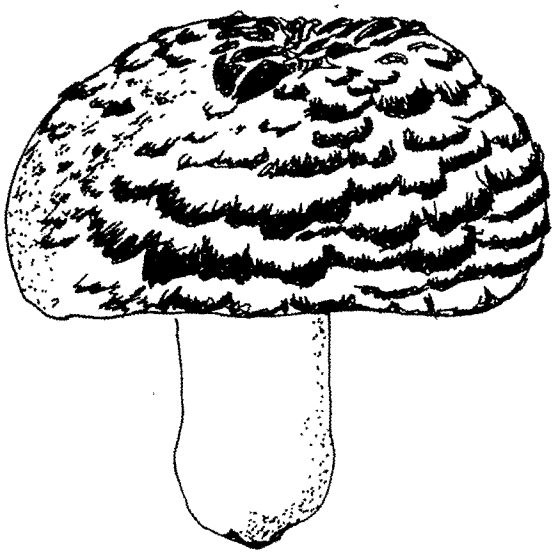
Schaeffer's cross reaction-negative

Season and distribution : Collected from Vellayani of Thiruvananthapuram district during south west Monsoon- February 1999.

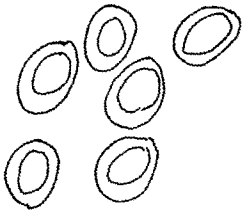
Edibility: Not poisonous, but have a disagreeable smell.

A. ingrata is very much related to this species, but usually it occur solitary and the scales are also not aerolate. *A. bernardii* decays only slowly.

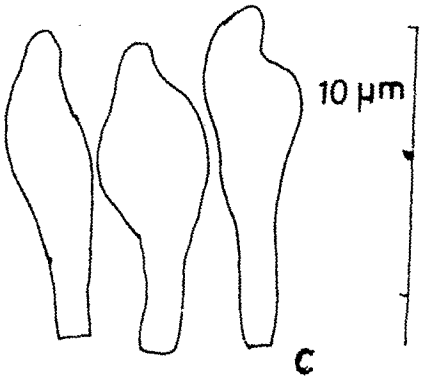
Fig. 10 *A. bernardii*



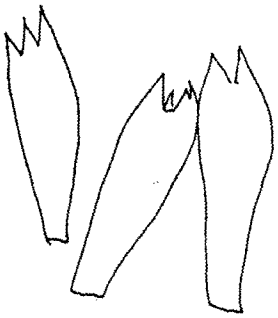
A



B



C



D

A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus bulbosus sp. nov. (Plate 11, Fig. 11)

Pileus 6-8 cm in diameter, light pink (7.5 YR 8/2) with yellowish brown centre (10YR 5/8), surrounded by small adpressed yellowish brown squamules arranged concentrically; convex when young, becoming aplanate at maturity. Stipe 6-8 x 1-1.5 cm, central, cylindrical slightly enlarging towards base, fistulose, with a prominent bulbous base, glabrous, white, turn pinkish brown on bruising and handling. Gills crowded, 16 nos /cm. free, rosy pink when young turning chocolate brown on ageing. Annulus white, superior, Context white, turning pink on cutting and bruising. Gill trama regular. Basidia clavate, four spored, 15-18 x 8-10 µm. Pleurocystidia absent. Cheilocystidia broadly clavate or piriform, abundant, 18-25 x 16-18 µm. Spores roundly ovate, 6-7.5 x 5-6 µm. Scattered on ground under shade of casurina tree.

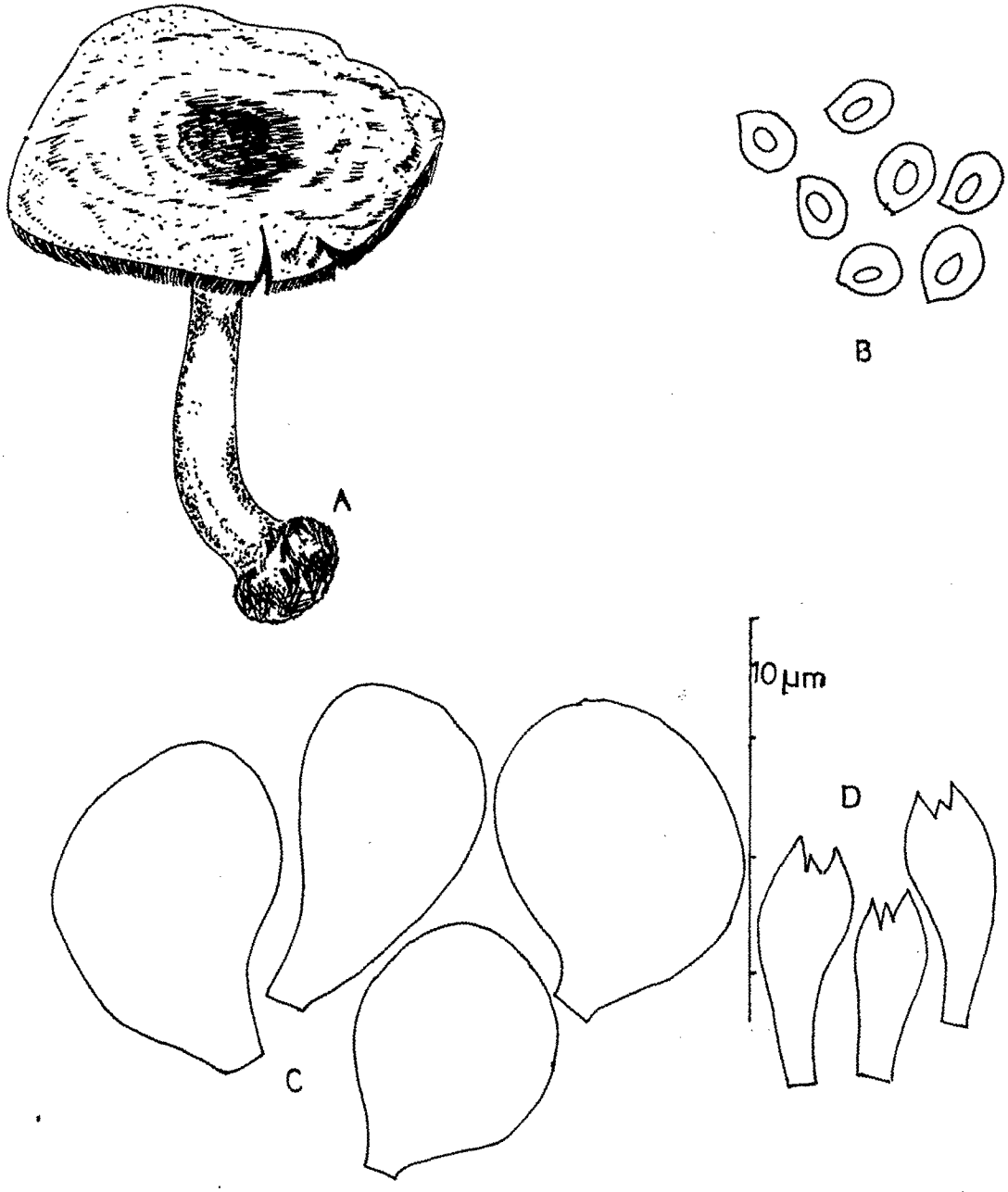
Schaeffer's cross reaction-negative

Season and distribution : Collected from Kanjiramkulam and Neyyardam of Thiruvananthapuram district during December 1999.

Edibility: Unknown

This species is allied to *A. ochraceous* but have a prominent basal bulb. *A. ochroflavus* also resembles *A. bulbosus* but *A. ochroflavus* has more slender stipe.

Fig. 11 *A. bulbosus*



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

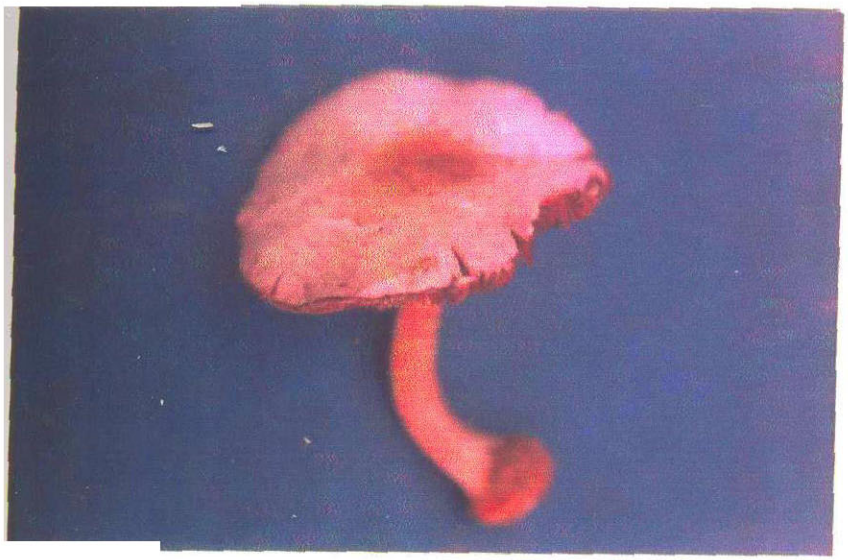


Plate 11 ***A. bulbosus***

Plate 12 ***A. campestris*** **var.** ***floccipes***

Agaricus campestris* (L.) Fr. var. *floccipes Moeller (Plate 12, Fig. 12)
Friesia IV -1950:57

Synonym: *Psalliota flocculosa* Rea. Brit. Bas; 1932:50

Pileus 4-5 cm in diameter highly convex with a flattened centre, white (10YR 8/2) floccose to fibrillose. Stipe 3-5 x 0.75-1 cm, white with pinkish tinge, pithy, narrowly hollow, floccose on lower stipe, Annulus white, simple. Context thin, white, turn pinkish on cutting and bruising. Gills free, crowded 18 nos/cm bright reddish pink, on ageing becomes blackish brown. Gill trama regular. Cheilocystidia and pleurocystidia absent, Basidia four spored, clavate, 20 -24 x 7-9 µm. Spores ovate, 6-7.25 x 4.5 µm. Seen gregariously growing in grassy land, fairy rings also develop.

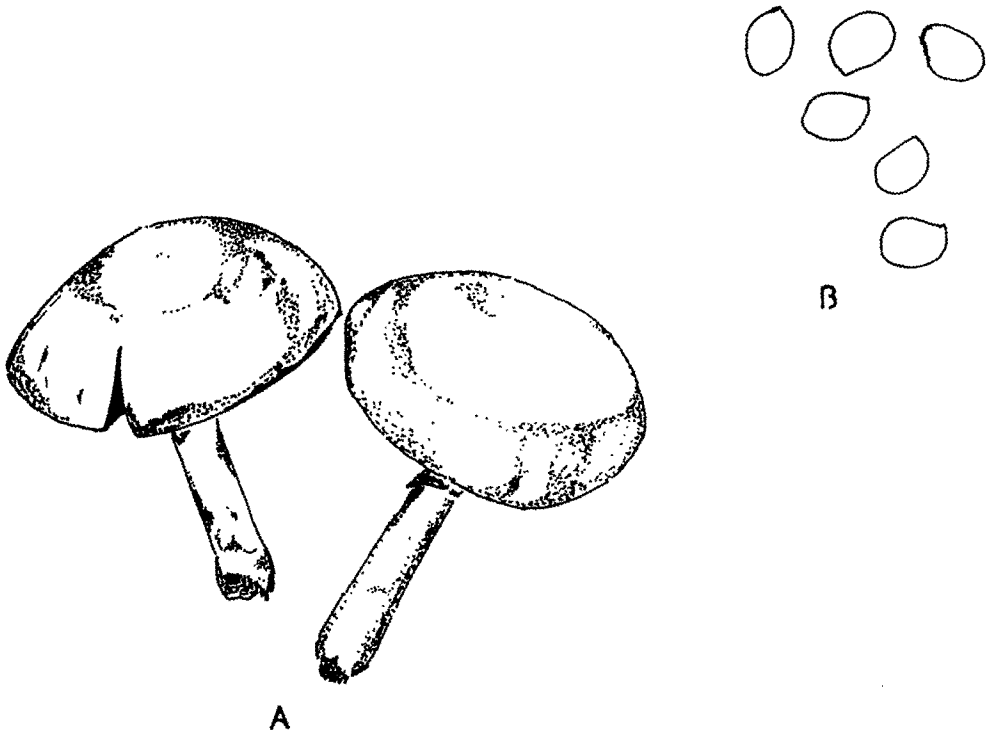
Schaeffer's cross reaction-negative

Season and distribution: Collected from Kozhikode during June, 2000

Edibility -Good

A. campestris var. *floccipes* is characterised by its highly floccose pileus and stipe. The name itself indicates its floccose nature.

Fig. 12 *A. campestris*



A. Sporophore

B.Basidiospore 1000x

C. Basidia 1000x

Agaricus caroli Pilat (Plate 13, Fig. 13)

The Bohemian species of the genus *Agaricus* : 1951

Pileus 5-6.5 cm diameter, pure white, fleshy, broadly glandiformly arched, then more hemispherical with truncated apex and aplanate at maturity. Pileus white (2.5 Y N8) and turn light whitish grey at maturity, with regular and sharply delimited projecting small squamules more at the centre. Stipe 6 x 2 cm thick, cylindrical, central, basal region slightly bulbously thickened, white both upper and lower stipe. Near the base especially in lower region with several irregular rows of squamules. Annulus membraneous, large, persistent and split into two in periphery and lower side is cracked. Gills free, crowded, 18 nos/cm, light pink which turn to reddish chocolate brown and later turn reddish black. Trama regular to subregular. Basidia tetra spored, clavate, 18-19.5 x 9 µm. Cheilocystidia is abundant, clavate, 24-27 x 15 µ m. Spores ellipsoid, brownish black, 7.5 x 5 µm. Found solitary in soil under Gulmohr tree.

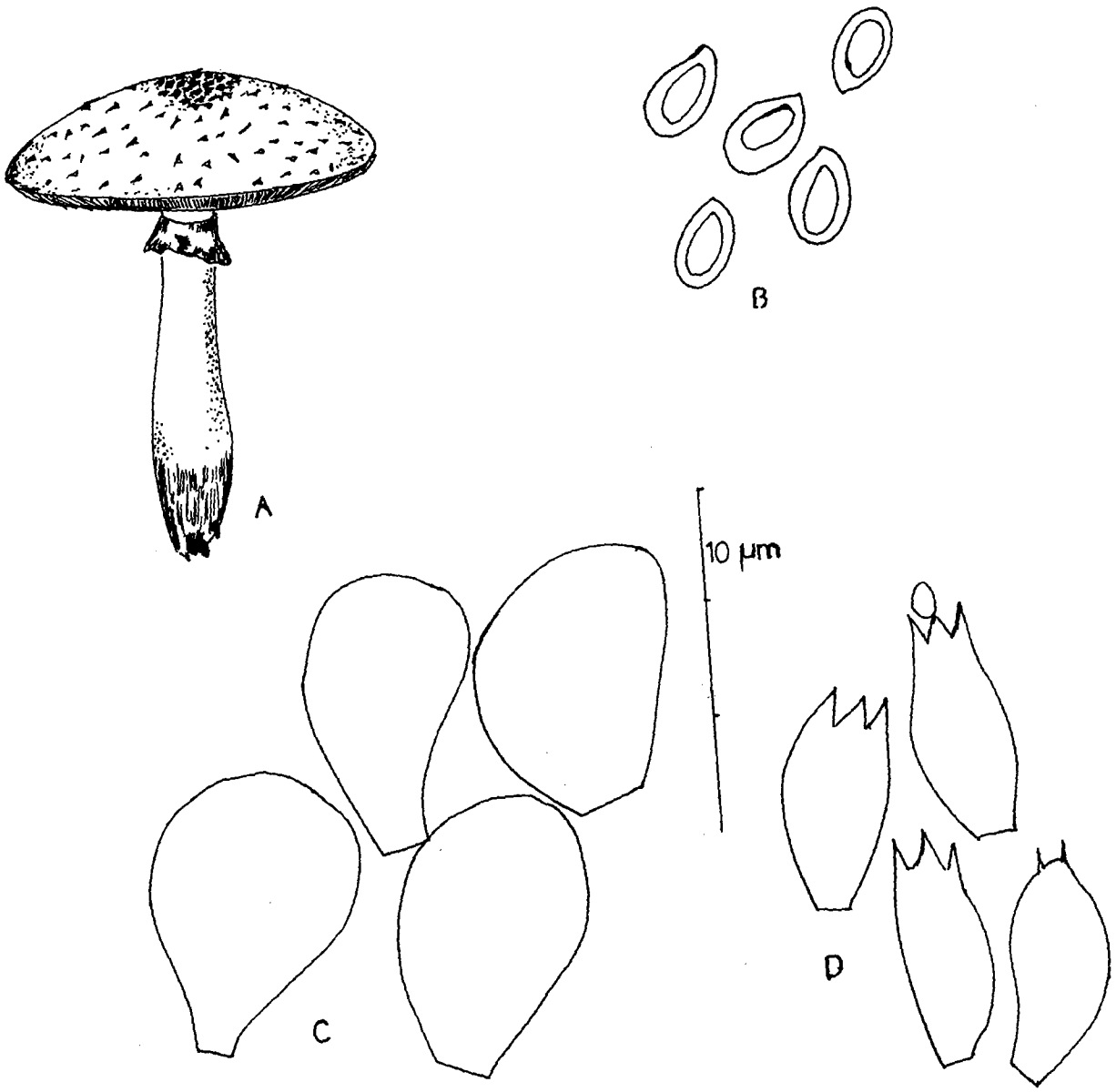
Schaeffer's cross reaction-negative

Season and distribution : Collected during North East monsoon, 1999 October from Neyyardam premises.

Edibility : Good

A. caroli is nearly allied to *A. squamuliferus* and *A. campestris*. Unlike *A. squamuliferus* which has squamules towards periphery; *A. caroli* has regular and sharply delimited projecting small squamules more towards centre and the gill edges are sterile, whereas in *A. campestris* gill edges are fertile without cheilocystidia.

Fig. 13 *A. caroli*



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Plate 13 ***A. caroli***

Plate 14 ***A. endoxanthus***

Agaricus chloroconius Berk. and Br. (Fig. 14)

Journ. Linn. Soc. Bot. 1871 11:552

Synonym

Stropharia chloroconia (Berk. and Br.) Sacc.,Syll. Fung. 1887: 1018

Pileus 1.5-2 cm in diameter, subcampanulate with an umbo when young and becomes convex to aplanate at maturity. Surface sulphur yellow (10 YR 8/6) with minute slightly darker squamules and it turns brownish on ageing. Stipe 1.5-2 x 0.5, cylindric, slender, white, with small squamules, hollow, slightly enlarged below. Context thin, light pink on cutting. Gills free, crowded, 16 nos/cm, pink at younger stage and becomes brown on ageing. Annulus white, thin, superior, evanescent. Gill trama regular to subregular Basidia clavate, four spored, 13-14 x 4.5 µm. Pleurocystidia absent. Cheilocystidia crowded, prominent, cylindric, 14-19 x 4.5-7 µm. Spores ovoid, brown, 5-6 x 3-3.5 µm. Grows in groups and as scattered on earthern walls.

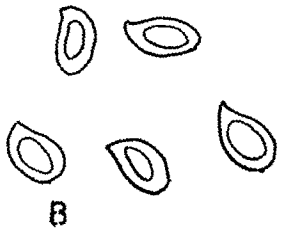
Schaeffer's cross reaction-negative

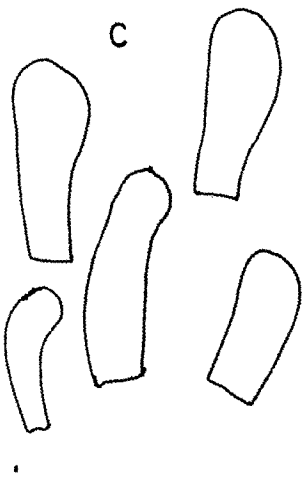
Season and distribution : Collected from Vellayani during October, 1999 (north east monsoon period).

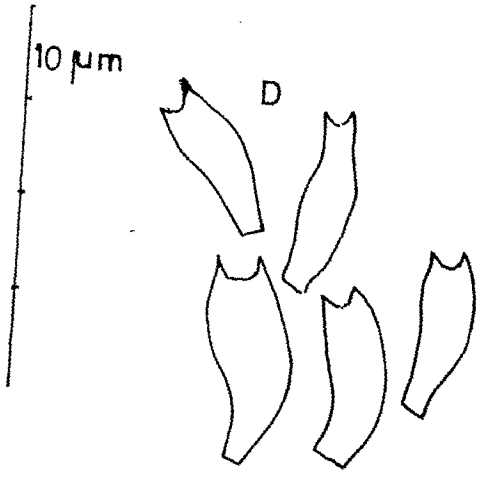
Edibility : Unknown

A. chloroconius is characterised by its small size, colour of pileus and cylindrical shaped cheilocystidia.

Fig. 14 *A. chloroconius*







A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus endoxanthus Berk and Br. (Plate14, Fig. 15)

Journ. Linn. Bot. 1871, 11: 548

Synonym

Psalliota endoxantha (Berk and Br.) Petch. Ann. Roy. Bot. Gard. Peradeniya 1917 : 320

A. arvensis sensu Berk. Hooker, Lond. Journ. Bot. 6:488

Pileus 7-10 cm in diameter, convex when young and becomes aplanate with a small depression in the centre at maturity, brown (7.5 YR 3/2) blackish brown towards centre, cracking radially into fibrillose scales. Stipe 6-8 x 0.75-1.0 cm, surface brownish, cylindric without bulbous base. The context of the stipe base discolouring bright chrome yellow. After sometime the colour change disappear. Annulus large, pendulous, superior, context thin, white turns light yellow which changes to reddish brown on exposure and also on ageing. Gills free, moderately crowded, 16 nos/cm, broad, pink when young and later turns to purplish brown. Trama regular. Basidia clavate, 16-20 x 5.5-6.5 µm bearing four spores. Cheilocystidia abundant, piriform, 12-14 x 8-10 µm. Spores ovoid to ellipsoid, dark brown, 5-6 x 3-4.5 µm. Grows as solitary and caesipitose in soil around Acasia tree and banana plant.

Schaeffer's cross reaction -negative

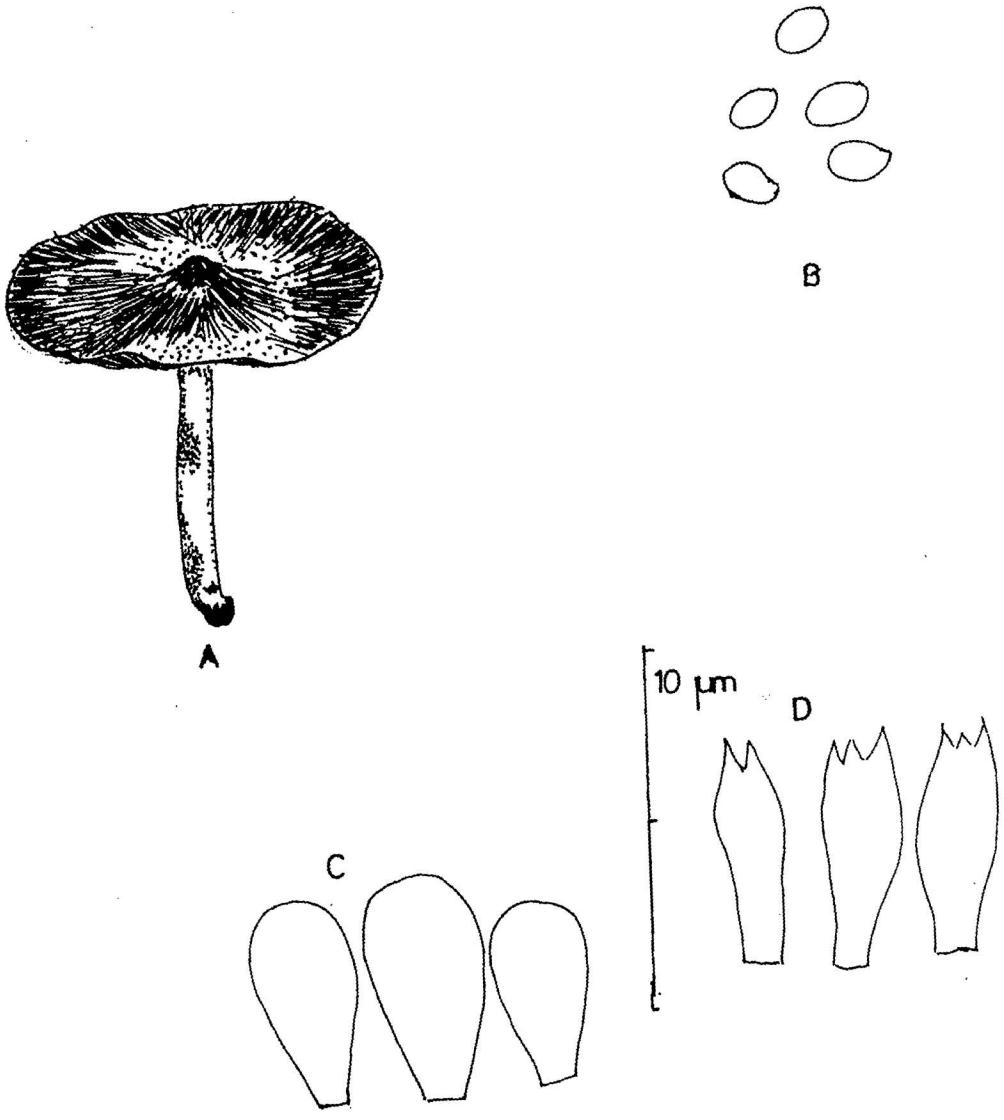
Season and distribution

Collected from Vellayani of Thiruvananthapuram district and Kollam during May, 1999.

Edibility : Allergic to some people

A. endoxanthus can be easily distinguished by its dark brown fibrillose pileus and the colour change of base of stipe which disappear after some time.

Fig. 15 *A. endoxanthus*



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus haemorrhoidaria (Kalchbr. et. Schulzer) (Plate 15, 16 and Fig. 16)

Ic. Sel. Hymen. Hung, 1873

Synonym

Psalliota langei Moeller, Friesia 4: 28, 1950

Pileus 8-9 cm in diameter, semiglobate at first then aplanate with a flattened centre, centre greyish brown without scales, towards margin whitish with small squamulose scales of the same colour as the centre of pileus. Stipe 8-10 x 1.5 -2.5 cm, central, cylindrical, with a bulbous base. Annulus white, superior. Gills free, crowded, 18 nos/cm, pink with pink fluid droping from gills during humid condition. Context white, when bruished becomes pinkish red suddently especially at the apex of stem, later changes to reddish brown. Gill trama regular to sub regular. Basidia four spored, clavate 18-20 x 5.5-8 µm. Pleurocystidia absent. Cheilocystidia abundant, shortly clavate, 20-24 x 7-10 µm. Spores ovate, brown, 4.5-6 x 3-3.75µm. Spore powder dark brown. Grows gregariously near the side wall of building.

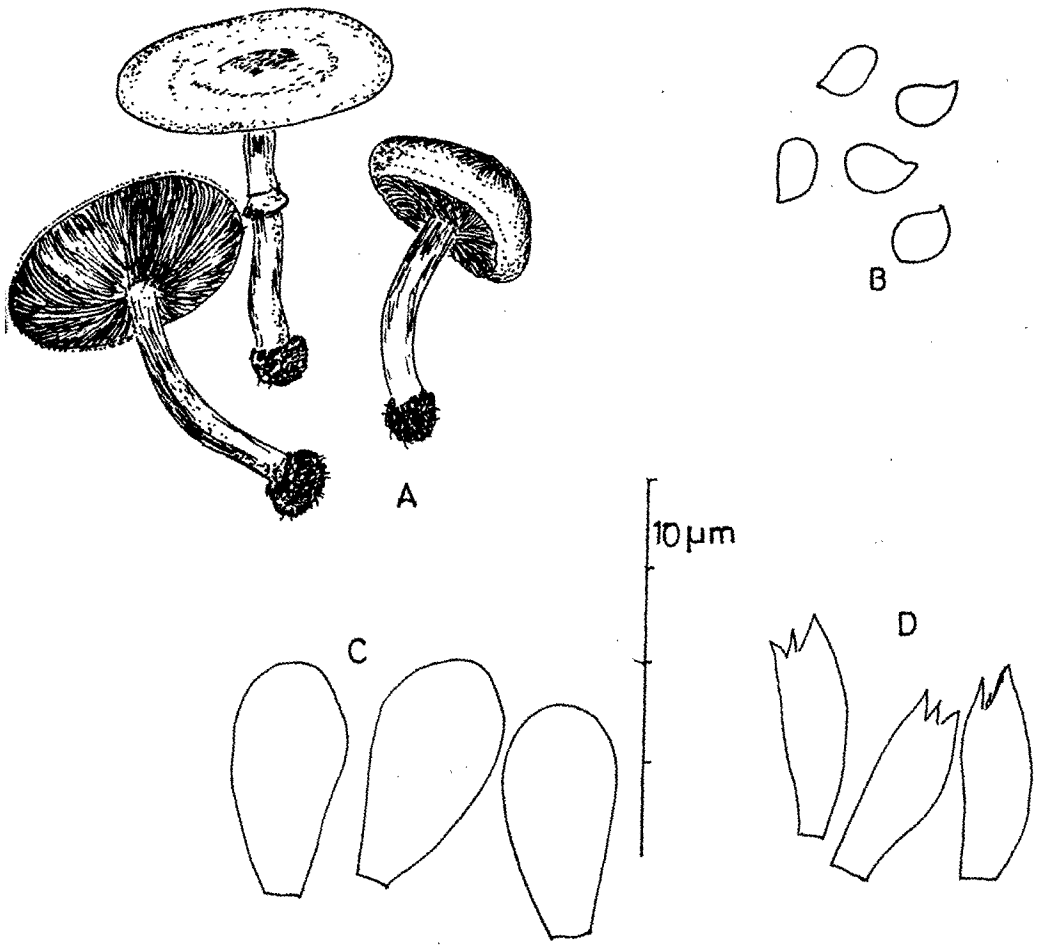
Schaeffer's cross reaction-negative

Season and distribution- Collected from RARS Kayamkulam during June 2000.

Edibility - Good

A. haemorrhoidaria is similar to *A. silvaticus* but slightly larger with a rounded bulbous base, strongly rubescent context, clavate cystidia and rather small spores.

Fig. 16 *A. haemorrhoidaria*



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Plate 15 ***A. haemorrhoidaria*** **in natural habitat**

Plate 16 ***A. haemorrhoidaria***

Agaricus ingrata Moeller (Fig. 17)

The Bohemian species of Genus *Agaricus* : 1951

Synonym

Psalliota ingrata Moeller. Friesia 4. 1951: 30

Pileus 6-7cm, thick fleshed, convex to aplanate brown coloured (7.5 YR 4/4) whitish towards margin, almost smooth when young then radially breaking up into adpressed scales giving a bark like appearance, without deep cracks in context. Stipe 5-7 x 1.5-2 cm thicker below, often with curved base, solid, whitish, dull brown on ageing, squamulose scales in lower stipe. Annulus white, thin, persistent. Context whitish, dark pink when cut. Gills free, crowded, 18 nos/cm, grey pink turn to brown on ageing. Gill trama regular. Basidia clavate, tetra spored 26-28 x 6.7 µm. Pleurocystidia absent. Cheilocystidia abundant, fusiform to clavate, 30-37.5 x 10.5 cm. Spores roundish 5 x 3.5 µm. Growing solitarily on bare soil under mahagony.

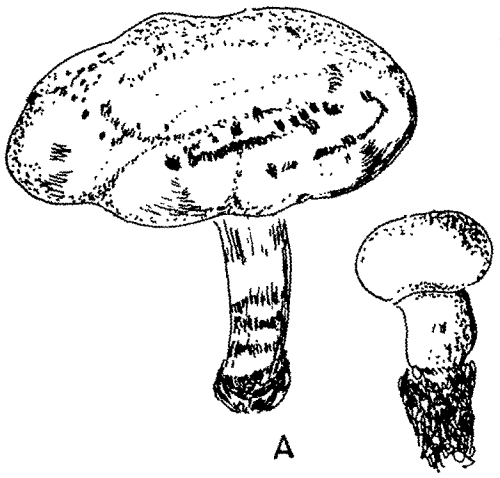
Schaeffer's cross reaction-negative

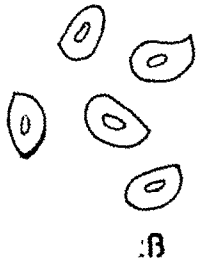
Season and Distribution : Collected from Neyyardam premises of Thiruvananthapuram district during October 2000, North East Monsoon period.

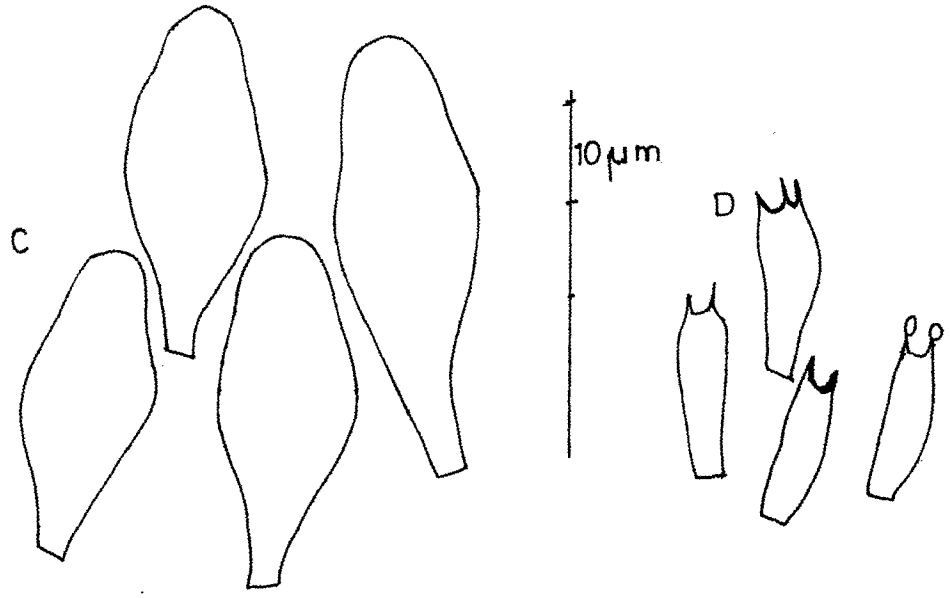
Edibility : Unknown

A. ingrata is much related to *A. bernardii* which has more deeply broken scales. *A. bernardii* is seen in fairy rings where as *A. ingrata* is seen solitarily.

Fig. 17 *A. ingrata*







A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus livido nitidus Moeller (Plate 17, Fig. 18)

Friesia 4. 1951: 47

Pileus 5-6 cm in diameter, convex with a slightly flattened centre, light violent grey (7.5 YR N 7) in the centre, more darker grey towards margin, smooth and silky to half of the pileus and then radially striate with fibrils. Stipe 3-5 x 0.75-1 cm, central, cylindrical, equal, white at younger stage which later turn grey. Annulus white, narrow, simple which turn greyish on ageing. Flesh comparatively thin, white turn pinkish on bruising. The context of stipe and pileus turn reddish on ageing. Gills free, crowded, 16 nos /cm thin, broad, rosy pink when young and later becomes brownish black. Gill trama regular. Basidia clavate, four spored, 22-24 x 7-8 μm. Cheilocystidia and pleurocystidia absent. Spores ovate to globose 6 x 4.5 μm. Seen scattered on grassy land.

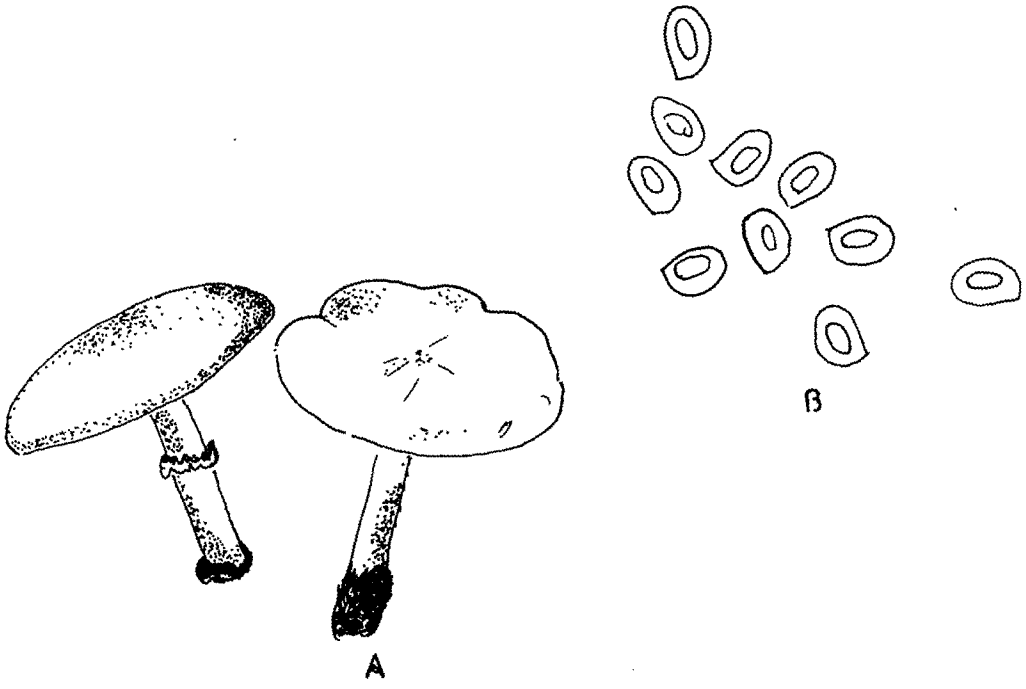
Schaeffer's cross reaction -negative

Season and distribution : Collected from Quilandy of Kozhikode district during June 2000.

Edibility -Unknown

A. livido nitidus differs from other species of *Agaricus* which lack Cheilocystidia by its colour of pileus and short stipe.

Fig. 18 *A. lividonitidus*



A. Sporophore

B.Basidiospore 1000x

C. Basidia 1000x

Plate 17 ***A. lividonitidus***

Plate 18 ***A. mediofuscus***

Agaricus mediofuscus (Moell.) Moeller (Plate 18, Fig. 19)

Friesia 1951. 4: 205

Synonym

Psalliota mediofuscus. Moeller. Friesia IV 1950: 30

Pileus 4-7 cm in diameter, plano-convex, with dark brown (10 YR 3/3) adpressed squamulose umbo surrounded by adpressed narrow dark brown squamules on pale greyish brown (2.5 Y 5/2) background. Stipe 5-9 x 1-1.5 cm, central, cylindrical slender, hollow, upper stipe smooth, lower stipe densily brownish covered by squamules as the pileus. Annulus white turning blackish brown, thin, membraneous. Context white becoming pink. Gills free, crowded, 18 nos/cm, light flesh colour, later becoming blackish brown. Gill trama regular. Basidia clavate, bearing four spores, 15-18 x 7-7.5 µm. Pleurocystidia absent. Cheilocystidia broadly clavate, 25-40 x 8-15 µm. Spores ovate, 7.5-8.5 x 5 µm. Grows scattered near building on humus rich soils.

Schaeffer's cross reaction negative

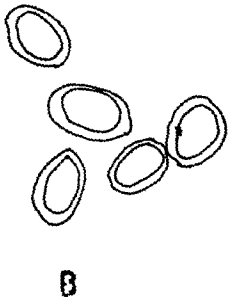
Season and distribution

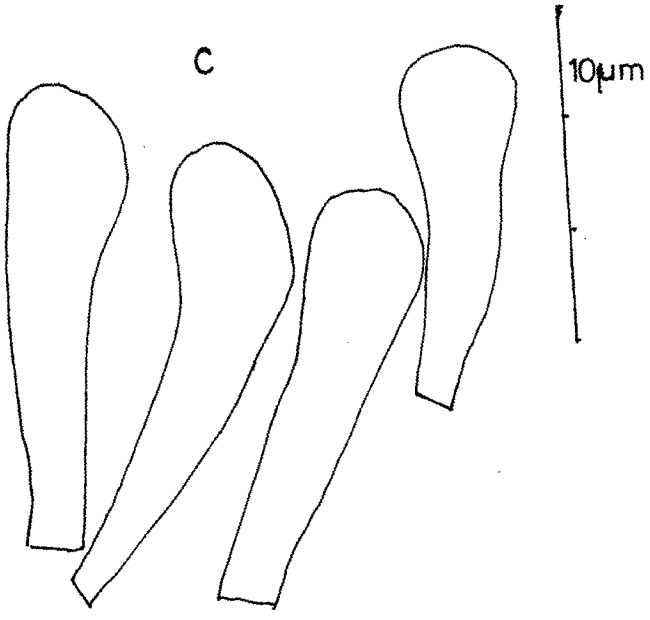
Collected from Balaramapuram during May, 1999.

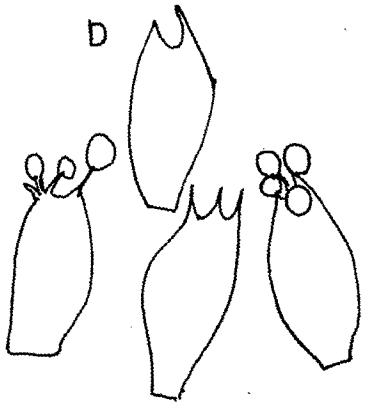
Edibility - Unknown

This species is characterised by its dense brown squamules on pileus and lower stipe; large sized clavate cystidia.

Fig. 19 *A. mediofuscus*







A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x.

Agaricus meleagris (J. Schaeff.) (Plate 19, 20 and Fig. 20)

Imbach, Mitt naturf. Ges. Luzern, 1946, 15 : 68

Synonym

Psalliota meleagris. J. Schaeff. Zeitschr. F. Azk. 1955: 28

P. xanthodermus subsp. *meleagris*, J. Schaeff.

A. meleagris (J. Schaeff.) Pil. Acta. Mus. Nat. Prag. 1951: 106

A. placomyces var. *meleagris* (J. Schaeff.) Mos Die Rohrlinge 1967: 163

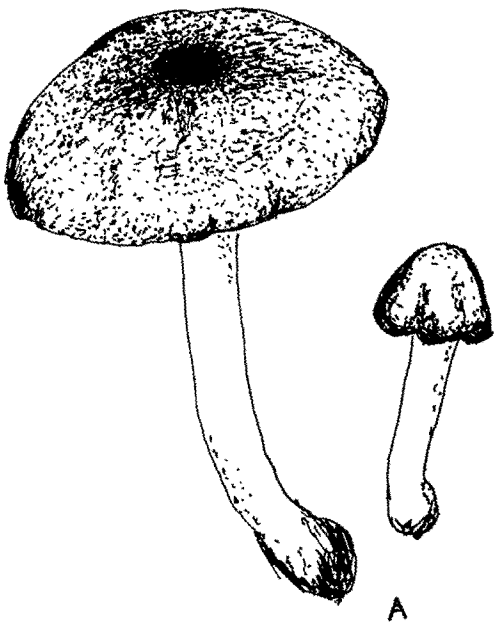
Pileus 8-10 cm diameter, campanulate when young, convex to aplanate at maturity, surface with adpressed fibrillose dark brown (10 YR 4/3) scales on whitish grey (10YR 7/1) pileus, arranged in more or less regular concentric circles, the centre dark brown. Stipe 6.5-8 x 1-1.5 cm, central, erect, cylindrical, solid, white with a slightly enlarged bulbous base; glabrous, becomes yellow when bruised and later brownish. Annulus superior, broad, simple, thin, whitish. Context white, on exposure especially on stem base became light yellow later brown. Gills free, crowded, 20 nos/cm, white when young, later at maturity pinkish grey and finally dark brown. Gill trama regular. Basidia four spored, clavate, 18-20 x 5.6 µm Pleurocystidia absent. Cheilocystidia 15-16.5 x 8-10 µm, piriform. Spores ovate to ellipsoid, dark brown, 4.75 x 3 µm. Odor unpleasant like mouldy straw. Grows gregariously in sandy loam soil around the coconut basin.

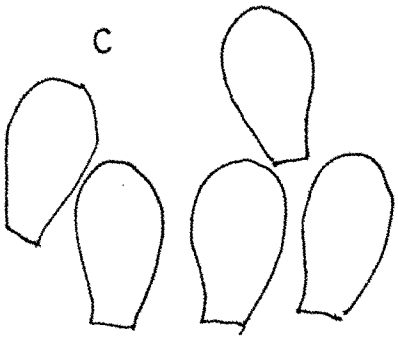
Schaeffer's cross reaction -negative.

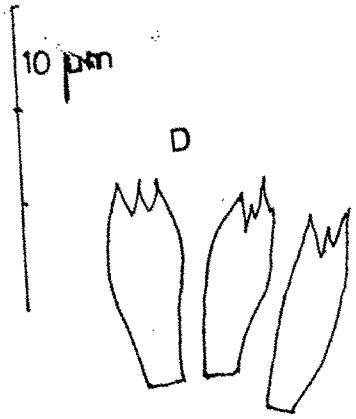
Season and distribution: South West and North East Monsoons. Collected from Kayamkulam, RARS premises in 1998, 1999 and 2000.

A. meleagris is closely related to *A. phaeolepidotus* but differ from them microscopically by shape and size of cheilocystidia, spore size and morphologically by the very small sized scales.

Fig. 20 *A. meleagris*







A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Plate 19 ***A. meleagris*** **in natural habitat**

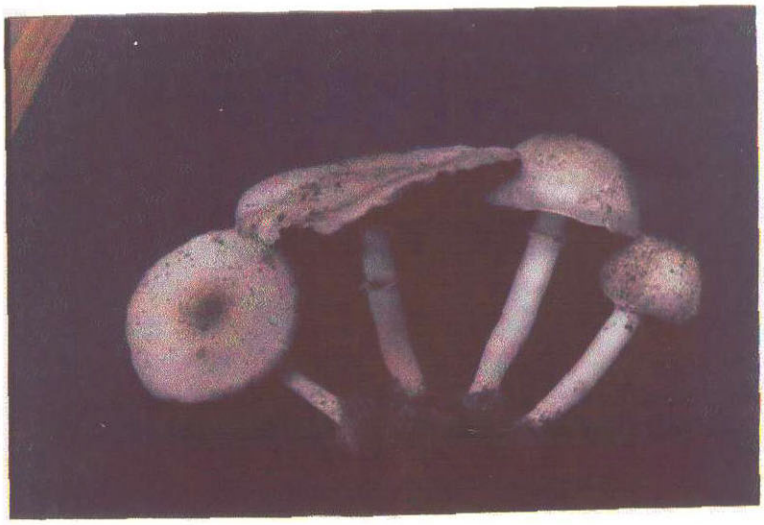


Plate 20 ***A.meleagris***

Agaricus microflavus sp. nov (Plate 21, Fig. 21)

Pileus 3-6 cm in diameter, convex when young, aplanate at maturity with a small umbo; greyish white (10 YR 7/2) with small orange brown (10 YR 6/8) squamules arranged densily in the centre. Stipe 3-4 x 0.5-1 cm, central, cylindrical, slender, fistulose, greyish white; on touching become yellow. Annulus white, superior, small, thin, evanescent. Gills crowded, 16 nos/cm, free, greyish when young turns to chocolate brown at maturity. Context white changes to yelow especially in the base of stem when bruised. Gill trama regular to subregular. Basidia 12-13.5 x 6.5-7.5 µm, clavate, four spored. Pleurocystidia absent. Cheilocystidia broadly clavate, piriform or clavate, 22.5-27 x 9 -16 µm. Spores ovoid, brown, 4.5 -6 x 3.75 - 4 µm. Grows scattered on humus rich soil under shades of trees like Acasia and also in open pastures.

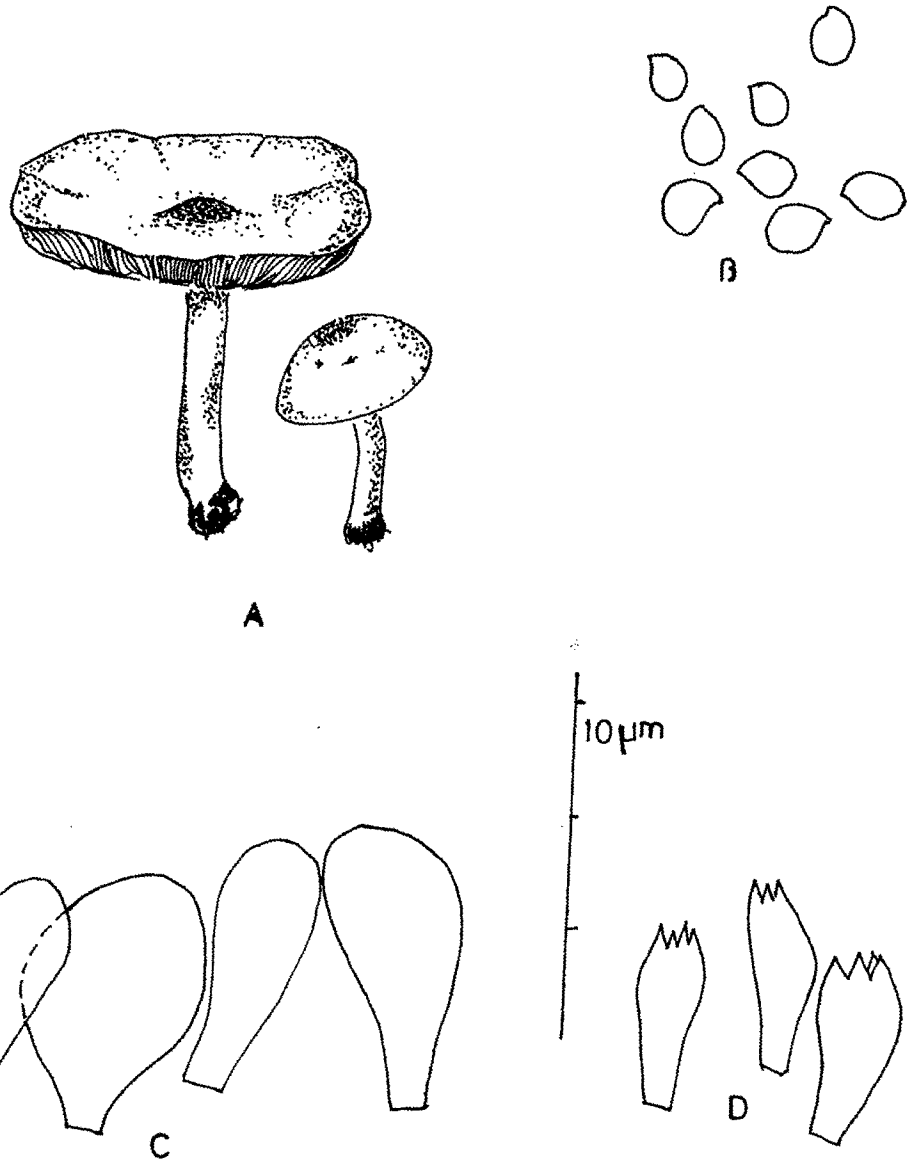
Schaeffer's cross reaction-positive.

Season and distribution – Collected from College of Agriculture, Vellayani of Thiruvananthapuram district during June 2000.

Edibility - unknown

A. microflavus is similar to *A. xantholepis* by the colour of pileus and colour change on bruising, but differ from it by the short, cylindrical stipe and colour of gills.

Fig. 21 *A. microflavus*



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Plate 21 ***A. microflavus***

Plate 22 ***A. micromegethus***

Agaricus micromegethus Pk. (Plate 22, Fig. 22)

N.Y State Mus. Bull., 1905, 94: 35

Pileus 2.5-5cm in diameter, convex with a flattened disc, cream (10 YR 8/2) with yellowish brown (10 YR 5/4) to brown centre and surrounded by small fibrillose to squamulose scales, staining lemon yellow, when touched or bruised. Stipe 2.5-5 x 0.5 -1cm, smooth, white staining yellowish, equal, central, cylindrical. Gills free, crowded, 18 nos/cm, off white to greyish pink when young and become dark brown. Context white, discolouring yellow. Gill trama regular. Basidia clavate, four spored, 18-20 x 7.5-8 µm. Pleurocystidia absent. Cheilocystidia broadly clavate to piriform, 12-24 x 8-18 µm. Spores ovoid, 6-6.5 x 4.5 µm. Grows scattered in open pastures and roadside.

Schaeffer's cross reaction - positive.

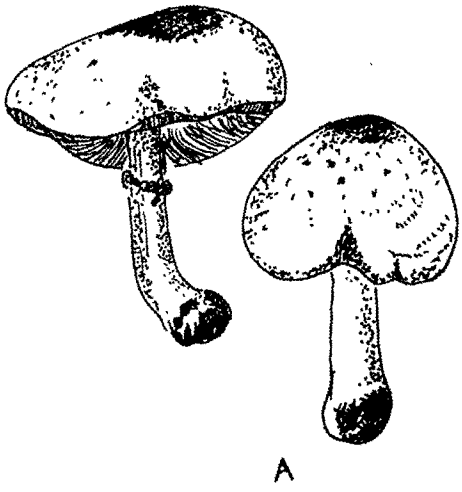
Season and distribution

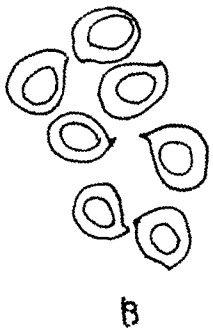
Collected from Thodupuzha during June 2000

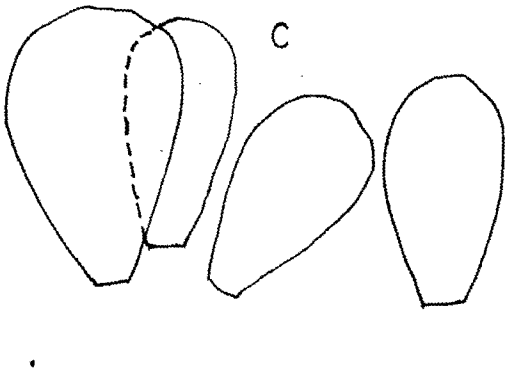
Edibility-Edible

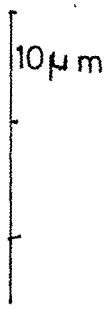
This species is similar to *A. rusiophyllus*, where as *A. rusiophyllus* is small, lack cheilocystidia and had an obclavate stipe.

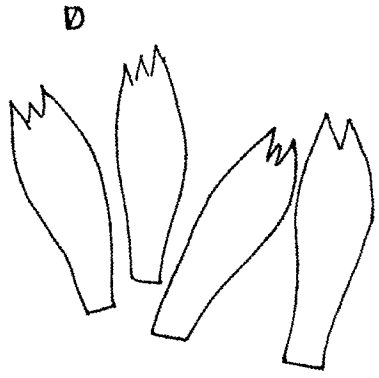
Fig. 22 *A. micromegethus*











A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus microrubescens sp. nov. (Plate 23, Fig. 23)

Pileus 2-4 cm in diameter, convex when young, aplanate at maturity; light greyish pink (5 YR 7/2) with rusty brown (5YR 4/4) squamules more in the centre arranged in more or less concentric manner. Margin appendiculate with reminants of veil. Stipe 2.5 -3 x 0.75-1 cm, central, cylindric, fistulose, light pink. Annulus white, membraneous. Gills free, crowded, 16 nos/cm, pink turn to chocolate brown. Context white, reddening strongly on exposure. Gill trama regular to subregular. Basidia clavate, four spored, 20-22 x 7.5-9 µm. Pleurocystidia absent. Cheilocystidia broadly clavate, piriform, 20-26 x 18-24 µm. Spores ovoid, 6-7 x 4.5 µm. Seen scattered on ground on coconut garden near house.

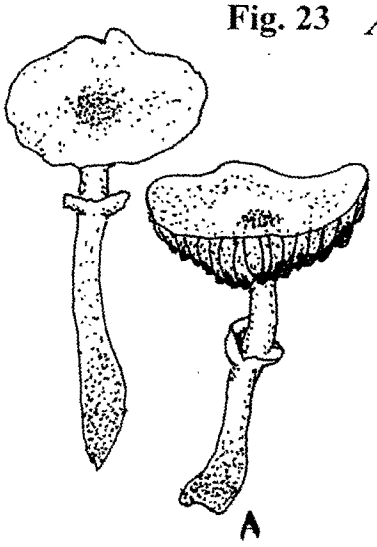
Schaeffer's cross reaction -negative

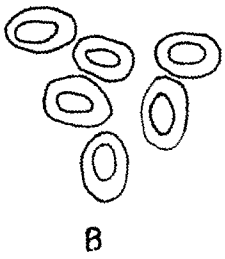
Season and distribution: Collected from Balaramapuram of Thiruvananthapuram district during May, June, October 1999 and 2000.

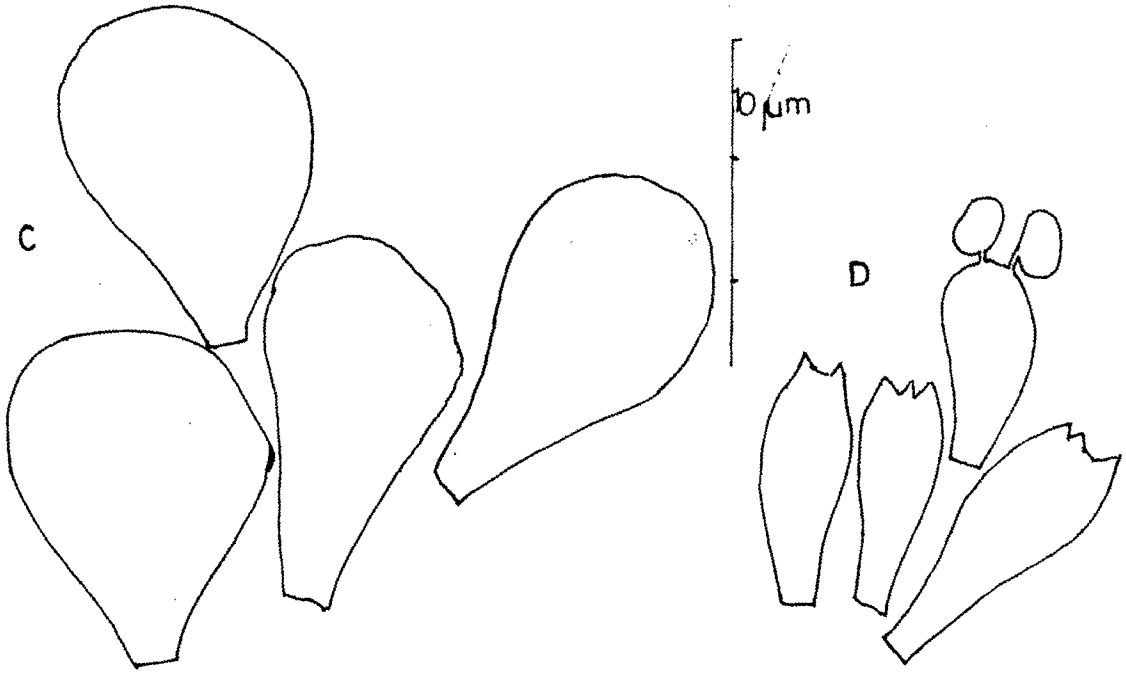
Edibility: unknown

A. benzodorus Heinem and Gooss reported from East Africa is close to this species but with smaller spores and cystidia.

Fig. 23 ***A. microrubescens***







A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

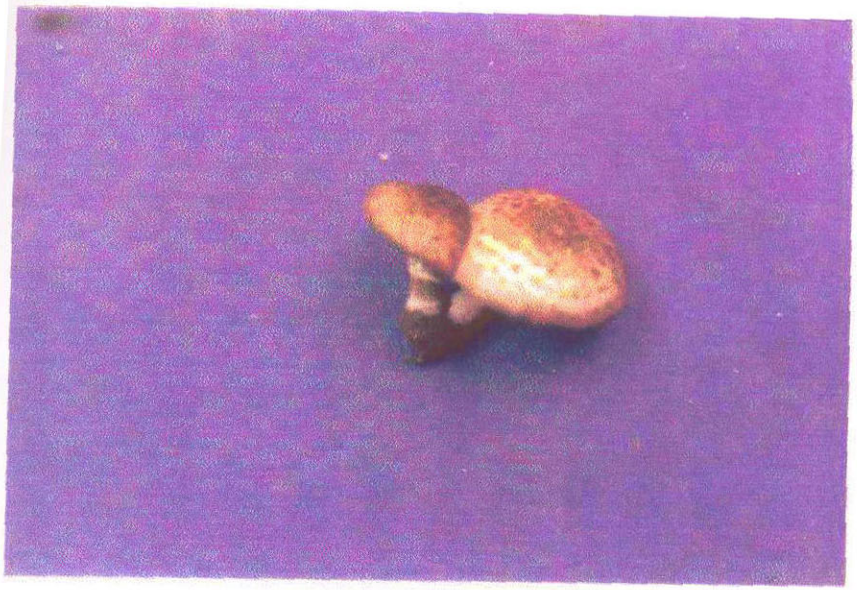


Plate 23 ***A. microrubescens***

Plate 24 ***A. moelleri***

Agaricus moelleri S. Wasser (Plate 24, Fig. 24)

New arrangements of lower plants 13, 1976 : 77

Synonym

A. xanthodermus Gen var, *obscuratus* R. Mve. BSMF. 1910: 192

Psalliota silvatica S. Bres. var. *nigricans* Beck. Pilz-v Kreuterfr, 1921 : 42

P. meleagris J. Schaeff. var. *obscurata* (R. Mre) Moell. BSMF, 1951 : 173

A. melagris J. Schaeff. var. *obscurata* (R. Mre) Heinem. BSMF: 1965: 397

A. meleagris J. Schaeff. var. *tenicolor* Moell. Friesia, 5. 1951: 208

Pileus 5-10 cm in diameter, thick, fleshy, convex at young and at maturity become aplanate, centre black, fibrillose scaly, towards the edges pale and dry. Margin involute often with remnants of veil. Stipe 5-9 x 1-2 cm, white, central, equal with small basal bulb, on handling colour of stipe changes to yellow. Context dirty white to white at the base of stipe becomes orange yellow. Annulus broad, superior, white. Gills free, narrow, crowded, 18 nos/cm, whitish and later become dark brown. Gill trama regular become irregular. Basidia tetra sporic, clavate, 18-20 x 5.5-6 µm. Pleurocystidia absent. Cheilocystidia abundant, oval to piriform 18-25 x 8-13 µm. Spores brownish, ovate, 5-6 x 3 µm. Grows gregariously around the banana stump.

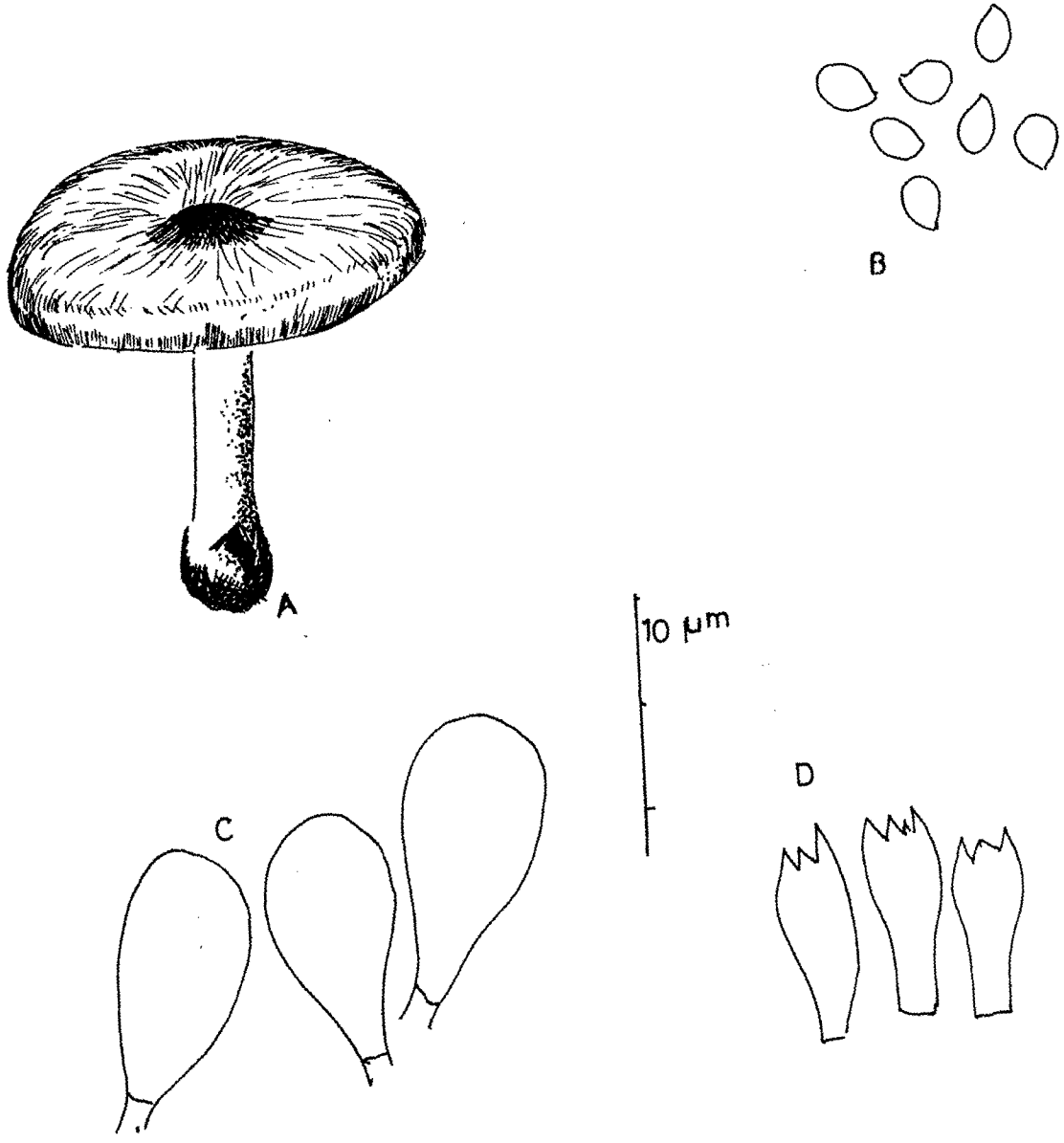
Schaeffer's cross reaction - negative

Season and distribution:
Collected from Vellayani of Thiruvananthapuram district during June, 2000

Edibility : Toxic

The species is closely related to *A. meleagris* and *A. placomyces* and differ from them by colour and structure of pileus and size of cheilocystidia.

Fig. 24 *A. moelleri*



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus nivescens (Moell.) (Fig. 25)

Friesia, IV 1952 5: 204

Synonym

Psalliota nivescens Moell. 4, 1950 : 155

A. arvensis Scheff. Brit. Fung. 1881-1891 : 523

Pileus 5-7 cm in diameter, semi globose with a flattened centre, then convex to companulate, silky snowy white (10 YR 8/1), on handling and ageing carpophore become lemon yellow, glabrous. Margin thin, undulating often craked with remnants of veil. Stipe 4-6 x 1.5 -2 cm, cylindrical, towards base stipe become slightly narrow filled with pith and when decaying start it become hollow. Colour of the stipe yellow when touched. Annulus white, sheathed above, thick, placed little above middle, pendulous. Context white, with lemon coloured spots during touching or bruising especially in the stem. Gills free, crowded, 19 nos/cm, narrow, light in colour at younger stage and later flesh coloured and on maturity become blackish brown. Gill trama regular. Basidia four spored, clavate, 20-22 x 6-8 µm. Cheilocystidia clavate-balloon shaped to shortly clavate, 14-16 x 8-11 µm. Spores blackish brown, ovate, 5-6.5 x 4.5 µm. This is seen scattered in soils of coconut basins and on coconut debris on ground.

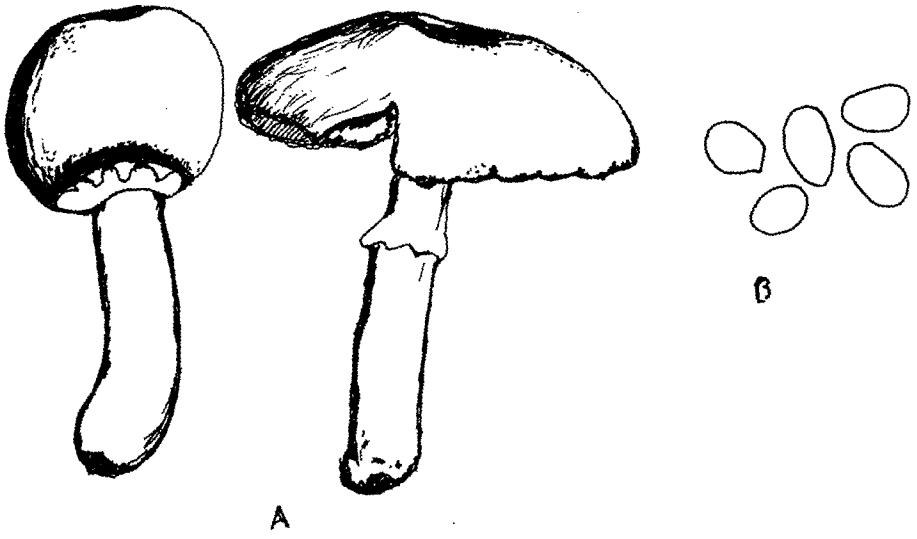
Schaeffer's cross reaction-positive

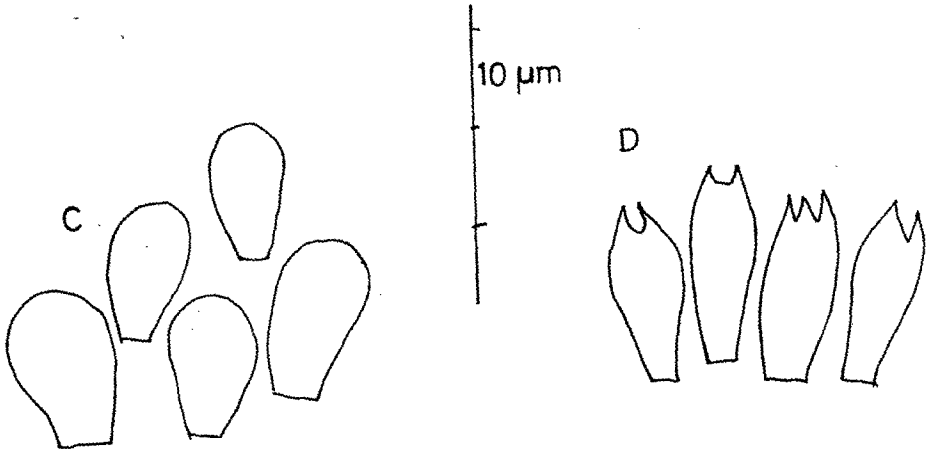
Season and distribution: Collected from Vellayani of Thiruvananthapuram district during May 1999.

Edibility: Unknown

This species is allied to *A. arvensis* but *A. arvensis* has a longer stipe with a slightly enlarged bulbous base. Size of Cheilocystidia and spores of *A. arvensis* is also larger than *A. nivescens*..

Fig. 25 *A. nivescens*





A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus ochraceous sp. nov. (Plate 25, Fig. 26)

Pileus 5-6 cm diameter, globose to convex when young and become aplanate when mature, pale white (10 YR 8/2) with yellowish brown centre without scale, and with scattered small yellowish brown squmules on pileus. Margin appendiculate with velar reminants. Stipe 6-7 x 1.5 cm, obclavate or cylindrical and gradually enlarged downwards, white, fistulose, strains reddish brown when bruised or on ageing. Annulus superior, white. Gills crowded, 18 nos/cm, free, pink when unfolds and later turn dark purplish brown. Gill trama regular. Basidia 19-21 x 7-10 µm, clavate, bearing four spores Pleurocystidia absent. Cheilocystidia of variable shape (globose, broadly clavate, even in chains) 15-24 x 7.5-24 µm. Spores ovoid, irregular or broadly ellipsoid 6.5-7.5 x 4.5-5 µm. Seen scattered among grass on roadside.

Schaeffer's cross reaction negative

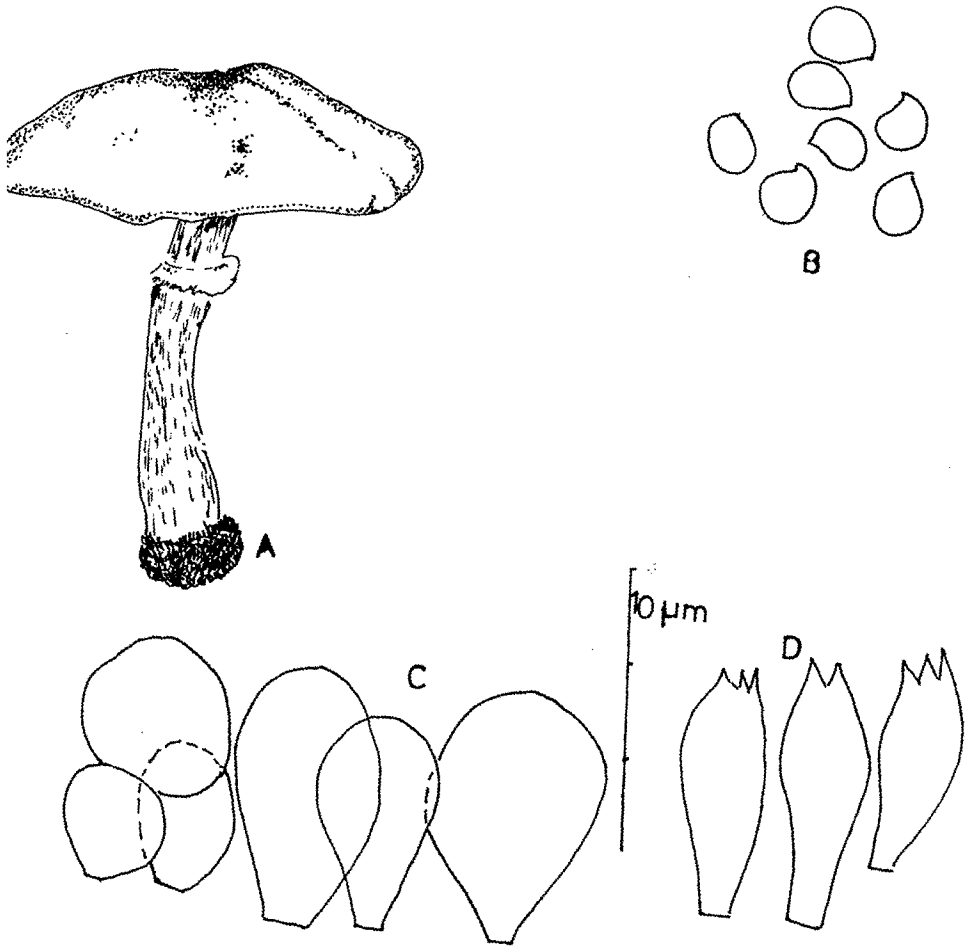
Season and distribution

Collected from Balaramapuram of Thiruvananthapuram district during May, 1999 and from Varkala during June 2000.

Edibility -unknown

This species is similar to *A. nivescens* reported by Pegler in Preliminary Agaric flora of East Africa, but differ by its yellowing and positive Schaeffer's cross reaction.

Fig. 26 ***A. ochraceous***



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

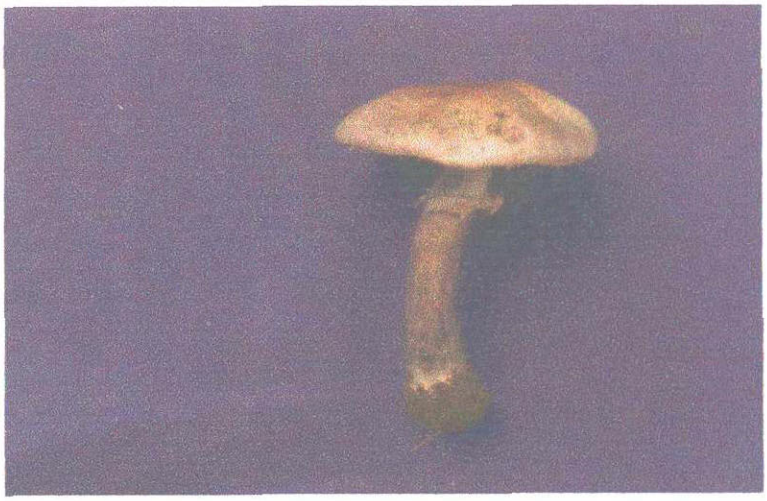


Plate 25 ***A. ochraceous***

Plate 26 ***A. ochroflavus***

Agaricus ochroflavus sp. nov. (Plate 26, Fig. 27)

Pileus 5-7.5 cm in diameter, globose when young and become convex to aplanate at maturity, yellowish brown (10 YR 5/8) centre and small yellowish brown squamules arranged more or less concentrically on pale (10 YR 8/3) back ground. Stipe 6-9 x 1-1.5 cm, central, slender, hollow, cylindrical, slightly enlarged at the base with white mycelial strands; upper part of the stipe light pink as in the case of gills and lower stipe whitish to pale yellowish brown. Annulus white, superior. Gills free, crowded, 19 nos /cm, light pink when young and turn to dark brown at maturity. Context thick, white, on exposure becoming pink. Gill trama regular. Basidia four spored, clavate, 19.5 x 7.5 µm. Pleurocystidia absent. Cheilocystidia abundant, piriform, 22.5-24 x 13.5 -16.5 µm. Spores dark brown, ovoid to ellipsoid, 6 x 4.5 µm. Grows solitarity, scattered on ground under shades of jack tree, bread fruit tree, among grass on roadside of buildings.

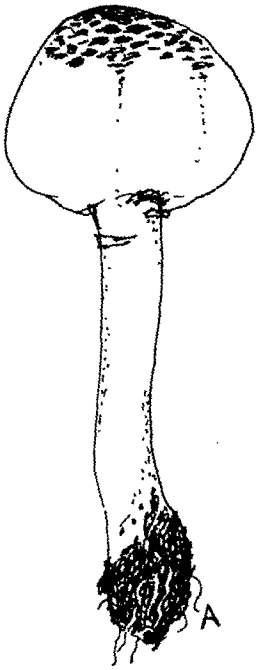
Schaeffer's cross reaction-negative

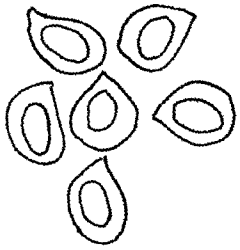
Season and distribution : Collected from Balaramapuram during May 1999, and Ocotober 1999 and from Kottarakkara during June 2000.

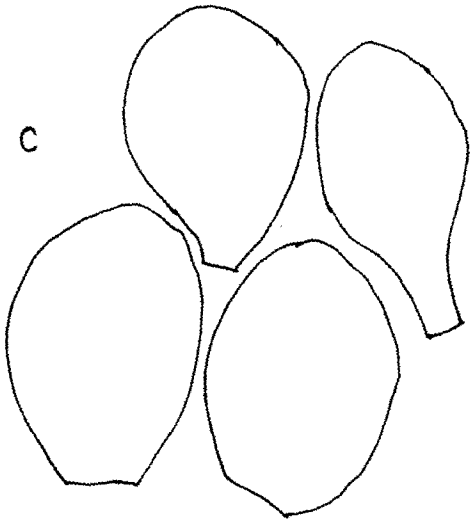
Edibility- Unknown

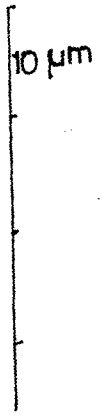
- This species is closely allied to *A. augustus* but it has a solid stipe and more densely arranged squamules on pileus.

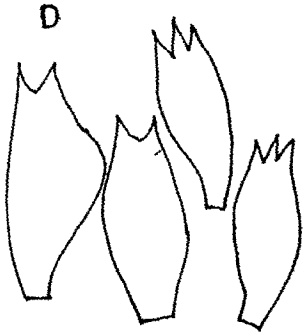
Fig. 27 *A. ochroflavus*











A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus phaeolepidotus (Moell.) (Plate 27, Fig. 28)

Moell. Friesia, 4, 1952 : 204

Synonym

Psalliota phaeolepidota Moell. Friesia 4, 1952 : 170

Pileus 5-8 cm diameter, campanulate when young, convex to aplanate with a flattened centre at maturity. The centre is dark brown (10 YR 3/3) without scales surrounded by diffusely squamulose scales on whitish background (10YR 8/2) towards periphery less scaly. Stipe 4-6 x 1-1.5 cm, cylindrical, central, erect with a bulbous base, white with pink tinge, silky, glabrous. Annulus simple, white, thin, broad. Context white, on exposure stipe base stains yellow, rest of the stipe turn slightly pink. Gills free, crowded, 18 nos/cm, pink later turn brown. Gill trama regular to subregular. Basidia four spored, 18-20 x 6μm, clavate. Pleurocystidia absent. Cheilocystidia broadly clavate, 18-22 x 12-15 μm. Spores ovate, brown 5.25-6x3.75 μm. This grows gregariously on groups in areas with dense vegetation of broadleaved trees.

Schaeffer's cross reaction negative

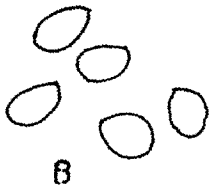
Season and distribution

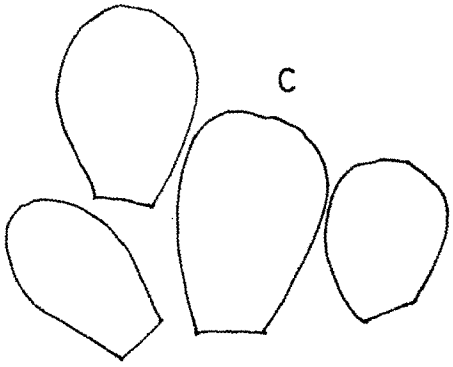
Collected from Peringala of Kayamkulam during May 2000.

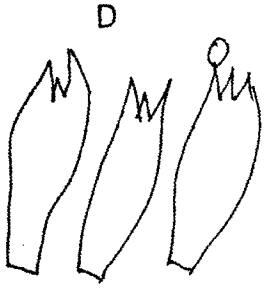
Edibility : unknown

A. phaeolepidotus is morphologically similar to *A. silvaticus* and differing from them in the discolouration of stipe and also very closely related to *A. meleagris* and *A. moelleri* but differ from them by shape and size of cheilocystidia.

Fig. 28 *A. phaeolepidotus*







A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

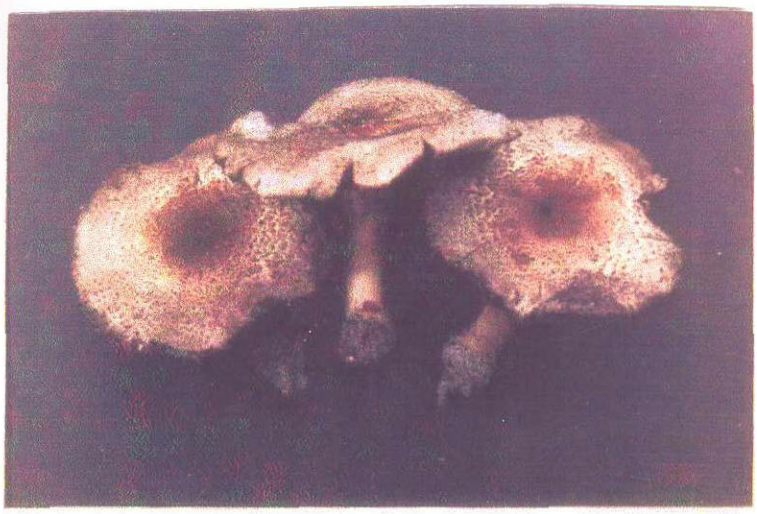


Plate 27 ***A. phaeolepidotus***

Plate 28 ***A. pseudopratensis***

Agaricus pseudopratensis (Bohus) S. Wasser (Plate 28, Fig. 29)

Ukr. Bot. J. 1976: 250

Synonym

Psalliota pseudopratensis Bohus, Borbasia, 1939:114

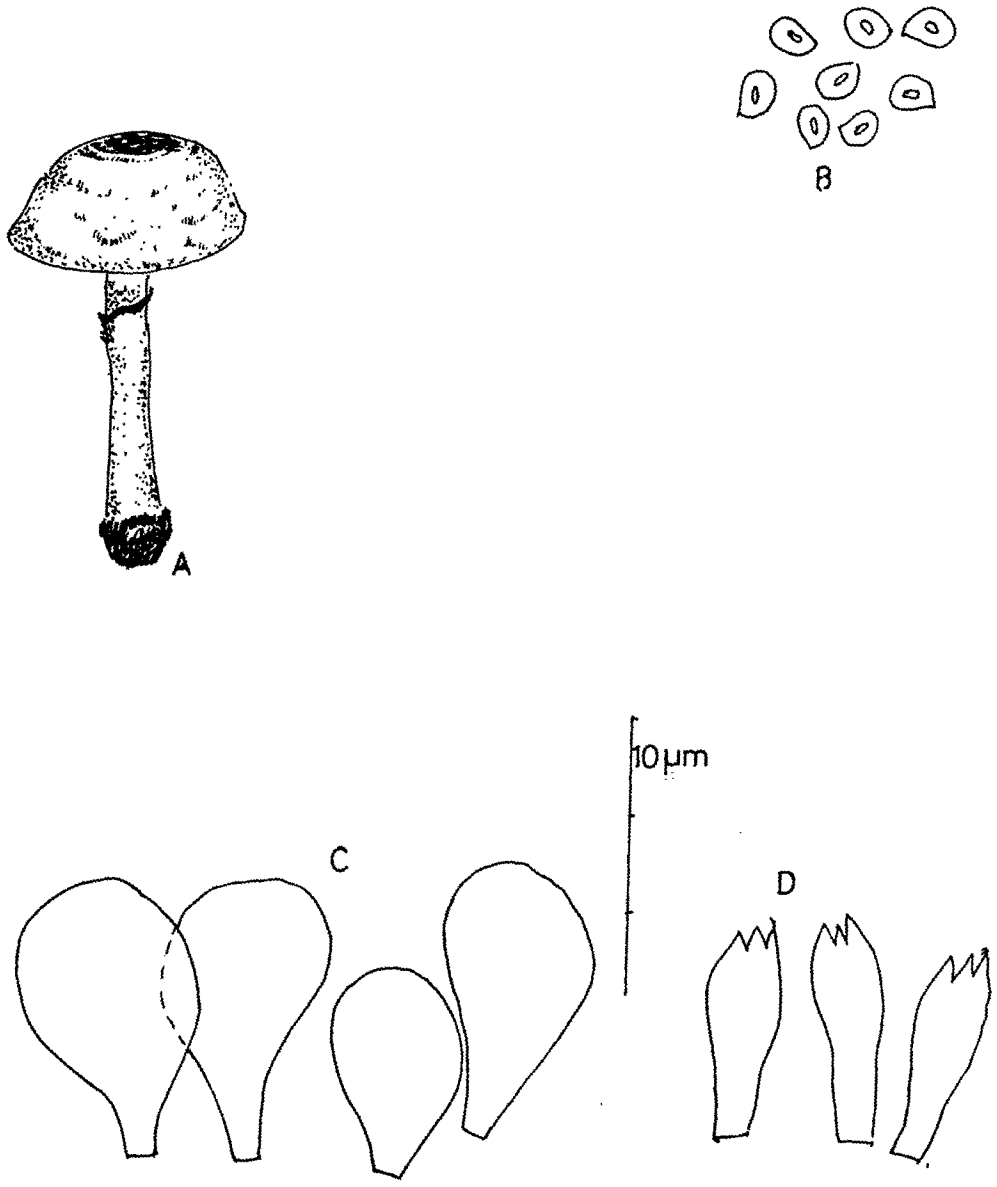
Pileus 3-7 cm in diameter, companulate to convex and become aplanate on ageing; greyish white (10 YR 6/1) with greyish brown (10 YR 5/2) centre, glabrous or with few adpressed scales. Margin of the pileus in young carpophores involute, later straight. Stipe 3-7 x 0.5-1 cm, cylindrical enlarging into a small bulbous base, glabrous, greyish white. Annulus apical, simple, whitish. Gills free, thin, crowded (18 nos/cm) at first pink later turns dark brown. Context greyish white, one exposure at the base of stipe become yellow, then changes to brownish red. Gill trama regular. Basidia four spored, clavate, 20-24 x 9μm. Cheilocystidia abundant, broadly clavate, piriform, 15-22 x 12-13.5 μm. Spore globose-ovate brownish 5.25-6 x 3.75-4.5 μm. Grows solitarily in roadsides.

Schaeffer's cross reaction negative.

Season and distribution : Collected from Kozhikode during June 2000 and from Vellayani of Thiruvananthapuram district during October 1998.

Edibility-toxic

Fig. 29 ***A. pseudopratensis***



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus purpurellus (F.H. Moller) (Plate 29, Fig. 30)

Friesia 4, 1952: 204

Synonym

Psalliota purpurellus (F.H. Moller). Friesia 4, 1952: 193

Pileus 4-5cm in diameter, thin, conico-convex with a brown (7.5 YR 4/4) disk which lightens to pink (5YR 8/2) to white (5 YR 8/1) towards margin, fibrillose with radiating innate fibrills not squamulose. Stipe 4.5-5 x 0.5-0.75 cm, white, slender, cylindric with a small bulbous base, hollow to fistulose. Annulus superior, pendulous white. Context white Gills free, crowded, 18 nos/cm, grey at first which turn brown. Gill trama regular. Basidia clavate, four spored 18-21 x 6-7.5 cm. Pleurocystidia absent. Cheilocystidia abundant. 15-18 x 9.10.5 µm, piriform to broadly clavate, brownish. Spores ovoid to short ellipsoid, dark brown, thick walled, 4.5-5.25 x 3-3.75 µm. Grows in small groups of 2-3 on compost heap.

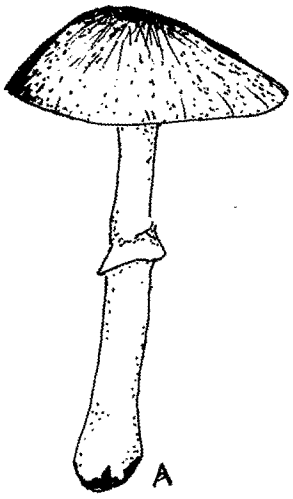
Schaeffer's cross reaction-positive.

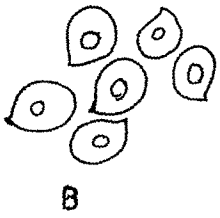
Season and distribution

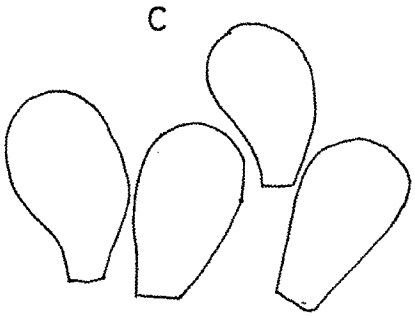
Collected from museum compound, Thiruvananthapuram during May, 2000.

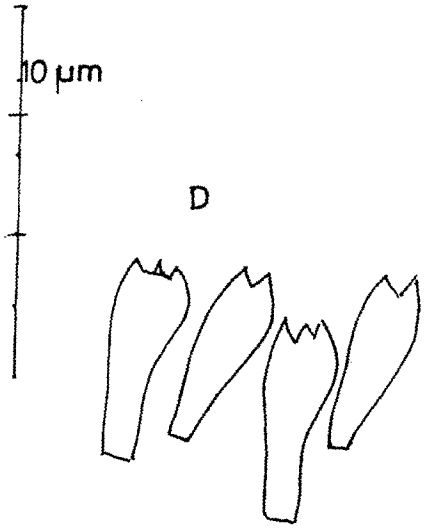
Edibility: Unknown

Fig. 30 *A. purpurellus*









A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Plate 29 *A. purpurellus*

Agaricus rubicolus sp. nov. (Plate 30, 31 and Fig. 31)

Pileus 4-12 cm in diameter, semiglobose when young and become companulate to convex or aplanate at maturity, thick, fleshy, brownish yellow, smooth when young which crack to firmly adpressed fibrillose to squamulose scales. Margin undulating with reminants of veil. Stipe 8 -10 x 1.5 –2 cm, white, solid, highly floccose on lower stipe, central, obclavate when young and become cylindrical and equal at maturity. Annulus white cog wheel type, larger, pendulous. Gills free, crowded, 20 nos/cm, pale white when young changing to pink and brownish black on ageing. Context white, changing to dark pinkish red on bruising especially on pileus and gills. Gill trama regular to subregular. Basidia clavate, four spored, 14-16 x 7-8 µm. Cheilocystidia abundant with variable shape of broadly clavate, piriform or irregular. 22-30 x 9-12 µm. Spores ovoid, 6x3-3.75 µm. Grows gregariously in groups on humus rich soil under shades of large trees like Mahagoni, casurina etc.

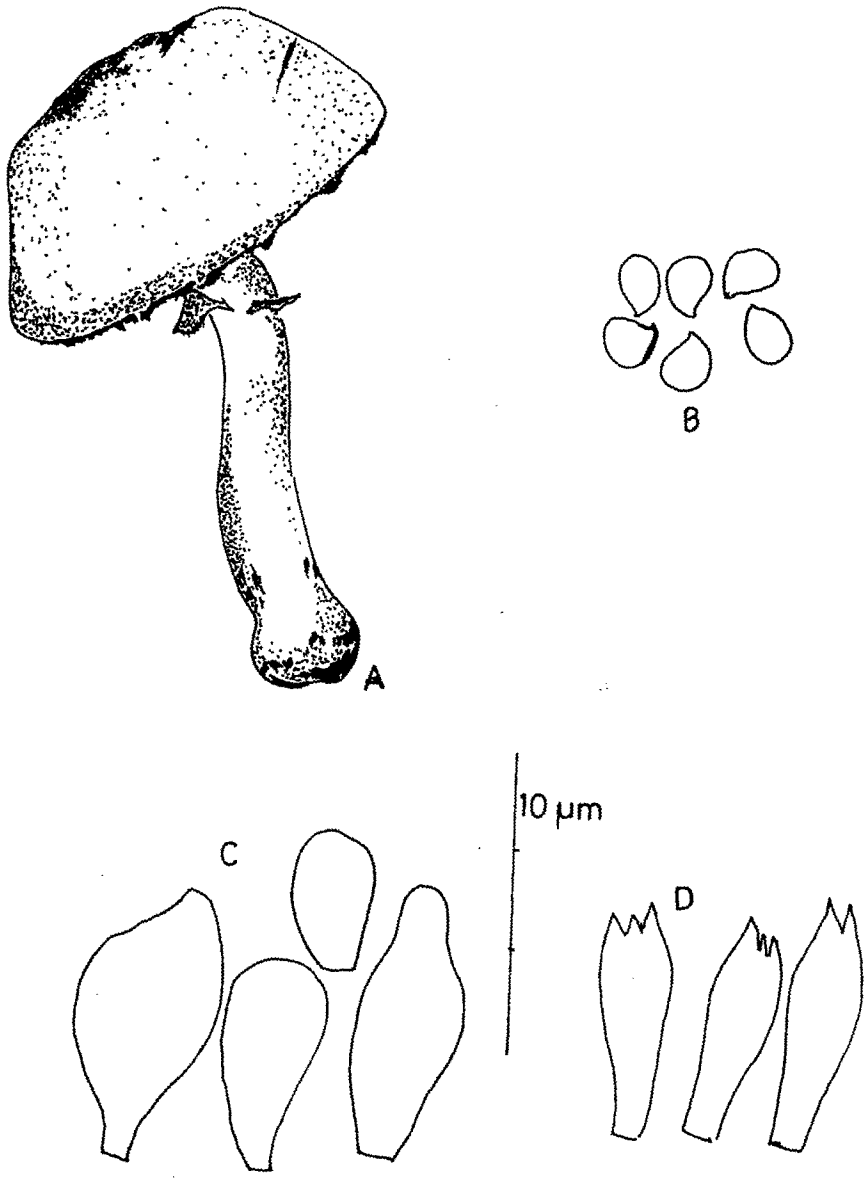
Schaeffer's cross reaction-negative

Season and distribution : Collected from Kariavattom, Kerala Universtiy Campus during October 1999 and from Quilandy of Kozhikode district during June 2000.

Edibility - Good

The species is characterised by its sudden reddening of context and the gills, stipe is also densily floccose.

Fig. 31 ***A. rubicolus***



A. Sporophore

B.Basidiospore 1000x

C. Chetlocystidia 1000x

D. Basidia 1000x

Plate 30 ***A. rubicolus***

Plate 31 ***A. rubicolus*** **in natural habitat**

Agaricus rusiophyllus Lasch (Plate 32, Fig. 32)

Linnaea, 3, 1828:37

Synonym

A. comtulus var. rusiophyllus (Lasch) Konr. & Maubl. Icon. Sel. Fung. 1924: 233

A. comtulus Fr. Epicr. Syst. Myco. 1836: 215

Psalliota comtula (Fr.) Quel., Champ. Jura et Vosges. 1872: 97

Pratella comtula (Fr.) Gill; Champ. Fr. 1874: 132

Psalliota minuta Vel. Ceske Houby. 1921: 564

P. rosea Vel. Novit. Mycol., 1939: 155

P. depressa Novis. Mycol., 1939:83

Pileus 2-4 cm, thin margin, fleshy, campanulate, later convex-aplanate, the centre with a small umbo, yellowish white (5 Y 8/3) with pinkish tinge, especially in the centre with adpressed scales. Margin involute, later straight, undulating with remnants of the veil. Stipe 3.5 x 0.25-0.5cm, central, cylindrical, enlarged towards base, solid. Annulus apical, simple, white, narrow, after sometimes disappearing. Context white with yellowish tinge, more on the stipe base; on bruising and cutting become yellow. Gills free, crowded, 16 nos/cm, narrow, pink later turn dark brown. Gill trama regular. Basidia four spored, clavate, 14-15 x 7μm. Pleurocystidia and cheilocystidia absent. Spores pale brown, ovate to ellipsoidal. 4.5-5.25 x 3 μm. Grows in groups caespitose in dense rubber plantation.

Schaeffer's cross reaction-positive

Season and distribution

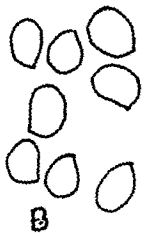
Collected from Thrissur during June, 2000

Edibility : Unknown

This species is characterised by its small size, having a solid obclavate stipe and absence of cheilocystidia.

Fig. 32 ***A. rusiophyllus***

A



B

C

A. Sporophore

B.Basidiospore 1000x

C. Basidia 1000x

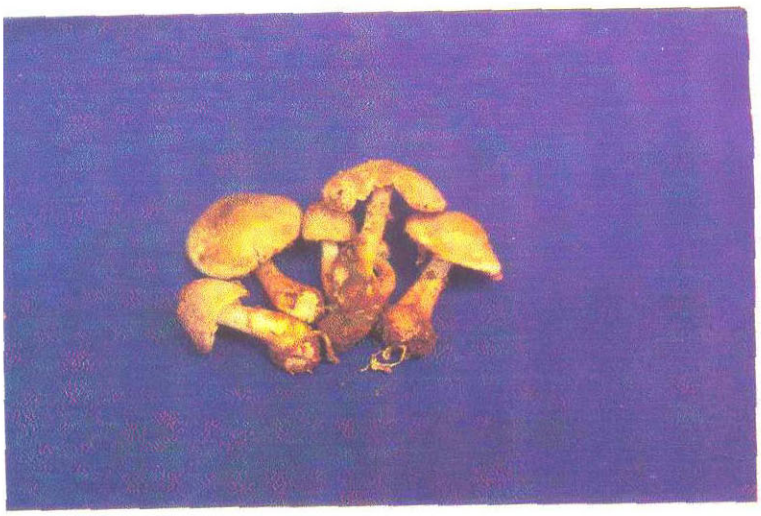


Plate 32 ***A. rusiophyllus***

Plate 33 ***A. semotus***

Agaricus semotus **Fr.** (Plate 33, Fig. 33)

Monogri. Hym. Suec. 1863: 347

Synonym

Pratella rubella Gill., Les Champ. qui croissent en Fr. 1878: 565

A. comtulus var. *rubellus* (Gill.) Konor. et Maubl. Icon. sel. Fung., 1924- 1933: 230

Pratella amethystina (Quel.) Flore myco. de la Fran. 1888 : 71

Psalliota rubella (Gill) Rea f. pallens. J. Lge, Dansk Bot Ark., VI 1926: 10

P. duriuscula vel. Novit. Mycol., 1947:83

Pileus 1-4 cm in diameter, thin, hemispherical, later convex, aplanate at maturity whitish (5 YR 8/2), in the centre reddish pink, the rest of the surface is covered with radially arranged fine purple-vinaceous fibres or small squamules on a whitish background often split radially. Margin involute, undulating. Stipe 4-6 x 0.5-0.75 cm, central, cylindrical, with small bulbous base, twisted at the base, fistulose, white, on handling becoming yellowish, glabrous. Annulus superior, simple, narrow, white, later-yellowish. Context white, on exposure the pileus becoming pink, at the base of stipe yellowish. Gill trama regular. Basidia clavate, four spored, 15-18 x 6-7 µm. Pleurocystidia absent. Cheilocystidia abundant, ovate or piriform. 12-15 x 9-10 µm. Spores ovate to ellipsoid, 4.5-5 x 2.5-3.5 µm. Seen scattered on roadsides

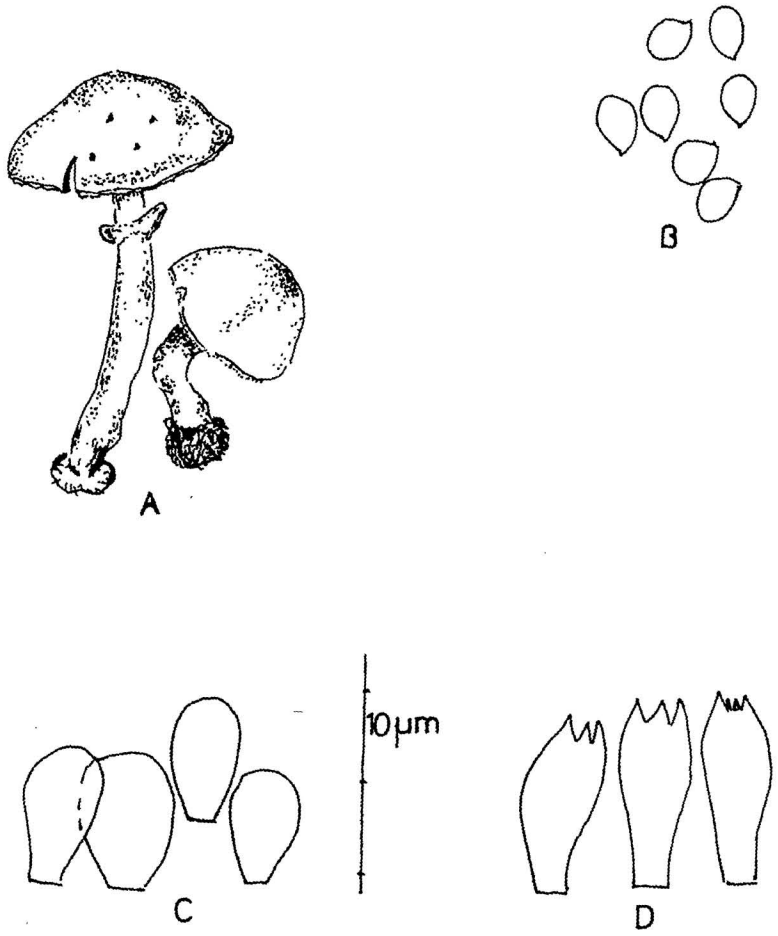
Schaeffer's cross reaction - positive

Season and distribution: Collected from Marykkunnu, Kozhikode, during June 2000

Edibility: Unknown

A. semotus is a small sized Agaricus with reddish pink squamules.

Fig. 33 *A. semotus*



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus silvaticus Schaeff. Secr. (Plate 34, Fig. 34)

Mycographie Suisse, 1983: 176

Synonym

Psalliota silvatica (Schaeff. Fries) Kumm. Der Führer in die Pilzkunde, 1871 : 79

P. sanguinaria (Karsg.) Lge. J. Dansk Bot. Arkiv. 1926:13

P. haemorrhoidaria Schulzer Kalchbrenner sensu Bresadola, Iconographia Mycologia, tab 1927-1933 : 831

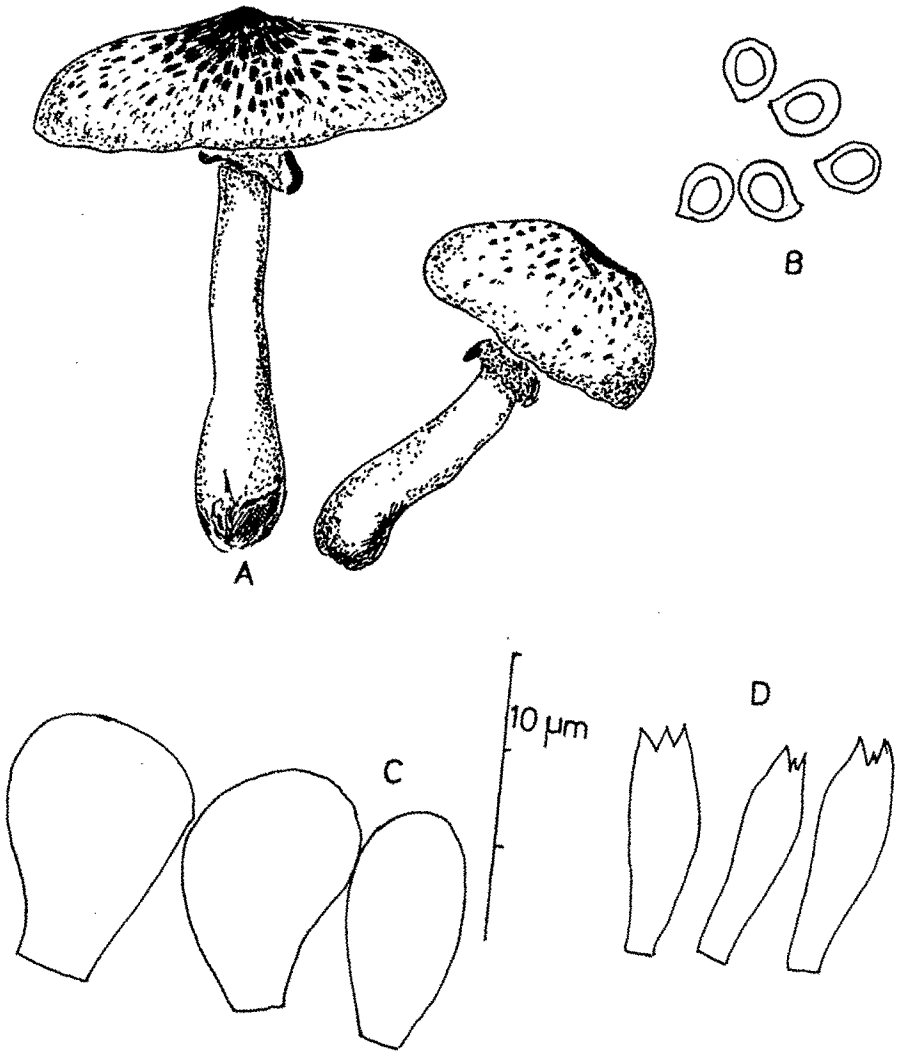
Pileus 5-7 cm in diameter, white to off white (10 YR 8/2) with dark umber brown (7.5 YR 5/6) centre. Centre darker and glabrous and is surrounded by adpressed moderate sized squamules of umber brown colour, which fades towards margin. Young carpophores campanulate, then become convex to aplanate with a small umbo. Stipe 6-7 x 1-1.5 cm, central, solid, later filled with pith, cylindrical with a slightly enlarged bulbous base, lower stipe off white and on handling changes to pinkish red, upper stipe as that of gills. Annulus simple, apical, white, pendulous. Context of pileus and stipe changes to pinkish red and later brown on exposure. Gills free, crowded, 20 nos/cm, narrow, light rosy pink when young, and turns to reddish brown at maturity. Gill trama regular to irregular. Basidia clavate, four spored, 20-21 x 7 µm. Pleurocystidia absent. Cheilocystidia clavate to globose, 18-24 x 10.5-15 µm. Spores pale brown, ovoid, 4.5-6 x 3.75-4 µm. Solitary and in groups in humus rich soils under cashew trees.

Schaeffer's cross reaction-negative

Season and distribution : Collected from Kozhikode during June, 2000

Edibility - Unknown

Fig. 34 ***A. silvaticus***



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Plate 29 *A. silvaticus*

Agaricus simulans Berk. in Hooker (Plate 35a, 35b and Fig. 35)

Lond. Journ. Bot. 1847 6 : 487

Pileus 4-7 cm diameter, hemispherical to strongly convex when young and also at maturity. Surface pure white (5 YR 8/1), thin, becoming dark reddish brown on bruising, covered by soft woolly squamules, margin appendiculate with velar remnants. Stipe 4-9 x 0.5-1 cm, cylindric, slender, solid with narrow tube, white, which turn reddish brown on bruising and handling. Annulus white, superior, ephemeral. Context white, reddens on exposure or on cutting. Gills free, crowded, 16 nos/cm, white turns pink and later turn dark brown. Trama regular. Basidia narrowly clavate, four spored 19-20 x 7.5 μm. Pleurocystidia absent. Cheilocystidia abundant, cylindric, often subapically constricted, hyaline, thin walled 21-26 x 4.5-6 μm. Spores ovoid, fuscous brown, 4.75-6.7 x 4.5 μm. This species is found to occur in groups on soil near sidewalls of buildings, emerging out through the space between the stones of foundation.

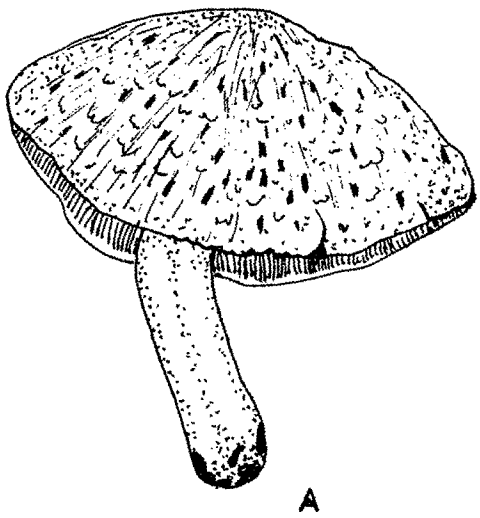
Schaeffer's cross reaction -negative

Season and distribution : Collected from Balaramapuram and Kakkamoola of Thiruvananthapuram district, during May, June and October 1999 and 2000.

Edibility : Unknown

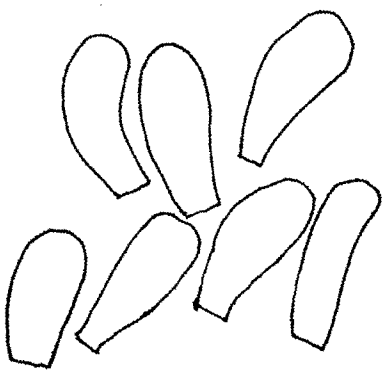
A. simulans differ from other white species of Agaricus by its thin pileus covered by woolly squamules and the colour of pileus changing to dark reddish brown in bruising.

Fig. 35 *A. simulans*

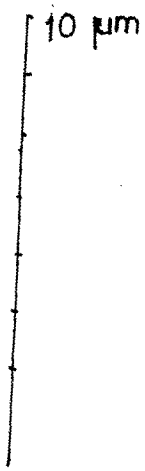


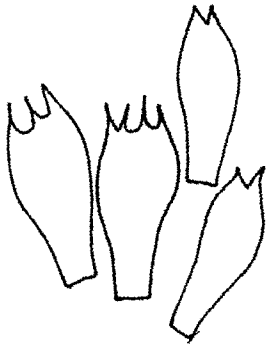
A

B



C





D

A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Plate 35a *A. simulans* in natural habitat

Plate 35b *A. simulans*

Agaricus silvicola (Vitt) Sacc. (Plate 36, Fig. 36)

Syll. Fung. V. 1887: 998.

Synonym

A. campestris L. Fr. var *silvicola* Vitt. Fung. Mang., 1835 : 43

Pratella silvicola (Vitt.) Epicr. Syst. Myc. 1836: 213

Psalliota campestris var. *silvicola*, Fr. Epicr. Syst. Myc. 1836: 213

P. flavescens (Gill) Rea. Brit. Bas. 1922: 32

P. silvicola (Vitt.) S. Ricken, Vademecus, 1920: 144

Pileus 4-6 cm in diameter, fleshy, hemispherical when young, at maturity convex to aplanate, white (10 YR 8/2) to off white, glabrous to silky fibrillose, on handling becomes yellow, margin involute, undulating with remnants of veil. Stipe 5-7 x 1-1.5 cm, central, cylindrical, erect, enlarged to form a bulbous base, soild, lower stem covered with floccose fibrils of the veil, on handling stipe becomes yellow. Annulus white, superior, pendulous, large. Context white, on cutting and exposure turn to pinkish. Gills free, crowded, 20 nos/cm, thin, pale at young and turns to greyish pink and later brown. Gills on injuring changes to reddish pink. Gill trama regular. Basidia four spored, clavate, 20-22 x 6.75-7.5 µm. Pleurocystidia absent. Cheilocystidia abundant, ovate to subglobose 18-20 x 10-18 µm. Spore purple brown, ovate to ellipsoid, 5-6 x 3.75 x 4.5 µm. Seen scattered on humus rich soils under broad leaves trees.

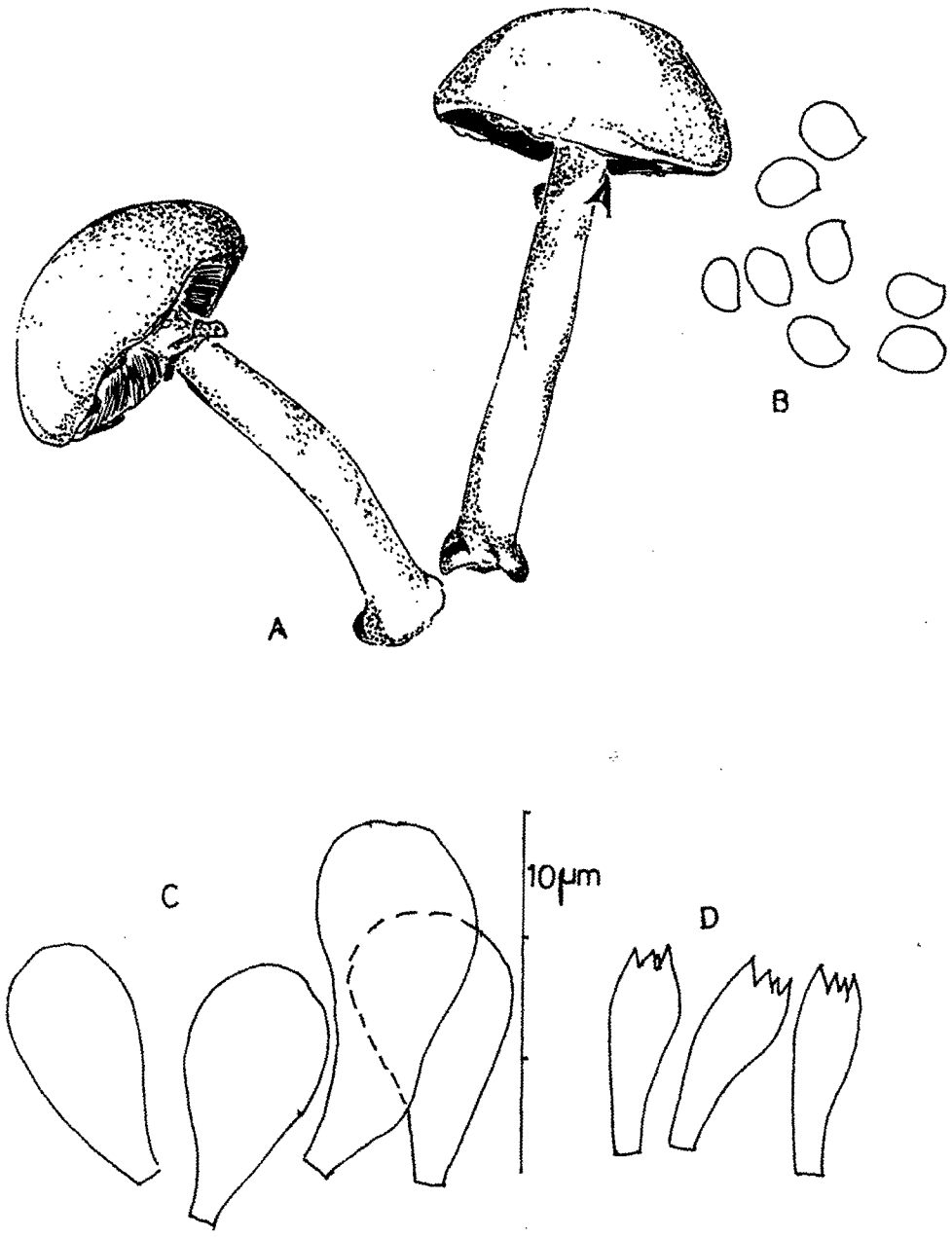
Schaeffer's cross reaction - positive

Season and distribution

Collected from Ramanattukara of Kozhikkode district during June, 2000.

A. silvicola is very much similar to *A. arvensis* and differ from it by the solid stipe, colour change on cutting and exposure (*A. silvicola* turns pink, whereas *A. arvensis* turns yellow) and also by the size and shape of cheilocystidia.

Fig. 36 ***A. silvicola***



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Plate 36 ***A. silvicola***

Plate 37 ***A. spissarufosa***

Agaricus spissarufosa sp. nov. (Plate 37, Fig. 37)

Pileus 5-8 cm in diameter, hemispherical when young and turn convex with flattened centre at maturity, whitish to light greyish-pink tinge (10 YR 8/2), with brownish (10 YR 5/3) adpressed broad squamulose scales arranged concentrically. Margin thin with involute edge. Stipe short, thick, 3-5 x 2-3 cm, white, central, solid, cylindrical, glabrous with a vigorous mycelial strand. Annulus white, thin, sheathed above, broad. Context thick, firm, white and turns greyish red when bruised especially in the stipe. Gills free, crowded, 20 nos/cm, pink, later turn brownish black. Gill trama regular. Basidia clavate, four spored, 12-14 x 9-11 µm. Pleurocystidia absent. Cheilocystidia subglobose, 18-20 x 15-17 µm. Spore ovoid, 5.5-6 x 4.5-5 µm. Grow solitarily on ground.

Schaeffer's cross reaction-negative

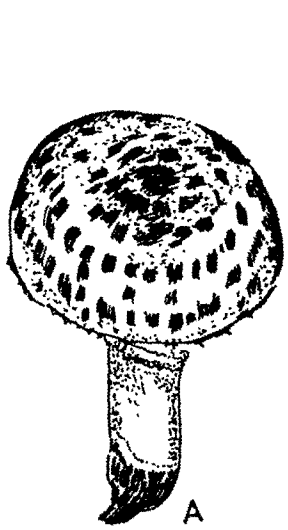
Season and distribution

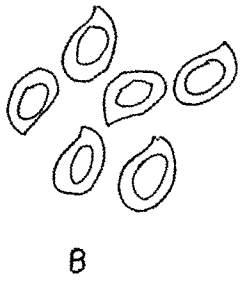
Collected from Thrissur during October, 1999

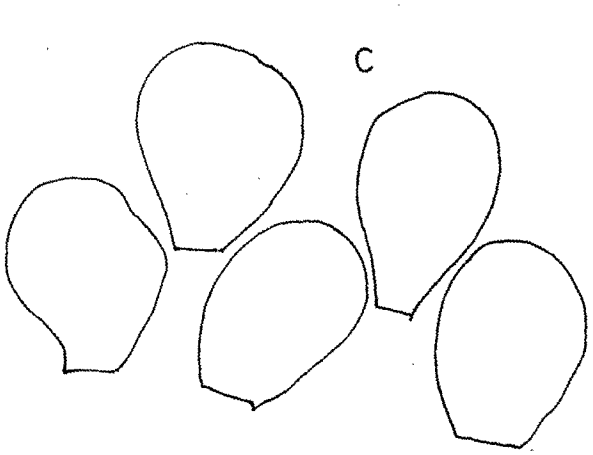
Edibility -Unknown

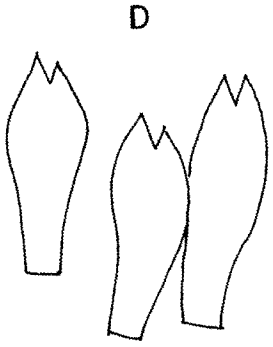
This species is medium sized with short stipe. It has many characters in common with *Psalliota spissa* Moeller, but the shape and size of cheilocystidia differ.

Fig. 37 *A. spissarufosa*









A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus squamuliferus (Moell.) (Plate 38a, 38b and Fig. 38)

Acta Mus. Nat. Prag VII 1951 : 7

Synonym

Psalliota squamulifera Moell. Friesia 4 1950 : 21

A. caroli Pil. Acta.Mus. Nat. Prag. VII B 1951: 59

A. squamuliferus (Moell.) Pil var. *caroli* Pil. O. Usak Nase houby 1959: 141

Pileus 6-13 cm diameter, thick, fleshy, globose when young, turn convex to aplanate at maturity, sometimes with a flattened centre; pure white (2.5 YN 8), on ageing turns amber-brown, finely squamulose towards periphery. Stipe comparatively thick, 6-10 x 2-3 cm, cylindrical. gradually thicker towards base, solid, lower stipe white and beautiful rosy pink above the annulus. Annulus simple, white, persistant, pendulous, biforcate with coarse white teeth which turn brown at maturity. Context white, thick, which turn pink when cut. Gills free, crowded, 20 nos/cm, when unfolding light flesh coloured which at length turn blackish brown. Gill trama regular. Basidia four spored, clavate, 18-24 x 5-7 µm. Pleurocystidia absent. Cheilocystidia abundant, globose to broadly ovate 14-24 x 18-25 µm. Spores dark brown, 6-7 x 4.25-4.75 µm, ovate in shape. Seen singly and in groups in coconut garden, road sides etc.

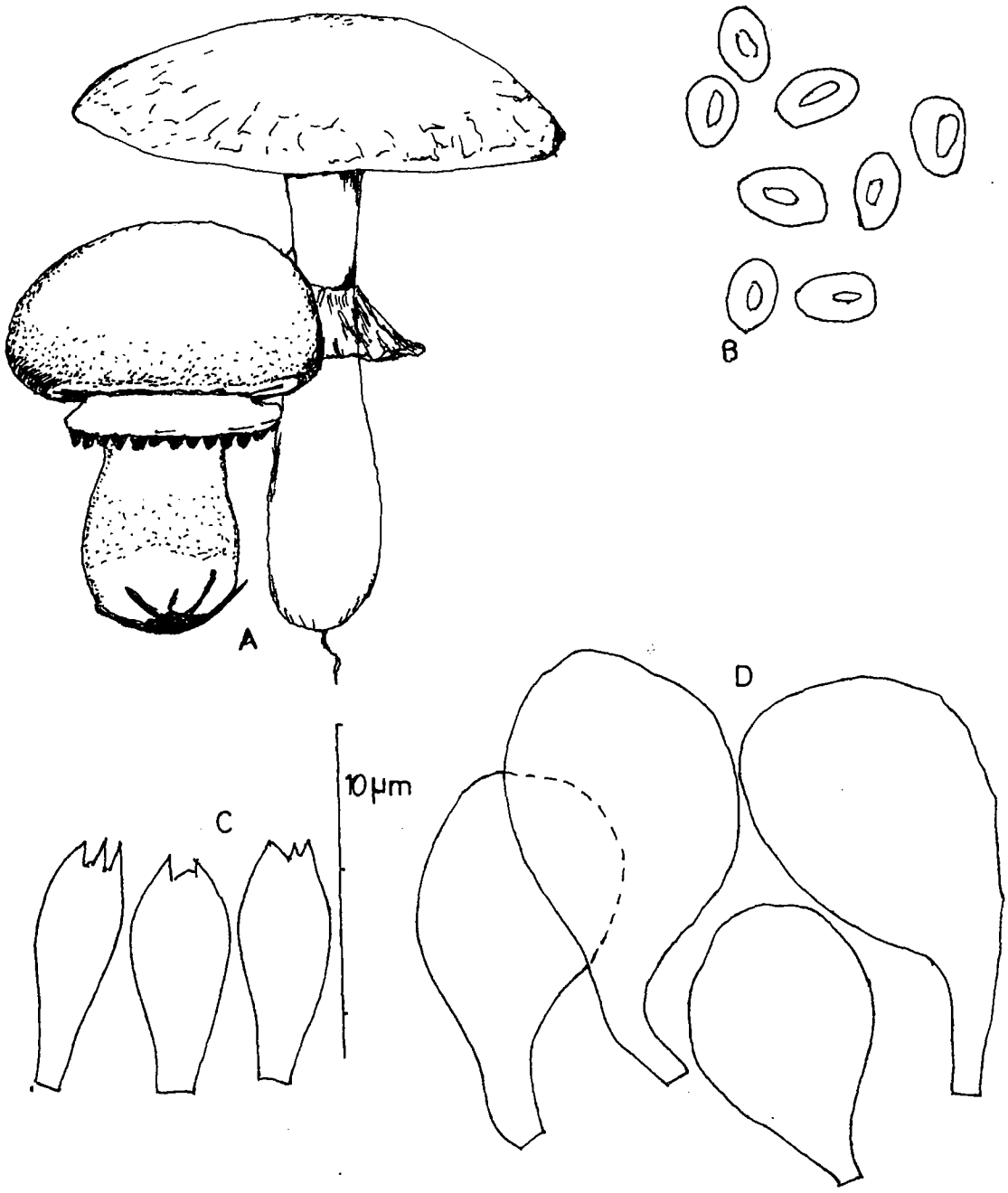
Schaeffer's cross reaction -negative

Season and distribution - Collected from Balaramapuram, Vellayani and Chirayinkil of Thiruvananthapuram district, Mavelikkara and Kozhikode during December 1998, April 1999, May 1999, October 1999 and June 2000.

Edibility - Good

This is allied to *A. caroli*, *A. benesi*, *A. campestris*. *A. caroli* have more sharp squamules and more crowded towards centre, where as *A. benesi* is characterised by its long stipe even two times that of the pileus and also have a glabrous pileus. *A. campestris* do not have cheilocystidia, its gill edges are fertile.

Fig. 38 *A. squamuliferus*



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Plate 38a ***A. squamuliferus*** **in natural habitat**

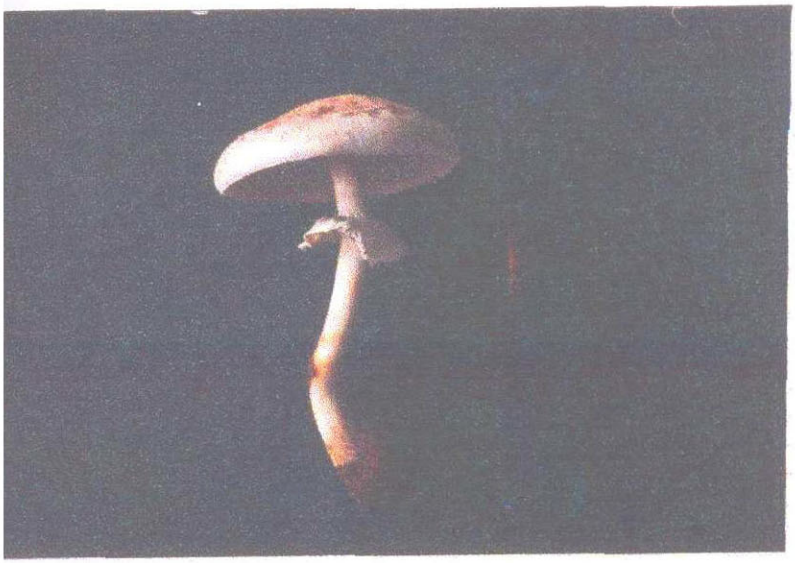


Plate 38b ***A. squamuliferus***

Agaricus stadii (Petch) Pegler. comb. nov. (Plate 39a, 39b and Fig. 39)

Synonym

Psalliota stadii Petch Ann. Roy. Bot. Gard; Peradeniya, 1925 . 9:314

A. campestris Sensu Benk. Hooker. Lond. Journ. Bot; 1847. 6: 488

non *A. campestris* L. Fr. Syst. mycol. 1821. 1: 281

Pileus 5-6 cm in diameter, silky white (10YR 8/1) with pale ochraceous tinge at the centre when become old, fleshy, campanulate at younger stage becoming convex and later turn aplanate. Stipe short, 3-5 x 0.5-1 cm, cylindric, silky white, narrowly hollow, on ageing filled with pith. Annulus superior, white, membraneous. Gills free, crowded, 16 nos/cm, broad, light pink which turn brown on ageing. Context white, moderately thick at centre and thin towards periphery. Gill trama regular. Gill edge fertile. Pleurocystidia and cheilocystidia absent. Basidia 13 x 6 µm, clavate, four spored, sterigmata 3 µm long. Spores ovoid, 6-6.75 x 4.5 µm. Occur in grass lands in groups and also in fairy ring.

Schaeffer's cross reaction-negative

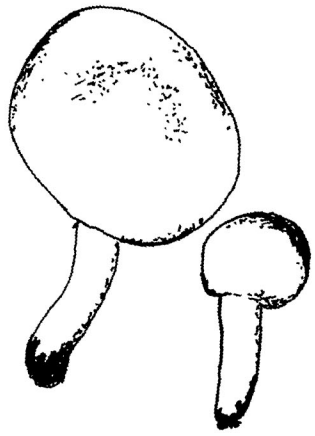
Season and distribution

Collected from Neyyatinkara of Thiruvananthapuram district during May, 1999 and from Vellayani of Thiruvananthapuram district during October 1999.

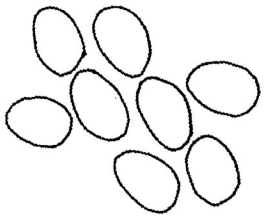
Edibility : Good

This is closely allied to *A. campestris* and is considered as the wild species of *A. campestris*, *A. stadii* differs by its much more strongly developed annulus, the lack of pink discolouration in the context and the pileus is silky white and glabrous.

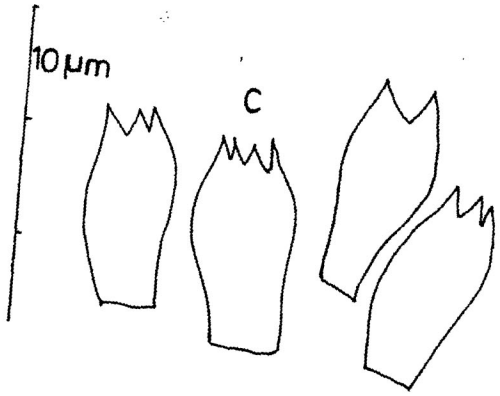
Fig. 39 *A. stadii*



A



B

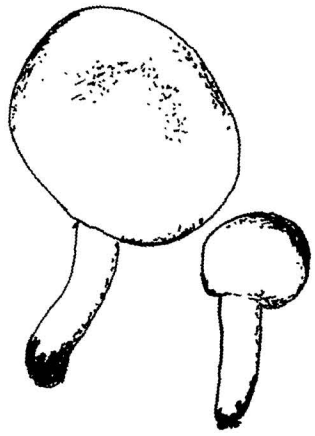


A. Sporophore

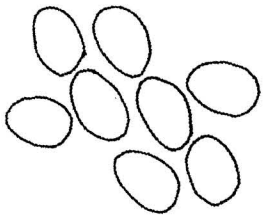
B.Basidiospore 1000x

C. Basidia 1000x

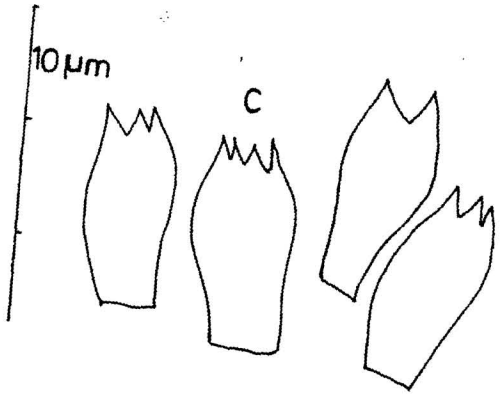
Fig. 39 *A. stadii*



A



B



A. Sporophore

B.Basidiospore 1000x

C. Basidia 1000x

Plate 39a *A. stadii* in natural habitat

Plate 39b *A. stadii*

Agaricus subperonatus (Lange) Lange (Plate 40, Fig. 40)

Friesia. IV. 1950 : 42

Synonym

Psalliota subperonata (Lange) Lange. Fl. Ag. Dan. IV. 1939 : 140

P. hortensis var. *subperonata* Lange. Dansk Botanisk Arkiv IV. 1926 : 8

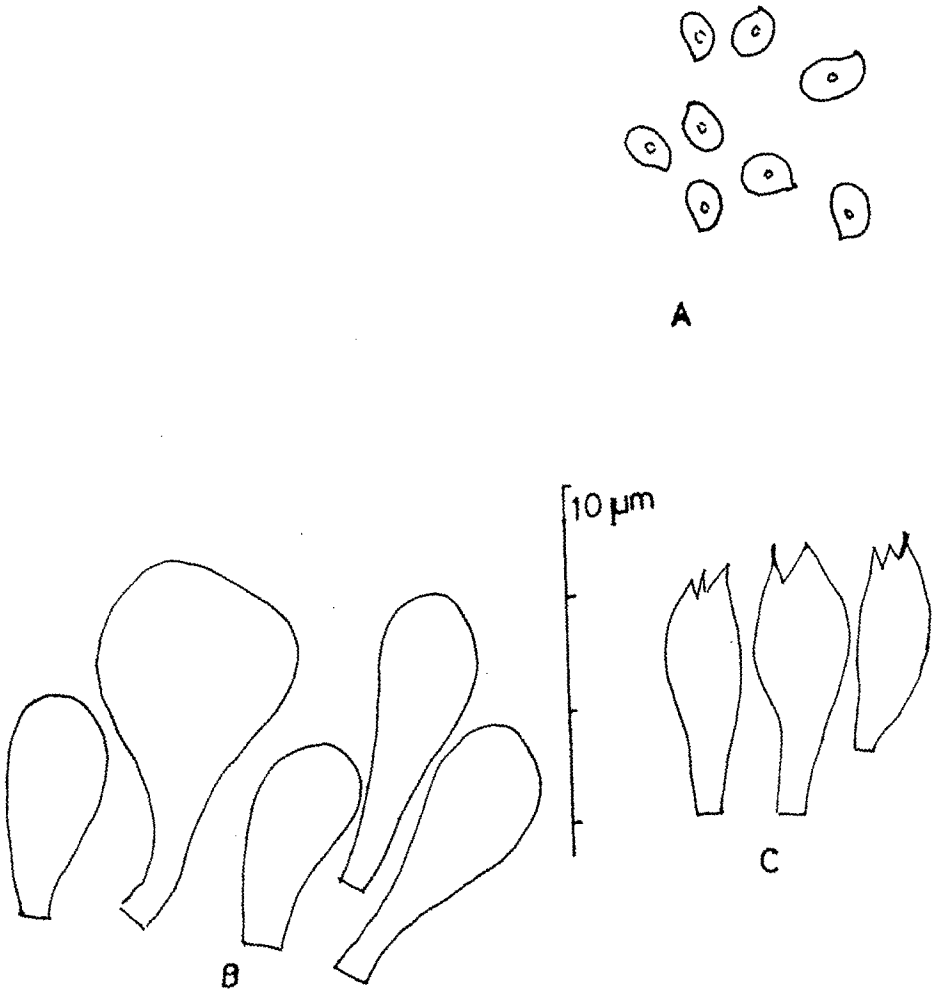
Pileus 7-8 cm diameter, convex, often with a flattened centre, shining dark brown (7.5 YR 4/4) broad, adpressed fibrillose scales arranging radially on a light reddish brown (5 YR 6/3) background. Stipe 6-7 x 1-1.5 cm, cylindrical, solid and later filled with pith or become hollow, white turning grey. Annulus white, superior. Context white but immediately turning dull pinkish when bruised, especially in the stipe. Gills free, crowded, 18 nos/cm, narrow, light pink turns dark brown on maturity. Gill trama subregular. Basidia clavate, four spored, 26-28 x 7-9 μm. Pleurocystidia absent. Cheilocystidia tufted, broadly clavate, 24-30 x 9-13 μm. Pleasant odour. Spores roundish ovate, 5.25-6 x 4 μm. Seen solitarily among small plants on roadside.

Schaeffer's cross reaction -negative

Season and distribution- Collected from Punnamoodu of Thiruvananthapuram district, during Ocotber, 1999 and from Kozhikode during June, 2000

Edibility - Unknown

Fig. 40 ***A. subperonatus***



A.Basidiospore 1000x

B. Cheilocystidia 1000x

C. Basidia 1000x

Plate 40 ***A. subperonatus***

Plate 41 ***A. trisulphuratus***

Agaricus trisulphuratus Berk. (Plate 41, Fig. 41)

Ann. Mag. Nat. Hist. V. 1885. 15 : 386

Synonym

A. burkillii (Massee) Sacc. and Trott. Sacc. Syll. Fung. 1925 : 302

A. nothus Berk L.C. 1885

A. mephistopheles Cooke. Grevillea 1890: 7

Stropharia mephistopheles (Cooke) Sacc. Syll. Fung. 1891: 139

S. stuhlmanni P. Henn. Engl. Bot. Jahrb. 1893 : 33

Cystoagaricus trisulphuratus (Berk.) Singer. Mycologia 1947: 87

Pileus 2-4 cm diameter, campanulate when young and at maturity becomes convex to aplanate, with orange felty flocculose squamules latter fades; margin involute with velar remnants. Stipe 3-5 x 0.5 cm, central, cylindrical, solid with a small tube; lower stipe covered by flocculose scales as in the pileus. Annulus thin, superior and floccose. Context thin, pale pink. Gills free, crowded, 20 nos/cm, pale pinkish at immaturity and later turn to dark brown. Gill trama regular to subregular. Basidia clavate, four spored, 14-15.5 x 5-6 µm. Pleurocystidia absent. Cheilocystidia abundant, cylindric to inflated, 23-24.5 x 7.5-9 µm. Spores 4.8-5.6 x 3.5 µm, ovoid to ellipsoid. Solitarily occurs throughout Kerala irrespective of soil type and vegetation in both season.

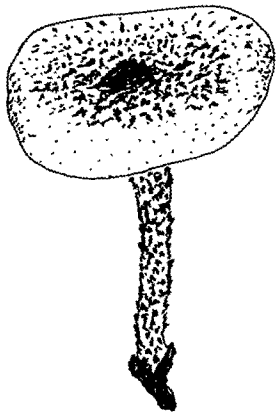
Schaeffer's cross reaction-negative

Season and distribution : Collected from Kanjiramkulam of Thiruvananthapuram district on May 1999, from Balaramapuram and Vellayani of Thiruvananthapuram district, Kayamkulam during October 1999 and June 2000.

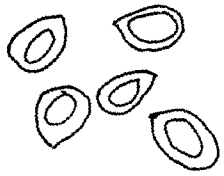
Edibility : Edible- But not commonly consumed by local people because of its bright colour.

A. trisulphatatus differ from all other Agaricus species because of the bright orange colour, floccose pileus and small size.

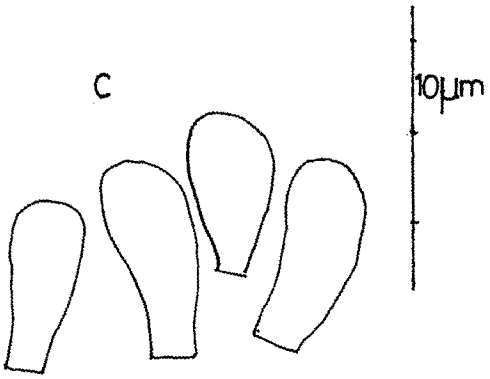
Fig. 41 *A. trisulphuratus*

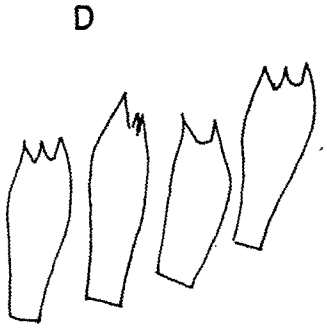


A



B





A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Agaricus xanthodermus Gen. (Plate 42, Fig. 42)

Bull. Soc. Bot. Fr., 1876. 23: 31

Synonym

Pratella campestris var. *silvicola* Vitt. S. Gill. Champ. Fr., 1878: 33

Psalliota xanthoderma Gen. (Rich and Roze) Atlos. Champ. Fr. 1885:53

P. cretaceae (Fr.) S. Quel. Fl. Myc. Fr., 1888:73

A. iodoformicus Speg. Ann. Mus. Nat. Buenons Aires, 1898 : 141

Psalliota foetens Smott. Cas. Cesk. Loub, 1920 : 70

P. psuedoarvensis Passecker Zeitschr, Pilzk, 1932: 36-39

Pileus 4-8 cm in diameter, thick, fleshy, campanulate, later become convex to aplanate, white (10 YR 8/1) on handling become yellowish, glabrous, smooth, silky fibrillose. Sometimes radially cracked towards margin. Margin thin, involute, later flat with remnants of the veil. Stipe 4-5 x 1.0 - 1.5 cm, white erect, central, cylindrical with a small bulbous base and white mycelial cords. Stipe on touching becomes yellow. Annulus apical, wide, simple, white, along the edge sometimes yellowish. Context white, on exposure staining chrome yellow mainly at the stipe base. Gills free, thin, crowded, 18 nos/cm, whitish on younger stage and turn pinkish brown and later to brownish purple. Gill trama in young carpoohore regular, later irregular. Basidia four spored, clavate, 13.5-18 x 6 µm. Cheilocystidia piriform, 18-20 x 12- 13.5 µm. Spores subovate, small, 4.75-5.25 x 3 µm. Growing in groups in humus rich soils under Acasia tree canopy.

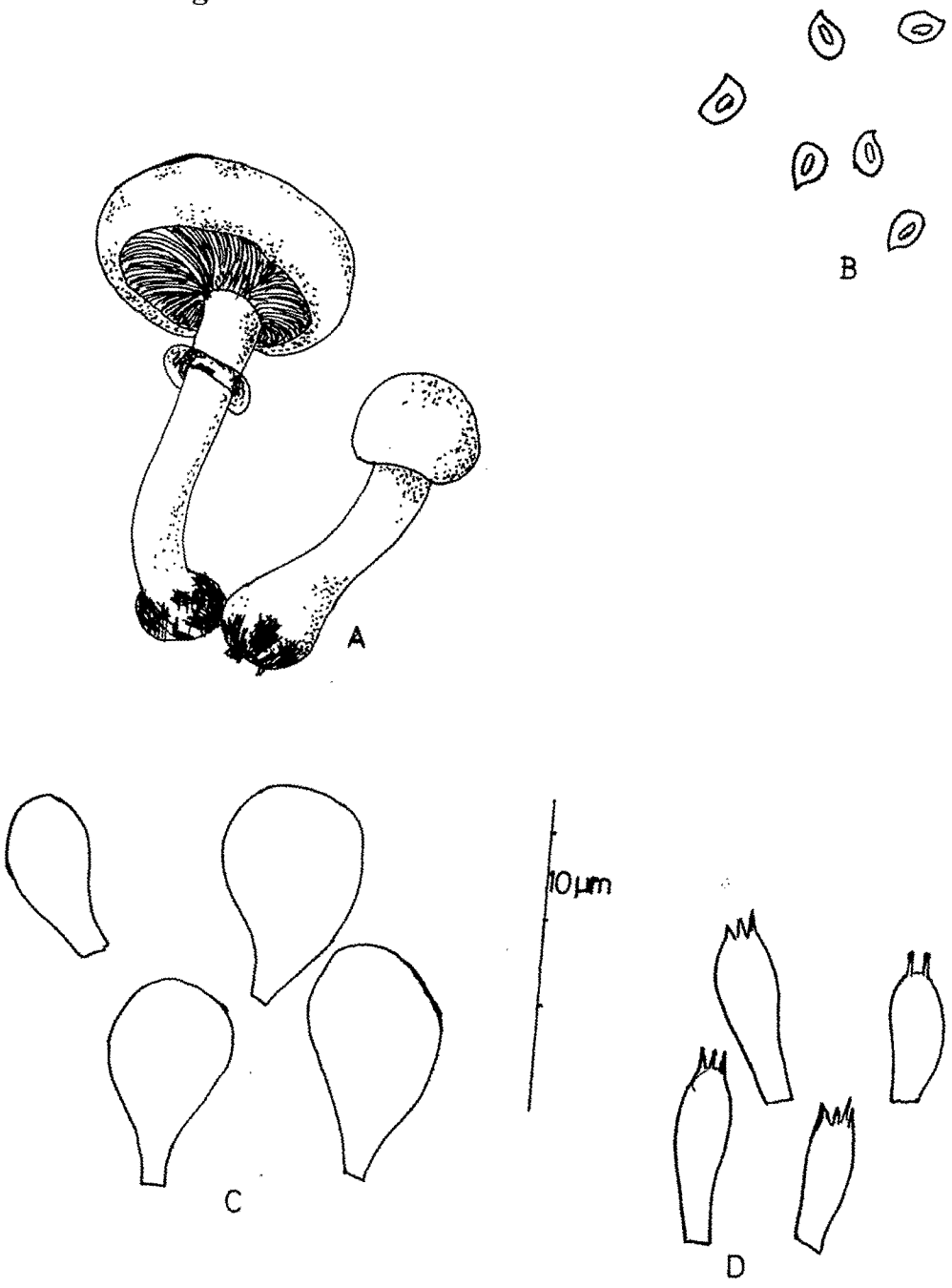
Schaeffer's cross reaction-negative

Season and distribution: Collected form Kanjiramkulam of Thiruvananthapuram district during October, 1999.

Edibility: Allergic

A. xanthodermus is similar to *A. arvensis* but differ from it by the negative Schaeffer's cross reaction, shape and size of cheilocystidia and the chrome yellow discolouration in the stipe base.

Fig. 42 *A. xanthodermus*



A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

Plate 42 ***A. xamthobermus***

Plate 43 ***A. xamtholepis***

Agaricus xantholepis (Moell.) Moell. (Plate 43, Fig. 43)

Friesia, 4. 1952 : 204

Synonym

Psalliota xantholepis Moell., Friesia, 4, 1952: 191

Pileus 2-5 cm in diameter, globose when young and at maturity convex to aplanate. Clay yellow to golden yellow at younger stage and when mature the centre covered with clay yellow to golden yellow (10 YR 7/8) adpressed fibrillose scales against a whitish background, towards the centre glabrous, dark yellow, thick, fleshy in centre and thin at margin, often with remnants of veil. Stipe elongate, 4-6 x 0.5 cm, slender, fistulose, central, equal with a small bulbous base, thin root like mycelial strands present. Annulus thin, white on touching turn yellow. Context white, on exposure and bruising turn yellow. Gills thin, free, crowded, 18 nos/cm, silvery white, when young which turn to pink later brownish. Gill trama regular. Basidia clavate, four spored, 18-20 x 5-6 µm. Pleurocystidia absent. Cheilocystidia 15-22 x 7-9 µm, broadly clavate to piriform. Spores brown, ovate, 4.5-5.25 x 3-3.5 µm. Grows in groups in humus rich soil under coconut tree.

Schaeffer's cross reaction -positive

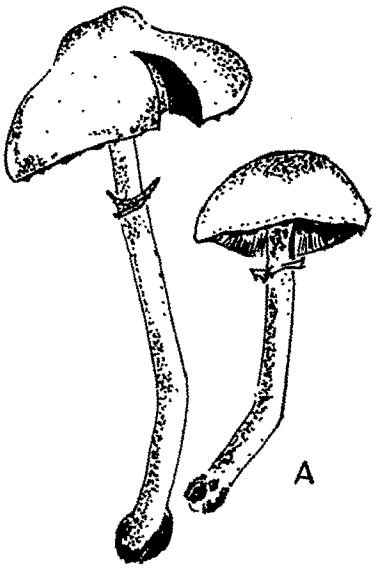
Season and distribution

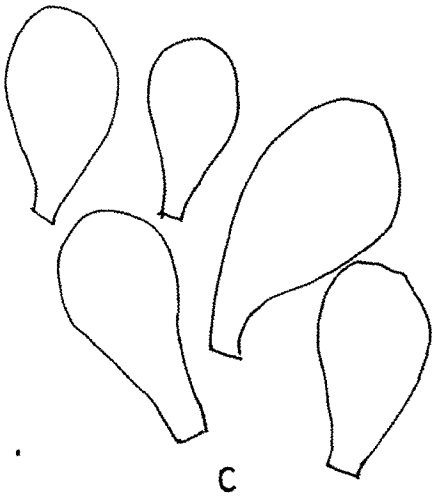
Collected from Payyoli of Kozhikode district during June 2000.

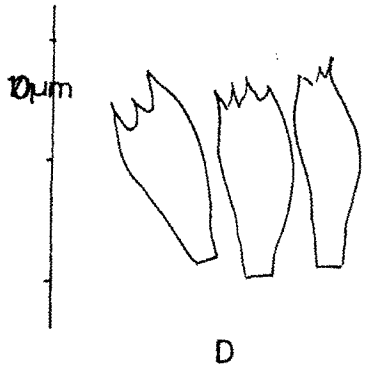
Edibility - Unknown

This species is characterised by its golden yellow centre with whitish background and the silvery white gills during unfolding.

Fig. 43 *A. xantholepis*







A. Sporophore

B.Basidiospore 1000x

C. Cheilocystidia 1000x

D. Basidia 1000x

A. abruptibulbus, *A. actinorachis*, *A. altipes*, *A. annae*, *A. arenicolus*, *A. benesi*, *A. bernardii*, *A. bulbosus*, *A. caroli*, *A. chloroconius*, *A. ingrata*, *A. haemorrhoidaria*, *A. livido nitidus*, *A. mediofuscus*, *A. meleagris*, *A. microflavus*, *A. micromegethus*, *A. microrubescens*, *A. moelleri*, *A. nivescens*, *A. ochraceous*, *A. ochroflavus*, *A. phaeolepidotus*, *A. pseudopratensis*, *A. purpurellus*, *A. rubicolus*, *A. rusiophyllus*, *A. semotus*, *A. silvicola*, *A. simulans*, *A. spissarufosa*, *A. squamuliferus*, *A. stadii*, *A. subperonatus*, *A. trisulphuratus* and *A. xantholepis* are new reports from Kerala. Among these species *A. actinorachis*, *A. annae*, *A. arenicolus*, *A. benesi*, *A. bernardii*, *A. bulbosus*, *A. caroli*, *A. chloroconius*, *A. ingrata*, *A. livido nitidus*, *A. mediofuscus*, *A. microflavus*, *A. microrubescens*, *A. moelleri*, *A. nivescens*, *A. ochraceous*, *A. ochroflavus*, *A. phaeolepidotus*, *A. purpurellus*, *A. rubicolus*, *A. rusiophyllus*, *A. simulans*, *A. spissarufosa*, *A. stadii* and *A. subperonatus* are first report from India.

A. bulbosus, *A. microflavus*, *A. microrubescens*, *A. ochraceous*, *A. ochroflavus*, *A. rubicolus* and *A. spissarufosa* are the new species reported during this study. These are the proposed names considering the morphological characters. *A. bulbosus* sp. nov. has a medium size to large pileus with yellowish brown centre surrounded by small adpressed squamules arranged concentrically. Context white soft turning pink on bruising. Stipe 6-8 x 1-1.5 cm, cylindrical, glabrous with a prominent bulbous base. Stipe tissue also turns pinkish brown on bruising. Cheilocystidia piriform, abundant, 18-25 x 16-18 μm. This species slightly resembles *A. ochroflavus* and *A. ochraceous* in having yellowish brown squamules in the pileus. In case of *A. ochroflavus* the stipe is slender and longer. The stipe of both species lack a priminent bulbous bse. Regarding the bulbous base *A. abruptibulbus* and

A. placomyces both have more prominent bulbous base and showing resemblence to *A. bulbosus* but other macroscopic and microscopic characters are entirely different from the present species.

A. microflavus sp. nov., as the name indicate it is a small sized greyish white species with small yellowish orange brown squamules arranged densily in the centre. Stipe is slender, smooth short, the pileus and stipe turn yellow on bruising. Eventhough the species is similar to *A. arvensis* by the positive Schaeffer's cross reaction and colour change of the context turning chrome yellow especially in the base of the stipe on bruising; it differ from *A. arvensis* in having a scaly pileus. *A. microflavus* is similar to *A. xantholepis* by the colour of scales but differ in having a short stipe and greyish white gills when young.

A. microrubescens sp. nov. is a small sized species with characteristic reddening on exposure. Margin of the pileus appendiculate with reminants of veil. The large basidia and inflated Cheilocystidia are some of the other striking microscopic character. *A. benzodorus* Heinem. and Gooss reported from East Africa is close to this species but it has smaller spores and cheilocystidia.

A. ochraceous sp. nov. come under sub genera *Agaricus* (Pegler) because of the colour change to reddish brown when bruised. Schaeffer's cross reaction is negative. Eventhough this species is similar to *A. nivescens* reported by Pegler from Africa by the external characters, *A. nivescens* have positive Schaeffer's cross reaction and colour change to yellow. *A. bulbosus* and *A. ochroflavus* seem to be similar to this species, but stipe of *A. bulbosus*

is with a prominent bulbous base and that of *A. ochroflavus* is slender and hollow.

A. ochroflavus sp. nov. is a medium sized species with small yellowish brown squamules somewhat concentrically arranged in the centre. Stipe is slender and hollow. Context white, turns pink on exposure. This species is closely allied to *A. augustus* in colour and size, but differs in having slender stipe and larger chielocystidia. Cross reaction is negative in the case of *A. ochraflavus* while positive in *A. augustus*.

A. rubicolus sp. nov. grows gregariously in groups on humus rich soil and of variable size (4-12 cm in diameter). Pileus thick, fleshy with brownish yellow firmly adpressed fibrillose to squamulose scales. Margin undulating with remnants of veil. Stipe is white, solid and highly floccose in nature. Chielocystidia abundant with variable shape and this species is characterized by its sudden reddening of context and gills.

A. spissarufosa sp. nov. is medium sized with short stipe. Pileus whitish to greyish pink with brownish adpressed broad squamose scales arranged concentrically. Context thick firm, white and turn greyish red when bruised. This species is very much similar to *Psalliota spisssa* by the macroscopical characters, but the chielocystidia of *P. spissa* is small whereas that of *A. spissarufosa* is subglobose and large in size.

Table 2 Species of *Agaricus* collected from different agroclimatic zones of Kerala

Sl. No.	Agroclimatic zones	*Agaricus* spp. collected
1	Dry forest loam	*A. actinorachis*
2	Semi dry red loam	*A. benesi*, *A. bernardii*, *A. chloroconius*, *A. endoxanthus*, *A. moelleri*, *A. ochroflavus*, *A. microrubescens*, *A. simulans*, *A. squamuliferus*, *A. trisulphuratus*
3	Semidry laterite	*A. annae*, *A. arvensis*, *A. endoxanthus*, *A. mediofuscus*, *A. nivescens*, *A. ochroflavus*, *A. ochraceous*, *A. purpurellus*, *A. pseudopratensis*, *A. rubicolus*, *A. squamuliferus*, *A. stadii*, *A. subperonatus*
4	Semi dry alluvium	*A. altipes*, *A. arenicolus*, *A. microflavus*, *A. squamuliferus*, *A. stadii*. *A. trisulphuratus* *A. campestris*
5	Semidry black soil	-
6	Semi dry forest loam	-
7	Sub humid red loam	-
8	Sub humid laterite	*A. benesi*, *A. bulbosus*, *A. caroli*, *A. augustus*, *A. ochraceous*, *A. rusiophyllus*, *A. ingrata*, *A. spissarufosa*, *A. squamuliferus*
9	Sub humid alluvium	*A. xanthodermus*
10	Sub humid saline	-

Table 2 Contd...

Sl. No.	Agroclimatic zones	*Agaricus* spp. collected
11	Sub humid forest loam	-
12	Humid laterite	*A. livido nitidus, A. pseudopratensis, A. ochraceous, A. rubicolus, A. semotus, A. silvaticus, A. silvicola, A. subperonatus, A. squamuliferus, A. xantholepis*
13	Humid alluvium	-
14	Humid greyish Onattukara	*A. abruptibulbus, A. meleagris, A. phaeolepidotus, A. haemorrhoidaria, A. squamuliferus, A. trisulphuratus*
15	Humid saline	-
16	Humid forest loam	*A. squamuliferus*
17	Per humid laterite	*A. micromegethus*
18	Per humid forest loam	-
19	Wet laterite	*A. squamuliferus*
20	Wet forest loam	-

During the survey it was observed that maximum number of species (13 spp.) were obtained from semi dry laterite zone, viz., *A. annae*, *A. arvensis*, *A. endoxanthus*, *A. mediofuscus*, *A. nivescens*, *A. ochroflavus*, *A. ochraceous*, *A. purpurellus*, *A. pseudopratensis*, *A. rubicolus*, *A. squamuliferus*, *A. stadii* and *A. subperonatus* (Table 2). Ten collections were obtained from humid laterite and semi dry red loam zones. From semi dry black soil, semi dry forest loam, sub humid red loam, sub humid saline, sub humid forest loam, humid alluvium, humid saline, per humid forest loam and wet forest loam no collections were obtained. *A. squamuliferus* was the most commonly occurring species and collected from eight zones viz., semi dry red loam, semi dry laterite, semi dry alluvium, sub humid laterite, humid laterite, humid greyish Onattukara, humid forest loam and wet laterite. *A. ochraceous* was collected from semi dry laterite, humid laterite and sub humid laterite; *A. trisulphuratus* from semi dry red loam and semi dry alluvium; *A. subperonatus* from humid laterite and semi dry laterite; *A. ochroflavus* from semi dry red loam and semi dry laterite soils.

In general *Agaricus* spp. were more predominant in laterite soils, viz., semidry laterite, sub humid laterite, humid laterite, per humid laterite, wet laterite and also on semi dry red loam. Few species were collected from alluvium soils; semi dry alluvium and sub humid alluvium. No collection were obtained form saline soils and forest soils.

Relative humidity and atmospheric temperature of the locality on the day of collections were observed (Table 3). Maximum temperature recorded on the day of collection of most of the species ranged from 27-31.6 ^{0}C. From this it was observed that tropical *Agaricus* sp. grow on relatively higher

temperature of more than 27^{0}C. Relative humidity recorded on the day of collection ranged between 78-98 per cent.

Table 3 Temperature and relative humidity of the locality on the day of collection

Sl. No.	*Agaricus* spp.	Atmospheric Temperature (^{0}C)		Relative humidity (%)
		Maximum	Minimum	
1.	*A. abruptibulbus*	29.00	24.00	82.50
2.	*A. actinorachis*	26.00	20.00	90.00
3.	*A. altipes*	28.00	22.00	90.00
4.	*A. annae*	29.50	22.60	98.00
5.	*A. arenicolus*	28.50	23.80	91.50
6.	*A. arvensis*	30.00	22.80	80.00
7.	*A. augustus*	30.00	22.00	78.00
8.	*A. benesi.*	28.00	22.00	88.50
9.	*A. bernradii*	30.20	21.90	98.00
10.	*A. bulbosus*	30.20	22.70	82.50
11.	*A. campestris* var. *floccipes*	28.80	24.30	92.00
12.	*A. caroli*	29.00	22.60	85.50
13.	*A. chloroconius*	29.00	24.50	88.00
14.	*A. endoxanthus*	31.60	24.90	90.00
15.	*A. haemorrhoidaria*	29.60	22.80	92.00
16.	*A. ingrata*	29.40	23.00	83.00
17.	*A. lividonitidus*	28.80	24.30	92.00
18.	*A. mediofuscus*	31.50	24.40	89.00
19.	*A. meleagris*	29.00	24.00	89.50
20.	*A. microflavus*	30.50	23.00	78.00

Table 3 Contd...

Sl. No.	*Agaricus* spp.	Atmospheric Temperature (^{0}C)		Relative humidity (%)
		Maximum	Minimum	
21.	*A. micromegethus*	30.00	22.00	82.00
22.	*A. microrubescens*	26.50	22.00	96.00
23.	*A. moelleri*	30.00	23.00	78.00
24.	*A. nivescens*	31.60	24.90	90.00
25.	*A. ochraceous*	28.00	22.00	88.50
26.	*A. ochroflavus*	29.50	23.80	92.00
27.	*A. phaeolepidotus*	29.00	24.00	90.00
28.	*A. pseudopratensis*	30.50	24.10	91.00
29.	*A. purpurellus*	27.60	23.70	92.00
30.	*A. rubicolus*	28.80	24.30	92.00
31.	*A. rusiophyllus*	30.00	22.00	95.00
32.	*A. semotus*	27.40	23.40	97.00
33.	*A. silvaticus*	27.00	22.50	95.50
34.	*A. silvicola*	28.60	22.20	90.50
35.	*A. simulans*	31.50	24.40	93.00
36.	*A. spissarufosa*	28.50	23.80	91.50
37.	*A. squamuliferus*	30.10	23.50	96.00
38.	*A. stadii*	28.50	23.80	91.50
39.	*A. subperonatus*	27.00	22.50	95.50
40.	*A. trisulphuratus*	30.50	22.40	93.00
41.	*A. xanthodermus*	29.20	24.60	88.00
42.	*A. xantholepis*	28.80	24.30	92.00

4.1.2 Isolation and purification of the fungus

Tissue isolation was done for obtaining the pure culture from all the collections of *Agaricus* spp. obtained from different places. Out of the 42 *Agaricus* sp. observed only13 could be isolated and purified. They are :

1. *A. benesi*
2. *A. microrubescens*
3. *A. moelleri*
4. *A. orchraceous*
5. *A. ochroflavus*
6. *A. pseudopratensis*
7. *A. purpurellus*
8. *A. rubicolus*
9. *A. semotus*
10. *A. spissarufosa*
11. *A. squamuliferus*
12. *A. xanthodermus*
13. *A. trisulphuratus*

4.1.3 Mositure content of the substrate

Most of the species were found to occur on substrate where moisture content ranged between 10 – 20 per cent. *A. bernardii* which was found growing on cowdung heap and *A. microrubescense*, *A. purpurellus* and *A. xanthodermus* found on soil with high content of partly decomposed leaf litter grow on substrate with more than 20 per cent moisture content (Table 4).

4.1.4 pH of the substrate

All the *Agaricus* sp. recorded in the study were seen only on acidic soils. The pH of the soils where mushrooms were collected ranged from 4.05 – 6.82. None of the mushrooms were observed from soils with a pH below four and above seven (Table 4).

Table 4 pH and moisture of the substrate

Sl. No.	*Agaricus* spp.	pH of substrate	Moisture (%) of substrate
1.	*A. abruptibulbus*	5.35	13.15
2.	*A. actinorachis*	4.25	18.40
3.	*A. altipes*	4.23	15.15
4.	*A. annae*	4.67	15.11
5.	*A. arenicolus*	5.01	14.50
6.	*A. arvensis*	5.37	12.20
7.	*A. augustus*	4.30	14.16
8.	*A. benesi*	4.77	16.39
9.	*A. bernardii*	4.20	24.99
10.	*A. bulbosus*	4.05	11.80
11.	*A. campestris* var. *floccipes*	4.90	13.63
12.	*A. caroli*	5.60	15.73
13.	*A. chlorconius*	4.90	17.15
14.	*A. endoxanthus*	6.32	13.17
15.	*A. haemorrhoidaria*	5.32	13.20
16.	*A. ingrata*	5.50	15.70
17.	*A. lividonitidus*	4.37	14.10

Table 4 Contd...

Sl. No.	*Agaricus* spp.	pH of substrate	Moisture (%) of substrate
18.	*A. mediofuscus*	6.82	16.28
19.	*A. meleagris*	5.42	11.50
20.	*A. microflavus*	5.27	15.42
21.	*A. micromegethus*	5.30	11.00
22.	*A. microrubescens*	6.38	21.23
23.	*A. moelleri*	4.89	15.33
24.	*A. nivescens*	4.24	16.77
25.	*A. ochraceous*	4.28	13.40
26.	*A. ochroflavus*	5.40	16.92
27.	*A. phaeolepidotus*	5.43	11.66
28.	*A. pseudopratensis*	4.07	13.65
29.	*A. purpurellus*	4.22	25.23
30.	*A. rubicolus*	4.48	17.58
31.	*A. rusiophyllus*	4.30	15.10
32.	*A. semotus*	4.40	14.35
33.	*A. silvaticus*	4.24	14.67
34.	*A. silvicola*	4.70	14.49
35.	*A. simulans*	5.35	11.94
36.	*A. spissarufosa*	5.21	18.17
37.	*A. squamuliferus*	5.30	13.78
38.	*A. stadii*	4.35	15.3
39.	*A. subperonatus*	5.20	14.32
40.	*A. trisulphuratus*	4.20	15.95
41.	*A. xanthodermus*	5.15	20.02
42.	*A. xantholepis*	4.72	12.83

4.2. Physiological studies

4.2.1 Growth of *Agaricus* spp. in liquid media

Growth of *Agaricus* spp. were studied in the following liquid media viz., malt extract media, potato dextrose media, oats media, Czapek's Dox media and complete media. Mycelial growth of *A. bitorquis*, *A. squamuliferus*, *A. purpurellus* and *A. pseudopratensis* was maximum on complete media and malt extract media, while the maximum growth of *A. bisporus*, *A. ochroflavus* and *A. trisulphuratus* was observed in complete medium followed by malt extract medium. Growth was minimum on Czapek's Dox medium (0.02g) for *A. bisporus* where as in the other species, growth on oats agar and Czapek's Dox agar were in par with each other (Table 5, Fig - 44)

4.2.2 Growth of *Agaricus* spp. in solid media

Growth of *Agaricus* spp. was tried in different solid media including semisynthetic media, viz., malt extract agar, potato dextrose agar, oats agar, yeast extract agar and complete media and synthetic media viz., Czapek's Dox media, Coon's medium, Richard's medium, Sacch's medium, glucose mineral medium and Hendrix medium. Of these medium yeast extract medium, Czapek's Dox medium and Hendrix medium did not favour the growth of *Agaricus* spp (Table 6 and Plate 44).

Maximum growth of *Agaricus bisporus* was found on complete media (6.03 cm) followed by malt extract agar (4.97 cm). No growth was in yeast extract agar, Czapek's Dox agar, Coon's media and Hendrix media. In Richard's media, Sacch's media and glucose mineral media growth was less

Table 5 Growth of *Agaricus* spp. in different liquid media

Agaricus spp	Mycelial growth (wt. in g)					CD (0.05)
	Malt extract medium	Potato Dextrose medium	Oats mediu m	Czapek's Dox medium	Complete medium	
A. bisporus	0.39	0.28	0.09	0.02	0.47	0.06
A. bitorquis	0.28	0.25	0.08	0.01	0.31	0.05
A. psuedopratensis	0.18	0.15	0.08	0.03	0.22	0.08
A. squamuliferus	0.45	0.26	0.07	0.03	0.48	0.08
A. trisulphuratus	0.24	0.21	0.05	0.02	0.37	0.06
A. ochroflavus	0.21	0.18	0.07	0.02	0.33	0.06
A. purpurellus	0.23	0.20	0.05	0.03	0.28	0.08

Fig. 44 Growth of *Agaricus* spp. in different liquid media

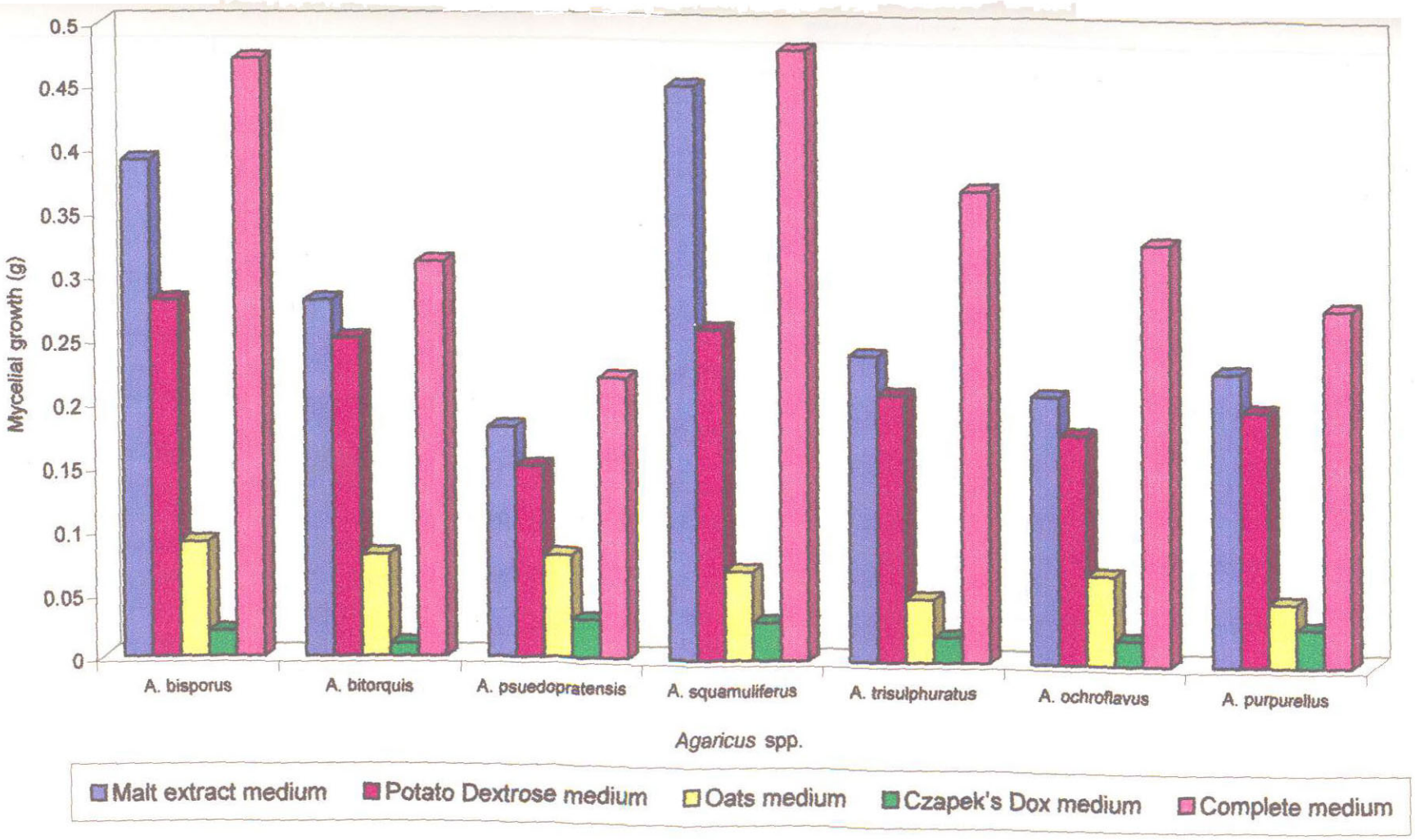
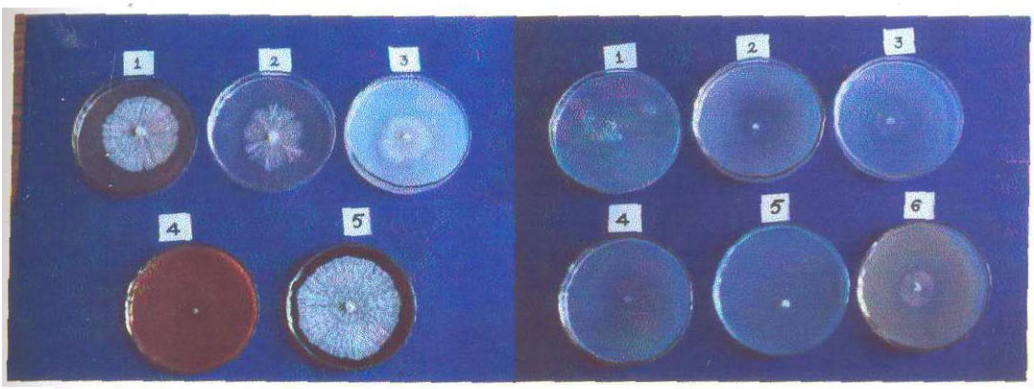


Table 6 Growth of *Agaricus* spp. in different solid media

Agaricus spp.	Mycelial growth (Radial growth in cm)											CD (0.05)
	Malt extract Agar	Potato Dextrose Agar	Oats Agar	Yeast Extract Agar	Complete medium	Coon's medium	Richard's medium	Sacch's medium	Glucose Mineral medium	Czapek's Dox medium	Hendrix medium	
A. bisporus	4.93	4.20	2.70	0	6.03	0	0.33	0.27	0.67	0	0	0.64
A. bitorquis	3.87	3.67	2.77	0	5.17	0	0	0.40	0.23	0	0	0.46
A. ochroflavus	3.07	1.73	1.90	0	4.03	0.80	0	0.70	0.73	0	0	0.82
A. psuedopratensis	2.93	1.10	1.93	0.77	2.87	0	0.40	0.80	0.67	0	0	0.19
A. purpurellus	3.67	2.07	0.60	0	4.03	0.80	0	0.70	0.70	0	0	0.75
A. squamuliferus	6.17	4.90	3.70	0	7.40	1.37	0.93	0.83	2.40	0	0	0.40
A. trisulphuratus	4.07	2.67	2.37	0	4.20	0	0.67	0	0.60	0	0	0.47



A B

Plate 44 Growth of *Agaricus* spp. in different media

A

1. Malt extract agar
2. Potato dextrose agar
3. Oats agar
4. Yeast extract agar
5. Complete medium

B

1. Czapek's Dox medium
2. Sacch's medium
3. Coon's medium
4. Hendrix medium
5. Richards medium
6. Glucose mineral medium

than one cm. *Agaricus bitorquis* grows best in complete media (5.17 cm) followed by malt extract agar (3.87 cm) and potato dextrose agar (3.67cm). No growth was found in yeast extract agar, Czapek's Dox agar, Coon's media, Richard's media and Hendrix media.

A. purpurellus, *A. pseudopratensis* and *A. trisulphuratus* had maximum growth on complete medium and Malt extract agar. Hendrix medium, Coon's medium and Czapek's Dox medium did not favour the growth of *A. pseudopratensis* and mycelial growth was less than one cm in Yeast extract agar, Richard's medium, Sacch's medium and Glucose Mineral medium. No growth was found in Yeast Extract medium and Hendrix medium for *A. purpurellus*. Less than one cm growth occur on oats agar, Czapek's Dox agar, Richard's medium and Sacch's medium for *A. purpurellus*. For *A. trisulphuratus* also no growth occur in yeast extract agar, Czapek's Dox agar, Coon's medium, Sacch's medium and Hendrix medium. Scanty growth found in Richard's medium (0.67 cm) and glucose mineral medium (0.6 cm).

Maximum growth (7.40 cm) was observed in complete media followed by malt extract agar (6.17 cm) for *A. squamuliferus*. No growth was found on yeast extract agar, Czapek's Dox medium and Hendrix medium. In the case of *A. ochroflavus* maximum growth (4.03 cm) was observed in complete medium and no growth occur in yeast extract agar, Czapek's Dox agar, Richard's medium and Hendrix medium.

4.2.3 Influence of different temperatures on the growth of *Agaricus* spp.

Effect of temperature on the mycelial growth of *Agaricus* sp. was studied by growing them in complete media at temperature viz., 10, 15, 20,

25, 30 and 35^{0}C. It was observed that *Agaricus* spp. grow best at 25 and 30 ^{0}C. For *A. bisporus* (0.39 g), *A. ochroflavus* (0.35 g) and *A. benesi* (0.19 g) the ideal temperature was 25 ^{0}C, while for *A. bitorquis* (0.23 and 0.22 g), *A. pseudopratensis* (0.13 and 0.13 g), *A. trisulphuratus* (0.32 and 0.32 g), *A. purpurellus* (0.24 and 0.24 g), *A. microrubescens* (0.44 and 0.42 g), *A. spissa rufosa* (0.3 and 0.29 g), *A. ochraceous* (0.48 and 0.5 g), *A. squamuliferus* (0.24 and 0.31 g), *A.xanthodermus* (0.44 and 0.44 g), *A. rubicolus* (0.18 and 0.16 g), *A. semotus* (0.28 and 0.26 g) and *A. moelleri* (0.23 and 0.26). There was no difference in growth at 25 and 30^{0}C. At 10^{0}C no growth was recorded in all species except *A. bisporus* (0.04 g). Similarly only *A. bitorquis* (0.02 g), *A. microrubescense* (0.02 g) and *A. trisulphuratus* (0.04 g) grow at 35^{0}C (Table 7).

Regression and correlation analysis were done and the optimum temperature for the growth were worked out. The results showed that the *Agaricus* spp. isolated from Kerala preferred a temperature range of 22.02 to 25.07^{0}C for best growth.

4.2.4 Influence of different pH on the growth of *Agaricus* spp.

Effect of pH on the growth of *Agaricus* spp. was studied by growing it in complete media with different pH, viz., 4.5, 5,6,7 and 8. It was observed that growth of mycelium increased upto pH of six and then the growth decreased. Growth was found to be minimum at pH 8 (Table 8). Least mycelial growth was observed at pH 7 and pH 8 in *A. ochraceous* (0.24 and 0.20 g) and *A. squamuliferus* (0.22 and 0.20 g). In the case of *A. ochroflavus* and *A. benesi*, the growth was found to be poor at pH 4.5 and pH 8 which

Table 7 Effect of temperature on the growth of *Agaricus* spp.

Agaricus spp.	Mycelial growth (wt. in g) at different pH						CD (0.05)	Optimum temperature for maximum growth
	10°C	15°C	20°C	25°C	30°C	35°C		
A.benesi	0	0.02	0.04	0.19	0.15	0	0.02	24.54
A. bisporus	0.04	0.10	0.20	0.39	0.00	0	0.02	22.02
A. bitorquis	0	0.02	0.19	0.23	0.22	0.02	0.03	24.07
A. microrubescens	0	0.02	0.24	0.44	0.42	0.02	0.05	24.43
A. moelleri	0	0	0.16	0.23	0.24	0	0.03	24.39
A. ochraceous	0	0.16	0.22	0.48	0.50	0	0.03	23.96
A. ochroflavus	0	0.03	0.18	0.35	0.28	0	0.03	23.99
A. psuedopratensis	0	0.01	0.10	0.13	0.13	0	0.03	23.09
A. purpurellus	0	0.01	0.16	0.24	0.24	0	0.02	24.16
A. rubicolus	0	0	0.05	0.18	0.16	0	0.03	24.72
A. semotus	0	0	0.13	0.28	0.26	0	0.03	24.41
A. squamuliferus	0	0	0.18	0.29	0.31	0	0.03	24.35
A. spissarufosa	0	0	0.2	0.30	0.29	0	0.03	24.21
A. trisulphuratus	0	0.02	0.1	0.32	0.32	0.04	0.05	25.01
A. xanthodermus	0	0.05	0.23	0.44	0.44	0	0.04	24.23

Table 8 Effect of pH on the growth of *Agaricus* spp.

Agaricus sp.	Mycelial growth (wt in g) at different pH					CD (0.05)	Optimum pH for maximum growth
	4.5	5	6	7	8		
A. benesi	0.06	0.15	0.17	0.09	0.04	0.04	5.87
A. bisporus	0.34	0.33	0.40	0.21	0.10	0.03	5.35
A. bitorquis	0.14	0.19	0.23	0.14	0.09	0.04	5.9
A. microrubescens	0.40	0.39	0.45	0.35	0.25	0.06	5.55
A. moelleri	0.13	0.22	0.24	0.15	0.07	0.03	5.91
A. ochraceous	0.41	0.42	0.48	0.24	0.20	0.04	5.14
A. ochroflavus	0.18	0.24	0.30	0.2	0.17	0.03	6.1
A. psuedopratensis	0.08	0.1	0.13	0.07	0.03	0.02	5.79
A. purpurellus	0.15	0.22	0.25	0.18	0.08	0.04	5.91
A. rubicolus	0.09	0.18	0.20	0.08	0.04	0.02	5.86
A. semotus	0.22	0.28	0.29	0.2	0.10	0.03	5.72
A. squamuliferus	0.26	0.26	0.28	0.22	0.20	0.04	5.29
A. spissarufosa	0.20	0.3	0.31	0.21	0.20	0.03	5.95
A. trisulphuratus	0.22	0.32	0.31	0.24	0.12	0.06	5.81
A. xanthodermus	0.40	0.44	0.47	0.38	0.27	0.04	5.58

were on par with each other. For *A. spissarufosa* the growth on media with pH 4.5 (0.20 g), pH 7(0.21 g) and pH 8 (0.20 g) were found to be least and on par with each other. The growth on pH 8 was found minimum for *A. bisporus* (0.1 g), *A. bitorquis* (0.09 g), *A. pseudopratensis* (0.03 g), *A. trisulphuratus* (0.12 g), *A. purpurellus* (0.08 g), *A. microrubescens* (0.25g), *A. xantodermus* (0.27 g), *A. rubicolus* (0.04 g), *A. semotus* (0.1 g) and *A. moelleri* (0.07 g). Maximum mycelial growth was obtained in pH 6 for *A. bisporus* (0.4 g), *A. bitorquis* (0.23 g), *A. ochroflavus* (0.3 g), *A. microrubescens* (0.45 g) and *A. ochraceous* (0.48 g). *A. pseudopratensis* (0.1g and 0.13 g), *A. trisulphuratus* (0.32 and 0.31 g), *A. purpurellus* (0.22 and 0.25 g), *A. spissarufosa* (0.3 and 0.31 g), *A. xanthodermus* (0.44 and 0.47 g), *A. rubicolus* (0.18 and 0.20 g), *A. semotus* (0.28 and 0.29 g) and *A. moelleri* (0.22 and 0.24 g) grow best at pH 5 and 6.

Regression and correlation analysis were statistically carried out and optimum pH for their growth were calculated (Table 8). It was found that the ideal pH for the growth of *Agaricus* spp. ranges from 5.14 to 6.10.

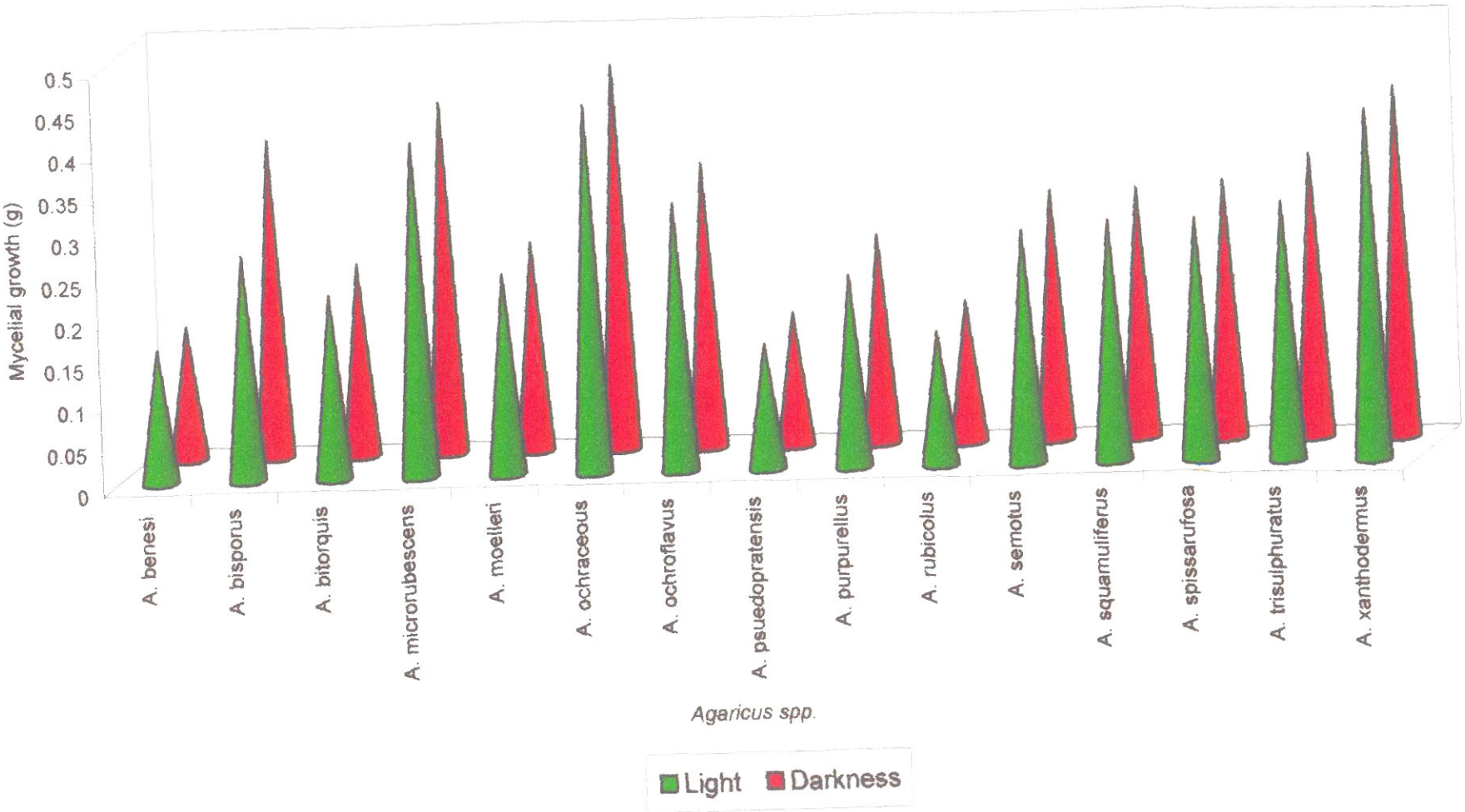
4.2.5 Influence of light and darkness on the growth of *Agricus* spp.

Role of light on the growth of mycelium of *Agaricus* spp. was studied and it was observed that light has little effect on the growth. Certain species has better growth on darkness. *A. bisporus*, *A. purpurellus*, *A. spissarufosa* and *A. semotus* had better growth on darkness. *A. bitorquis*, *A. pseudopratensis*, *A. trisulphuratus*, *A. ochroflavus*, *A. benesi*, *A. ochraceous*, *A. squamuliferus*, *A. xanthodermus*, *A. rubicolus* and *A. moelleri* grows equally on light and darkness (Table 9, Fig - 45)

Table 9 Effect of light on growth of *Agaricus* spp.

Agaricus sp.	Mycelial growth (wt. in g)		CD (0.05)
	Light	Darkness	
A. benesi	0.16	0.16	0.02
A. bisporus	0.27	0.38	0.04
A. bitorquis	0.22	0.23	0.02
A. microrubescens	0.40	0.42	0.03
A. moelleri	0.24	0.25	0.02
A. ochraceous	0.44	0.46	0.03
A. ochroflavus	0.32	0.34	0.03
A. psuedopratensis	0.15	0.16	0.01
A. purpurellus	0.23	0.25	0.02
A. rubicolus	0.16	0.17	0.01
A. semotus	0.28	0.30	0.02
A. squamuliferus	0.29	0.30	0.03
A. spissarufosa	0.29	0.31	0.02
A. trisulphuratus	0.31	0.34	0.03
A. xanthodermus	0.42	0.42	0.04

Fig. 45 Effect of light on the growth of *Agaricus* spp.



4.2.6 Infleunce of different carbon sources on the growth of *Agaricus* spp.

To study the effect of different carbon source on the growth of *Agaricus* spp., various carbon sources, viz., fructose, glucose, mannose, sucrose and xylose were used. Almost all species showed less growth on xylose and mannose. Glucose and sucrose favour better growth. *A. bisporus* grows better in Fructose (0.3 g) and sucrose (0.32 g) whereas the growth was least in xylose (0.02 g). The growth on fructose, glucose and sucrose were on par with each other in the case of *A. bitorquis*, *A. pseudopratensis*, *A. ochraflavus* and *A. tirsulphuratus*. Their growth were also found to be least in xylose. In the case of *A. purpurellus, A. microrubescens, A. ochraceous*, *A. semotus*, *A. squamuliferus* and *A. moelleri* growth was more in glucose and sucrose. Xylose and mannose favour least growth for *A. microrubescens* (0.23 and 0.21 g), *A. ochraceous* (0.27 and 0.26 g), *A. semotus* (0.06 and 0.08 g), *A. squamuliferus* (0.16 and 0.14 g) and *A. moelleri* (0.09 and 0.11 g) and for *A. purpurellus* least growth was found in xylose (0.06 g). Mycelial growth was more on sucrose for *A. benesii* (0.22 g) and *A. rubicolus* (0.20g). For *A. benesi* growth was less on xylose (0.03 g) and for *A. rubicolus* growth on mannose (0.07) and xylose (0.05 g) were on par with each other. Growth of *A. spissarufosa* was more on glucose (0.31 g) and fructose (0.28 g)and least on mannose (0.18 g) and xylose (0.14 g). In the case of *A. xanthodermus* growth was best on glucose (0.45 g) and least on mannose (0.12 g) and xylose (0.08 g) (Table 10).

Table 10 Effect of different carbon source on the growth of *Agaricus* spp.

Agaricus spp.	Mycelial growth (wt. g)					CD (0.05)
	Fructose	Glucose	Mannose	Sucrose	Xylose	
A. benesi	0.18	0.18	0.09	0.22	0.03	0.04
A. bisporus	0.3	0.48	0.20	0.32	0.03	0.06
A. bitorquis	0.22	0.21	0.13	0.24	0.04	0.06
A. microrubescens	0.39	0.43	0.23	0.46	0.21	0.06
A. moelleri	0.23	0.26	0.10	0.27	0.11	0.03
A. ochraceous	0.37	0.47	0.27	0.49	0.26	0.03
A. ochroflavus	0.30	0.28	0.19	0.31	0.24	0.04
A. psuedopratensis	0.19	0.15	0.09	0.19	0.03	0.04
A. purpurellus	0.18	0.24	0.13	0.27	0.06	0.05
A. rubicolus	0.16	0.18	0.08	0.20	0.05	0.03
A. semotus	0.18	0.28	0.06	0.25	0.08	0.04
A. squamuliferus	0.25	0.31	0.16	0.29	0.14	0.04
A. spissarufosa	0.28	0.31	0.18	0.26	0.14	0.06
A. xathodermus	0.25	0.45	0.12	0.28	0.08	0.05
A. trisulphuratus	0.34	0.25	0.22	0.37	0.08	0.11

4.2.7 Influence of different nitrogen sources on the growth of *Agaricus* spp.

Growth of *Agaricus* spp. on different inorganic nitrogen sources, viz., Ammonium nitrate, Ammonium chloride and sodium nitrate and organic nitrogen source, viz., peptone were studied. All species of *Agaricus* studied show maximum growth on media with the organic nitrogen source peptone (Table 11). Growth of *A. bisporus* on peptone (0.42 g) and ammonium nitrate (0.40 g) were on par with each other. Growth on ammonium chloride, ammonium nitrate and sodium nitrate were on par with each other for *A. bitorquis*, *A. pseudopratensis*, *A. trisulphuratus*, *A. microrubescens* and *A. semotus*. Least growth was obtained in media with ammonium nitrate for *A. ochroflavus* (0.21 g) and in media with ammonium nitrate and ammonium chloride for *A. ochraceous* (0.26 and 0.27 g) and for *A. squamuliferus* (0.17 and 0.19g). Sodium nitrate favour least growth for *A. bisporus* (0.10g) and *A. purpurellus* (0.14 g). In the case of *A. spissarufosa* and *A. benesi* growth was poor on ammonium chloride and sodium nitrate. Ammonium nitrate and sodium nitrate favour least growth for *A. xanthodermus* and *A. moelleri.*

4.3 Cultivation

4.3.1 Comparative efficacy of different spawn substrate in supporting mycelial growth

Five grain substrates viz., paddy, maize, ragi, sorghum and wheat were used to study their comparative efficiency in supporting mycelial growth of *A. bitorquis* and *A. squamuliferus*. It was observed that wheat grain supported maximum growth for both species. Sorghum, maize and ragi supported good

Table 11 Effect of different nitrogen sources on the growth of *Agaricus* spp.

Agaricus spp.	Mycelial growth (wt. g)				CD (0.05)
	Ammonium chloride	Ammonium nitrate	Peptone	Sodium nitrate	
A. benesi.	0.09	0.10	0.19	0.08	0.03
A. bisporus	0.21	0.40	0.42	0.10	0.03
A. bitorquis	0.15	0.16	0.23	0.18	0.04
A. microrubescens	0.23	0.22	0.43	0.23	0.04
A. moelleri	0.12	0.05	0.26	0.06	0.03
A. ochraceous	0.27	0.26	0.44	0.31	0.04
A. ochraflavus	0.25	0.21	0.35	0.26	0.05
A. psuedopratensis	0.11	0.11	0.16	0.12	0.04
A. purpurellus	0.20	0.20	0.26	0.14	0.03
A. rubicolus	0.07	0.09	0.19	0.09	0.02
A. semotus	0.17	0.15	0.27	0.16	0.03
A. squamuliferus	0.19	0.17	0.32	0.2	0.03
A. spissarufosa	0.20	0.21	0.31	0.17	0.03
A. trisulphuratus	0.21	0.18	0.31	0.2	0.05
A. xanthodermus	0.19	0.18	0.41	0.18	0.04

growth while the growth of these fungi was very poor in paddy grain (Table 12 and Plate 45).

4.3.2 Effect of temperature on mycelial growth of *Agaricus* spp.

In order to study the effect of temperature on the spawn growth of *A. bitorquis* and *A. squamuliferus*, spawn was incubated at 15, 20, 25 and 30^{0}C. The results showed that *A. bitorquis* growth was maximum at 25^{0}C and 30^{0}C while it fail to grow when they were incubated at 15^{0}C (Table 13 and Plate 46). Similar effect was noticed with *A. squamuliferus* also (Table 13 and Plate 47).

4.3.3 Production technology

Three types of compost viz., coir pith compost, vermicompost and traditional compost prepared by short method (Sinden and Hausen, 1983) were used to study the spawn run of *A. bitorquis* and *A. squamuliferus*. Spawn run was obtained only in traditional compost (Plate 48).

In the case of *A. bitorquis* spawn run on traditional compost was started after five days of incubation and completed by 20 days (Plate 48). On the 21st day casing was given. It took 7-10 days to complete case run. The pin heads started appearing 10-12 days after casing (Plate 48) and developed into buttons of 4-5 cm in diameter within 4th or 5th day (Plate 48). These buttons matured and fully opened on 6th day. Average weight of matured fruiting body ranged from 20-25 g. On an average 400 g of buttons were harvested from 10 kg of compost.

Table 12 Growth of *Agaricus* spp. in different grains after 20 days

Grain	*A. bitorquis*	*A. squamuliferus*
Maize	+ + +	+ + +
Paddy	+	+
Ragi	+ + +	+ + +
Sorghum	+ + +	+ + +
Wheat	+ + + +	+ + + +

Table 13 Growth of *Agaricus* spp. in wheat at different temperature

Temperature (^{0}C)	*A. bitorquis*	*A. squamuliferus*
15	–	–
20	+ +	+
25	+ + + +	+ + + +
30	+ + + +	+ + + +

Plate 45 spawn growth of *A. bitorquis* on different grains

1. Wheat 2. Ragi 3. Maize

4. Sorghum 5. Paddy

Plate 46 spawn growth of A. bitorquis at different temperatures
1. 15^{0}c 2. 20^0 3. 25^{0}c 4. 30^{0}c

Plate 47 spawn growth of *A. squamuliferus* at different temperatures
1. 15^{0}c 2. 20^{0}c 3. 25^{0}c 4. 30^{0}c

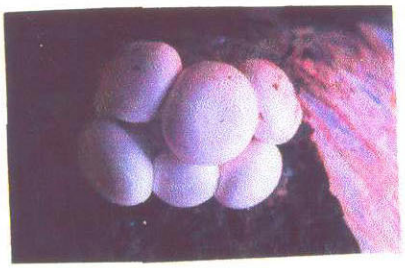
Plate 48 Production technology of *A. bitorquis*

Spawn

Spawn run compost

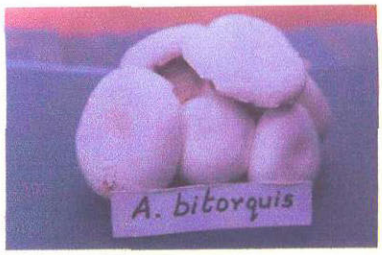
Casing

Pin head emergence



Button stage

Open fruiting bodies



Bunch of A. bitorquis

4.3.4 Study of developmental morphology of fruit body

It takes six days to fully open the fruit body from the day of pin head formation. The developmental morphology of fruit body from the day one (pin head stage) to maturity is given in Table 14 and Plate 49a, 49b.

Table 14 Developmental morphology of *A. bitorquis*

Day	Growth
1	Pin head formation, the tissues not differentiated into pileus, gills and stipe
2	Pileus 1 cm in diameter, tissues differentiated into pileus, gills and stipe, small white gills developed
3	Pileus 3 – 4 cm in diameter, universal veil break and partial veil intact, colour of gills changed to light grayish pink, immature spores also developed.
4	Fruiting body attained button stage, pileus 5 – 6 cm in diameter, partial veil intact. Spores sparce
5	Fruting body opens, partial veil break, pileus 7 – 8 cm in diameter and convex in shape, margin curved inward. Spores numerous, purple brown in colour, gills grayish pink
6	Fruting body completely opens, pileus 8 – 10 cm in diameter, aplanated.

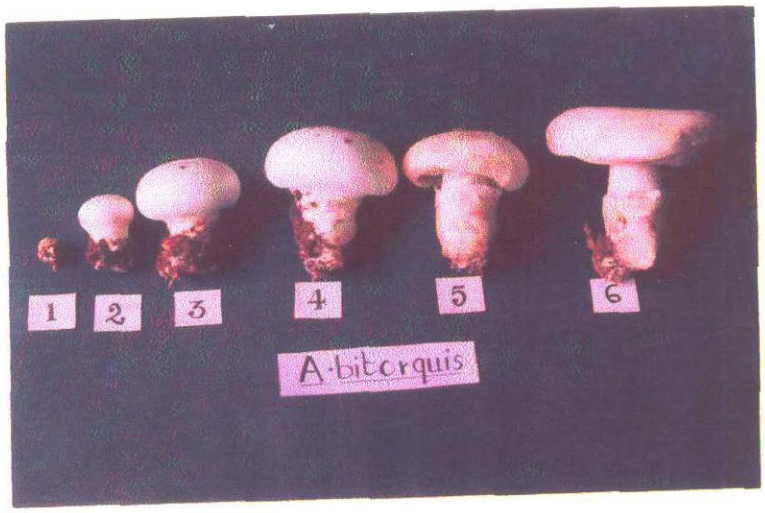


Plate 49a Fruiting bodies at different days of growth

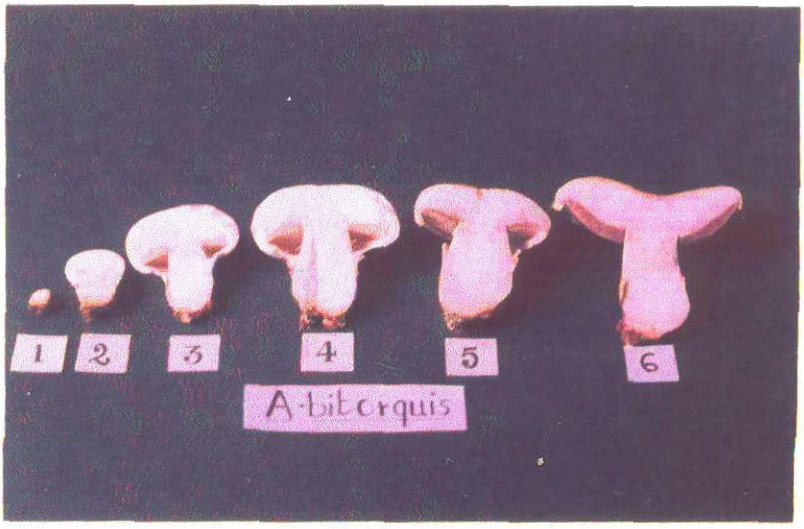


Plate 49b Cross section of fruiting bodies of different stages of growth

Agaricus bitorquis (Quel) Sacc. (Plate 50a, 50b, Fig. 44)

Syll. Fung. 1887-998

Synonym

Psalliota bitorquis Quel. Ass. Franc. Avanc. Sci. 1883 : 500

Agaricus campestris, A. edulus Vitt. Fung. Mang. 1835 : 41

A. campestris L. Fr. subsp. *bitorquis* (Quel.) Konr. and Maubl. Icon. Sel. Fung. 1924 : 60

A. edulis (Vitt.) Moell. & J. Schaeff. Ann. Myc. 1938 : 75

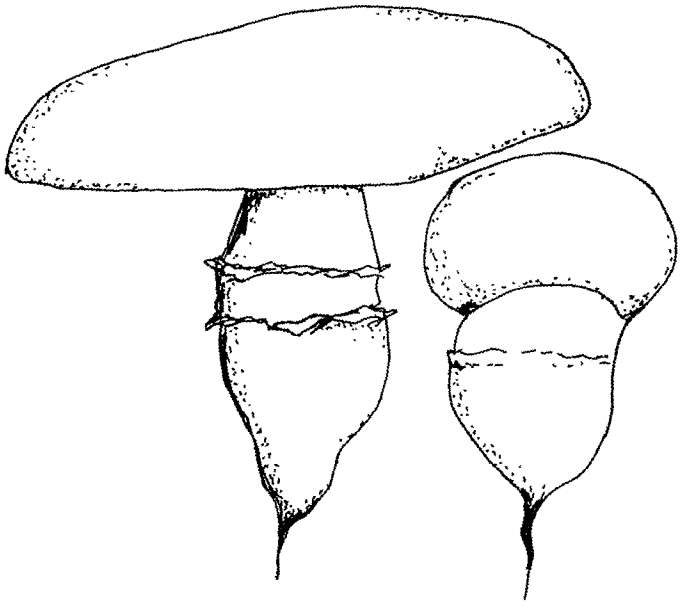
Agaricus rodmanii Pk., Ann. Rep. NY state Mus. 1894 : 45

Pileus 4-12 cm in diameter, white, thick, fleshy, globose to semi globose at younger stage, which later turn covex with flat to slightly depressed centre, shiny, glabrous often with a thin, adnate membrane derived from the universal veil on the disc. Margin is involute, pileus turn ochraceous when touched. Stipe central, 4-7 x 2.5 cm, cylindrical to slightly swollen towards base, solid, white. Annulus double, first is broad and thicker upper ring, peronate rigid, second is narrow and the thin lower ring. Context thicker both in cap and stipe, on exposure becoming gradually pinkish with reddish tinge. Gills free, narrow, crowded, light pink, later blakish brown. Gill trama in young carpophore regular later irregular. Basidia 4 spored, 22-25 x 8-9 µm, clavate. Cheilocystidia numerous, broadly clavate, 24-30 x 7.5-9 µm. Spores roundish, 6 – 6.75 x 4.5 µm, pale brown.

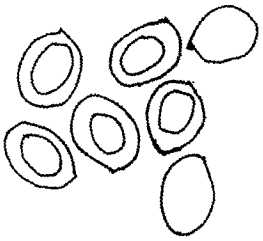
Schaeffer's cross reaction – negative

Edibility : Very good, commercially cultivated

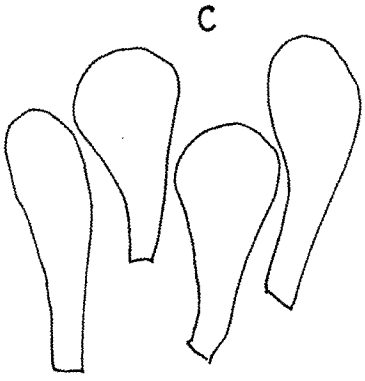
Fig. 47. A. bitorquis



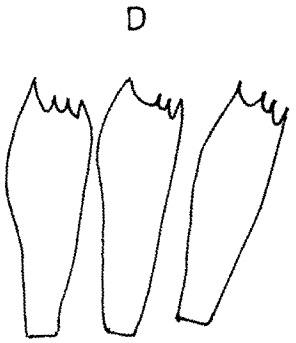
A



B



C



D

A. Sporophore

B.Basidiospore 1000x

C. Chielocystidia 1000x

D. Basidia 1000x

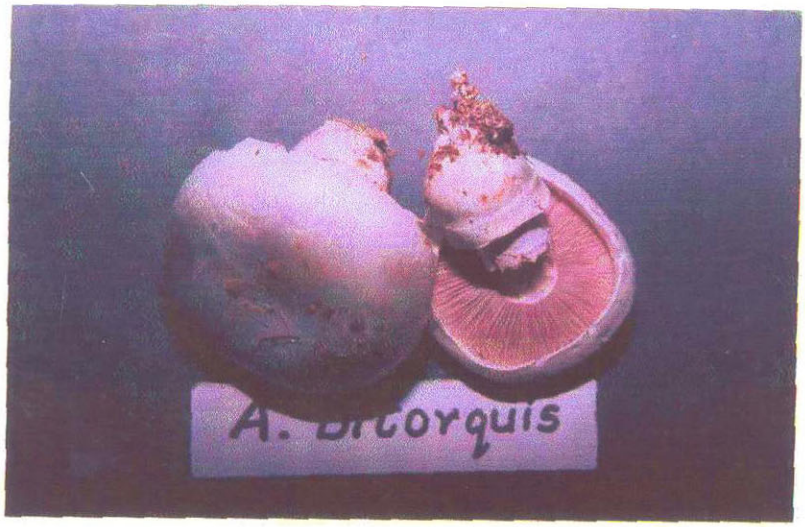


Plate 50a A. *bitorquis*

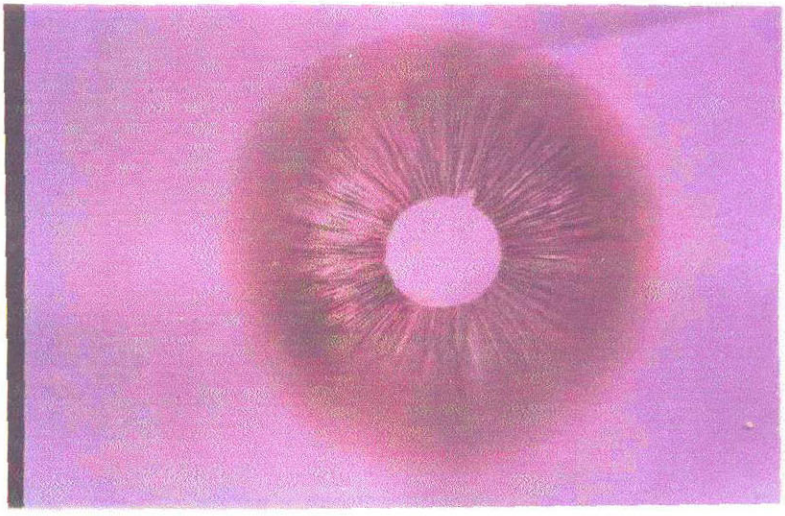


Plate 50b Spore print of *A. bitorquis*

Discussion

5. DISCUSSION

The warm humid climatic conditions and wide diversity in soil type and pattern favoured the luxuriant growth of a wide variety of fungal flora in Kerala. But so far very little efforts were made for a systematic study of this highly priced esculent native macrofungi belonging to the Genus *Agaricus*. Preliminary work on mycofloristic study was started by Bhavani Devi (1982). She reported nine species of *Agaricus* from Kerala. Results of the present state wide survey conducted on the occurrence of *Agaricus* spp. of Kerala revealed the occurrence of a wide range of the 42 species, indicating that the state is ideally suited to support luxuriant growth of this excellent species. For exploitation of the flora, systematic collection identification, description and documentation of each species along with the place of occurrence and the seasons of its appearance are necessary.

In the present study collections were made during South-West and North East monsoon periods of 1998-2000 in 20 agroclimatic zones of Kerala. Forty two species of *Agaricus* were collected from the different agro-ecological regions of the state :

1. *A. abruptibulbus* PK
2. *A. actinorachis* Berk and Br.
3. *A. altipes* (Moell.) Pill.
4. *A. annae* Pilat
5. *A. arenicolus* Wakefield et Pearson
6. *A. arvensis* Schaeff. Secr.

7. *A. augustus* Fr. var. *albus* Mos.

8. *A. benesi* Pilat

9. *A. bernardii* (Quel) Sacc.

10. *A. bulbosus* sp. nov.

11. *A. campestris* var. *floccipes* (L.) Fr.

12. *A. caroli* Pilat

13. *A. chloroconius* Berk and Br.

14. *A. endoxanthus* Berk and Br.

15. *A. haemorrhoidavia* (Kalchbr. et. Schulzer) Fr.

16. *A. ingrata* Moeller

17. *A. livido nitidus* Moeller

18. *A. mediofuscus* (Moell.) Moeller

19. *A. meleagris* (J. Schaeff.)

20. *A. microflavus* sp. nov.

21. *A. micromegethus* PK.

22. *A. microrubescens* sp. nov.

23. *A. moelleri* S. Wasser

24. *A. nivescens* Moller

25. *A. ochraceous* sp. nov.

26. *A. ochroflavus* sp. nov.

27. *A. phaeolepidotus* (Moell.) Moeller

28. *A. pseudopratensis* (Bohus) S. Wasser

29. *A. purpurellus* Moeller

30. *A. rubicolus* sp. nov.

31. *A. rusiophyllus* Lasch

32. *A. semotus* Fr.

33. *A. silvaticus* Schaeff Secr.

34. *A. silvicola* (Vitt) Sacc.

35. *A. simulans* Hooker

36. *A. spissarufosa* sp. nov

37. *A. squamuliferus* Moeller

38. *A. stadii* (Petch) Pegler. Comb. nov.

39. *A. subperonatus* (Lange) Lange

40. *A. trisulphuratus* Berk

41. *A. xanthodermus* Gen

42. *A. xantholepis* (Moell.) Moeller

In order to document the most common species of the state, their frequency of occurrence, and abundance were recorded by repeated collections in the four consecutive monsoon seasons from 20 agroclimatic zones of the state (Table 1). Among the species *A. squamuliferus* was seen abundantly throughout the state during North East and South West monsoons irrespective of soil type and vegetation. *A. ochraceous*, *A. ochroflavus*, *A. trisulphuratus*, *A. subperonata* and *A. psuedopratensis* were also collected from different locations of the state mainly from laterite and red loam soils. Saini *et al.* (1991) collected *A. trisulphuratus* from various localities of Punjab. The common occurrence of *A. campestris* was reported by Sharma *et al.* (1993). In Kerala also *A. campestris* was collected from different places. (Bhavani Devi, 1995 and Sathe and Sasangam 1997) *A. squamuliferus* was reported from Assam also (Kalitha *et al.*, 1999).

Table 15 Periodicity of occurrence and distribution of *Agaricus* spp.

Name of species	Place of collection	Habitat	Zone	Soil type	Month of occurrence
A. abruptibuilbus	Kayamkulam	Coconut basin	Humid greyish onattukara	Sand	November, 1999
A. actinorachis	Silent valley	Forest area	Dry forest loam	Black loam	October 2000
A. altipes	Kozhikode	Grass on road side	Semidry alluvium	Alluvium	June 2000
A. annae	Vellayani, Museum (Thiruvananthapuram)	Under Acacia, oilpalm	Semi dry laterite	Laterite	May 1999
A. arenicolus	Vellayani (Thiruvananthapuram)	Kayalside among grasses	Semidry alluvium	Alluvium	October 1999 May 2000
A. arvensis	Vellayani (Thiruvananthapuram)	Coconut basin, fodder grass on road side	Semi dry laterite	Laterite	April & June 2000
A. augustus	Alwaye	Roadside	subhumid laterite	Laterite	June 2000
A. benesi	CRS, Balaramapuram (Thiruvananthapuram)	Ornamental plants	Semi dry red loam	Red loam	October 1999
A. bernadii	Vellayani (Thiruvananthapuram)	Cowdung heap	Semi dry red loam	Red loam	February 1999
A. bulbosus	Kanjiramkulam (Thiruvananthapuram)	Shades of casuarina	Subhumid laterite	Laterite	December 1999
A. campestris var. floccipes	Kozhikode	grassy land on sides	Semidry alluvium	Alluvium	June 2000
A. caroli	Neyyardam (Thiruvananthapuram)	Near gulmohr	Subhumid laterite	Laterite	October, 1999
A. chloroconius	Vellayani (Thiruvananthapuram)	On earthern walls, roadsides	Semidry red loam	Red loam	October 1999
A. endoxanthus	Vellayani (Thiruvananthapuram) Kollam	Under Acacia & banana	Semidry red loam & semi dry laterite	Red loam, laterite	May, 1999
A. haemorrhoidaria	ORARS, Kayamkulam	Near side walls of buildings	Humid gryish onattukara	Sand	June 2000
A. ingrata	Neyyardam (Thiruvananthapuram)	Under mahagony	Subhumid laterite	Laterite	October, 2000

Table 15 Contd...

Name of species	Place of collection	Habitat	Zone	Soil type	Month of occurrence
A. livido nitidus	Quilandy, (Kozhikode)	Grassy land	Humid laterite	Laterite	June 2000
A. mediofuscus	Balaramapuram (Thiruvananthapuram)	Near side walls of buildings	semi dry laterite	Laterite	May, October 1999 June-2000
A. *meleagris*	ORAS, Kayamkulam	Coconut basin	Humid greyish onattukara	Sand	October 1998 May and October 1999 June 2000
A. microflavus		Grasses on road sides & under Acacia	Semidry alluvium	Alluvium	June 2000
A. micromegethus	Thodupuzha	Open pastures and on road side	Per humid laterite	Laterite	June 2000
A. microrubescens	Balaramapuram (Thiruvananthapuram)	Coconut basin	Semidry red loam	Red loam	May, June & October 1999 June 2000
A. moelleri	Vellayani (Thiruvananthapuram)	Around banana stump	Semidry red loam	Red loam	June 2000
A. nivescens	Vellayani (Thiruvananthapuram)	Coconut basin	Semidry laterite	Laterite	may, 1999
A. ochraceous	Balaramapuram (Thiruvananthapuram) Varkala (Thiruvananthapuram)	Grasses on road side	Semidry laterite, subhumid laterite, Humid laterite	Laterite	May, October 1999, June 2000
A. ochroflavus	Balaramapuram (Thiruvananthapuram) Kottarakkara (Kollam)	under Jack, bread fruit, roadside, near side walls	Semidry red loam, semi dry laterite	Red loam laterite	May 1999 October June 2000
A. phaeolepidotus	Kayamkulam	Dense vegetation	Humid greyish onattukara	Sand	May 2000
A. psuedopratensis	Vellayani (Thiruvananthapuram) Kozhikode	Roadside	Humid laterite, semidry laterite	Laterite	October 1998, June 2000
A. purpurellus	Museum (Thiruvananthapuram)	compostheap	Semidry laterite	Laterite	May, 2000
A. rubicolus		Shades of mahagony, casurina	Humid laterite, semi dry laterite	Laterite	June 2000
A. rusiophyllus	Thrissur	Rubber plantation	Subhumid laterite	Laterite	June 2000

Table 15 Contd...

Name of species	Place of collection	Habitat	Zone	Soil type	Month of occurrence
A. semotus	Marykkunnu (Kozhikode)	Roadside	Humid laterite	Laterite	June 2000
A. simulans	Balaramapuram &Kakkamoola (Thiruvananthapuram)	Side walls of building	Semidry red loam	Red loam	May, June & October-1999 May 2000
A. silvaticus	Kozhikode	Under cashew	Humid laterite	Laterite	June 2000
A. silvicola	Ramanattukara (Kozhikode)	Under broad leaved trees	Humid laterite	Laterite	June 2000
A. spissarufosa	Thrissur	Road side	Subhumid laterite	Laterite	October 1999
A. squamuliferus	Balaramapuram, Neyyardam, Vellayani, Nedumangad Chirenyinkil (TVM) Mavelikkara, Kozhikode, Pathanamthitta	Coconut basin road sides	Semi dry red loam, semi dry laterite, semidry alluvium, subhumid laterite, humid laterite, humid greyish onattukara, Humid forest loam, wet laterite	Red loam laterite alluvium sand forest loam	December 98 April, may, October 99 June 2000
A. stadii	Neyyatinkara Vellayani (Tvm)	Grass lands	Semidry alluvium, semidry laterite	Alluvium laterite	May 1999 October 99
A. subperonatus	Punnamoodu (Tvm) Kozhikode	Roadside	Humid laterite, semidry laterite	Laterite	October 1999 June 2000
A. trisulphuratus	Kanjiramkulam (Tvm) Balaramapuram, Vellayani, (Tvm) Kayamkulam	Roadside coconut basin among grasses	Semidry red loam, semi dry alluvium, Humid greyish onattukara	Red loam alluvium onattukara	October 99 June 2000
A. xanthodermus	Kanjiramkulam (Thiruvananthapuram)	Under acacia tree	Subhumid alluvium	Alluvium	October 99
A. xantholepis	Payyoli (Kozhikode)	Coconut basin	Humid laterite	Laterite	June 2000

In general *Agaricus* spp. preferred laterite soil (Table 15). No collections were obtained from saline soils. Five species were observed from sandy soils of Onattukara region.

Growth, occurrence and distribution of mushroom flora generally depend on rainfall and availability of suitable substrate. Most of the collections were obtained during the month of May-June and September-October which coincide with the early periods of South-West and North-East monsoons (Table 16, Fig. 46). Maximum number of species were recorded immediately after the onset of the monsoons (Table 17). Few species were also observed during April when summer showers were received. In some years some isolated showers were received in April, therefore a few species appeared in April. Bhavanidevi and Nair (1988) classified *Agaricus* as pre-monsoon flora. The above observations reveal that all the species of this genus are premonsoon flora, North East and South West monsoon were equally preferred by *Agaricus* species. Based on the present observation it can be concluded that in Kerala *Agaricus* species prefer periods just before the on set of heavy rains. Summer as well as peak rainy seasons are not conducive for the mushroom flora.

Observations showed that *Agaricus* spp. preferred open grassy areas to woody areas. Only the exception was *A. actinorachis* which could be collected from forest also. Majority of mushrooms were collected from open areas like lawns, roadsides, near side walls of buildings or shades of isolated bushes. Occurrence was mostly isolated or scattered. Groups and fairy ring formation were rare. This agrees with the Pegler's observation that "Generally large troops of fleshy fungi are not be found in East Africa at least not in forest

areas, usual to find the forest floor covered with numerous individual basidiocarps".

Table 16 Seasonal distribution of *Agaricus* spp. during 1999

Month	No. of collections obtained	Temperature (^{0}C)		Rainfall (mm)	R.H. (%)
		Maximum	Minimum		
January	-	31.2	22	5.2	84.6
February	1	31.4	22.8	78.6	81.9
March	-	32.5	24.4	58.2	65.7
April	1	33.5	24.9	147.2	82.1
May	16	30.5	23.2	408.5	87.3
June	1	29.5	23.9	297.4	36.9
July	-	29	23.5	154.2	83.9
August	-	29.7	23.7	108.4	86.1
September	-	31.1	23.9	10.4	74
October	14	29	22.5	374.9	86.8
November	2	29.7	23.2	156.8	81.7
December	1	30.4	21.7	6.6	79.2

Fig. 46 Seasonal distribution of *Agaricus* spp. during 1999

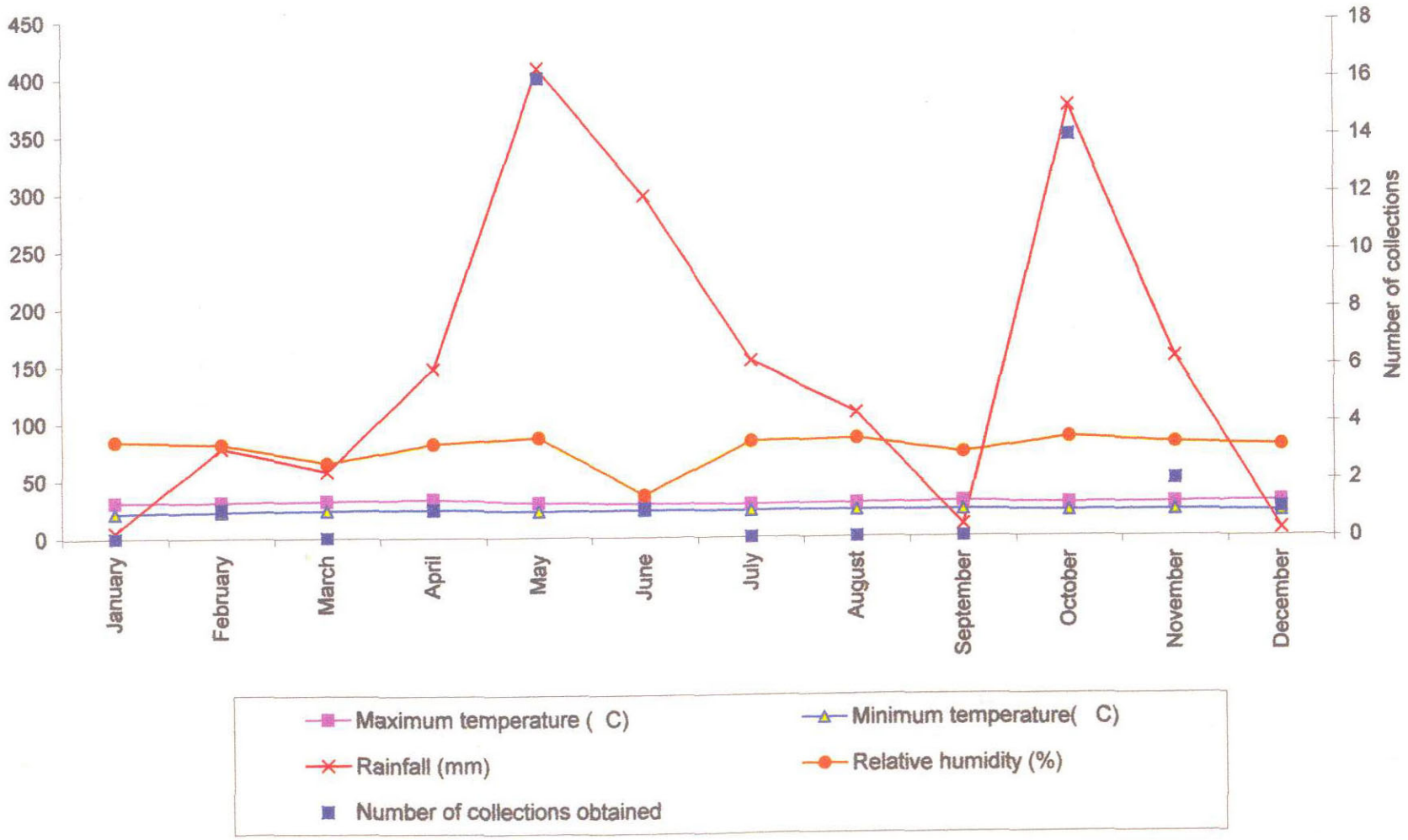


Table 17 Collection obtained and rainfall data during south west and north east monsoons of 1999

Date	Collections obtained	Rainfall (mm)
6-5-99	-	0.8
7-5-99	-	-
8-5-99	*A. trisulphuratus*	38.8
9-5-99	-	0.6
10-5-99	-	-
11-5-99	-	2.6
12-5-99	-	2
13-5-99	-	-
14-5-99	*A. mediofuscus*	4.6
15-5-99	-	62.6
16-5-99	-	66
17-5-99	-	12.2
18-5-99	*A. nivescens*	0.6
19-5-99	*A. squamuliferus*	24.6
20-5-99	-	1.8
21-5-99	*A. squamuliferus*	10.4
22-5-99	*A. orchroflavus*	0.8
23-5-99	-	11.2
24-5-99	*A. squamuliferus*	3.6
25-5-99	-	59
26-5-99	*A. ochroflavus, A. annae*	30
27-5-99	-	7.6
28-5-99	-	0.6
29-5-99	*A. purpurellus, A. annae*	12.2
30-5-99	-	26.9
31-5-99	*A. endoxanthus*	29
1-6-99	-	1.6
2-6-99	-	6.2
3-6-99	-	2.6
4-6-99	-	0

Table 17 Contd...

Date	Collections obtained	Rainfall (mm)
5-6-99	-	0
6-6-99	-	71.4
7-6-99	-	58.8
8-6-99	-	117.4
9-6-99	-	17.4
10-6-99	-	42.2
11-6-99	-	3.6
12-6-99	-	12.4
13-6-99	-	14.8
14-6-99	-	10.4
15-6-99	-	2.6
16-6-99	-	9.0
17-6-99	-	0.4
18-6-99	-	1.2
19-6-99	-	0
20-6-99	-	1
21-6-99	-	24.4
1-10-99	-	1.2
2-10-99	-	6.8
3-10-99	-	-
4-10-99	-	-
5-10-99	-	11.6
6-10-99	-	41.2
7-10-99	-	1.6
8-10-99	-	4.6
9-10-99	-	47.8
10-10-99	*A. stadii, A. arenicolus*	-
11-10-99	-	7
12-10-99	-	0.4
13-10-99	*A. spissarufosa*	5.8
14-10-99	*A. ochroflavus*	26.1
15-10-99	*A. squamuliferus*	44.8

Table 17 Contd...

Date	Collections obtained	Rainfall (mm)
16-10-99	*A. benesi*, *A. squamuliferus* *A. ochraceous*	19.8
17-10-99	*A. squamuliferus*	11.4
18-10-99	*A. subperonatus*	15.6
19-10-99	*A. rubicolus*, *A. squamuliferus*	-
20-10-99	-	20.6
21-10-99	*A. xanthodermus*	-
22-10-99	*A. squamuliferus*	-
23-10-99	*A. chloroconius*	10.8
24-10-99	*A. caroli*	-
25-10-99	*A. squamuliferus*	-
26-10-99	*A. ingrata*	-
27-10-99	-	70.8
28-10-99	-	15.4
29-10-99	-	-
30-10-99	-	11.2
31-10-99	-	0.4

The spores of these species are purple brown in colour and can be grouped under porphyrosporeae (Singer, 1961). Out of the 42 spp. identified, in 24 spp. context of the carpophore remained unchanged or stained pinkish or reddish on handling or on ageing. They are *A. trisulphuratus*, *A. benesi*, *A. squamuliferus*, *A. caroli*, *A. arenicolus*, *A. simulans*, *A. mediofuscus*, *A. spissarufosa*, *A. bernadii*, *A. ingrata*, *A. ochroflavus*, *A. bulbosus*, *A. ochraceous*, *A. actinorachis*, *A. chloroconius*, *A. silvaticus*, *A. subperonatus*, *A. rubicolus*, *A. microrubescens*, *A. haemmorrhoidarius*, *A. stadii*, *A. altipes*, *A. lividonitidus* and *A. campestris* var. *floccipes*. In the others, the context of

the carpophores when fresh becomes pale yellow, lemon yellow or bright chrome yellow on ageing or on handling. .

A. trisulphuratus has bright orange and felty floccose pileus. Pileus of *A. benesi*, *A. squamuliferus A. caroli*, *A. arenicolus*, *A. simulans*, *A. stadii*, *A. altipes*, *A. campestris* var *floccipes*, *A. xanthodermus*, *A. abruptibulbus* and *A. arvensis* are white, *A. endoxanthus* is brown, *A. psuedopratensis* and *A. lividonitidus* are grey. In the rest of the collection, pileus was covered with brown, yellowish brown, yellow or reddish brown small or large squamulose scales arranged concentrically or not, in the pale background.

A. abruptibulbus, *A. arvensis*, *A. nivescens*, *A. silvicolus*, *A. rusiophyllus*, *A. semotus*, *A. xantholepis*, *A. purpurellus*, *A. micromegethus*, *A. microflavus* and *A. augustus* showed positive reaction with aniline oil and nitric acid. Generally cystidia except chielocystidia are absent in agaricus species and *A. rusiophyllus*, *A. stadii*, *A. altipes*, *A. lividonitidus* and *A. campestris* var. *floccipes* lack both chielocystidia and pleurocystidia.

Stipe of *Agaricus* species is central, cylindrical with or without a basal bulb. *A. silvicolus*, *A. abruptibulbus*, *A. phaeolepidotus*, *A. meleagris*, *A. bulbosus*, and *A. ochroflavus* have bulbous base. In *A. rusiophyllus*, *A. altipes* and *A. ochraceous* stipe enlarge gradually towards base. A comparison of the morphological characters of the collected species are given in Table 18.

Most of the reports of the genus *Agaricus* were from the northern parts of India. The species so far reported from Kerala are *A. campestris* (Sathe and Sasangan, 1977), *A. arvensis*, *A. augustus*, *A. campestris*, *A. diminutives*, *A. iodolens*, *A. langei*, *A. placomyces*, *A. silvaticus*, *A. xanthodermus* (Bhavani Devi,

1995). *A. johnstoni* (Vrinda *et al.*, 1997) and *A. volvatus* (Vrinda *et al.*, 1999).

A. abruptibulbus, *A. actinorachis*, *A. altipes*, *A. annae*, *A. arenicolus* *A. benesi.*, *A. bernadii*, *A. bulbosus*, *A. caroli*, *A. chloroconius*, *A. ingrata*, *A. haemorrhoidaria*, *A. lividonitidus*, *A. mediofuscus*, *A. meleagris*, *A. microflavus*, *A. micromegethus*, *A. microrubescens*, *A. moelleri*, *A. nivescens*, *A. ochraceous*, *A. ochroflavus*, *A. phaeolepidotus*, *A. pseudopratensis*, *A. purpurellus*, *A. rubicolus*, *A. rusiophyllus*, *A. semotus*, *A. silvicola*, *A. simulans*, *A. spissarufosa*, *A. squamuliferus*, *A. stadii*, *A. subperonatus*, *A. trisulphuratus* and *A. xantholepis* arte new reports from Kerala. Among these species *A. actinorachis*, *A. annae*, *A. arenicolus*, *A. benesi.*, *A. bernadii*, *A. bulbosus*, *A. caroli*, *A. chloroconius*, *A. ingrata*, *A. lividonitidus*, *A. mediofuscus*, *A. microflavus*, *A. microrubescens*, *A. moelleri*, *A. nivescens*, *A. ochraceous*, *A. ochroflavus*, *A. phaeolepidotus*, *A. purpurellus*, *A. rubicolus*, *A. rusiophyllus*, *A. simulans*, *A. spissarufosa*, *A. stadii* and *A. subperonatus* are first report from India.

A. bulbosus, *A. microflavus*, *A. microrubescens*, *A. ochraceous*, *A. ochroflavus*, *A. rubicolus* and *A. spissarufosa* are the new species reported during the study. *A. bulbosus* is a medium sized *Agaricus* sp. Pileus is light pink with yellowish brown centre surrounded by small adpressed squamules arranged concentrically and stipe with a prominent bulbous base. Eventhough *A. placomyces*, *A. abruptibulbus* have bulbous base, the colour of pileus and scales are different. In the case of *A. ochraceous* and *A. ochroflavus*, pileus is covered with yellowish brown squamules and their stipe is different. The chielocystidia of *A. bulbosus* is also larger.

A. microflavus is a small sized species, having pileus of 3-6 cm in diameter with small orange brown squamules arranged more in the centre. This species is also characterized by the positive Schaeffer's cross reaction and the colour change of the context (turns chrome yellow) especially in the base of stipe on bruising. This species is similar to *A. xantholepis* by the colour of scales in the pileus, but differ in having a short stipe and greyish white gills when young.

As the name indicate *A. microrubescens* is mall in size and the context reddens strongly on exposure. Chielocystidia is large. *A. benzodorus* Heinem and Goss reported from East Africa is close to this species, but the spores and cystidia are smaller.

In *A. ochraceous*, pileus is a pale white with yellowish brown centre and scattered small squamules. The stipe is obclavate or gradually enlarged downwards. *A. bulbosus, A. ochroflavus* are similar to this species in colour of pileus, but the stipe of *A. bulbosus* is with a prominent bulbous base and that of *A. ochroflavus* is slender and hollow. *A. nivescens* reported by Pegler in his preliminary Agaric flora of East Africa is similar to *A. ochraceous,* morphologically but *A. ochraceous* has negative Schaffer's cross reaction and changes to red on bruising.

A. ochroflavus is similar to *A. ochraceous, A. bulbosus* and *A. augustus* by the colour of pileus and scales, but differ from all these by the slender, hollow stipe.

A. rubicolus is a gregariously growing species and the size of pileus varies from 4-12 cm and the pileus and the stipe are densily covered with

firmly adpressed fibrillose to squamulose scales. The sudden reddening of the context and gills on bruising are the important characters of this species.

A. spissarufosa is medium sized *Agaricus* with short stipe. This species is very much similar to *Psalliota spissa* macroscopically. But the chielocystidia of *P. spissa* is small whereas that of *A. spissarufosa* is subglobese and large in size.

Table 18 Morphological characters of collected *Agaricus* spp.

Name of species	Pileus diameter and colour	Basidia size	Cheilocystidia	Spores	Schaeffer's cross reaction
A. abruptibulbus	White, 4-7 cm	clavate, 20 x 6µm	globose balloon shaped 21-30x10.5-18µm	oval 6 x 4 5µm	+
A. actinorachis	6-7.5 cm, grayish white with brown squamules	clavate, 14-15 x 6µm	piriform 14-16.5 x 10-12 µm	ellipsoid 6-7.5 x 3.5-4.5 µm	-
A. altipes	yellowish white, 4-7cm	clavate, 24-26 x 8-10 µm	absent	oval, 6-7. 5x4. 5-5.2 µm	-
A. annae	pinkish white with reddish brown squamules 7-9cm	clavate 15-19.5 x 7.5 µm	long, piriform, 21-36 x 13.5-15 µm	ovoid 6-6.75 x 3.75 µm	–
A. arenicolus	White 4-5m	clavate 21 x 6 µm	clavate 23-25 x 7.5 µm	roundish oval 6 x 4.5 µm	-
A. arvensis	white, 5-8 cm	clavate, 21-24x6-9µm	clavate to balloon shaped, 10.5-15 x 7.5-12µm	ovate, 6.75-7.5 x 4.25 -45 µm	+
A. augustus	6-8.5 cm, brownish yellow squamules on pale background	clavate, 20-25 x 7.5-10µm	variable shape, 15-25 x 17-18µm	ovate, 7-8 x 4.5-5.25 µm	+
A. benesi	white, 5-7 cm	clavate, 19.5-20 x 6-7.5 µm	clavate to piriform, 19.5 -24 x 12-15 µm	ovate to ellipoid, 19.5-24 x 12-15 µm	-

Table 18 Contd...

Name of species	Pileus diameter and colour	Basidia size	Cheilocystidia	Spores	Schaeffer's cross reaction
A. bernardii	dark brown, 8-9 cm scales on pale background	clavate, 20-28 x 8-8.5 µm	clavato piriform, 24-28x 8-12 µm	ovate to round, 5.5-6x4-5 µm	-
A. bulbosus	6-8cm, light pink with yellowish brown squamules	clavate, 15-18 x 8-10µm	piriform, 19.5-24 x 12-15cm	ovate to ellipsoid, 19.5-24 x 12-15 µm	-
A. campestris var. *floccipes*	4-5 cm, white	clavate, 20-24 x 7.9µm	absent	ovate, 6-7.25 x 4.5 µm	-
A. caroli	5-6.5, white	clavate, 18-19.5 x 9µm	clavate, 24-27 x 15µm	ellipsoid, 7.5 x 5µm	-
A. chloroconius	1.5-2cm, sulphur yellow with darker squamules	clavate, 13-14 x 4.5 µm	cylindric, 14-19 x 4.5-7 µm	ovoid, 5-6 x 3-3.5 µm	-
A. endoxanthus	7-10 cm, brown	clavate, 16-20 x 5.5-6.5 µm	piriform, 12-14 x 8-10 µm	ovoid to ellipsoid 5-6 x 3-4.5 µm	-
A. haemorrhoidaria	8-9 cm, brown squamules on pale background	clavate, 26-28x6-7µm	clavato fusiform, 30-37.5 x 10.5 µm	ovately round , 5x 3.5 µm	-
A. ingrata	6-7cm, brown sales on whitish background	clavate, 26-28 x 6-7 µm	clavato fusiform, 30-37.5 x 10.5 µm	ovately round, 5x 3.5 µm	-
A. lividonitidus	5-6 cm, light violet grey	clavate, 22-24 x 7.8µm	absent	ovate to globose, 6x4.5 µm	-
A. mediofuscus	4-7 cm, pale greyish brown with dark brown squamules	clavate, 15-18 x 7-7.5 µm	clavate, 25-40 x 8.15 µm	ovate, 7.5-8.5 x 5µm	-
A. meleagris	8-10cm, whitish grey with dark brown scales	clavate, 18-20 x 5-6µm	15-16.5 x 8-10µm, piriform	ovate to ellipsoid, 4.75 x 3µm	-
A. microflavus	3-6 cm, greyish white with orange brown squamules	clavate, 12-13.5 x 6.5-7.5 µm	piriform or clavate, 22.5-27 x 9-16µm	ovoid, 4.5 - 6x3.75-4µm	+

Table 18 Contd...

Name of species	Pileus diameter and colour	Basidia size	Cheilocystidia	Spores	Schaeffer's cross reaction
A. micromegethus	2.5-5cm, cream with yellowsih brown squamules	clavate, 18-20 x 7.5-8µm	piriform, 12-24 x 8-18µm	ovoid, 6-6.5 x 4.5µm	+
A. microrubescens	2-4cm, greyish pink with brown squamules	clavate, 20-22 x 7.5-9µm	broadly clavate, piriform, 20-26 x 18.24µm	ovoid, 6-7x 4.5 µm	-
A. moelleri	5-10cm, black in centre which lightens towards margin	clavate, 18-20 x 5.5-6 µm	piriform, 18-25x 8-13µm	ovate, 5-6x3µm	-
A. nivescens	5-7cm, white	clavate, 20-22x6-8µm	shortly clavate to button shaped, 14-16 x 8-11 µm	ovate, 5-6.5 x 4.5 µm	+
A. ochraceous	5-6cm, pale white with yellowish brown squamules	clavate, 19-21 x 7-10µm	variable shape, 15-24 x 7.5-24 µm	broadly ellipsoid, 6.5-7.5 x 4.5-5 µm	-
A. ochroflavus	5-7.5cm, yellowish brown squamules on pale background	clavate, 19.5 x 7.5 µm	piriform, 22.5-24 x 13.5-16.5µm	ellipsoid, Ovoid 6 x 4.5 µm	-
A. phaeolepidotus	5.8cm, dark brown squamules on whitish background	clavate, 18-20x6µm	broadly clavate, 18-22 x 12-15µm	ovate, 5.25-6 x 3.75 µm	-
A. pseudopratensis	3-7cm, grey	clavate, 22-24 x 9µm	piriform, 15-22 x 12-13.5µm	globose to ovate, 5.256 x 3.75-4.5 µm	-
A. purpurellus	4.5cm, pink with a brown centre	clavate, 18-21x6-7.5 µm	piriform, 15-18 x 9-10.5µm	ovoid, 4.5-5.25 x 3-3.75 µm	+
A. rubicolus	4-12 cm, brownish yellow	clavate, 14-16 x 7-8µm	piriform variable shape, 22-30x 9.12 µm	ovoid, 6x 3-3.5	-

Table 18 Contd...

Name of species	Pileus diameter and colour	Basidia size	Cheilocystidia	Spores	Schaeffer's cross reaction
A. rusiophyllus	2-4cm, yellowish white with pinkish red squamules	clavate, 14-15 x 7µm	absent	ovate to ellipsoid, 4.5 x 5.25 x 3µm	+
A. semotus	1-4cm, whitish with reddish pink squamules	clavate, 15-18 x 6-7 µm	piriform, 12-15 x 9-10 µm	ovate to ellipsoid, 4.5-5 x 2.5-3.5 µm	+
A. silvaticus	5-7cm, off white with umber brown squamules	clavate, 20-21x7µm	clavate to globose, 18-24x10.5-15µm	ovoid, 4.5-6 x 3.754 µm	-
A. silvicola	4-6cm, white	clavate, 20-22 x 6.75-7.5 µm	ovate to subglobose, 18-20 x 10-18Vm	ovate to ellipsoid 5-6x 3.75 -45 µm	+
A. simulans	4-7cm, white	clavate, 19-20x 7.5 µm	cylindric, 21-26 x 4.5-6µm	ovoid, 4.75-6.75 x 4.5 µm	-
A. spissarufosa	5-8cm greysih white with brown squamules	clavate 12-14 x 9-11 µm	subglobose 18-20 x 15-17µm	ovoid, 5.5-6x4.5-5µm	-
A. squamuliferus	6-13 cm, white	clavate, 18.24 x 5.7µm	globose to broadly clavate, 14-24 x 18-25µm	ovate, 6-7x4.25-4.75 µm	-
A. stadii	5-6cm, white	clavate, 13x6µm	absent	ovoid, 6-6.75 x 4.5µm	-
A. subperonatus	7-8cm, light reddish brown with brown squamulus	clavate, 26-28x7-9µm	broadly clavate, 30x9-13µm	ovate, 5.25-6x4µm	-
A. trisulphuratus	orange, 2.4cm floccose squamulus	clavate, 14-15.5x 5-6µm	cylindric, 23-24.5x7.59 µm	ovoid to ellipsoid, 4.8-5.6 x 3.5 µm	-
A. xanthodermus	4-8cm white	clavate, 13.5-18 x 6 µm	piriform, 18-20 x 12-13.5 µm	subovate, 4.75-5.25 x 3 µm	-
A. xantholepis	2.5 cm, white with yellow squamules	clavate, 18-20x 56µm	broadly clavate, 15-22 x 7-9 µm	ovate, 4.5-5.25 x 3-3.5 µm	+

Eventhough most of the *Agaricus* spp. except few like *A. xantodermus*, *A. endoxanthus* and *A. xantolepis* were reported as edible (Dornberger *et al.*, 1986; Bhavani devi, 1995 and Patil *et al.*, 1995) the ethnomycological data revealed that local people rarely consume *A. campestris*, *A. stadii* and *A. squamuliferus*. Characters like coloured scales, purplish brown gills make the other *Agaricus* species available locally disagreeable to country folk.

Based on the morphological characters like size, shape, colour, smell and the abundance of occurrence *A. caroli*, *A. ochraceous*, *A. ochroflavus*, *A. stadii* and *A. squamuliferus* could be recommended as potential species for cultivation.

Relative humidity and atmospheric temperature on the day of collections were observed and found that minimum and maximum temperature for the day of collection ranged from 21.9 – 31.6^0 C. Maximum temperature recorded on the day of collection of most of the species ranges from 27 to 30^{0}C. From this it is clear that tropical *Agaricus* spp. grow on relatively higher temperature of more than 27^{0}C. Relative humidity recorded on the day of collection ranged between 78-98 per cent.

The moisture content of the substrate on which the *Agaricus* grow ranged from 10 – 20 per cent. *A. bernadii*, *A. microrubescence*, *A. pupurellus* and *A. xanthodermus* were found to occur on soils with high organic matter content and moisture percentage above 20. *Agaricus* spp. preferred an acidic medium; pH ranging from 4.2-6.6. Laboratory studies also supported this (Distisch, 1978 and Furlan, 1997).

Growth of *Agaricus* spp. was tried in different solid media including semisynthetic media viz., malt extract agar, potato dextrose agar, oats agar,

yeast extract agar and complete media and synthetic media viz., Czapek's Dox media, Coon's media, Richard's media, Sacch's media, glucose mineral media and Hendrix media. Various *Agaricus* spp. viz., *A. bisporus*, *A. bitorquis*, *A. ochroflavus*, *A. pseudopratensis*, *A. purpurellus*, *A. squamuliferus* and *A. trisulphuratus* were used as test fungi. All the species prefer semi synthetic media than synthetic media. Out of the eleven media tested yeast extract media, Czapek's Dox media and Hendrix media did not favour the growth of *Agrcius* spp.

In the case of *A. bisporus* and *A. squamuliferus* maximum growth was found on complete media followed by malt extract agar. *A. bitorquis* grows best in complete media followed by malt extract agar malt extract agar potato dextrose agar. *A. purpurellus*, *A. pseudopratensis* and *A. trisulphuratus* had maximum growth on complete media and malt extract. Malt extract agar, potato dextrose agar and compost agar were recommended as best media for culture maintenance of *A. bitorquis* by Fritsche (1968) and Hayes (1972). Iqbal *et al.* (1988) tested complete medium, malt extract medium and potato dextrose medium and found that complete medium gave maximum radial colony diameter followed by the malt extract agar and potato dextrose agar. In liquid media also growth of *Agaricus* spp. was found to be maximum on complete media and malt extract.

Effect of temperature on the mycelial growth of *Agaricus* spp. was studied by growing them in complete media at different temperature viz., 10,15, 20, 25, 30 and 35^{0}C. It was observed that 25 and 30^{0}C were favourable for the growth of *Agaricus* spp. At 10^{0}C all the test fungus except *A. bisporus* had no growth and at 35^{0}C only *A. bitorquis, A. trisulphuratus* and *A. microrubescens* had scanty growth. Based on the regression and correlation analysis optimum

temperature for the growth of tropical species were found to be 23.96 to 25.01^{0}C. For *A. bisporus,* which is a temperate species the optimum temperature was found to be 22.02^{0}C Fritsche (1968) reported that temperature requirements of *A. bitorquis* and *A. bisporus* are 20-30^{0}C and 24^{0}C respectively. Similar observation was also made by Iqbal (1988) and Khan *et al.* (1991) on different media. .

Agaricus spp. were grown in complete media with different pH viz., 4.5, 5, 6, 7 and 8 to study the effect of pH on the its growth and observed that growth of mycelium increase upto pH of six and then growth decreased. Growth was found to be minimum at pH eight. During the survey, substrate from where collections were obtained were analysed and it was found that, the pH of the substrates ranges from 4.2-6.6. Regression and correlation analysis indicate that the optimum pH for the growth of different species of *Agaricus* ranges from 5.14 to 6.1. Dirtisch (1978) observed maximum growth of *A. bisporus* when the organism was grown pH of 5.3. Furlan (1997) found higher growth of *A. bitorquis* at pH 5.0.

Role of light on the growth of mycelium of *Agaricus* spp. was stu. d and it was observed that light had little effect on the growth. Certain species preferred darkness. *A. bisporus*, *A. purpurellus*, *A. spissarufosa* and *A. semotus* had better growth in darkness. *A. bitorquis*, *A. pseudopratensis*, *A. trisulpharatus*, *A. ochroflavus A. benesi*, *A. ochraceous*, *A. squamuliferus*, *A. xanthodermus*, *A. rubicolus* and *A. moelleri* grows equally well in light and dark. Growth of *A. edulis* and *A. campestris* were studied in moderate day light and in dark and found that their growth was uninfluenced by light

(Gramss, 1984). Furlan *et al.* (1997) reported that the absence of light favoured rapid mycelial development of *Agaricus* spp.

To study the effect of different carbon source on the growth of *Agaricus* spp. various carbon sources viz, fructose, glucose, mannose, sucrose and xylose were used. Almost all species did not prefer xylose and mannose. Growth was maximum on glucose, sucrose and fructose. Distsch (1978) reported that *A. bisporus* can be grown on synthetic medium containing hexose viz., fructose, glucose and mannose. Baurs *et al.* (1994) observed good growth is defined buffered medium with glucose as a carbon source.

Growth of *Agaricus* spp. on different inorganic nitrogen sources viz., ammonium nitrate, ammonium chloride and sodium nitrate and organic nitrogen viz., peptone were studied. All species of *Agaricus* studied showed maximum growth on media with the organic nitrogen source i.e. peptone. Khan *et al* (1991) reported peptone as the best source of nitrogen. Baurs (1994) studied the nitrogen assimilation in white button mushroom by growing *A. bisporus* in a defined medium with a number of organic nitrogen and no growth was observed when nitrate was used as the nitrogen source.

Five grain substrates viz., paddy, maize, ragi, sorghum and wheat were used to study their comparative efficiency in supporting mycelial growth of *A. bitorquis* and *A. squamuliferus*. It was observed that wheat supported maximum growth for both the species. This was followed by sorghum, maize and ragi which gave good growth. Both *A. bitorquis* and *A. squamuliferus* grow poorly on paddy grain.

Mycelial growth on wheat grain was maximum when incubated at 25^0C and 30^0C, whereas growth was poor at 20^0C and it failed to grow at 15^0C.

Guleria (1985) also reported that incubation temperatures of 30^0C was good for spawn growth on grains.

Three types of compost viz., coirpith compost, vermicompost and traditional compost prepared by short method were used to study the spawn run of *A. bitorquis* and *A. squamuliferus* and spawn run was found in traditional compost. Growth started five days after spawning and completed by 20 days. After that casing was given and case run completed by 7-10 days. The pin heads started appearing within 10-12 days after casing and they matured and fully opened on 6th day.

An yield of 400g buttons was obtained from 10 kg compost. Even though the yield obtained was less than the average yield obtained in our country, this preliminary study showed the possibilities of commercial cultivation of this excellent mushroom species under Kerala conditions.

Summary

6. SUMMARY

The warm humid climatic conditions and diversity in soils of the state favour the luxuriant growth of a wide variety of fungal flora. Results of the present survey conducted reveal the occurrence of a wide range of *Agaricus* species in Kerala thereby indicating the congenial conditions and immense potentialities of this state to support the luxuriant growth of this excellent species. For the exploitation of the flora, systematic collection identification, detailed description and documentation of each species along with the place of occurrence and the seasons of its appearance are inevitable.

For the study, collections were made during South-West and North East monsoon periods of 1998-2000 in 20 agroclimatic zones of Kerala. Forty two species of *Agaricus* were collected from different zones.

1. *A. abruptibulbus* PK.
2. *A. actinorachis* Berk and Br.
3. *A. altipes* (Moell.) Pill.
4. *A. annae* Pilat
5. *A. arenicolus* Wakefield et Pearson
6. *A. arvensis* Schaeff. Secr.
7. *A. augustus* Fr. var. albus Mos.
8. *A. benesi* Pilat
9. *A. bernardii* (Quel.) Sacc.
10. *A. bulbosus* sp. nov.
11. *A. campestris* var. *floccipes* (L.) Fr.
12. *A. caroli* Pilat

13. *A. chloroconius* Berk and Br.

14. *A. endoxanthus* Berk and Br.

15. *A. haemorrhoidavia* (Kalchbr. et. Schulzer.) Fr.

16. *A. ingrata* Moeller

17. *A. livido nitidus* Moeller

18. *A. mediofuscus* (Moell.) Moeller

19. *A. meleagris* (J. Schaeff.)

20. *A. microflavus* sp. nov.

21. *A. micromegethus* PK.

22. *A. microrubescens* sp. nov.

23. *A. moelleri* S. Wasser

24. *A. nivescens* Moller

25. *A. ochraceous* sp. nov.

26. *A. ochroflavus* sp. nov.

27. *A. phaeolepidotus* (Moell.) Moeller

28. *A. pseuedopratensis* (Bohus) S. Wasser

29. *A. purpurellus* Moeller

30. *A. rubicolus* sp. nov.

31. *A. rusiophyllus* Lasch.

32. *A. semotus* Fr.

33. *A. silvaticus* Schaeff. Secr.

34. *A. silvicola* (Vitt.) Sacc.

35. *A. simulans* Hooker

36. *A. spissarufosa* sp. nov.

37. *A. squamuliferus* Moeller

38. *A. stadii* (Petch) Pegler. Comb. nov.

39. *A. subperonatus* (Lange) Lange

40. *A. trisulphuratus* Berk.

41. *A. xanthodermus* Gen.

42. *A. xantholepis* (Moell.) Moeller

Out of the 42 species 36 species were new reports from Kerala, *A. abruptibulbus*, *A. actinorachis*, *A. altipes*, *A. annae*, *A. arenicolus*, *A. benesi*, *A. bernardii*, *A. bulbosus*, *A. caroli*, *A. chloroconius*, *A. ingrata*, *A. haemorrhoidaria*, *A. livido nitidus*, *A. mediofuscus*, *A. meleagris*, *A. microflavus*, *A. micromegethus*, *A. microrubescens*, *A. moelleri*, *A. nivescens*, *A. ochraceous*, *A. ochroflavus*, *A. phaeolepidotus*, *A. pseudopratensis*, *A. pupurellus*, *A. rubicolus*, *A. rusiophyllus*, *A. semotus*, *A. silvicola*, *A. simulans*, *A. spissarufosa*, *A. squamuliferus*, *A. stadii*, *A. subperonatus*, *A. trisulphuratus* and *A. xantholepis* were new reports to Kerala. Among this species *A. actinorachis*, *A. annae*, *A. arenicolus*, *A. benesi*, *A. bernardii*, *A. bulbosus*, *A. caroli*, *A. chloroconius*, *A. ingrata*, *A. livido nitidus*, *A. mediofuscus*, *A. microflavus*, *A. microrubescens*, *A. moelleri*, *A. nivescens*, *A. ochraceous*, *A. ochroflavus*, *A. phaeolepidotus*, *A. purpurellus*, *A. rubicolus*, *A. rusiophyllus*, *A. simulans*, *A. spissarufosa*, *A. stadii* and *A. subperonatus* were first reports from India.

Considering the morphological characters like size, shape, colour, smell and the abundance of occurrence *A. caroli*, *A. ochraceous*, *A. ochroflavus*, *A. stadii* and *A. squamuliferus* are recommended as potential species for cultivation under Kerala conditions.

Agaricus spp. preferred laterite soil. No collections were obtained from saline soils. Five species were observed from sandy soils of Onattukara region.

Growth occurrence and distribution of mushroom flora generally depend on rainfall and availability of suitable substrate. Most of the collections were obtained during May-June and September-October months coinciding with the early south-west and north-east monsoon seasons. Table-17 reveals that mushroom growth reduced considerably during the peak monsoon season. The above observations reveal that all the species of this genus are premonsoon flora and North East and South West monsoon were equally preferred by *Agaricus* species.

Growth of *Agaricus* spp. was tried in different solid media. All the *Agaricus* spp. *viz., A. bitorquis, A. bisporus, A. squamuliferus* and *A. purpurellus, A. pseudopratensis* and *A. trisulphuratus* which were grown on artificial media preferred complete medium for its growth.

Effect of temperature on the mycelial growth of *Agaricus* spp. was studied by growing them in complete media at different temperature viz., 10,15, 20, 25, 30 and 35^{0}C. It was observed that *Agaricus* spp. preferred a temperature range between 25 and 30^{0}C for its growth.

The maximum growth of *Agaricus* spp. in complete media was noticed when the pH of the media was six and at pH 8 it failed to grow. The result on the growth of mycelium of *Agaricus* spp. revealed that light did not play any significant effect on growth of the fungi. Among the different carbon sources tried *Agaricus* spp. preferred glucose, sucrose and fructose while its growth

was reduced considerably in xylose and mannose. Among the different nitrogen sources *Agaricus* spp. exhibited best growth in organic nitrogen (peptone) compared to inorganic sources of nitrogen.

Growth of *A. bitorquis* and *A. squamuliferus* was maximum in wheat grain compared to four other (paddy, maize, ragi and sorghum) grain substrates. Among the grain substrates paddy grain was least effective one. Mycelial growth on wheat grain was maximum when it was incubated at 25^0C and 30^0C, no growth was recorded at 15^0C.

Spawn run of *A. bitorquis* and *A. squamuliferus* were noticed only on traditional compost and they failed to grow on coir pith and vermicompost. Growth of *A. bitorquis* was started five days after spawning and it completed by 20 days. After that casing was given and case run was completed by 7-10 days. The pin heads started appearing within 10-12 days after casing and they matured and fully opened on the 6^{th} day.

Four hundred grams of buttons were obtained from 10 kg compost. Even though the yield obtained was less than the average yield obtained in India, this preliminary study showed the possibilities of commercial cultivation of this excellent mushroom species under Kerala condition. For this studies are required and standardisation of cultivation practices is necessary before it is commercialized.

References

REFERENCES

*Abraham, S.P and Kaul, T.N. 1988. Large fungi from Kashmir. *V. Mycologica Neotropica Applicada.* **1** : 55-70

Abraham, S.P. 1991. Kashmir Fungal flora an overview. *Proceedings of National Symposium on Mushroom*, January 22-24, 1991 (ed. Nair, M.C.). Kerala Agricultural University, Thrissur, pp. 13-14

Arora, D. 1989. Mushrooms Demystified. Ten speed press, USA, p. 395

Atri, N.S., Saini, S.S and Gupta, A.K. 1991. Systematic studies on *Agaricus campestris* L. Fr. *Geobios New Rep.* **10** : 32-37

*Atri, N.S., Saini, S.S and Gupta, A.K. 1992. Fungi of Punjab VI. Studies on the genus *Agaricus* L: Fr. *J. Indian Bot. Soc.* **71** : 119-121

Bahukhandi, D and Kapoor, J.N. 1991. Low cost substitute of malt extract agar medium. *Proceedings of National Symposium on Mushroom*, January 22-24 1991 (ed. Nair, M.C.). Kerala Agricultural University, Thrissur, pp. 9

Bakshi, B.K and Puri, Y.N. 1978. Edible fungi - their survey and cultivation. *Indian Mushroom Science* - I. (eds. Atal,C. K., Bhat, B.K. and Kaul, T. N.). Indo Am. Literature house. pp. 465-473

Banerjee, S. N. 1947. Fungus flora of Calcutta and Subarbs. *Bull. Bot. Soc. Bengal.* **1** : 37-54

Baurs, J.J.P., Camp, H.J.M., Hermons, J.M.H; Mikes, V., Drift. Evander Griensven, L., Van; J.L.D., Vogles, Z.D. 1994. Nitrogen assimilatory enzymes in the white button mushroom. *A. bisporus. Microbiol. Readings UK.* **140** : 1161-1168

Berkeley, M. J. 1856. Decades of fungi. *Hooker's London J. Bot.* **3-8** : 1844-1856

Bhattacharya, B., Dutta, A. and Baruah, H.K. 1952. Fungi of Assam. *J. Univ. Gouhati* **4** : 287-312

Bhavani Devi, S. 1982. Studies on edible mushrooms of Kerala with special reference to paddy straw mushrooms. Ph.D thesis. Kerala Agricultural University, Thrissur, p. 221

Bhavani Devi, S. 1995. Mushroom flora of Kerala. *Advances in Horticulture* : 13 Mushroom (eds. Chadha, K.L.and Sharma, S.R.). Malhotra Publishing House, New Delhi, pp. 277-317

Bhavani Devi, S. and Nair, M.C. 1988. Mushroom flora of Kerala. DST Project Report, Kerala Agricultural University, Thrissur, p.58

Bose, S.R and Bose, A. B. 1940. An amount of edible mushrooms of India. *Sci. Cult.* **6** : 141-149

Bose, S.R. 1921. Possibilities of mushroom Industry in India by cultivation. *Agric. J. India.* **16** : 643-647

*Butler, E.J. and Bisby, G.R. 1931. *The fungi of India.* Imperial Council of Agricultural Research, India, p. 237

Butler, E.J and Bisby, G.R. 1960. *The fungi of India.* Indian Council of Agricultural Research, New Delhi, p. 552

Cappelli, A. 1983. II genere *Agaricus* L. ex Fr. SS. *Karst. Boll. Gruppo Micologico G. Bresadola.* **XXVI** : 4-381

Chavan, P.B and Barge, S. N. 1977. Some fleshy fungi of Maharashtra. *Botanique* **8** : 124-128

*Cooke, D.C and Flegg, P.B. 1962. *Annual Report.* Glass House Crops Res. Instt., UK., p. 181

Dirtsch, G.A. 1978. Submerged culture of *Agaricus bisporus* in a synthetic medium. *Trans. Bri. Mycol.* Soc. **12-13** : 119

*Dornberger, K., Ihni, W., Schade, W; Frosett, Zureck, A., Radics, L. 1986. Antibiotics from Basidiomycetes. Evidence for the occurrence of the A. hydroxy benzendiazonium ion in the extracts of *A. xanthodermus* Genevier. *Tetrahedron letters* **27** : 559-560

Edwards, R.L. 1973. Casing. *Mush. J.* **69** : 450-451

Fati, M, Irick, S.E., Erk el, I. and Gen, C.A. 1977. Studies on the effect of different rates of spawn on the quality and yield of mushrooms. *Hort. Abstr.* **49** : 109

Fritsche, G. 1968. Strain selection, development and maintenance. *Mush. Sci.* 7 : 531

Furlan, S.A., Virmond, L.J., Miers, D.A., Bonatti, M. Gern R. M. M; Jonas, R. 1997. Mushroom strains able to grow at high temperature and CO_2 concentration. *Wld. J. Microbiol. Biotech.* **13** : 689-692

Garcha, H.S. 1981. *Manual of Indian edible Mushrooms*. Jagmander Book Agency. Deshbandu Gupta Road, New Delhi, p.321

Ghosh, R.N., Pathak, N. C and Singh, B.P. 1974. Studies on Indian Agaricales II. *Proc. Natl. Acad. Sci. India.* **44** : 125-128

*Gramss, G. 1984. Alternation in competitive force of certain basidiomycetous ground fungi as exposed to daylight. *Z. Allg. Mikrobiol.* **24** : 591-598

Guleria, D.S. 1985. Studies on *Agaricus bitorquis* (Quel.) Sacc. Ph. D. thesis. College of Agriculture, Solan, p.260

Gupta, Y and Vijay, B. 1992. Post composting supplementation in *Agaricus bisporus* under seasonal growing conditions. *Mush. Res.* **1**: 115-117

Hayes, W.A. 1969. Microbiological changes in composting wheat straw/horse manure mixture. *Mush. Sci.* 7 : 173-186

Hayes, W.A. 1972a. Biological nature. *The biology and cultivation of edible mushrooms* (eds. Chang, S.T. and Hayes, W.A) Academic Press. New York, San Francisco, London, pp. 191-218

Hayes, W.A. 1972b. Nutrition, Substrates and Principles of Disease Control. *The biology and cultivation of edible mushrooms.* (eds. Chang , S.T. and. Hayes, W.A) Academic Press. New York, San Francisco London, pp. 220-236

Hayes, W.A. and Shandilya, T.R. 1977. Casing soil and compost substrates used in the artificial culture of *Agaricus bisporus*, the cultivated mushroom. *Indian J. Mycol. Plant Pathol.* 7 : 5-10

*Heinamann, P. and Little flower. 1984. *Hymenagaricus* (Agaricaceae) from Kerala (India) and Sri Lanka. *Bull. Jard. Bot. Nalt. Belg.* **54** : 151-182

*Henning, P. 1901 Fungi Indiae orientalis II U. W. Gollana. 1900. Colecti. Hedw. **40** : 325

Herman, C. 1988. Climate and cultivation technique. *The cultivation of mushrooms* (eds. Griensven, L. J. and Van, L.D.) Darligton Mushroom Laboratory, Sussex, England and Somycel, S.A. Langeais. France, pp. 213-248

Humfeld, H. and Frank, T.S. 1949. Mushroom mycelium production by submerged propagation. *Fd. Tech.* **3** : 335-356

Iqbal, S.M; Khan, S.M; Khan, N.A. 1988. Studies on growth of *Agaricus bitorquis* (Quel) Sacc on different culture media and substrates. *Pakist. J. scient. ind. Res.* **31**: 354-356

Kachroo, J.L., Ahmad, N., Amanullah, N. and Kaul, I.N. 1979. Experiments in the improvement of compost formulae and procedure in *Agaricus bisporus* cultivation. *Mush. J.* **82** : 434-440

Kalisz, H.M., Moore, D and Wood, D.A. 1986. Protein utilization by basidiomylate fungi. *Trans. Br. Mycol. Soc.* **86** : 579-526

Kalitha, M.K., Bhagabati, K. N and Rathaiah, Y. 1997. Some edible fungal flora of Assam new records. *Mush. Res.* **6** : 49-50

Khan, S.M., Asad, S., Mirza, S.H., Maher, M.J. 1991. Studies on button mushroom (*A. brunnescens* Peck) in Pakistan. *Mush. Sci.* **13** : 281-286

Lakhanpal, T. N. 1995. Mushroom flora of North West Himalaya. *Advances in Horticulture* : 13 Mushroom (eds. Chadha, K.L. and Sharma, S.R.) Malhotra Publishing House, New Delhi, pp. 351-373

Losel, D. L. 1964. The stimulation of spore germination in *A. bisporus* by living mycelium. *Ann. Bot.* **28** : 541-554

Manjula, B. 1983. A revised list of agaricoid and boletoid basidiomycetes from India and Nepal. *Proc. Indian Acad. Sci.* **92** : 81-213

Manoharachary, C and Vijaya Gopal, K. 1991. Mycoflovistic study of Agaricales from Andra Pradesh. *Proceedings on the National Symposium on Mushroom*m, January 22-24, 1991 (ed. Nair, M.C.) Kerala Agricultural University, Thrissur, pp.3-5

Mantel, E.F.K. 1973. Casing soil made from spent compost. *Indian J. Mush.* **1** : 15-16

Mantel, E.F.K., Agarwala, R.K and Seth, P.K. 1972. *A guide to mushroom cultivation.* Ministry of Agriculture Farm Information unit. Directorate of Extension, New Delhi. *Frm. Bull.* No. 2, p. 24

Martin, A.M., Bailey, V. I, Hall, D.E. 1984. Nitrogen and amino acid composition of *A. campestris* in peat extract. *Mush. J.* **42**: 356-359

Massee, G. 1912. Fungi exotic – 13. *Kew Bull.* **13** : 253-255

Mc Rae, W. 1910. The edible mushroom. *Agric. J. India.* **5** : 197-204

Moller, F.H. 1950. Danish Psalliota species. *Friesia IV* **1-2** : 1-60

Moller, F.H. 1954. *Psalliota meleagris* Schaff. and its allies. *Friesia V* **1** : 99-103

Munsell Colour Company . *Munsell colour chart for plant tissues.* N. Calvert Street. Baltimore, Mary Land, USA

Nair, M.C. and Bhavani Devi, S. 1986. Collection and identification of Agaricales. *Beneficial fungi and their utilization* (eds. Nair, M.C. and Balakrishnan, S.). Scientific Publishers, Ratanada road, Jodhpur, pp. 35-42

Natarajan, K. and Manjula, B. 1981. South Indian Agaricales XIV. *Indian J. Bot.* **4**: 50-59

Pandotra, V.R. 1966. Notes on fungi Jammu and Kashmir - I. *Proc. Indian Acad. Sci.* **54**: 68-73

Panse, V.G. and Sukhatme, P.V. 1967. *Statistical methods for agricultural workers.* Second edition. Indian Council of Agricultural Research, New Delhi, p. 381

Paracer, C. S and Chahal, D.S. 1962. A new edible sp. of genus *Agaricus* in the Punjab (India). *Mycopath. Mycol. Appl.* **18** : 267-270

Patil, B.D and Shinde, P.A. 1983. Effect of spawning rate and method of spawning on yield of white button mushroom (*Agaricus bisporus*) *J. Maharashtra Agric. Sci.* **8**: 82

Patil, B.D., Jadhav, S.W., Sathe, A.V. 1995. Mushroom flora of Maharashtra. *Advances in Horticulture.* : 13 Mushroom (eds. Chadha, K.L. and Sharma, S.R.) Malhotra Publishing House, New Delhi, pp. 317-328

Pegler, D.N. 1977. *A preliminary agaric flora of East Africa.* Her Majesty's Stationary Office, London, p. 596

Pegler, D.N. 1983. *Agaric flora of Lesser Antilles.* Her Majesty's Stationary Office, London, p. 669

Pegler, D.N. 1986. *Agaric flora of Sri Lanka.* Her Majesty's Stationary Office, London, p. 486

Pilat, A. 1951. *The Bohemian species of the Genus Agaricus.* PRAHA 11-1700 Vaclavaske Nam, p. 139

Poppe, J.A. 1972. Unexcellent *Agaricus* terasporique cultivable commercialent avec success. *Mush. Sci.* **8**: 517-25

Rai, M.K., 1997. Wild edible mushrooms of tribal areas of Seoni district, Madhya Pradesh. *Mush. Res.* **6** : 107-108

Raper, C.A., Raper, J. R and Miller, R.E. 1972. Genetic analysis of the life cycle of *A. bisporus. Mycologia.* **64** : 1088-1117

Raper, J.A. 1976. Sexuality and life cycle of the edible wild *Agarcius bitorquis. J. Gen. Microbiol.* **95** : 54-66

*Rawla, G.S., Sarwal, B.M., Arya, S. 1982. Agarics new to India I. *Nova Hedwigia.* **36** : 433-443

Roy, A and Sampathi. 1986. Agaricales of West Bengal, India. *Bull. Bot. Soc. Bengal* **33** : 139-148

*Saini, S.S., Atri, N.S. 1983. North Indian Agaricales IV. *Proc. 70th Indian Sci. Cong.* Part IV. Thirupathi, p. 77-78

*Saini, S.S and Atri, N.S. 1989. Some note worthy taxa of *Agaricus* from North India. *Proceedings of National Symposium on plant systematics, Advances and trends.* Punjab University, pp. 9

Saini, S.S., Atri, N.S and Gupta, A.K. 1992. *Agaricus lanipes* var. *macrosporus* var. nov and *A. edulis* (vilf) Mull and Schaeffer, a new record for India. *Geobios New Rep.* **11** : 109-112

*Saini, S.S., Atri, N.S and Gupta, A.K. 1993. Systematic studies on the genus *Agaricus* L : Fr. *Proc. 80th Indian Sci. Cong.* Part III Goa, p. 26

Saini, S.S., Atri, N.S and Gupta, A.K. 1991. Additional studies on North West Indian *Agaricus. Proceedings the National Symposium on mushroom,* January 22-24, 1991 (ed. Nair, M.C.). Kerala Agricultural University, Thrissur, pp.7-8

Saini, S.S., Atri, N.S and Gupta, A.K. 1997. Studies on the genus *Agaricus.* L. Fr., the subgenus *Agaricus* Section *Sanguinolenti* Schaef. et Moller from North West India. *Mush. Res.* **6** : 53-58

San Antanio, J.P and Thomas, R.L. 1972. Carbon dioxide stimulation of hyphal growth of the cultivated mushroom *Agaricus bisporus* (Lange) Sing. *Mush. Sci.* **8** : 623-29

Sathe, A.V and Sasangan, K.C. 1977. Agaricales from South West India- II *Biovigyanam.* **3** : 119-121

Saxena, A.S and Mukerji, K.G and Agarwala, M.K. 1969. Spread of fungal spores causing allergic diseases- Aspects of allergy. *Appl. Immun* **2** : 175-180

Saxena, S. and Gupta, Y. 1986. *Annual Report.* National Centre for Mushroom Research and Training, Solan, pp. 29-30

Seth, P. K and Shandilya, T. R. 1975. Effect of different quantities of superphosphate on the yield of *A. bisporus. Indian J. Mush.* **1** : 3-9

Shandilya, T.R. 1976. Preparation of mushroom compost on wheat straw plus chicken manure. *Indian J. Mush.* **2** : 43-48

Shandilya, T.R. 1988. Polythene sacks or wooden trays for growing white button mushrooms. *Indian Hort.* **33** : 4 -5

Shandilya, T.R and Agarwala, R.K. 1983. Evaluating farm yard manure and spent compost as casing substrate in the cultivation of *Agaricus bisporus*. *Indian J. Plant Pathol.* **1** : 34-37

Sharma, A.D., Munjal, R.L. and Seth, P.K. 1978. Some fleshy fungi from Himachal Pradesh. III *Indian J. Mush.* **4** : 27-29

Sharma, S.R. 1991. Mycoflora of casing soils. *Indian mushrooms* (ed. Nair, M.C). Kerala Agricultural University, Thrissur, pp. 56-58

Sharma, S.R. and Vijay, B. 1992. *Annual Report.* National Centre for Mushroom Research and Training, Solan, pp. 50-51

Sinden, J.W and Hauser, E. 1950. The short method of mushroom composting. *Mush.* Sci. **1** : 52-59

Sinden, J.W and Hauser, E. 1953. The nature of the composting process and its relation to short composting. *Mush. Sci.* **2** : 123-130

Singer, R. 1961. *Mushrooms and Truffles.* Leonard Hill Ltd. Inter science publishers. INC. New York, p. 272

Singer, R. 1962. *The Agaricales in modern taxonomy.* Third edition. Vaduz. J. Cramer, p. 912

Singer, R. 1969. *Mycoflora Australis.* Verlag Von. J. Cramer Lehre, p.260

*Siwulski, M. 1990. Effect of agar media on mycelial growth in tissue culture of mushroom. (*Agaricus bisporus* (Lange) Sing.) *Rocznaki Akad emii- Rol niczej - W. Ponznanju* **217** : 79-83

Smith, A.H. 1949. *Mushrooms in their natural habitats.* Sawyer's Inc. Portland, Oregon, p. 626

Song, S.F. 1976. Studies on *Agaricus bitorquis*. The preparation and amount of spawn needed for spawning. *Taiwan Agric. Q.* **11** : 40-37

*Stanek, M, Kubatora, Z. Wurst, M. 1983. Bacterial polysaccharides, a source of nutrition for mushrooms. *A. bisporus* in a fermented substrates *Sbornik - UVTIZ- Zabra dmitvi*. **10** : 299-306

Tanaka, T. 1976. Tanaka's encyclopaedia of edible plants of the world. (ed. Nakao, S.) Keisaku publishing Co. Tokyo, Japan, p. 924

*Tewari, R.P and Sohi, M.S. 1976. Studies on the effect of depth of casing soil on mushroom production in *Agaricus bitorquis* (Quel.) Sacc. *Proceedings of the First Symposium on survey and cultivation of edible mushroom in India.* Regional Research Laboratory. Srinagar, pp. 46-47

Trivedi, T.K. 1972. Agaricales of Nagpur – I. *Botanique* **3** : 53-54

Tschierpe, H.J. 1973. Environmental factors and mushroom growing. *Mush. J.* : 79-94

Upadhyay, R.C and Vijay, B. 1988. Optimum compost depth in polythene bags for *Agaricus bisporus* cultivation. *Indian J. Agric. Sci.* **58** : 778-779

Van Zaayen, A and Pol - Luiten, B. 1977. Heat resistance, biology and prevention of *Diehliomyces microsporus*, in crops of *Agaricus* species. *Neth. J. Pl. Pathol.*. **83** : 221-240

*Vasser, S.P. Berchova, V. I. Bilal, vit 1980. Cultural characteritics of species of the genus *Agaricus*. *Vkr Zh.* **37** : 62-71

Vedder, P.J.C. 1975. Our experience with growing *A. bitorquis*. *Mushroom J.* **32** : 262-269

Verma, R.N., Singh, G.B and Mukta Singh, S. 1995. Mushroom flora of North Eastern hills. *Advances in Horticulture.* : 13 Mushroom (eds. Chadha, K.L. and Sharma, S.R). Malhotra Publishing House, New Delhi, pp. 329-349

Vijay, B. and Gupta, Y. 1992. Studies on manipulation of casing microflora on the yield of *Agaricus bisporus* (Lange.) Sing. *Mush. Res.* **1** : 61-63

Vrinda, K.B., Pradeep, C.K., Sibi Mathew and Abraham, T.K. 1997. Agaricales from Western Ghats. V. *Mush. Res.* **6** : 7-10

Vrinda, K.B., Pradeep, C.K., Sibi Mathew and Abraham, T.K. 1999. Agaricales from Western Ghats - VI. *Indian Phytopath.* **52** : 198-200

Wasser, S.P. 1988. *Tribe Agriceae Pat. of the Soviet Union.* The N.G. Kholodny Institute of Botany, Ukrainian SSR Academy of Science, p. 120

Wood, D.A. 1976. Primordium formation in axenic cultures of *A. bisporus* (Lange) Sing. *J. gen. Microbiol.* **95** : 313-323

---

*Original not seen

Appendices

APPENDIX - I

Data sheet

Sl. No. ..... Date of collection: ..... 199.....

Collected by: Locality:

(Village/Taluk/Dist.)

Final Identification:

(confirmed by .....)

Taxonomy:

Order:

Family:

GENERAL

Common name: Local name:

Soil type: Vegetation:

Substrate:

Season: Temp. R.H. Rainfall:

Any other information on climate:

Others:

Habitat: Terrestrail/Lignicolous/Epixylose/ Coprophilous/ Humicolous

Habit: Solitary/ Scattered/ Caespitose/ Gregarious

PILEUS

When young : Conical/ Spherical/ Campanulate/ Convex

Shape:

At maturity : Infundibuliform/ Umbonate/ Broadly umbonate / Campanulate/ umbilicate/ Aplanete/ Conical Petaloid/ Flabelliform/ Mucronate/ Depressed/ Dimidiate/ Resupinate

When young : . . . .

Size:

At maturity : . . . . . .

Colour: . . . . . .

Texture : Soft/ Brittle/ Fleshy/ Coriaceous/ Hygrophanous/ Fragile/ Cartilaginous/ Membraneous.

Surface : Smooth/Scaly/ Rugose/ Rugulose/ Viscid/ Striate/ Dry/ Squamulose/ Velutinous/ Pubescent/ Strigose/ sulcate/ Tomentose/Alveolate/ Farinose/ Floccose/ Punctate/ Rivose/ Rivulose

Margin : Serrate/ Serrulate/ Smooth/ Undulate/ Reflexed / Involute/ Fimbriate/ Incised/ Lobed/ Revolute

Context : Before cutting: Colour:

After cutting:

Colour changes with:-

1. Melzer's reagent : Amyloid /Pseudoamyloid/ Inamyloid
2. Green Vitrial : . . . . . .
3. Phenol : . . . .
4. Sulphovanilin : . . . .

GILLS

Arrangement : Remote/ Free/ Decurrent/ Adnate/ Adnexed/ Sinuate

Shape : Rounded anteriorly or posteriorly/ Lanceolate/ Ventricose/ Reticulate

Texture : Soft/ Brittle/ Ceraceous/ Waxy/ Thick/ Papery/ Opaque

Margin : Smooth/ Wavy/ Serrate/ Fimbriate/ Dentate

Size : Number per Cm.

Gill trama : Regular/ Irregular/ Bilateral/ Inverse

Cystidia	Size
1. Pilocystidia	1
2. Pleurocystidia	2
3. Cheilocystidia	3
4. Caulocystidia	4

Shape:

a. Ventricose/	b. Clavate/
c. Filiform/	d. Napiform
e. Lageniform/	f. Rostrate/
g. Encrusted/	h. Ramified/
i. Lanceolate/	j. Pyriform/
k. Granulate/	l. Pointed/
m. Beaked/	n. Capitate
o. Lacyliform/	p. Cylindrical
1 2	3 4

VEIL

Type	: Present/ Absent	Universal/ Partial
Colour	:	. . . . .
Texture	:	Membraneous/ Fleshy/ Smooth/ Coriaceous
Position	:	

ANNULUS

Size	:	. . . . .
Texture	:	Fleshy/ Coriaceous/ Papery/ Thin
Colour	:	. . . . .
Attachment	:	Superior broad/ medial pendulous/ Inferior/ Narrow fragments/ Appendiculate/ Fibrillose/ Movable

STIPE

Present (Stipitate)/ Absent (Sessile)

Length . . . . . .

Size:

Diameter . . . . . .

Shape: Clavate/ Obclavate/ Cylindrical/ Solid/ Hollow/ Slender/ Short

Attachement to pileus : Lateral/ Eccentric/ Central/ Resupinate

Surface : Glabrous/ Scaly/ Pubescent/ Velutionous/ Squamose/ Tomentose/ Fibrillose

Before cutting: . . . . . .

Colour:

After cutting: . . . . . .

Reaction with Melzer's reagent : Amyloid/ Pseudoamyloid/ Inamyloid

Basal part : Globular/ Annular stripes/ Fusoid/ Bulbous/ sheathing Bulbous/ Marginately depressed bulb. Pseudorhizoid/ Rhizines/ Rhizemorphoid

VOLVA

Present/ Absent Persistent/ Evanescent

Shape : Free/ Lobsed/ Irregular/ Cup like

Colour : . . . . . .

Texture : Soft/ Fleshy/ Tough/ Papery

Before cutting: . . . . . .

Odour:

After cutting : . . . . . .

Taste : Acrid/ Mealy/ Acidulous/ Blunt

SPORE PRINT

Colour : . . . . . .

Other details : . . . . . .

BASIDIA

Size : . . . . . .

Shape : .....

Sterigmata : No. 1 / 2 / / 4 /

SPORES

Colour : .....

Reaction with:

Cotton blue : Cyanophilic/ Acyanophilic

Melzer's reagent : Amyloid/ Pseudoamyloid/ Inamyloid

Shape : Ovate/ Elliptical/ Globose/ Sub globose/ apiculate/ Cylindrical/ Fusiform/ Angular/ Echinulate/ Verrucose/ Reticulate/ Tuberculate/ Ovoid/ Abtusely fusiform/ Allantoid/ Guttulate/ Pip shaped/ Piriform/ Pedicilate/ Muriform/ Filiform (Fig.)

Other characters of spores:

ANY OTHER DETAILS:

APPENDIX –II

COMPOSITION OF MEDIA

Complete medium

Dextrose	-	20 g
Peptone	-	2 g
Yeast extract	-	2 g
Magnesium sulphate	-	1 g
Dipotassium orthophosphate	-	1 g
Potassium dihydrogen orthophosphate	-	0.46 g
Agar	-	20 g
Water	-	1 litre

Coon's medium

Sucrose	-	7.2g
Dextrose	-	3.6g
Magnesium sulphate	-	1.23 g
Potassium dihydrogen orthophosphate	-	2.72g
Potassium nitrate	-	2.02 g
Agar	-	20g
Water	-	1 litre

Czapek's (Dex) agar

Sodium nitrate	-	209
Potassium dihydrogen orthophosphate	-	1g
Magnesium sulphate	-	0.5g
Potassium chloride	-	0.5g
Feuous sulphate	-	0.01 g
Sucrose	-	30g
Agar	-	20g
Water	-	1 litre

Glucose-mineral medium

Glucose	-	30g
Dipotassium orthophosphate	-	1g
Magnesium sulphate	-	0.5g
Magneese sulphate	-	0.5 mg
Sodium molybdate	-	10 μ
Potassium nitrate	-	2g
Potassium dihydrogen orthophosphate	-	0.9g
Zine sulphate	-	0.05 mg
Copper sulphate	-	0.16 mg
Agar	-	20g
Water	-	1 litre

Hendrix medium

Glucose	-	5.4g
Potassium dihydrogen orthophosphate	-	1g
Sodium nitrate	-	1.5g
Magnesium sulphate	-	0.5 g
Thiamin	-	2 mg
Agar	-	20g
Water	-	1 litre

Malt extract Agar

Malt extract	-	20g
Agar	-	20g
Water	-	1litre

Oats meal agar

Oat meal	-	30g
Agar	-	20g
Water	-	1 litre

Potato dextrose agar

Potato	-	200g
Dextrose	-	20g
Agar	-	20g
Water	-	1 litre

Richard's medium

Sucrose	-	50g
Potassium nitrate	-	10g
Potassium dihydrogen orthophosphate	-	5g
Magnesium sulphate	-	2.5g
Ferric chloride	-	0.02g
Agar	-	20g
Water	-	1 litre

Sach's Agar

Calcium nitrate	-	1g
Magnesium sulphate	-	0.5g
Ferric chloride	-	trace
Dipotassium orthophosphate	-	0.35g
Calcium carbonate	-	49
Agar	-	20g
Water	-	1 litre

Yeast extract agar

Yeast extract	-	10g
Glucose	-	10g
Calcium carbonate	-	20g
Agar	-	20g
Water	-	1 litre

APPENDIX – III

GLOSSORY

Adpressed	Closely flattened down; commonly of scales on a fruiting body
Agaric	Any gill fungi
Annulus	A ring like parted veil, or part of it round the stipe after expansion of pileus
Appendiculate	(of gill fungi), where expanded cap edge is fringed with tooth-like velar remains
Applanate	Flattered out, horizondally expanded
Areolate	Divided in to small segments by cracking
Attenuate	nontapering
Basidium	Spore mother cell of basidiomycetes bearing spores on short sterigmata
Bulbous	Enlarged at the base
Buttons	Young expanded cap
Caesipitose	Growing in clumps or in tuffs
Campanulate	Bell shaped
Capitate	Having a head or the form of a head
Cheilocystidium	Cystidium in the edge of a gill
Clavate	Club like
Context	The hyphal mass between the superior surface and subhymenium or trama of basidiomycetes
Cuticle	Outermost layer of cap or stipe
Cystidia	Sterile, unicellular, light colured, large cell in the hymenium of Dasidiomycetes
Epigeous	Above the ground
Evanescent	Vanishing
Fibrillose	Composed of longitudual fibres or hairy filament.
Floccose	Wooly, composed of or bearing flocci
Free (gills)	Gills that do not touch the stipe
Glabrous	Smooth not hairy

APPENDIX – III Contd...

Globose	Globe-shaped
Gregarious	Growing in groups but not in tufts
Guttulate	Spores with one or many oil droplets.
Hymenium	A fertile layer that bears either basidia and basidiospores or asci & ascospores mixed with paraphyses. etc.
Hymenophore	The portion of the carpophore which beans the hymenium
Involute	Margin (of pileus) rolled inward
Lamellate	Having gills
Ochraceous	Colour of Orchra, dead yellow, or non rust colur
Ovoid	Spores widest near the point of attachment
Pileus	That portion of carpophore which resembles umbrellas like cap
Piriform	Pear shaped
Pleurocystidium	Cystidium on the sides of the gill
Rimose	(of gill fungi) where hyphae of cap become slightly separated radially showing underlying tissue.
Sporophore	Fruit body of a mushroom
Squamose	Having scales
Squamulose	Having smaller scales
Stipe	Stem/stalls of fungal fruit bodies
Subglobose	Roughly globe shaped
Trama	The tissue lying between the hymenial layer usually consisting of densely packed or loosely interwoven hyphae.
Umbo	A central swelling like the boss of as
Veil	Usually membraneous structures or sometimes spider web like. It envelopes the part or the entire carpophore

MONOGRAPHIC STUDIES ON *AGARICUS* SPECIES OF KERALA

By
SUSHA, S. THARA

ABSTRACT OF A THESIS
submitted in partial fulfillment of the
requirement for the degree
DOCTOR OF PHILOSOPHY
Faculty of Agriculture
Kerala Agricultural University

Department of Plant Pathology
COLLEGE OF AGRICULTURE
Vellayani, Thiruvananthapuram

2001

ABSTRACT

The warm humid climatic conditions and wide diversity in soil types and pattern favoured a luxuriant growth of a wide variety of fungal flora in Kerala. In the present study collections were made during south-west and north-east monsoon periods of 1998-2000 in twenty agro climatic zones of Kerala and forty two species of *Agaricus* were collected.

Among the 42 species collected *A. abruptibulbus, A. actinorachis, A. altipes, A. annae, A. arenicolus, A. benesi, A. bernardii, A. bulbosus, A. caroli, A. chloroconius, A. ingrata, A. lividonitidus, A. mediofuscus, A. microflavus, A. micromegethus, A. microrubescens, A. moelleri, A. nivescens, A. ochraceous, A. ochroflavus, A. phaeolepidotus, A. pseudopratensis, A. purpurellus, A. rubicolus, A. rusiophyllus, A. semotus, A. silvicola, A. simulans, A. spissarufosa, A. squamuliferus, A. stadii, A. subperonatus, A. trisulphuratus* and *A. xantholepis* are new reports from Kerala. Among these *A. abruptibulbus, A. annae, A. arenicolus, A. benesi, A. bernardii, A. bulbosus, A. caroli, A. chloroconius, A. ingrata, A. lividonitidus, A. mediofuscus, A. microflavus, A. microrubescens, A. moelleri, A. nivescens, A. ochraceous, A. ochroflavus, A. phaeolepidotus, A. purpurellus, A. rubicolus, A. rusiophyllus, A. simulans, A. spissarufosa, A. stadii* and *A. subperonatus* are first reports from India. *A. bulbosus, A. ochraceous, A. ochroflavus, A. microflavus, A. microrubescens, A. rubicolus* and *A. spissarufosa* are the new reports during the study.

Most of the collections were obtained during May-June and September-October months coinciding with the early south-west and north-east monsoon periods. The species of the Genus *Agaricus* preferred laterite soils.

Growth of *Agaricus* species was maximum on complete medium and they preferred a temperature range between 25 and 30^{0}C and pH 6. The results of the studies revealed that light did not play any significant role on growth of the fungi. Among the different carbon sources tried *Agaricus* spp. preferred glucose, sucrose and fructose. *Agaricus* spp. exhibited best growth in organic nitrogen compared to inorganic sources of nitrogen.

From the study it was observed that wheat grain is best for the production of spawn of *A. bitorquis* and maximum growth was obtained when incubated at 25 and 30^{0}C.

Spawn run of *A. bitorquis* was observed in traditional compost and pinheads started appearing within 30-35 days after spawning. The buttons can be harvested on fourth or fifth day after pinhead emergence. 400 g of buttons were obtained from 10 kg compost and this preliminary study showed the possibilities of commercial cultivation of this excellent mushroom species under Kerala condition.