Table 2. Head protein content (mg/g tissue) of 5th stadium of *H. armigera* influenced by injected dose of azadirachtin after 48 h

Dose (µg)	Protein mg/g tissue
Control	21.020
0.05	20.672
0.1	16.958
0.2	15.360
0.3	14.942
0.5	13.736

In addition, azadirachtin did not maintain reduced level of protein for 72 h, in agreement with observations by Rembold[17]. This may imply that azadirachtin may not exist in the neuroendrocrine system up to 72 h when administered topically. Similarly, ingested azadirachtin has been found accumulated in the head and other tissues of *Peridroma sausia*[18]. Azadirachtin imposed longer effects (72 h) in reducing protein in 2nd stadium. Head proteins of *Helicoverpa* are derived from storage proteins in the insect body or are synthesized by neurosecretory cells. Observed changes in head protein may arise through several possible physiological perturbations, including modulation of protein synthesis or turnover rate.

Injection of azadirachtin in the 5th stadium in increasing doses, showed dose-dependent trend in the level of protein. It also resulted in maximum decrease in protein level at 0.5 µg (Table 2). This may be due to altered feeding behaviour at higher doses[19]. It is assumed that higher doses of azadirachtin may alter the feeding in larvae towards food-avoidance and maintain body metabolism at the expense of the storage or cellular proteins. There may be more than one site of action of azadirachtin and their manifestations may depend on the mode of application of the phytochemical.

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N. K. NEOLIYA[1]
DWIJENDRA SINGH[1,*]
RAJENDER S. SANGAWAN[2]

[1]*Entomology Division and*
[2]*Biochemistry Division,*
Central Institute of Medicinal and Aromatic Plants,
P.O. CIMAP,
Lucknow 226 015, India
**e-mail: dsinghlko@sify.com*

Biodiversity of agarics from Nilgiri Biosphere Reserve, Western Ghats, India

To conserve biological diversity, several biosphere reserves have been established in India. The Nilgiri Biosphere Reserve (NBR) is one of the oldest among them. The total area of the NBR extends over 5520 km^2, comprising the whole of Nilgiri district, parts of Coimbatore plains, Mysore plateau consisting of Bandipur National Park, Wyanaad Wildlife Sanctuary, Silent Valley National Park and Nilambur plains[1]. The floristic composition of this region has been studied earlier by several workers[1–4]. It has been emphasized that understanding of the phytogeographical affinities would help policy makers in deciding the right choice of species. Similar work with reference to other groups of organisms is an urgent need.

Fungi which form an important component of the forest ecosystem have been largely neglected in any of the biodiversity studies of a given area. The present correspondence is an attempt to give a broad picture of the biodiversity of a particular group of fungi, viz. members of order Agaricales, class Basidiomycetes in the NBR.

During the last two decades, considerable work has been done on the floristic components of these fungi in the NBR[5–9]. In these studies several areas in the NBR of the Western Ghats have been covered, for the collection of different species of fungi belonging to order Agaricales. A consolidated result of several studies is presented here.

Table 1. Total number of agarics from three states forming part of the NBR

State	Area (km^2)	No. of agarics
Tamil Nadu	2537.6	195
Kerala	1455.4	28
Karnataka	1527.4	–

Table 2. Agarics reported from the NBR

Polyporaceae	*Pleurotus* (2), *Lentinus* (1)
Hygrophoraceae	*Camarophyllus* (1), *Hygrocybe* (8)
Tricholomataceae	*Laccaria* (2), *Lepista* (1), *Clitocybe* (3), *Gerronema* (1), *Anthracophyllum* (1), *Armillaria* (1), *Tricholoma* (1), *Marasmiellus* (1), *Collybia* (7), *Gymnopus* (1), *Resupinatus* (1), *Hohenbuehelia* (3) *Oudemansiella* (1), *Marasmius* (12), *Chaetocalathus* (2), *Crinipellis* (1), *Hydropus* (1), *Mycenella* (1), *Mycena* (10), *Hemimycena* (1), *Filoboletus* (1), *Clitocybula* (1), *Xerulina* (1), *Xerula* (1)
Amanitaceae	*Amanita* (1)
Pluteaceae	*Pluteus* (5)
Agaricaceae	*Macrolepiota* (2), *Leucoagaricus* (2), *Leucocoprinus* (5) *Agaricus* (4), *Micropsalliota* (1), *Lepiota* (6)
Coprinaceae	*Coprinus* (6), *Copelandia* (1), *Psathyrella* (5), *Panaeolus* (3)
Bolbitiaceae	*Agrocybe* (5), *Conocybe* (8), *Descolea* (1), *Pholiotina* (4)
Strophariaceae	*Stropharia* (3), *Hypholoma* (2), *Psilocybe* (18), *Melanotus* (3) *Pholiota* (8), *Pleuroflammula* (1), *Phaeomarasmius* (1)
Cortinariaceae	*Cortinarius* (4), *Anamika* (1), *Inocybe* (17), *Hebeloma* (1) *Gymnopilus* (6), *Galerina* (8)
Crepidotaceae	*Crepidotus* (11), *Tubaria* (1)
Entolomataceae	*Entoloma* (10)
Strobilomycetaceae	*Suillus* (1)

Number in parenthesis denotes the number of species in each genus.

Table 3. New genus and species of members of Agaricales from the NBR

New species	Collection site
Psilocybe gigaspora Natarajan and Raman[6]	Sandynallah
Melanotus macrosporus Natarajan and Raman[6]	Forest near Gandhipettai
Gymnopilus giganteus Natarajan and Raman[6]	Doddabetta
Galerina yungicola var. *bispora* Natarajan and Raman[6]	Naduvattam
Tubaria pentstemonis var. *phragmocystidosa* Natarajan and Raman[6]	Doddabetta
Hygrocybe westii Natarajan and Manjula[5]	Melodayaratty
Marasmius nilgiriensis Natarajan and Raman[6]	Forest near Gandhipettai
Psilocybe pseudoaztecorum Natarajan and Raman[11]	Melodayaratty, Naduvattam, Mullikorai, Sandynallah
Xerula furfuracea var. *bispora* Natarajan and Purushothama[12]	Sandynallah
Pholiota catervaria (Lev.) Manjula[5]	Nilgiri Hills
Macrolepiota mallea (Berk.) Manjula[5]	Wellington
Entoloma nilgirisiensis Natarajan and Ravindran[13]	Snowdon
Entoloma indica Natarajan and Ravindran[13]	Kolakumbai
Pholiota sylva Natarajan and Ravindran[14]	Thaishola Reserve Forest
Pholiota cystidiata Natarajan and Ravindran[14]	Naduvattam
Agrocybe wayanadensis Thomas and Manimohan[15]	Muthanga forest
Psilocybe keralensis Thomas, Manimohan and Guzman[16]	Ponkuzhy
Psilocybe wayanadensis Thomas, Manimohan and Guzman[16]	Muthanga
Cortinarius phlegmophorus Thomas, Moser, Peintner and Manimohan[17]	Ponkuzhy
Cortinarius conopileus Thomas, Moser, Peintner and Manimohan[17]	Ponkuzhy
Cortinarius keralensis Thomas, Moser, Peintner and Manimohan[17]	Ponkuzhy
Anamika indica Thomas, Peintner, Moser and Manimohan[18]	Ponkuzhy

It should be kept in mind that the list of fungi is a result of collections over a period of several years. It is a compilation which throws light on several important features such as the occurrence of several new species of fungi and economically important ectomycorrhizal fungi. These fungi are identified by the production of above-ground basidiomata which are seasonal in occurrence, and without which it will be difficult to give names for the fungi.

Among the three states comprising the NBR, a total number of 195 species from Tamil Nadu and 28 species from Kerala have so far been described. It is surprising to find Karnataka is totally neglected (Table 1).

A total number of 223 species belonging to 61 genera have so far been reported from the NBR (Table 2).

Table 2 gives the total number of species under individual genera. Genera like *Mara-*

Table 4. New species of agarics from the NBR which are yet to be published

New species	Collection site
Marasmius tax. sp. 1	Thaishola Reserve Forest
Marasmius tax. sp. 2	Thaishola Reserve Forest
Marasmius tax. sp. 3*	On the way to Doddabetta
Hohenbuehelia tax. sp. 1	Vandishola
Hohenbuehelia tax. sp. 2	Kolakumbai
Crinipellis tax. sp. 1	Kattuputhur
Mycena tax. sp. 1	Kherbetta
Mycena tax. sp. 2	Loz falls
Clitocybula tax. sp. 1	Thaishola Reserve Forest
Leucocoprinus tax. sp. 1	Droog
Lepiota tax. sp. 1	Kattushola
Copelandia tax. sp. 1	Gymkana
Pholiota tax. sp. 1	Doddabetta
Pholiota tax. sp. 2*	Sandynallah
Pholiota humidicola var. nov.*	Doddabetta
Inocybe tax. sp. 1	Doddabetta
Inocybe tax. sp. 2	Vandishola
Gymnopilus tax. sp. 1	Snowdon
Galerina tax. sp. 1	Doddabetta
Crepidotus tax. sp. 1	Konnakarai
Crepidotus tax. sp. 2*	Kargudi–Mudhumalai road
Coprinus erythrocephalus var. *macrosporus* var. nov.	Masinigudi
Pholiotina tax. sp. 1#	Muthanga forest, Ponkuzhy
Conocybe tax. sp. 1#	Nilambur
Conocybe tax. sp. 2#	Ponkuzhy
Conocybe tax. sp. 3#	Muthanga
Pholiota tax. sp. 3#	Ponkuzhy
Psilocybe tax. sp. 1#	Ponkuzhy
Inocybe tax. sp. 3#	Ponkuzhy
Inocybe tax. sp. 4#	Meppady
Inocybe tax. sp. 5#	Ponkuzhy
Inocybe tax. sp. 6#	Meppady
Inocybe tax. sp. 7#	Ponkuzhy
Inocybe tax. sp. 8#	Ponkuzhy
Crepidotus tax. sp. 3#	Ponkuzhy

*Collections from different places in Tamil Nadu[9].
#Collections from different places in Kerala[7].
Rest are collections from different places in Tamil Nadu[8].

Table 5. Ectomycorrhizal fungal species in the NBR

Ectomycorrhizal fungal species	Collection site
Laccaria fraterna	Naduvattam *Eucalyptus* plantations, Doddabetta
Tricholoma rhacophorum	Lamb's rock
Amanita muscaria	Pykara pine plantations
Descolea maculata	Sim's Park, Coonoor
Inocybe glabripes	Thaishola Reserve Forest
Inocybe neoumbrina	Thaishola Reserve Forest
Inocybe egenula	Thaishola Reserve Forest
Inocybe petiginosa	Bakkasurah hills, Forest Department Nursery, Ootacamund
Inocybe jacobii	Masinigudi
Inocybe trivialis	Lovedale
Inocybe corydalina	Ootacamund
Inocybe flocculosa	Ootacamund
Inocybe lanuginosa	In *Pinus patula* plantations, Sandynallah
Inocybe tax. sp. 1	Ponkuzhy
Inocybe tax. sp. 2	Meppady
Inocybe tax. sp. 3	Ponkuzhy
Inocybe tax. sp. 4	Meppady
Inocybe tax. sp. 5	Ponkuzhy
Inocybe tax. sp. 6	Ponkuzhy
Hebeloma catervarium	Ootacamund
Suillus punctatipes	In *P. patula* plantation, Thalaikunda
Cortinarius pseudosalor	Ponkuzhy
Cortinarius phlegmophorus	Ponkuzhy
Cortinarius conopileus	Ponkuzhy
Cortinarius keralensis	Ponkuzhy
Anamika indica	Ponkuzhy

smius, *Mycena*, *Psilocybe*, *Inocybe* and *Crepidotus* are found to predominate.

From the NBR of the Western Ghats, one new genus and 21 new species belonging to 13 genera of order Agaricales have been reported so far (Table 3).

Apart from this, there are another 35 new species belonging to 17 genera which are yet to be published (Table 4).

In both Tamil Nadu and Kerala regions of the NBR, apart from the occurrence of naturally occurring forest types, there are several areas where plantations of *Pinus*, *Eucalyptus* and *Acacia* have been established. One of the important fungal components of these natural forests as well as the plantations are the ectomycorrhizal fungi, most of which belong to the members of order Agaricales. Potential ectomycorrhizal species associated with trees in the forests and in the plantations are given in Table 5.

It is surprising that a relatively small number of ectomycorrhizal species is found in this region (9 genera, 26 species). In a recent study on species diversity of ectomycorrhizal fungi associated with temperate forests of Western Himalaya, Pande *et al.*[10] have shown a total number of 43 ectomycorrhizal species from oak forest and 55 from conifer forest. These species belong to 12 different genera. Unfortunately, this study has not given the species diversity and hence does not reveal the exact species of the fungus associated with the various tree species. From the list of ectomycorrhizal genera occurring in Western Himalayas, it is clear that the generic composition present in the NBR is more or less similar.

Considering the large area of the NBR, it is quite evident that there are wide gaps in our knowledge regarding biodiversity of gilled fungi occurring in this region. This study indicates the occurrence of these fungi only in places where collections have been made, and there are vast areas especially in the Karnataka region of the NBR where no gilled fungus has so far been reported.

This preliminary report on the biodiversity of a particular group of a fungi in a selected area only reinforces the often repeated call and attention for more studies on biodiversity, especially in tropical regions

such as the Western Ghats, which is considered to be a hotspot of biodiversity.

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K. NATARAJAN*
K. NARAYANAN
C. RAVINDRAN
V. KUMARESAN

Centre of Advanced Study in Botany,
University of Madras,
Guindy Campus,
Chennai 600 025, India
**e-mail: knraj42@yahoo.com*

Diversity in ectomycorrhizal fungi of a dipterocarp forest in Western Ghats

According to Gadgil[1], biological diversity in the Western Ghats faces threats due to the exploitation of its habitat. Inventorying and monitoring of the biological diversity of the Western Ghats is therefore an important challenge before the community of systematists, biogeographers and ecologists in India. Fieldwork, which forms the basis of this correspondence, was carried out largely in the Uppangala Reserve Forest, Western Ghats region, Karnataka, India. The Uppangala forest is situated in Kadamakkal Reserve Forest (Kodagu district) in the foothills of the Ghats and lies at 12°30′N, 75°39′W at an altitude of 500–600 m amsl. Floristically, it belongs to the low elevation *Dipterocarpus indicus – Kingiodendron pinnatum – Humboldtia brunonis* type of wet evergreen forests. One of the main plots where extensive collections have been made during two seasons (June 2001 to May–June, 2002) consists mainly of trees belonging to the family Dipterocarpaceae, viz. *D. indicus* and *Vateria indica*. In the surrounding areas, other dipterocarp trees such as *Hopea parviflora* and *Hopea ponga* are dominant.

Genera belonging to the Dipterocarpaceae are predominantly ectomycorrhizal. Dipterocarps were thought to dominate extensively throughout South East Asia. Watling and Lee[2] have reported over 20 different agarics and boleti, four earth balls and a new species of *Pisolithus*, which were found associated with dipterocarps in Malaysia. The dominant fungi were species of *Amanita*, *Boletus* and *Russula*, with members of Russulaceae being most numerous. Species belonging to the genus *Amanita* and the families Russulaceae, Boletaceae and Sclerodermataceae have also been reported as mycorrhizal associates of dipterocarps in Malaysia[3–5]. The same genera were also found to be associated with dipterocarps in Indonesia[6,7]. Similarly, many ectomycorrhizal fungal species associated with dipterocarps have been reported from Philippines[8], Thailand[9], Sri Lanka[10] and Indonesia[11]. Recently Thomas *et al.*[12] have reported a new genus *Anamika*, with the species *A. indica* under *Hopea* sp. in Wayanad District, India.

In the present study, many ectomycorrhizal fungal species were found to be associated with the dominant tree species in the Uppangala area, such as *D. indicus*, *V. indica* and *H. parviflora* (Table 1).

It is seen from Table 1 that majority of fungi collected in the present study were found to be associated with *V. indica* followed by *D. indicus*. Only two species were found to be associated with *H. parviflora*. As in the other South East Asian countries, species of *Amanita* and *Russula* were found to be dominant, with members of the Russulaceae being numerous. The genus *Russula* is represented by twelve species and the genus *Amanita* by five species (Figure 1).

Since this is mainly a study on fungal biodiversity, no attempt has been made to collect root samples with a view to study the ectomycorrhizal types in the above-mentioned tree species. In earlier studies in India[13,14], the ectomycorrhizal types in the roots of *Shorea robusta*, *D. indicus*, *H. parviflora* and *V. indica* had been investigated. However, the fungi involved in these roots are not known. In an extensive study on the ectomycorrhizas of *Shorea leprosula* occurring in Malaysia in FRIM, Kepong in the state of Selanangor, Lee *et al.*[15] have reported 24 ectomycorrhizal types from seedlings and 20-year-old trees. The dominant ectomycorrhizal type was formed by the members of Russulaceae. They have also collected fungal fruting bodies under adult *S. leprosula* in various parts of peninsular Malaysia over a period of three years. Among the 28 species of putative ectomycorrhizal fungi collected, fifteen were members of Russulaceae. It