Current Research in Environmental & Applied Mycology (Journal of Fungal Biology)
7(1): 8–18 (2017) ISSN 2229-2225
www.creamjournal.org **Article**
Doi 10.5943/cream/7/1/2

Eco-diversity, productivity and distribution frequency of mushrooms in Gurguripal Eco-forest, Paschim Medinipur, West Bengal, India

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Singha K, Banerjee A, Pati BR, Das Mohapatra PK 2017 – Eco-diversity, productivity and distribution frequency of mushrooms in Gurguripal Eco-forest, Paschim Medinipur, West Bengal, India. Current Research in Environmental & Applied Mycology (Journal of Fungal Biology) 7(1), 8–18, Doi 10.5943/cream/7/1/2

Abstract

Gurguripal is a forest based rural area situated in Paschim Medinipur District, West Bengal, India. It is located at 22°25" - 35°8"N latitude and 87°13" - 42°4"E longitude, having an altitude about 60 M. This area represents tropical evergreen and deciduous mixed type of forest dominated mainly by „Sal". The present study deals with the status of mushroom diversity and productivity in Gurguripal Eco-forest. Field survey has been conducted from May 2014 to October 2015 and a total of 71 mushroom species of 41 genera belonging to 24 families were recorded including 32 edible, 39 inedible and altogether 19 medicinally potential mushrooms. The genus *Russula* exhibited the maximum number of species and the family Tricholomataceae represented the maximum number of individuals. According to Simpson"s index of diversity, the calculated value of species richness was 0.92 and as to Shannon"s diversity index, the relative abundance of species was found to be 2.206. Evenness of the mushrooms was also calculated as 0.333. The mushroom genera *Termitomyces heimii*, *Astraeus hygrometricus*, *Leucopaxilus sp.*, *Amanita vaginata*, *Volvariella volvacea*, *Agaricus campestris* are found as potential food sources to the Santal livelihood in Gurguripal Eco-forest. Wild mushrooms have immense importance in the maintenance of forest ecology and act as an indicator of forest management. In this context the present study opens up new possibilities regarding the exploitation and utilization of wild mushrooms in India.

Key words – Food sources **–** habitat **–** species richness

Introduction

Mushrooms are seasonal fungi, which occupy diverse niches in nature in forest ecosystem. They predominantly occur during the rainy season, particularly in forests, where the dense canopy shade from trees provide a moist atmosphere and decomposing organic material such as leaf litter, and favors the germination and growth of mushrooms. Wild mushrooms have manifold impacts on the biology, ecology and economy in forest based areas. Mushroom species are the indicators of the forest health (Stametes 2000). Diversity and abundance of mushroom species are the useful indicators to assess the current status of an ecosystem. Data on the diversity of mushrooms is very important for maintaining and managing the ecosystem of a forest. Many species also play a vital ecological role through symbiotic relationships as mycorrhizae that they form with trees. Truffles

Submitted 30 June 2016, Accepted 20 February 2017, Published 12 March 2017
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and other valuable wild edible fungi depend on trees for their growth and cannot be cultivated artificially. Wild edible fungi have been collected and consumed by people for thousands of years. Wild fungi also have medicinal properties some of which are found in edible species. Native tribal people living in or nearby forest areas are directly linked with wild mushrooms in respect to their socio-economic lifestyles.

Generally mushrooms are the macroscopic fruiting bodies of underground mycelium that release spores for reproduction, such as agarics, boletes, jelly fungi, coral fungi, stink horns bracket fungi, puff balls and bird‟s nest fungi. Mushroom can be epigeous or hypogeous, large enough to seen with the unaided eye and can be picked by hand (Chang & Miles 1992). They may be fleshy or leathery or sometimes woody and bear their spore producing structures on lamellae or within the tubes, opening out through pores. The lamellate members are called agarics and the tube bearing poroid members as boletes and polypores.

Mushrooms have been valued throughout the world as both food and medicine for thousands of years. Due to the high content of vitamin, protein and minerals, fibers, trace elements and no/low calories and cholesterol (Wani et al. 2010, Agahar-Murugkar et al. 2005) they are considered as "poor man‟s protein". Due to the low fat and oil content, they are recommended as good source of food supplement for patients with cardiac problem or at risk with lipid. In general the fruit bodies of mushrooms contain about 56.8% carbohydrates, 25.0% protein, 5.7% fat and 12.5% ash on a dry weight basis. Their energy value also varies according to species. Earlier mushroom eating was restricted to specific regions and areas of the world but due to globalization, interaction between different cultures, and growing consumerism, this has ensured the accessibility of mushrooms to all areas. They have created a space in a common man‟s kitchen. Not only in terms of edibility there lie enormous applications of these mushrooms for bioremediation, biodegradation, biopesticidal and pharmacological values that could be exploited.

Of the 14,000 known mushroom species, nearly 7000 species are well-studied to possess varying degree of edibility, and more than 3000 species spread over in 31 genera are regarded as prime edible. Thus far, only 200 species are experimentally cultured, 100 economically cultivated, and approximately only 60 commercially grown and about 10 have reached industrial importance (Chang & Miles 2004, Rai et al. 2005).The number of poisonous mushrooms is usually reported to be relatively less (approximately 1%), but an estimate revealed that approximately 10% may have poisonous attributes and of these around 30 species are considered to be lethal (Miles & Chang 1997, Deshmukh et al. 2006).

The Indian subcontinent is blessed with several diverse agro-climatic zones that harbor a treasure trove of fungal diversity. In India the total recorded mushrooms are approximately 850 species (Deshmukh et al. 2004), one third of fungal diversity on the globe and of this 50% are characterized (Manoharachary et al. 2005). The occurrence of mushrooms revealed the richness of mycoprotein in our country. Only a fraction of total fungal wealth has been subjected to scientific scrutiny and mycologists continue to unravel the unexplored and hidden wealth. Collection and scientific study of mushrooms in India really began during the 19th century (Kaul 2002).

Mushrooms have been extensively studied in the western countries, while tropical countries such as India are less well explored. Recent studies from tropical forests suggested that fungal diversity is greater in the tropics than that in temperate regions (Suryanarayanan et al. 2003).Fungal species are especially important components of biodiversity in tropical forests where they are major contributors to the maintenance of the earth‟s ecosystem, biosphere and biogeochemical cycle. Fungi have beneficial roles in nutrient cycling, agriculture, biofertilizers, antibiotics, food and biotechnological industries. Several researches have been carried out in some specific regions of India including the studies of Sikkim (Das 2010), Jammu & Kashmir (Kumar et al. 2011), Amarkantak Biosphere Reserve (Dwivedi et al. 2012), Bangalore, Karnataka (Pushpa et al. 2012), Nagaland (Kumar et al. 2013), Meghalaya (Khaund 2013) and Western Ghat ranges (Thiribhuvanamala et al. 2014).Dutta et al. (2014) reported about traditional and ethno-medicinal knowledge of mushrooms in West Bengal. The dense forest areas of Paschim Medinipur are the perfect climatic zones for fungal growth but no research or findings about mushrooms have been made to date. The present investigation on mushrooms of Gurguripal Eco-forest of Paschim

Medinipur, West Bengal is poor. Our study site is a treasure trove of mushrooms and the present research work explores new information regarding the diversity of mushrooms in Gurguripal Eco-forest.

Materials and methods

Collection Site

Gurguripal is a forest based rural area situated in Paschim Medinipur District of West Bengal, India (Fig. 1). It is located at 22°25" - 35°8"N latitude and 87°13" - 42°4"E longitude, having an altitude about 60 M. Gurguripal forest experiences a tropical monsoon type with distinct wet and dry seasons. The average temperature is 22°C to 27°C. In the summer, it remains within 30°C to 40°C and in the winter it ranges from 10°C to 16°C. Gurguripal receives an average annual rainfall of 1500mm as a result of the south west monsoon. The soil is of the alluvial type at the regions beside Kangsabati River and is of lateritic type far from the riverside. This area represents tropical evergreen and deciduous mixed type of forest dominated mainly by „Sal" trees (*Shorea robusta*).

Collection of Mushrooms

The production of fruiting bodies by different mushroom species may vary from month to month and at different altitudes and regions. Thus, a particular mushroom species may fruit in different seasons at the onset of diverse climatic conditions. During frequent field surveys from May 2014 to October 2015, many mushroom species were collected. Sampling was done using quadrant method (20×20 m). For collection of mushrooms various equipment, such as hunting knife, scissor, digging tools and zipped polythene packets for preserving the collected mushrooms were used.

During survey the morphological & ecological characters of observed specimens were properly noted. Photographs of specimen from different angles were also taken for future studies.

Collected specimens were then preserved in a mixture of liquid preservatives using rectified alcohol, formalin, and distilled water at a ratio of 25:5:70. Some of the collected samples were dried in a hot air oven for biochemical and genetic study. Identifications of specimens were done by authentic mushroom data bases and standard keys.

Data Analysis

The frequency of occurrence for each species was calculated by following formula as suggested by Aung et al. (2008).

$$\text{Occurrence frequency of Taxon A} = \frac{\text{Occurrence of taxon A}}{\text{Total number of all species}} \text{ X } 100$$

Shannon diversity index for mushroom was calculated as proposed by Margalef (2008). $H = - \sum (n/N) \log_e (n/N)$

„H" is the diversity index, „N" is the total number of individuals of all the species, and „n" is the total number of individuals of the individual species.

Simpson Index of diversity was calculated as suggested by Simpson (1949). Simpson Index of diversity =1-D

Where, $D = \sum (n/N)^2$

n= Total number of organism of a particular species.
N= Total number of organism of all species.
D= Simpson"s index.

According to Pielou (1996), considering the values of diversity index, the evenness of the mushroom was calculated.

$e = H/\log S$

Where „e‟ is the evenness, „H‟ is Shannon index and „S‟ is the number of species.

Table 1 Distribution of mushroom species at Gurguripal Eco-forest (E= Edible, NE= Not-edible, M= Medicinal)

Family	Mushroom Species	Observed Frequency	Remark
	Agaricus peroboscurus	4	E
	Leucocoprinus brinbaumii	1	NE
	Agaricus crocopeplus	1	NE
	Lepiota sp.	1	NE
Agaricaceae	*Leucocoprinus* sp. (yellow cap)	5	NE
	Lepiota cristata	8	NE
	Agaricus sp.	2	E/M
	Agaricus campestris	65	E/M
	Leucocoprinus sp.(white cap)	2	NE
	Polyporus arcularis	5	E
	Polyporus squamosus	7	E
	Pleurotus sp.(large white cap)	6	E/M
Polyporaceae	*Lentinus* sp.	8	E/M
	Pleurotus sp.(small white cap)	6	E/M
	Polyporus tuberaster	8	E
Auriscalpiaceae	*Lentinellus cochleatus*	2	NE/M
	Coprinus comatus	1	E/M
	Coprinus picaceus	6	NE
Coprinaceae	*Coprinus* sp. (white funnel shaped cap)	7	NE
	Coprinus sp.(pleated cream cap)	4	NE
	Boletus sp.(black cap)	1	E
Boletaceae	*Boletus* sp.(brown cap)	2	E
	Boletus rubellus	3	E
	Boletus sp.(white cap)	2	E
	Cerrena sp.	4	NE
Coriolaceae	*Pycnoporus sanguineus*	7	NE
	Irpex sp.	25	NE
	Trametes sp.	5	NE
Peniphoraceae	*Sterium* sp.	3	NE
Schizophyllaceae	*Schizophyllum commune*	38	NE
	Daldinia concentrica	13	NE
Xylariaceae	*Xylaria polymorpha*	13	NE
Auriculariaceae	*Auricularia aurilia*	2	E/M
Sclerodermataceae	*Scleroderma verrucosum*	4	NE
Entolomataceae	*Astraeus hygrometricus*	23	NE/M
	Entoloma incanum	3	NE
	Mycena sp. (grooved margin)	8	NE
	Leucopaxillus sp.	26	E
	Mycena sp.	1	NE
	Crinipellis scabella	20	NE
Tricholomataceae	*Collybia rancida*	1	NE
	Collybia maculata	9	NE
	Lepista flaccida	19	E
	Clitocybe inversa	9	NE
	Tricholomopsis rutilans	2	NE
	Termitomyces heimii	17	E
	Collybia tuberosa	11	NE
Lycoperdaceae	*Lycoperdon* sp.	9	E/M
	Russula sp. (light red cap)	2	E/M
	Lactarius fuliginosus	4	E

Table 1 Continued.

Family	Mushroom Species	Observed Frequency	Remark
	Russula emetica	19	NE
Russulaceae	*Russula* sp.	7	E/M
	Russula albonigra	2	E /M
	Russula laurocerasi	1	E
	Russula delica	7	NE/M
	Lactarius sp.(margin serrated)	1	E
	Russula similima	2	E
	Lactarius sp.(margin smooth)	2	NE
	Russula mairei	3	E
	Russula cyanoxantha	2	E/M
Hygrophoraceae	*Hygrocybe pratensis*	15	E
Cantharallaceae	*Cantharellus* sp.	11	E
Clavariadelphaceae	*Macrotyphula fistulosa*	12	E/M
Ganodermataceae	*Ganoderma applanatum*	1	NE/M
	Ganoderma lucidum	17	NE/M
Clavariaceae	*Clavaria fragilis*	28	NE
Amanitaceae	*Amanita* sp. (pale white cap)	25	NE
	Amanita vaginata	17	NE
Strobilomycetaceae	*Tylopilus* sp.	5	NE
Hydnangiaceae	*Laccaria fraterna*	34	E
Pluteaceae	*Volvariella volvacea*	88	E/M

Results and discussion

In the present investigation, a total number of 743 mushroom specimens (individuals) were observed in Gurguripal Eco-forest after field studies from May 2014 to October 2015 (two monsoons). Some were identified to species level. Altogether, 71 mushroom species in 41 genera belonging to 24 families were noted (Table-1). Among the mushroom species 32 are edible and 39 are inedible. In addition, 19 species were medicinally important.

The total mycotain this area are dominated by the family Tricholomataceae (18%) followed by Agaricaceae(12%), Pluteaceae (12%) and Russulaceae (7%).Other species belonged to the families

Polyporaceae, Auriscalpiaceae, Coprinaceae, Boletaceae, Coriolaceae, Peniphoraceae, Schizophyllaceae, Xylariaceae, Auriculariaceae, Sclerodermataceae, Entolomataceae, Lycoperdaceae, Hygrophoraceae, Cantharallaceae, Clavariadelphaceae, Ganodermataceae, Clavariaceae, Amanitaceae, Strobilomycetaceae, Hydnangiaceae and are listed Fig-2. Throughout the survey, the mushroom species such as *Volvariella volvacea*, *Agaricus campestris*, *Schizophyllum commune, Laccaria fraterna, Clavaria fragilis, Astraeus hygrometricus* and *Lepista flaccida* were found to be abundant in their occurrence. Among the collected genera *Russula* had the maximum number of species.

According to their habitat 20 are wood rotting (cellulolytic and lingolytic), 34 are saprobic (terrestrial or on humus), 13 grow on leaf litter and 4 are associated as symbionts (ectomycorrhizal with trees or with termites) (Fig-3). The occurrence frequencies of different taxonomic groups are represented in Fig-4. Gurguripal Eco-forest is rich in mushroom diversity may be due to availability of plant litter and other degradable materials which accumulate and increase the fertility of soil. This favored the occurrence of more litter and wood decomposing mushrooms in Gurguripal Eco-forest. Also, the moist environment under the thick canopy of dense forest provided a good environment for mushrooms.

Biological diversity can be quantified in many ways. The two main factors taken into account when measuring diversity are richness and evenness. According to Simpson‟s index of diversity, the calculated value of species richness was 0.92 and as to Shannon‟s diversity index, the relative abundance of species was found to be 2.206. In this study, Simpson‟s Diversity Index ranged between 0 and 1, which is significantly higher, providing more weight for the species abundance in

Gurguripal Eco-forest. Evenness of the mushrooms was also calculated as 0.333. This result referred that all the 71 mushroom species belonging to 24 families were not evenly distributed numerically in the community. This is probably due to existence of diverse habitats in the ecosystem which favours the occurrence and abundance of selective mushroom species of particular type. Earlier, a total number of 90 species in 48 genera belonging to 19 families were recorded in and around Bangalore, Karnataka and the Simpson and Shannon biodiversity index was found to be 0.8 and 1.24 respectively (Pushpa et al. 2012).

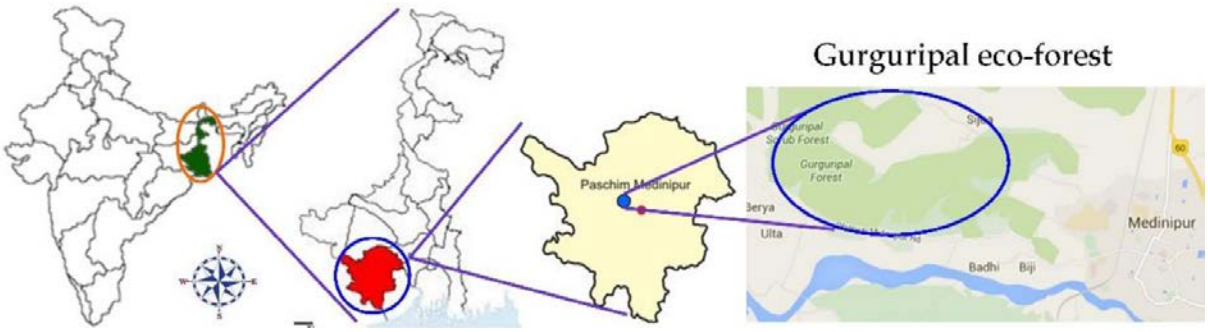

Fig. 1 - Study location and map of Gurguripal Eco-forest, Paschim Medinipur.

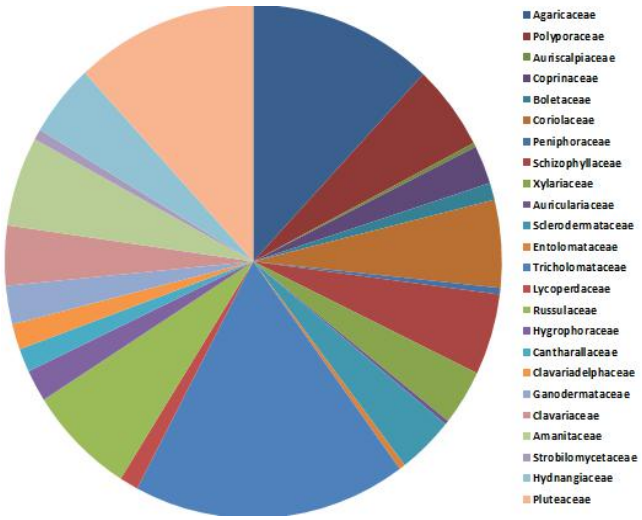

Fig. 2 - Family wise distribution of mycota in Gurguripal Eco-forest.

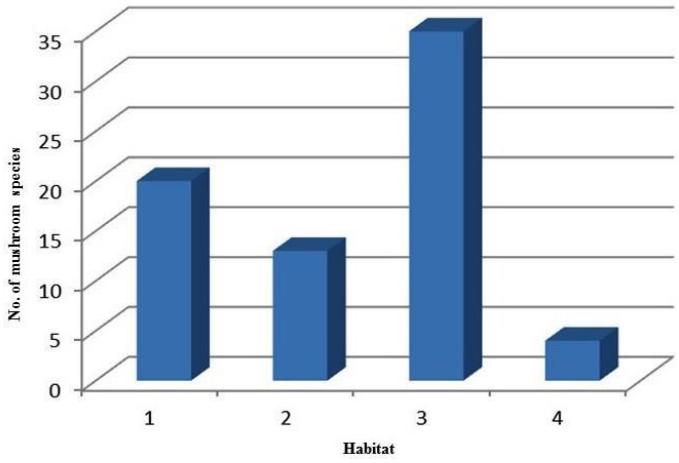

Fig. 3 - Distribution of mushroom on different habitat. Where, 1, wood rot species; 2, leaf litter species; 3, saprophytic species; 4, symbiotic species.

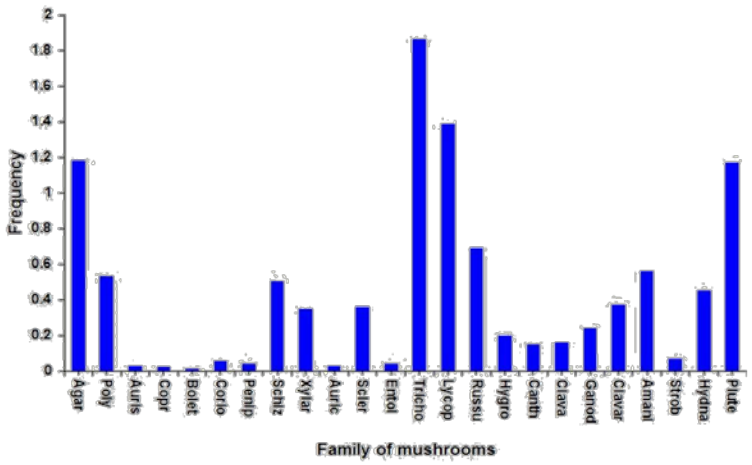

Fig. 4 - Family wise occurrence frequency of mushroom at Gurguripal Eco-forest.

Fig. 5 - Mushrooms at Gurguripal Eco-forest.

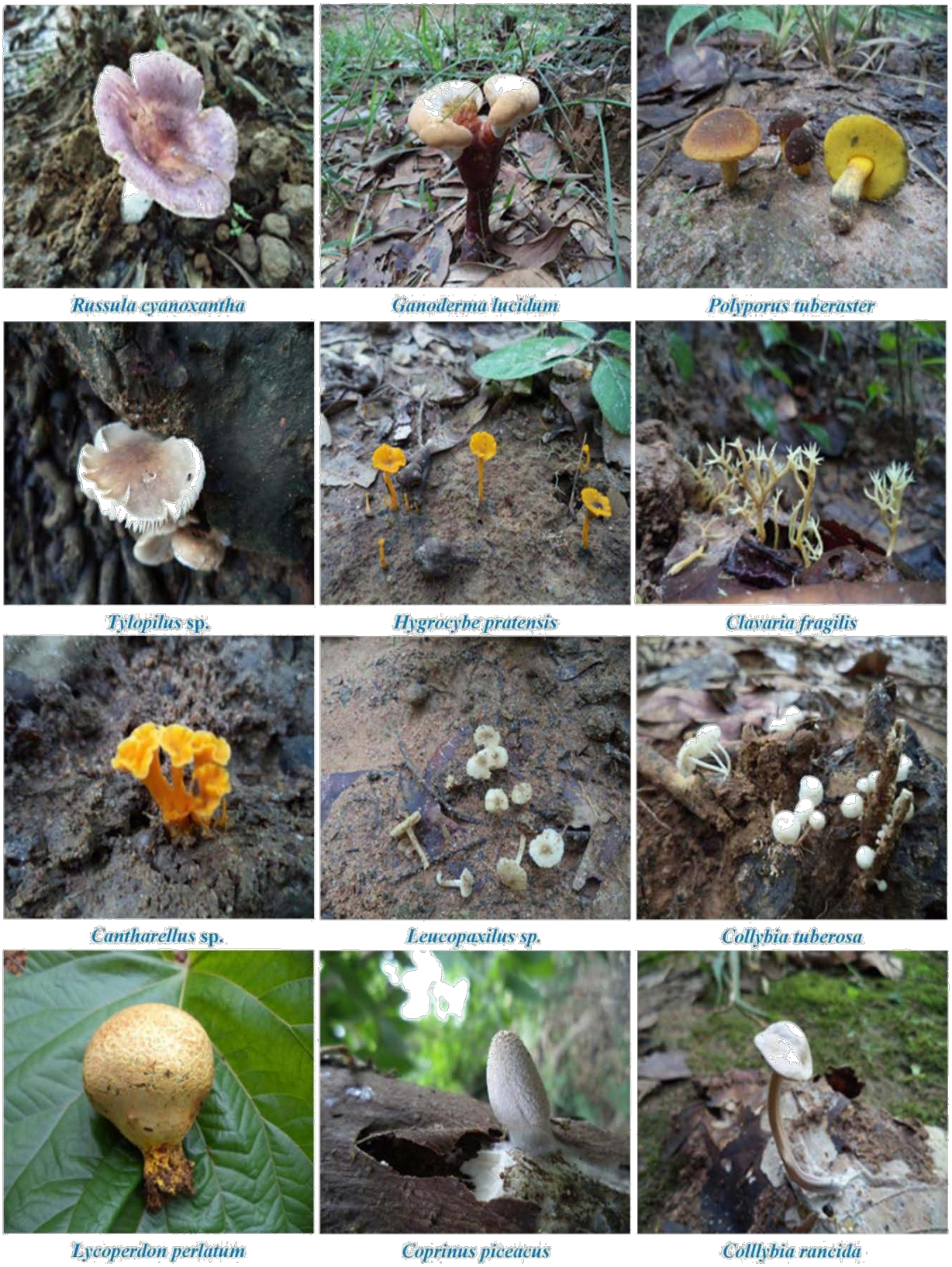

Fig. 6 - Mushrooms at Gurguripal Eco-forest.

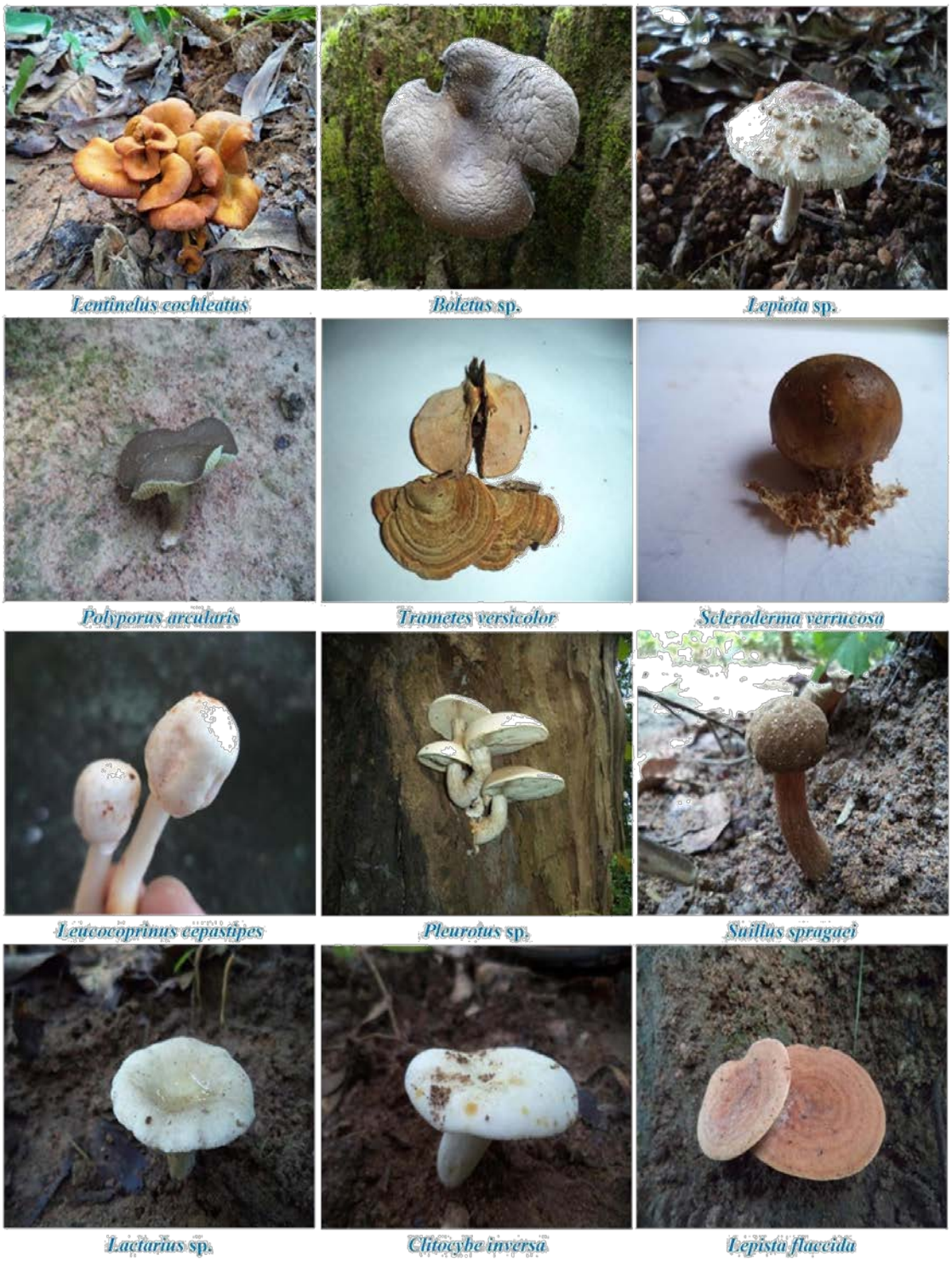

Fig. 7 - Mushrooms at Gurguripal Eco-forest.

The study of mushrooms in forest areas in various parts of India previously have been carried out by different workers. Pradeep et al. (1998) reported on the occurrence of mushrooms from Kerala. Singer (1952) reported 1320 species belonging to 129 genera under Agaricales. Doshi and Sharma (1997) recorded as wild mushrooms from Rajasthan. Thakur et al. (2011) reported on the biodiversity of mushrooms in the Chattishgarh region. A recent study by Chandulal et al. (2013) provided information regarding the diversity of mushrooms in Gujrat. The macro-fungi diversity in Patharia Forest of Sagar at Madhya Pradesh was reported by Vyas et al. (2014). In this respect, the present study revealed that Gurguripal Eco-forest is a good place to collect wild mushrooms comprising a significant number and diverse types of mushroom species.

Occurrence of mushrooms in tropical forests of the Indian sub-continent suggests a correlation between mushroom diversity and forest health. Interestingly, it was noted that richness and abundance of mushrooms was higher in the thick forest areas, whereas fewer species were observed in thin forest areas. According to Arnolds (1988) most healthy forest ecosystem housed at least 45% mycorrhizal fungi. The present research work explores a significant number of wild mushrooms occurring in a small village based forest area of Gurguripal, Paschim Medinipur West Bengal, India. The diversity of habitats and the edibility status of mushrooms have been reported in this study also. That surely opens up a new horizon regarding the exploitation and utilization of wild mushrooms in India in the future.

Acknowledgements

The authors are thankful to Mr. Arijit Jana and Mr. H. K. Santra for their kind assistance during the field survey.

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