

## DIVERSITY OF WILD MUSHROOM FLORA FROM INDIAN THAR DESERT

PRAVEEN GEHLOT\*, RUCHIKA SHARMA AND KAMNA SHARMA

Department of Botany, JNV University, Jodhpur 342001, Rajasthan, India

drpg73@rediffmail.com

### ABSTRACT

Indian Thar Desert harbours a treasure trove of fungal diversity especially wild mushrooms. Through exploration resulted in collection of 48 species belonging to 21 genera which were collected and studied. It was observed that these mushrooms were found to occur on a variety of substrates and in different habitats of Thar Desert. Threats to mushroom diversity in Thar Desert are of much concern due to ever increasing anthropogenic activities, frequent droughts and a high livestock population. Conservation of these wild mushrooms is urgent need of hour for their utilization as food, medicine and for utilizing active biomolecules in future.

**Keywords:** Basidiomycetes, Agricales, wild mushroom, Thar Desert

### INTRODUCTION

The Great Indian Desert, or Thar Desert, extends over about 0.32 million km<sup>2</sup> forming approximate 10% of the total geographic area of India. More than 60% of the Desert lies in the state of Rajasthan, followed by 20% in Gujarat. This desert from the eastern extremity of the great arid and semi arid belt of the world. It is one of the smallest deserts of the world but exhibits a wide variety of habitats and a high biodiversity due to juxtaposition of Palaeoartic, Oriental and Saharan elements. Owing to strong variations in climatic, edaphic, physiographic, topographic and geological characteristics, Thar Desert shows a wide variety of habitats and a high biodiversity. Thar Desert harbours a treasure trove of fungal diversity especially wild mushroom. In Thar Desert, wild mushrooms have an unestimated wealth of mushroom diversity, which needs to be tapped properly as there are still several undescribed species yet to be identified. Efforts need to make to identify and exploit these mushroom floras as their biodiversity and conservation and utility for the food security of a country.

The climate of Thar Desert is characterized by low rainfall with erratic distribution, extremes of diurnal and annual temperature, low humidity, high wind velocity and frequent dust storms. Soil profiles are characterized by low contents of silt, clay and humus but higher salt. Vegetation types are xerophytes thorn forest, mixed xerophytes woodland, lithophytic and psammophytic scrub desert and also halophytic vegetation.

In Thar Desert area, mushroom fungi tend to appear seasonally. The most productive months are those of the rainy season (July-September). The best conditions for the occurrence of a massive population of mushroom fruiting bodies (basidiocarps) are related with the presence of humidity in the nutritional substrate and in the air, coupled with a mild temperature. Thus during different climatic conditions (rainy, dry, sunny), different types of mushroom grow in different habitats, viz., on the ground in woodlands or associated with tree, on the ground in grasslands or open spaces, growing on trees stumps or woody debris, growing on burnt ground or brunt wood, growing on dung or enriched soil, growing on sand in sand dunes, on termite's nests and sometime parasite on living woods. This is because of a complex pattern of interaction with the climatic condition, soil profile, soil pH, soil humus, decomposed materials, plant debris and plants.

Alexopoulos *et al.* [1] classified Hymenomycetes fungi into Tremellales, Agaricales, Aphyllophorales, Auriculariales, Dacrymycetales, Ceratobasidiales, Tulasnellales and Gastromycetes lineage. The Agricales includes basidiomycetous fungi whose fruiting bodies are commonly called "mushroom". Typically the fruit body consists of an umbrella like cap on a central and vertical stipe. On the under side of the cap are radiating gills, upon which the microscopic spores are produced. Singer [2] has classified the order Agricales into 17 families as follows: Agaricaceae, Amanitaceae, Bolbitiaceae, Boletaceae, Coprinaceae, Cortinariaceae, Crepidotaceae, Entolomataceae, Gomphidiaceae, Hygrophoraceae, Paxillaceae, Polyporaceae, Russulaceae, Schizophyllaceae, Strobilomycetaceae, Strophariceae and Tricholomaceae.

## MATERIALS AND METHODS

Arid and semi arid area of Indian Thar desert viz., Jodhpur, Jaisalmer, Barmer, Bikaner, Churu, Jalore and Pali district were surveyed for wild agaricales mushroom collection during 2001 to 2010. Standard methods were followed for collection, preservation and macro and microscopic studies of mushroom [3, 4]. Macroscopic details such as shape, size, colour and odour of the fresh specimens were recorded before preservation. Fascinating feature of fruiting body, edibility, medicinal value, ectomycorrhizal association and other interesting feature were also noticed. Field photography was done using digital Nikon camera. Identification was made on the basis of critical observations of the specimens and perusal of relevant literature [2, 5-7]. The fruiting bodies were maintained in 4% formaldehyde solution in the laboratory and preserved in the herbarium division.

## RESULTS

In the present course of investigation, 48 species of 21 genera were collected from different habitat viz., grassland, pasture, roadsides, wooded area, sand dunes, over dead stumps and living trees. Detailed accounts of these wild mushroom with their families and taxonomic status were given as according to classification given by Singer [2]. Out of seventeen families mushroom belonging to eight families viz., Hygrophoraceae, Amanitaceae, Entolomataceae, Tricholomataceae, Agaricaceae, Coprinaceae, Strophariaceae and Crepidotaceae were collected and studied (Table 1).

**Table 1.** Characteristics feature and habitat of wild mushroom occurring in Indian Thar Desert

S. No.	Name of Mushroom	Family	Characteristics and Habitat
1.	<i>Hygrophoropsis aurantiaca</i>	Hygrophoraceae	Small orange-yellow basidiocarp with shallowly funnel shaped cap, reminiscent of a chanterelle but with true gills; in small troops on soil.
2.	<i>Volvariella bombycina</i> var. <i>flaviceps</i>	Amanitaceae	Bright-flavous basidiocarp with fibrillose cap and white gills found solitary on tree trunks.
3.	<i>Volvariella earlei</i>	Amantitaceae	White to pale gray basidiocarp found gregarious on soil.
4.	<i>Volvariella hypopithys</i>	Amanitaceae	Medium sized white basidiocarp with long stipe found on humus rich soil.
5.	<i>Volvariella pusilla</i>	Amanitaceae	Grayish white small sized basidiocarp with flattened cap and pinkish gills found on humus rich soil.
6.	<i>Volvariella speciosa</i> var. <i>gloioceplala</i>	Amanitaceae	Dull white pearl gray ovoid basidiocarp, flesh pink gills, found on soil.
7.	<i>Volvariella speciosa</i> var. <i>speciosa</i>	Amanitaceae	Large sized pale white to light brownish basidiocarp found growing on jowar straw on road sides
8.	<i>Pluteus subcervinus</i>	Amanitaceae	Medium or large agaric with pale brown cap and pink gills, found on rotting wood.
9.	<i>Termitomyces eurhizus</i>	Amanticeae	Large, white, fleshy basidiocarp with a broadly umbonate perforatorium, found solitary on termitaria.
10.	<i>Termitomyces heimii</i>	Amanitaceae	Large, white basidiocarp with umbonate and long pseudorrhiza found on the boundary walls of field on termite nests.
11.	<i>Termitomyces microcarpus</i>	Amantitaceae	Small white basidiocarp, found in group amongst where termite nests had been active.
12.	<i>Termitomyces tyleranus</i>	Amanitaceae	Small whitish basidiocarp with tall stem and pointed perforatorium found on leaf litter.
13.	<i>Termitomyces</i> sp.	Amanitaceae	Medium, white basidiocarp with long pseudorrhiza. Grow on termitaria soil.
14.	<i>Leptonia sericella</i>	Entolomataceae	Very small sized basidiocarp, white cap, decurrent gills, found amongst grass.

S. No.	Name of Mushroom	Family	Characteristics and Habitat
15.	<i>Clitocybe dealbata</i>	Tricholomaceae	Small fleshy basidiocarp with whitish-grey, shallowly depressed cap and white decurrent gills; trooping in rings on soil in lawns and pastures.
16.	<i>Tricholoma lobayense</i>	Tricholomataceae	Large fleshy basidiocarp with solid stipe swollen at base
17.	<i>Tricholoma sulphureum</i>	Tricholomataceae	Sulphur yellow coloured large fleshy basidiocarp found on soil and amongst leaf litter.
18.	<i>Marasmiellus sp.</i>	Tricholomataceae	Delicate white basidiocarp, found at the base of tree
19.	<i>Trogia infundibuliformis</i>	Tricholomataceae	Small brown basidiocarp with funnel shaped cap bearing deeply decurrent gills, found amongst leaf litter.
20.	<i>Marasmius confetus</i>	Tricholomaceae	On soil amongst grass
21.	<i>Marasmius oreades</i>	Tricholomaceae	Smallish, pale tan, fleshy basidiocarp, with blunt umbo and tough rooting stem, typically in rings on soil in short grass or lawns.
22.	<i>Hemimycena pithya</i>	Tricholomataceae	Small, delicate, chalk-white basidiocarp with bell-shaped irregularly grooved cap; in large troops or some somewhat tufted on plant debris.
23.	<i>Macrolepiota exocortata</i>	Agaricaceae	Large fleshy basidiocarp with white cap, gills and stem with ring; in scattered groups on soil in pastures.
24.	<i>Macrolepiota rachodes</i>	Agaricaceae	Large sized basidiocarp with coarse brown cap scales on a white background, free gills and a bulbous base solitary to gregarious, sometimes in caespitose clusters on garden soil.
25.	<i>Leucocoprinus cepaestipes</i>	Agaricaceae	Medium sized basidiocarp, white scaly campanulate cap, commonly found in parks, garden and roadsides.
26.	<i>Leucocoprinus zeylanicus</i>	Agaricaceae	Pale brown basidiocarp, campanulate cap with brown umbo found growing on the trunk of tree.
27.	<i>Agaricus alphitochrous</i>	Agaricaceae	Small size basidiocarp, cap creamish pale with squamules confined to the center pink to brown gills, found in groups amongst grass.
28.	<i>Agaricus augustus</i>	Agaricaceae	Medium to large basidiocarp with pale cap having fibrillose squamules, in field on sandy loam soil
29.	<i>Agaricus bambusophilus</i>	Agaricaceae	Small redish brown agaric, with dark center, appendiculate margin, found on leaf litter plant debris.
30.	<i>Agaricus benzodorus</i>	Agaricaceae	Medium sized basidiocarp with grayish brown cap, broadly umbonate found on soil or leaf litter.
31.	<i>Agaricus bisporus var. hortensis</i>	Agaricaceae	Medium to large basidiocarp with whitish cap and stem, pink or chocolate gills and ring on stem; in trooping groups often tufted on humus rich soil and plant debris.
32.	<i>Agaricus purpurellus</i>	Agaricaceae	Cremish basidiocarp with violaceous tins, appendiculate margin found solitary in field on sandy soil.
33.	<i>Agaricus silvicola</i>	Agaricaceae	Medium or large basidiocarp with creamy white cap, pink or chocolate gills, stipe with ring and bulbous base; in trooping groups on soil in leaf litter.
34.	<i>Agaricus silvaticus</i>	Agaricaceae	Medium basidiocarp with reddish brown cap, with radiating scales, flesh staining deep red, found on leaf litters.
35.	<i>Agaricus trisulphuratus</i>	Agaricaceae	Bright orange coloured basidiocarp, campanulate cap covered with numerous squamules found on soil
36.	<i>Lepiota mericana</i>	Agaricaceae	Medium sized basidiocarp, pinkish brown to reddish brown, squamulose, umbonate cap and a fusiform to club shaped stipe on soil in grassy habitats

S. No.	Name of Mushroom	Family	Characteristics and Habitat
37.	<i>Coprinus extimatorius</i>	Coprinaceae	Tall, pale brownish basidiocarp, with conical cap, blackening; solitary or in small groups, typically caespitose tufted, on stumps or wounds of broad-leaf tree.
38.	<i>Coprinus lagopides</i>	Coprinaceae	Tall, fragile, grey basidiocarp covered with whitish scurf, blackening scattered or solitary on soil or charred wood.
39.	<i>Coprinus sterquilinus</i>	Coprinaceae	White basidiocarp with blackening gills, campanulate cap covered with white fibrillose scales, found in grassy habitats.
40.	<i>Panaeolus fimicola</i>	Coprinaceae	Small grayish basidiocarp with mottled gills, becoming blackish, in trooping groups on soil in lawns parks and other grassy situation.
41.	<i>Psathyrella magambica</i>	Coprinaceae	Small basidiocarp with fuscous brown cap covered by numerous white velar squamules found in tufts on wood.
42.	<i>Psathyrella pygmaea</i>	Coprinaceae	Very small sized basidiocarp with brown cap, found in tufts on leaf litter.
43.	<i>Psathyrella spadicea</i>	Coprinaceae	Small brown basidiocarp forming caespitose clusters on dead wood and leaf litter.
44.	<i>Psathyrella tiarella</i>	Coprinaceae	Very small basidiocarp, clay brown umbonate cap, found in great numbers on soil in rainy season.
45.	<i>Pholiota squarrosa</i>	Strophariaceae	Large basidiocarp, straw-yellow covered with coarse rust scales and with ring zone on stem, caespitose tufts at the base of living broad-leaf trees.
46.	<i>Stropharia semiglobata</i>	Strophariaceae	Small or variable basidiocarp with domed slimy yellow cap, long slender stem with ring zone, clay or purplish brown gills; in small trooping groups, sometimes caespitose, on dung.
47.	<i>Crepidotus herbarum</i>	Crepidotaceae	Very small, whitish, kidney-shaped cap with buff gills, more or less sessile on twigs, and other plant debris.
48.	<i>Crepidotus quitensis</i>	Crepidotaceae	Very small, whitish to pale grayish cap, sessile, with dorsi-lateral attachment to substratum, on twigs and other debris.

**Family Hygrophoraceae:** Hygrophoraceae family is characterized by the ability to produce white, thin walled basidiospores from rather long, cylindrical basidia. Lamellae are thick and waxy. Many members of these families are colorful producing basidiocarps with white, yellow, orange or red caps. Only one species was collected i.e. *Hygrophoropsis aurantiaca*. Repeated forked nature of lamellae is the main distinguishing character of this genus.

**Family Amanitaceae:** This family is characterized by presence of small to large basidiocarp, presence of both an annulus and a volva or these velar structures may be absent. Twelve species were studied in this family belonging to three genera viz. *Volvariella*, *Pluteus* and *Termitomyces*. *Volvariella bombycina* var. *flaviceps*, *V. earlei*, *V. hypopithys*, *V. pusilla*, *V. speciosa* var. *gloicephala*, *V. speciosa* var. *speciosa*, are well distinguished morphologically due to typical characters presence of volva, spore and cystidia morphology. *Pluteus subcervinus* is characterized by the absence of velar structure at maturity. Five strains of genus *Termitomyces* viz., *T. eurhizus*, *T. heimii*, *T. microcarpus*, *T. tyleranus*, and *Termitomyces* sp. *Termitomyces* was distinguished by white basidiocarp with long pseudorrhiza found on the boundary walls of field on termite nests

**Family Entolomataceae:** Only one genus in this family has been collected and studied viz., *Leptonia sericella* which is well distinguished by infundibuliform pileus, central stipe, angular spores and presence of cystidia.

**Family Tricholomataceae:** This is a very large family. It is characterized by the stipe (if present), is confluent with the pileus. Basidiocarps are minute and delicate to large and fleshy. The colour of the spores is variable and the lamellae show

all possible forms of attachment with the stipe; rarely free. In this family, eight species of six genera were studied. These are belonging to the tribes Clitocybeae, Collybieae, Marasmiaceae and Mycenaceae. In the Clitocybeae, three species were studied namely *Clitocybe dealbata*, *Tricholoma lobayense* and *T. sulphureum*. The *Marasmiellus* sp. and *Trogia infundibuliformis* were studied under the tribe Collybieae. Tribe Marasmiaceae includes *Marasmius confertus* and *M. oredes*. *Hemimycena pithya* was studied belonging to the tribe Mycenaceae.

**Family Agaricaceae:** The family is characterized by the basidiocarp that is white to brown or grey-brown cap with free gills, an annulus but no volva and a stalk that readily separates from the cap. Gills may be light in colour-often pink or white but eventually darken. 14 species belonging to 4 genera viz., *Macrolepiota*, *Leucocoprinus*, *Agaricus*, and *Lepiota* were studied. These species are included under the tribes Leucocoprineae, Agaricaceae and Lepioteae respectively. Tribe Leucocoprineae included *Macrolepiota exorciata*, *M. rachodes*, *Leucocoprinus cepaestipes*, *L. zeylancius*. *L. zeylanicus* is characterized by lamellar colour due to an effect of the weather. Tribe agaricaceae included *Agaricus alphitochrous*, *A. augustus*, *A. bambusophilus*, *A. benzodorus*, *A. bisporus* var. *hortensis*, *A. purpurellus*, *A. silvicola*, *A. silvaticus* and *A. trisulphuratus*. In tribe Lepioteae, *Lepiota americana* was studied.

**Family Coprinaceae:** The family comprises of the black or brown large spores, basidiocarps are typically fragile and bear shreds of ruptured cutis. Members of this family may be found on dead wood, dung, soil and litter. Eight species belonging to 3 genera coming under subfamilies Coprinoideae, Panaeoloideae and Psathyrelloideae were studied. In Coprinoideae *Coprinus extintorius*, *C. lagopides*, *C. sterquilinus* were studied. In Panaeoloideae, *Panaeolus fimicola* was studied having deep purplish smooth spores. In *Psathyrelloideae*, *P. sathyrella*, *P. magambica*, *P. pygmaea*, *P. spadicea* and *P. tiarella* were reported

**Family Strophariaceae:** The family is characterized by the epicutis of the pileus that is composed of appressed narrow tubular often gelatinous hyphae. The basidiospores are brown and possess an apical germ pore or a minute apical discontinuity. The stipe and pileus are confluent. Two members of this family, *Pholiota squarrosa* and *Stropharia semiglobata* were collected. *S. semiglobata* is included under sub family Stropharioideae while *P. squarrosa* is included under the sub family Pholitoideae.

**Family Crepidotaceae:** Family Crepidotaceae is characterized by fruit bodies that are shell-like, lacking a stem and laterally attached to dead and decaying wood. The mature gills and spores range in colour from cinnamon-brown to stuff-brown. Two species *Crepidotus herbarum* and *C. quitensis* were studied.

## DISCUSSION

Considering the arid nature of this area, one may not think about the occurrence of mushroom because Thar Desert generally receives meager rains in comparison to other parts of India and this factor is coupled with a prolonged hot dry season. Therefore, it is logical not to expect the growth of mushroom which requires high humidity and low temperature. Earlier, surveys were conducted by Singh [8, 9], Nag *et al.* [10], Doshi *et al.* [11] in different areas of Rajasthan. Singh [8, 9] reported occurrence of edible mushroom from Rajasthan viz., *Agaricus spp.*, *Pleurotus spp.*, and *Coprinus spp.* Nag *et al.* [10] reported 22 genera and 43 species of mushroom from Jaipur district. Doshi *et al.* [11] reported 94 species of macro-fungi of 52 genera belonging 7 families. Later Doshi and Sharma [12] enlisted 173 species from 95 genera of macro-fungi including Agricales, Aphyllophorales, Gastromycetes and Dacrymycetales from Rajasthan. Most of these genera have been collected from humid areas of southern Rajasthan but no intensive exploratory work was conducted in the arid areas of Rajasthan. Doshi *et al.* [11] collected only 13 species from 12 genera from arid zone of western Rajasthan. In the present investigation, 48 species belonging to 21 genera are reported from Thar Desert.

Maximum 14 species were recorded from the family Agaricaceae followed by 12 species of Amanitaceae, 8 species of Tricholomataceae and Coprinaceae respectively, 2 species of Strophariaceae and Crepidotaceae respectively. 1 species of Hygrophoraceae and Entolomataceae respectively. As far generic distribution is concerned maximum 6 genera were reported in and family Tricholomataceae followed by 4 genera in Agaricaceae, 3 genera in family Amanitaceae and Coprinaceae, 2 genera in family Strophariaceae, and 1 genus belongs to family Hygrophoraceae, Entolomataceae and

Crepidotaceae respectively. Maximum 9 species belong to *Agaricus* followed by 6 species of *Volvariella*, 5 species of *Termitomyces*, 4 species of *Psathyrella* and 3 species of *Coprinus* were studied while the left over genera had either 1 or 2 species.

It was observed that these mushrooms were found to occur on a variety of substrates and in different habitats. Species such as *Leucocoprinus zeylanicus*, *Agaricus purpurellus*, *Lepiota cepaestipes*, *Coprinus extintorius*, *C. strequelinus*, *Psathyrella magambica* and *P. pygmaea* were found to occur on diverse habitats which have not been recorded earlier. For instance, *Leucocoprinus zeylanicus* was always found from soil habitat but during the present mycofloristic survey, it was collected from trunk of living tree of *Salvadora oleoides*. *Coprinus sterquilinus* previously reported from the mushroom beds but this is reported from grassy habitat. *Agaricus purpurellus* is found as solitary specimen but now reported gregariously on soil. *Psathyrella magambica* was reported on leaf litter but during the present studies it was found on rotting wood.

Threats of loss of mushroom diversity in the Thar Desert are of much concern since they play a significance role in human welfare. Over time, ever increasing anthropogenic activities have been accompanied by changes in the traditional pattern of land use, resulting in substantial alteration of habitats. Frequent droughts and a high livestock population are other threats. In more recent years, there has been ecological disturbances due to construction of the Rajasthan Canal (Indira Gandhi Nahar Project, IGNP).

## ACKNOWLEDGEMENTS

The author acknowledges Center of Advanced Studies, Department of Botany, JNV University Jodhpur for providing laboratory facilities and Grants. Directorate of Mushroom Research, Solan is also acknowledged for help in specimens identification.

## REFERENCES

- [1] Alexopoulos CJ *et al.* (1996). Introductory Mycology. Wiley Eastern Ltd. New Delhi.
- [2] Singer R. (1986). The Agaricales in modern taxonomy, 4<sup>th</sup> edn. Koeltz Scientific Book: Koenigstein. pp. 981.
- [3] Kumar A *et al.* (1990). The Amanitaceae of India. Bishen Singh mahendra Pal Singh, Dehra Dun, Uttaranchal, India.
- [4] Atri NS *et al.* (2003). Wild mushrooms-collection and identification. Chambaghat, Solan, HP, India
- [5] Smith AH *et al.* (1979). How to know the non-gilled mushroom, Second edition. W.C. Brown Company Publisher, Iowa
- [6] Purkayastha RP and Chandra A. (1985). Manual of indian edible mushroom. Today and Tomorrows Printers and Publishers, New Delhi. 267 p.
- [7] Pegler D and Spooner B. (1997). The mushroom identifier. Leefung-Asco printers Limited, China. 144 p.
- [8] Singh RD. (1977). Edible fleshy fungi in Rajasthan. *J. Mycol. Pl. Pathol.* 8: 78.
- [9] Singh RD. (2004). Mushroom scenario of Rajasthan. *J. Mycol. Pl. Pathol.* 34: 711-713.
- [10] Nag T *et al.* (1991). Studies on mushroom mycoflora of Rajasthan. Some Agaricales from Jaipur district. In Indian Mushroom. Published by Kerala Agricultural University, Vellari, Kerala.
- [11] Doshi A *et al.* (1994). Fleshy fungi from Rajasthan. In: National symposium on Mushroom. Solan pp 7.
- [12] Doshi A and Sharma SS. (1997). Wild Mushroom of Rajasthan. In: Proceeding of the Indian Mushroom Conference held at Solan pp 105-127. Advance in mushroom Biology and Production (Rai, Dhar and Verma, eds) 1997, MSI Solan.