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Diversity and conservation of wild mushrooms in Rinchenpong, West Sikkim of India

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Abstract

Apart from scenic beauty and mighty Mt Kanchenjunga the Eastern Himalayan state of Sikkim is also known for its rich species diversity of flora and fauna in India. From the same state many of the diverse mycofloral diversity were explored and new macro fungus species were discovered. Taking same thing in mind a survey was conducted on wild macrofungi associated with open mixed forest of the Rinchenpong region of the West Sikkim, India. In this survey we yielded Macrofungi specimens of 11 different species representing 11 different genera and 10 different families of fungi which includes: 1). *Boletellus emodensis* (shaggy cap), 2). *Xeromphalina kauffmanii* (cross vein troop), 3). *Lactifluus volemus* (Tawny milky cap), 4). *Russula dubdiana*, 5). *Fistulina hepatica* (Beefsteak or Oxtongue mushroom) and 6). *Micropus vernicipes* 7). *Amanita rubrovolvata* 8). *Stereum ostrea* 9) *Phyllotopsis nidulans* 10) *Coprinellus disseminatus* 11) *Cortinarius rubellus*. All of the collected macrofungi are completely different owing to special characteristics features and some of them might have reported first time in that particular area which might require further investigations. In this report all of the morphological features of six collected species are mentioned along with their ecological description, habitat and their status of edibility. This is one of the first report on the macrofungal diversity from the forest region of Rinchenpong, West Sikkim, India.

Keywords: Diversity, macrofungi, mushrooms, mycoflora, Sikkim, species

Introduction

The Mushroom word is generally used for fruiting body formed by the macrofungi of 2 different class such as Ascomycota and Basidiomycota with very short reproductive stage during their life cycle ^[1]. Mushrooms grow above the ground soil, or at tree logs or on wherever its food source is available by producing the fleshy spore bearing fruiting body of a fungus. In the world approximately about 1.5 million of fungi species are reported till now ^[2]. Some of the mushrooms species are edible and others are non-edible or poisonous in nature. Evidence taken from the fossil records of lower cretaceous period proves the existence of mushroom on earth before the appearance of human life ^[3]. About 2000 of these mushroom species are documented edible for consumption by humans and 650 of these possess medicinal properties ^[4]. Edible Mushrooms are good for human consumption due to high content of protein, fibre, vitamin, minerals and low content of cholesterol ^[5]. Since many decades Mushrooms are not only part of food but are important part of Folk or Traditional medicine ^[6]. Growing Wild edible mushrooms are one of the special forest based product which the prehistoric humans use to collect and consume it as a food from the forest ^[7]. Many of the edible food like volvarias and tuber fungi were utilized by the tribal community inhabiting the forest region of both India and Nepal ^[8]. This wild mushrooms are rich source of essential nutrients and were also valued as a medicine by the various tribes or people living in the forest. But still people living in the civilized scientific society had not accepted the food value and medicinal properties of all this wild edible mushrooms ^[9]. One of the beautiful Himalayan state of Sikkim is not only blessed with mighty Mt. Kanchenjunga but are also popular for its biodiversity richness due to high altitudinal and climatic variations. Out of the total Sikkim's geographical area the forest covers approximately 47.69% of area in a state with mostly subtropical and temperate mixed broadleaved forest areas favourable for the growth and establishment of mycorrhizal associations by the macrofungi or mushroom forming fungi. Resources such as Wild mushrooms also plays a significant role in life of tribal people because most of them are mainly dependent on the forest resources such as wild mushrooms as a food and source of income. During a season these wild mushroom are consumed widely in Sikkim by the locals

and some collect it from the forest and sell them in a nearby vegetable markets along with vegetables [10]. Mineral content in Mushrooms are higher than meat and fish as Indigenous people were utilizing these wild mushroom as tonic for treating many type of diseases [11]. Mushrooms are also rich source of novel bioactive compounds and many researchers are continuously searching for novel antimicrobial compounds in plants and still many species of wild mushroom are unexplored which might hold several hidden novel antimicrobial compounds.

It is impossible to predict when and which of these species may lost forever. So there is a need to explore the hidden flora of wild mushroom species in the forest which also helps to determine its diversity, habitat, distribution in the particular forest area and its utilization by the people living nearby.

The aim of this survey was to collect and study the diversity, distribution, habitat, morphology and uses of wild mushrooms found in the forest area of Rinchenpong, West Sikkim, India.

Materials and Methods

Collection site

Small hilly area of Rinchenpong lies in West Sikkim between 27.24° N, 88.27° E and 30 km away from the Barsey Rhododendron Sanctuary. Rinchenpong is above 1700m from the sea level whereas the minimum and maximum temperatures are between 15.9°C and 25°C respectively. As per previous reports the annual rainfall in Rinchenpong area is reported about 200-300 mm per year. Due to high altitudinal and climatic variation Rinchenpong in West Sikkim is also a home for many tree species. The available tree species growing in these areas other than rhododendrons are *Viburnum continifolium*, *Abies densa*, *Taxus wallichiana*, *Tsuga dumosa*, *Picea spinulosa*, *Lithocarpus pachyphylla*, *Castanopsis hystrix*, *Magnolia campbellii*, *Alnus nepalensis*, *Prunus napaulensis*, *Betula utilis*, *Betula alnoides*, *Castanopsis tribuloides*, *Sorbus vestita*, *S. insignis*, etc. [1] which are also a habitat for most of the wild mushrooms to grow and were mostly found in large numbers during rainy season in this area.

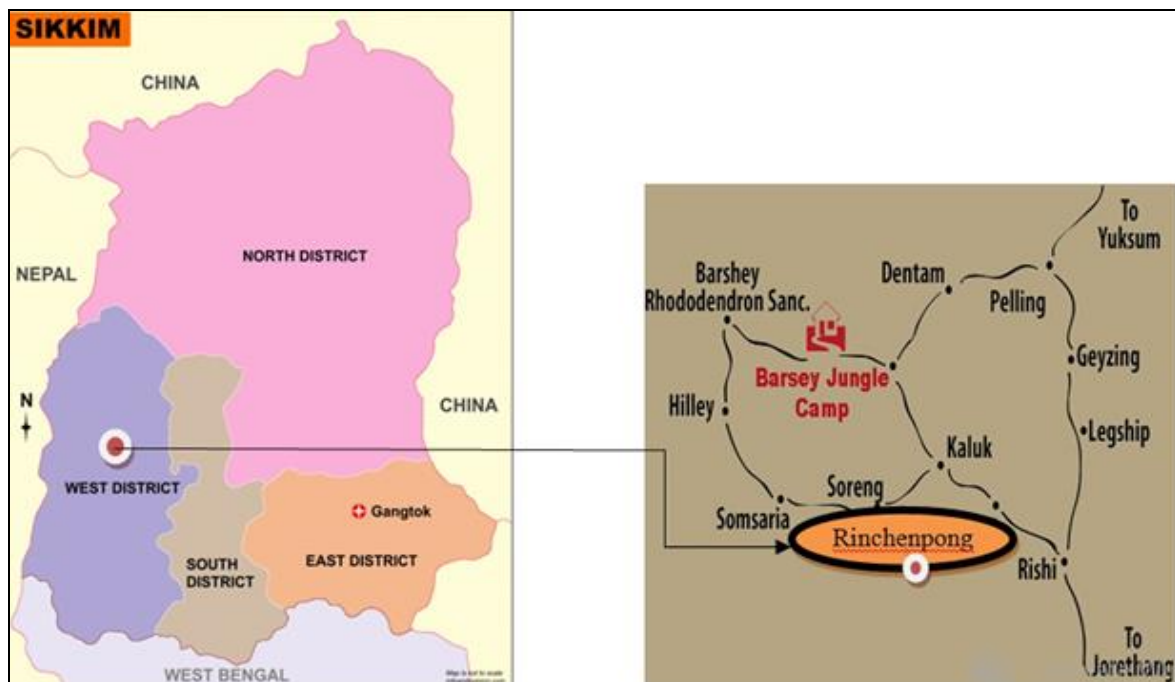


Fig 1: Showing Survey area of Rinchenpong, West Sikkim of India

Collection of mushroom samples

A survey was carried during a month of May to June, 2021 and eleven (11) different wild mushroom species were collected during this survey. The spotted mushrooms species were inspected and their photographs were taken at their natural habitat using a Samsung camera with power of 64 megapixels. After this the collected macrofungi species were studied for their morphological identification details, their habitat, their distribution, and their uses by the local or tribal peoples living nearby. All of these details were recorded and maintained in a separate sheet and all of these eleven (11) different macrofungi samples were dried using a commercial dryer for the preservation purpose. The photographs of all of the spotted macrofungi species were illustrated below along with their ecological description, distribution, habitat and uses of each particular species.

Processing of Mushrooms

It is reported from the previous data that fleshy mushrooms

are highly perishable, so there might be chance of deterioration by enzymes or by microorganism. If this fleshy fruiting bodies were not preserved properly then it may get damage or its quality will deteriorate and cannot be utilized for further analysis, so to prevent the same, some of the precautionary steps were followed before processing this fruiting body for analysis. Firstly to remove the debris the fruiting bodies were washed with the water followed by 2 different preservation method (a) short term preservation and (b) long term preservation for the study as well as for structure of mushrooms [12]. (a) Drying-Electric air dryer is used with the power capacity of 1000w which can easily remove all of the moisture content of collected fruiting bodies within a time period of 4 to 7 hrs maintaining the regular power supply which depends upon structure and texture of each collected mushroom. (b) Storage- Zip lock polybags were bought and the dried mushroom specimen were stored inside it and during this storage period silica gel

at the rate of 10% is used for preserving the stored mushroom specimen.

Morphological characterization of wild mushrooms

Various morphological features like shape, colour, size of mushrooms are very important for identification and characterization of mushrooms. Before analyzing the morphology the basidiocarp of the mushrooms were soaked in a water for rehydration. The morphological data is mostly recorded during collection of mushroom in fresh fleshy form. Eye observation can be made to observe the qualitative characters like color, shape etc. every mushrooms have a different texture which helps to differentiate with each other. The texture of the particular mushroom can be identified using fingers by touching and feeling both top and back surfaces of mushroom.

Results and Discussion wild macrofungi diversity

Out of the 11 macrofungi collected specimen: one species of *bolletellus emodensis* spotted growing on two different

habitat: on a soil under a tree while another with association with rhododendron tree species. One species of *Xeromphalina kauffmanii* fruiting bodies spotted growing on a dead wooden log, one specimen of *Lactifluus volemus* growing on decomposed leaves substrate above the soil, one new *Russula dubdiana* species growing on decaying leaves under *Castanopsis hystrix* tree, one *Fistulina hepatica* species spotted growing on a tree base and one species of *Microporus vernicipes* spotted growing on a decaying wooden log, one species of *Amanita rubrovolvata* on ground, one species of *Stereum ostrea* on decaying wood, one species of *Phyllotopsis nidulans* growing on a tree as a cluster, one *Coprinellus disseminatus* species on a decaying stump base and one species of *Cortinarius rubellus* on a ground under a coniferous tree shown in figures 2-4 given below and also mentioned in Table 1. While the dominant reported families were: Russulaceae, Mycenaceae, Boletaceae, Fistulinaceae, Polyporaceae, Amanitaceae, Steraceae, Tricholomataceae, Psathyrellaceae, Cortinariaceae as mentioned in the Table 2.



Fig 2: (1) *Boletellus emodensis* (2) *Xeromphalina kauffmanii* (3) *Lactifluus volemus* (4) *Russula dubdiana*

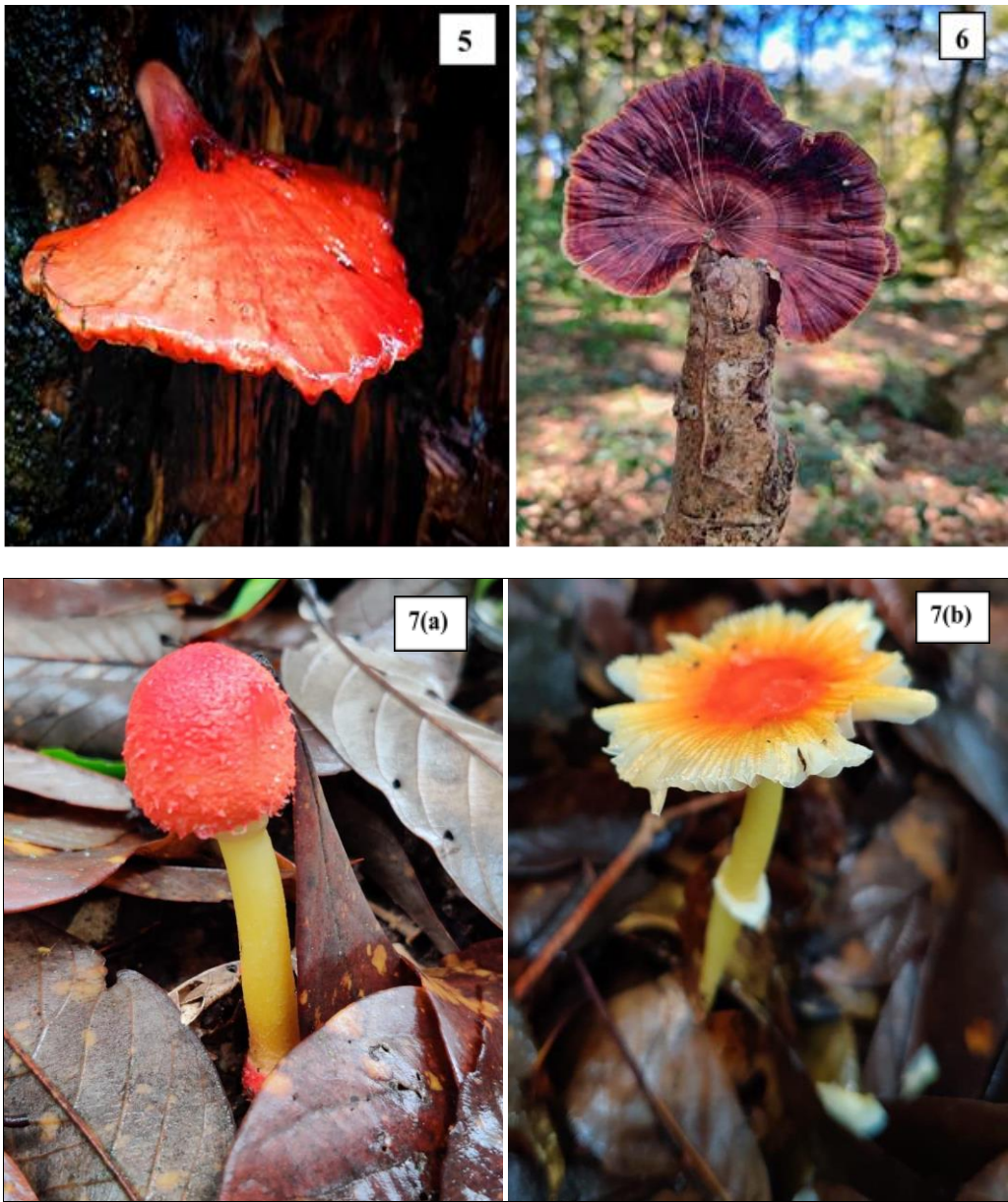


Fig 3: (5) *Fistulina hepatica* (6) *Microporus vernicipes* (7) *Amanita rubrovolvata* (a) Young stage (b) Mature stage





Fig 4: (8) *Stereum ostrea* (9) *Phyllotopsis nidulans* (10) *Coprinellus disseminatus* (11) *Cortinarius rubellus*

Table 1: List of wild mushrooms species found in Rinchenpong, West Sikkim of India

S. No.	Scientific names	Common name	Habitat	Description	Edibility status
1.	<i>Bolletelus emodensis</i> (Berk.) Singer	Shaggy cap	On the ground, sometimes grown on tree as association	Pileus about 4.5-10 cm, convex or hemispherical, dry surface, dull crimson to rose red colour with large and small scales at the surface. (Corner 1972)	Edible
2.	<i>Xeromphalina kauffmanii</i>	Cross vein troop	On the rotting hardwood logs	Pileus or cap is about 0.4-1.5 cm, convex shaped or flat overall, bright orange colour with reddish stipe about 1.7-3 cm. (Smith AH, 1953)	Inedible (non-poisonous)
3.	<i>Lactifluus volemus</i>	Tawny milky cap	Mostly at the base of broad leaves trees or coniferous tree	Pileus is about 11 cm, convex shaped apricot to tawny colour, releases milky latex when cap is damaged. (Katsaros, P, 1998)	Edible
4.	<i>Russula dubdiana</i>	Unknown	On ground, or under <i>Castanopsis hystrix</i> tree	Pileus is about 4.8-6.5cm, convex or planoconvex with depressed at centre at young, Stipe 3.2-5.0 × 0.9-1.5 cm mostly light saffronish in colour and cylindrical shape. (Das K, Atri, Buyck B 2013)	Edible
5.	<i>Fistulina hepatica</i>	Beefsteak or Ox-tongue mushroom	Grows mostly on oak, chestnut and Eucalyptus tree	Fruiting body is about 7-30cm wide and 2-6 cm thickness, appear pinkish red colour in young stage and brownish red at later, appears similar to the red meat. (Davis, R. Michael, John A. 2012)	Edible
6.	<i>Microporus vernicipes</i>	Unknown	Grow on dead wooden logs	Light dense mycelial pad spreading irregularly at the base end of pileus with stipe at laterally placed, from the back both the stipe and pileus appears white. (Rituparna Saha, Diptosh Das, 2018)	Edible
7.	<i>Amanita rubrovolvata</i>	Red volva amanita	Grown on ground, Mycorrhizal association with tree roots.	Orange-reddish cap about 0.65 cm wide, stipe creamy yellow in colour with height about 7.8-10 cm. red colour ring at the stipe base. (Weiβ M, Yang Z-L, Oberwinkler F, 1998)	Edibility & Toxicity unknown
8.	<i>Stereum ostrea</i>	False turkey tail or Golden curtain crust	Grows on the bark of tree	Fruiting body with colourful (yellowish to red) concentric circles resembles the shell, no stipe or stem present. Fruiting body are tough and (non-flat) grows about 1-7 cm high. (Kuo, Michael December 2008)	Inedible
9.	<i>Phyllotopsis nidulans</i>	Mock oyster or Orange oyster	Grows on decaying wood	Fan shaped fruiting body grows both singly or in cluster with fuzzy cap of orange colour with mostly overlapping pattern. (<i>Phyllotopsis nidulans</i> (Pers.) Singer 1936".)	Inedible
10.	<i>Coprinellus disseminatus</i>	Fairy ink cap or Trooping crumple	Grows on decaying wood at the stump bases.	Cap convex bell shaped about 0.5-2 cm wide and stipes about 4cm long, cap creamy white colour at beginning and yellow brown at later. (Lange & Smith, 1953)	Inedible
11.	<i>Cortinarius rubellus</i>	Deadly web cap	Grows on ground near coniferous pine tree and near spruce woodland.	Cortical to convex and somehow flat at maturity, brown dry cap about 4-8 cm in diameter and stipe about 5.5 to 11 cm and bulbous at the base. (Cooke MC 1887)	Inedible (Reported Poisonous)

Table 2: Diversity of mushroom family reported from Rinchenpong, West Sikkim, India

Mushroom Family	Total Species Found	Macrofungi Species (reported)
Mycenaceae	1	<i>Xeromphalina kauffmanii</i>
Boletaceae	1	<i>Bolletelus emodensis</i>
Rusulaceae	2	<i>Russula dubdiana</i> and <i>Lactifluus volemus</i>
Fistulinaceae	1	<i>Fistulina hepatica</i>
Polyporaceae	1	<i>Microporus vernicipes</i>
Amanitaceae	1	<i>Amanita rubrovolvata</i>
Steraceae	1	<i>Stereum ostrea</i>
Tricholomataceae	1	<i>Phyllotopsis nidulans</i>
Psathyrellaceae	1	<i>Coprinellus disseminatus</i>
Cortinariaceae	1	<i>Cortinarius rubellus</i>

Conservation of wild mushrooms

The anthropogenic factors and some natural factors like air pollution, climate change, global warming etc. and over exploitation of the natural resources are responsible for diminishing a large portion or huge biodiversity of organisms from the earth which includes microorganisms plants, animals etc. out of every living organism fungi are the group of organism which are very less explored especially the wild mushrooms which are mostly found and grown in forest or wild areas^[1]. As we know penicillin is world's first antibiotic which is developed from the fungi *penicillium notatum* which is also one of novel accidental discovery in the field of medicine. Multidrug resistance by the microorganisms is one of the serious problem which challenges researchers around the world to develop a novel antimicrobial compounds against them^[13]. This wild mushrooms shows possibility to be a source of novel antimicrobial compounds in nearby future. Like the same way the microplastic pollution in the environment especially in the waterbodies is affecting serious problems to several sea animals including fish, turtles, whales etc. In many of the studies it is found that several fungal enzymes shows potential efficacy on degrading the microplastic within short period of time which shows fungi to be effective in curbing the environmental pollution. There are many places in the world where people uses wild mushrooms from the forest as tonic, as a medicine and also as a good source of food and some income by selling them to nearby markets. this all proves fungi or mushroom as an important natural resources, keeping same thing in mind the fungal or mycofloral diversity in the forest area or wild areas must be preserved and effective methodologies must be followed to preserve rare, endemic and endangered species before they get diminished from the environment. Several trees serves as habitat for many of the wild mushroom species and deforestation may leads to serious threat for these wild mycoflora. So controlling it may also help increasing the mycofloral diversity of wild mushrooms in a particular area. Apart from that many ex-situ conservation steps also be followed like drying wild mushroom specimen and preserving it at herbaria and culturing or grown of its germplasm in synthetic media and preserving them using several storage methods for future use^[14].

Conclusion

The survey is conducted in Rinchenpong, West Sikkim and during the survey 11 different macrofungi were collected representing 11 different genus and species and also belonging to 10 different families of macrofungi. Which proves Rinchenpong region of West Sikkim, India have distinct diversity of Wild Mushroom in Sikkim, India.

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Conflicts of interest

The author declare that there is no conflict of interest.

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