



## Original Research Article

### Higher Fungi Associated with Decomposing Leaf Litter of *Pinus longifolia*

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#### A B S T R A C T

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Wild mushrooms play important role in biological cycles in nature. They have also impacts in ecology and economy. They are not only a good source of food but also helpful for the degradation of litter by breakdown of logs, stems, leaves and other organic debris. The present investigation was carried out in the Chandak forest of *Pinus longifolia* of Pithoragarh of the state Uttarakhand. The fruiting bodies of macrofungi were collected from the forest between 2011- 2013. In the present study 17 wild mushrooms collected from viz: *Amanita ceciliae*, *Amanita muscaria* var. *alba*, *Amanita pantherina*, *Amanita vaginata*, *Cantharellus cibarius*, *Coprinus disseminatus*, *Ganoderma lucidum*, *Gloeophyllum sepiarium*, *Hydnum repandum*, *Laccaria amethystea*, *Lactarius volemus*, *Russula emetica*, *Russula lepida*, *Russula nauseosa*, *Ramaria stricta*, *Scleroderma geaster* and *Suillus bovinus*. Mushrooms species were maximum in rainy season and minimum in winter season.

## Introduction

Wild mushrooms have manifold impacts in biology, ecology and economy. It is important to understand the beneficial role of mushrooms in the environment. In common they are called mushrooms which is a group of higher fungi belongs to class Basidiomycetes and Ascomycocetes. They can't make their own food due to lack of chlorophyll. They grows in wild habitats like grassy ground, rotten wood, leaf litter, dung and cellars and represent a short stage of reproduction in their life cycle. The wild mushroom seem to have been traditionally consumed by man since very early times, but these were then probably considered a food in wilderness, which now have come to occupy a very popular place in the modern

dietic regimen because of its nutritive value (Bano, 1976). Mushrooms are a good source of various bioactive substance like anticancer, antiparasitic, antiviral, antifungal, cytotoxic, anti HIV, DNA damaging, antidiabetic, anticoagulant etc (Wasser and Weis, 1999). We know very well that mushrooms were studied mostly by the Western workers.

The first list of Indian Fungi was published by Butler and Bisby (1931), and then revised by Vasudeva (1960). Several additional lists appeared in between culminating with the fungi of India by Bilgrami *et al.* (1979). Agriculture in India was reviewed first by Sathe and Rahalkar (1975) making 1825 as

the base and then by Manjula (1983), providing a very exhaustive list of Agaricoid and Boletoid fungi from India and Nepal. They enumerates 538 valid genera and 20 families in the Agaricales. This list has been recently updated by Natarajan *et al.* (2005). Adhikari (2001) reported 11 wild mushroom species from Kathmandu valley, Adhikari and Adhikari (2003) collected 12 fleshy fungi species from vicinity of Duradanda, Lamjung.

Bhatt *et al.* (2003) recorded 15 new species of *Amenita*, Christensen *et al.* (2007) recorded 228 species of wild mushrooms from Nepal, Das (2010) collected 126 wild mushrooms from Barsey Rhododendrom Sanctuary from Sikkim, Vishwakarma *et al.*, (2012) recorded 40 taxa belonging to 11 families of macrofungi out of different moist temperate forest of Pauri, Tehri, Chamoli and Rudraprayag districts of Garhwal Himalaya, Jha and Tripathi (2012) collected 22 species of macrofungal in Shivpuri National Park of Kathmandu Valley in Nepal. Keeping the aforesaid facts in view the present study was undertaken in the Chandak Forest of the Pithoragarh district to determine the macrofungal diversity in the region and provide information on macrofungi flora associated with decomposing pine leaf litter.

## Materials and Methods

### Study Area

In this study area is Chandak forest which is situated between Lat. 29°27' N. and 30°49' N. and Long. 79°50' E. and 81°3' E. Chandak forest region is present on 6000 ft (1.830m) altitude surrounded by 283 Hectare of pine forest.

### Collection

The extensive field trips were undertaken from 2011 to 2013 from the Chandak forest of

Pithoragarh to collect the sample of macro fungi. Necessary material and equipments digging equipment, hunting knife, scissors, digital camera for photography and polythene bags were arranged. During the field surveys, the macrofungi samples were collected with great care to avoid the damage to the base and other parts of the samples. Macroscopic details such as shape, size, colour, colour change on bruising or ageing, taste, odour, spore deposition and fresh specimens (Largent 1977a, b) and ecological characteristics of the sample were recorded and sample were photographed in their natural habitats. Samples were kept in the separate paper bags to avoid mixing and were taken to the laboratory. Macro- and microscopic investigations and micro chemical reaction were carried out on the samples. Identification was made on the basis of critical observation of the specimens and perusal of relevant literature of Hawksworth *et al.* (1995), Jordan (1995), Arora (1996), Singer (1996) and Adhikari (2002). Identification and information was also made on the basis of critical observation of the specimen, past reviews of Rogers key. (<http://www.rogersmushroom.com>).

## Result and Discussion

As the result of present survey, of different places of Chandak forest, 17 macrofungi species found and identified belonging to 10 families. All the taxa were listed along with relevant information. These are individually described as follow-

### *Amanita ceciliae* (Berk. & Br.) Fig.1

**Synonyms:** *Amanita inaurata*, *Amanita strangulata* (Figure1)

**Diagnostic characters :** Cap 5-12cm across, convex to flat with an upturned, deeply lined margin and a low umbo; brownish black to brownish gray, darker at the disc, paler toward the margin; smooth, slightly sticky when moist, with loose, charcoal-gray patches of volval remnants dotted around the cap. Gills free, close; white. Stem 50-160 x 7-15mm, hollow or lightly stuffed, tapering slightly toward the top; dingy white with flattened grayish hairs; no ring; no basal bulb, but loose, cottony, brownish or charcoal-colored patches of volval remnants

dotted around stem base and lower stem. Flesh thin, soft, white. Odor faint or none. Not edible

***Amanita muscaria var. alba* Pk. Fig.2**

**Diagnostic characters :** White to cream. Ring on stem, Volva on stem, Bulbous base of stem. Cap 4-21cm across, convex to plane, sometimes with a slightly depressed disc and a faintly lined margin; white to silvery white; smooth, slightly sticky when moist, and dotted with small cottony patches or pointed warts of pale brown volval material which stick quite firmly to the cap and are often arranged in concentric rings. Gills free to adnexed, close, moderately broad; white to cream. Stem 50-140 x 7-20mm, stuffed, tapering slightly toward the top; white, turning yellowish when bruised; finely hairy or cottony above the ring, roughly hairy to scaly below; the pale cream or pale yellow drooping ring near the top of the stem soon collapses; the white oval to ball-shaped basal bulb has a rim of volval material at its top, with flaky, pale brown patches and rings on the lower stem. Flesh white, but yellowish beneath the cap cuticle. Non edible.

***Amanita pantherina* (DC. ex Fr.) Secr. (Fig.3)**

**Synonyms:** Panthercap

**Diagnostic characters :** Brown in colour.

Convex to shield shaped. Ring on stem, Volva on stem, Bulbous base of stem. Cap 6–10cm across, ochraceous brown, covered with small pure-white warty fragments of the veil, finely striate at the margin. Stem 90–130 x 10–15mm, white with tattered, pendulous ring which is not striate or grooved, the stem base is bulbous and closely wrapped in the white volva which forms a distinct free rim around the base and one or two belt-like rings just above. Flesh white, becoming hollow in the stem. Taste and smell mild. Gills free, crowded white. Inedible. Poisonous.

***Amanita vaginata* (Bull. ex Fr.) Vitt. (Fig.4)**

**Synonyms:** Coucoumelle grise, Grauer Scheidenstreifling

**Diagnostic characters :** brown in colour. Cap 5–9cm across, ovoid at first expanding to almost flat with umbo, typically grey-brown, more rarely darker or lighter, or even white (var. alba), distinctly lined at margin. Stem 130–200 x 25–20mm, tapering towards the apex, whitish flushed with cap colour, base enclosed in large bag-like volva tinged grey, no ring. Flesh white, becoming hollow in stem. Taste and smell not distinctive. Gills crowded, adnexed, white. Inedible.

***Cantharellus cibarius* Fr. (Fig.5)**

**Synonyms:** Chanterelle

**Diagnostic characters:** Yellow in colour. Funnel shaped. Cap 3–10cm across, at first flattened with an irregular incurved margin later becoming wavy and lobed and depressed at the centre, pale to deep egg-yellow fading with age. Stem 30–80 x 5–15mm, solid, concolorous with cap or paler, tapering towards the base. Flesh yellowish. Taste watery at first then slightly peppery, smell faint, fragrant (of apricots). Gills narrow, vein-like. Edible.

***Coprinus disseminatus* (Pers. ex Fr.) S. F. Gray syn. (Fig.6)**

**Synonyms:** Coprin dissemine, Fairy Inkcap.

**Diagnostic characters:** White to cream in colour. Flesh granular or brittle. Cap 0.5-1.5cm high, ovoid at first, expanding to convex or bell-shaped; pale buff with buff or honey-buff center; deeply grooved, minutely scruffy. Gills attached, nearly distant, broad; white then amber to black, but not inky or deliquescent. Stem 15-40 x 1-3mm, hollow, fragile; white with a buff tinge near the base, which is covered in white down; smooth to minutely hairy. Flesh fragile. Inedible.

***Ganoderma lucidum* (Curt. ex Fr.) Karst. (Fig.7)**

**Synonyms:** Ganoderme laque, Ganoderme luisant

Figure 4

**Diagnostic characters:** Brown in colour. Fruit body usually stalked. Bracket 10–25cm in

diameter, 2–3cm thick, fan- or kidney-shaped, laterally attached, concentrically grooved and zoned ochraceous to orange brown, later purple-brown to blackish, and like the stem conspicuously glossy as if varnished. Stem up to 250 x 10–30mm, dark brown, glossy. Tubes 0.5–2cm long. Not edible.

***Gloeophyllum sepiarium* (Wulf. ex Fr.) Karst. (Fig.8)**

**Synonyms:** Conifer Mazegill

**Diagnostic characters:** Red or redish or pink, Brown. Stem is Lateral, rudimentary or absent. Bracket 2–3cm across, 5–12cm wide, 0.5–1cm thick, fan-shaped and often in tiered groups, corky; upper surface coarsely concentrically ridged and radially wrinkled, softly hairy at first later bristly, indistinctly zoned maroon to rusty darkening with age towards the point of attachment, lighter, even bright rusty-orange near the margin. Flesh rusty-brown. Taste and smell slight and not distinctive. Gills densely and radially arranged and often fusing together irregularly giving a maze-like appearance. Not edible.

***Hydnum repandum* L. ex Fr. (Fig.9)**

**Synonyms:** Chevrette, Hydne sinué

**Diagnostic characters:** White in colour. Convex to shield shaped. Flesh granular or brittle. Cap 3–17cm across, flattened convex or centrally depressed, even, velvety at first then more suede-like, cream, yellowish or pale flesh-coloured. Stem 35–75 x 15–40mm, often off-centred, cylindrical, finely downy, white bruising yellow near the base. Taste bitter after a few seconds, smell pleasant. Spines whitish to salmon pink. Edible.

***Laccaria amethystea* (Bull. ex Mérat) Murr. (Fig.10)**

**Synonyms:** Amethyst deceiver

**Diagnostic characters:** Violet or purple. usually 5 cm. Cap 1–4.5cm across, convex to flattened or centrally depressed, deep purplish-

lilac when moist drying pale lilac-buff, surface slightly scurfy at centre especially with age. Stem 40–100 x 5–10mm, concolorous with stem, covered in whitish fibres below but mealy near the apex, base covered in lilac down, passing into the lilac mycelium. Flesh thin, tinged lilac, stem becoming hollow. Edible.

***Lactarius volemus* Fr. (Fig.11)**

*Figure8*

**Synonyms:** Vachotte

**Diagnostic characters:** Yellow, Orange, 5-15cm. Cap 5–11cm across, convex with a depression, coloured apricot to tawny, fleshy, firm, shortly velvety to smooth, not sticky. Stem 40–120 x 10–30mm, concolorous with cap, but usually paler, shortly velvety to smooth, solid. Flesh whitish, firm. Gills slightly decurrent, narrow, somewhat closely spaced, easily breaking, pale golden yellow, bruising brown. Gill cystidia abundant, with thick, wavy walls. Milk white, abundant; taste mild. Smell fishy. Uncommon. Edible – good.

*Figure9*

***Russula emetica* (Schaeff. ex Fr.) S.F. Gray. (Fig.12)**

**Synonyms:** Colombe rouge,

**Diagnostic characters:** White to cream, Red or redish or pink, 5-15cm, Cap 3–10cm across, convex, later flattening or with a shallow depression, scarlet, cherry or blood red, sometimes with ochre-tinted to white areas, somewhat thin-fleshed, fragile, shiny, sticky when moist; skin easily peeling to show pink to red coloured flesh beneath, margin often furrowed when old. Stem 40–90 x 7–20mm, white, cylindrical or more usually somewhat swollen towards the base, fragile. Flesh white, red immediately beneath cap cuticle. Taste very hot, smell slightly fruity. Gills adnexed to free. Common. Poisonous.

**Table.1** Diversity of macrofungi in Chandak forest

Name of macrofungi	Family	Property
<i>Amanita ceciliae</i> (Berk. & Br.)	Amanitaceae	Inedible
<i>Amanita muscaria</i> var. <i>alba</i> Pk.	Amanitaceae	poisonous
<i>Amanita pantherina</i> (DC. ex Fr.) Secr	Amanitaceae	Poisonous
<i>Amanita vaginata</i> (Bull. ex Fr.) Vitt	Amanitaceae	Inedible
<i>Cantharellus cibarius</i> Fr	Cantherellaceae	Edible, antioxidant
<i>Coprinus disseminatus</i> (Pers. ex Fr.)	Coprinaceae	Inedible
<i>Ganoderma lucidum</i> (Curt. ex Fr.)	Ganodermataceae	Inedible,immunomodulating
<i>Gloeophyllum sepiarium</i> (Wulf. ex Fr.)	Polyporeceae	Inedible
<i>Hydnum repandum</i> L. ex Fr	Hydnagiaceae	Excellently Edible,antibiotic
<i>Laccaria amethystea</i> (Bull. ex Mérat) Murr	Hydnagiaceae	Edible
<i>Lactarius volemus</i> Fr.	Russulaceae	Edible
<i>Russula emetica</i> (Schaeff. ex Fr.) S.F. Gray	Russulaceae	Poisonous
<i>Russula lepida</i> Fr	Russulaceae	Inedible
<i>Russula nauseosa</i> (Pers. ex Secr.) Fr	Russulaceae	Edible
<i>Ramaria stricta</i> (Fr.)	Gomphaceae	Edible
<i>Scleroderma geaster</i> Fr	Sclerodermeacea	Inedible
<i>Suillus bovinus</i> (Fr.) O. Kuntze	Boletaceae	Edible

**Table.2** Monthly distribution of macrofungal species in Chandak forest

Year	No of species						
	May	June	July	August	September	October	November
2011-12	6	10	13	16	16	5	1
2012-13	8	10	15	17	15	7	2

**Table.3** Habitat diversity of wild macrofungi in Chandak forest

Major type	Ecological Habitat	Macrofungi
Saprophytic	Humid soil	<i>Amanita ceciliae</i> , <i>Amanita muscaria</i> var. <i>alba</i> , <i>Amanita pantherana</i> , <i>Amanita vaginata</i> <i>Laccaria amethystea</i> , <i>Lactarius volemus</i> , <i>Russula emetic</i> , <i>Scleroderma geaster</i>
	Wood log	<i>Gloeophyllum sepiarium</i> <i>Russula lepida</i>
	Leaf litter	<i>Hydnum repandum</i> , <i>Russula nauseosa</i> , <i>Ramaria stricta</i> , <i>Suillus bovines</i>
	Buried matter	<i>Coprinus disseminates</i>
	Wood	<i>Cantharellus cibarius</i>
Parasite	Pinus stem	<i>Ganoderma lucidum</i>



**Figure.1** *Amanita ceciliae*



**Figure.2** *Amanita muscaria* var. *alba*



**Figure.3** *Amanita pantherina*



**Figure.4:** *Amanita vaginata*



**Figure.5** *Cantharellus cibarius*



**Figure.6** *Coprinus disseminatus*



**Figure.7** *Ganoderma lucidum*



**Figure.8** *Gloeophyllum sepiarium*



**Figure.9** *Hydnum rependum*



**Figure.10** *Laccaria amenthystea*



**Figure.11** *Lactarius volemus*



**Figure.12** *Russula emetica*



**Figure.13** *Russula lepida*



**Figure.14** *Russula nauseosa*



**Figure.15** *Ramaria stricta*



**Figure.16** *Scleroderma geaster*



**Figure.17** *Suillus bovinus*

***Russula lepida* Fr. (Fig.13)**

**Synonyms:** Cul rouge, Russule jolie

**Diagnostic characters:** Red or redish or pink, 5-15cm Cap 4–10cm across, convex, later flattening or slightly depressed, red, often paler and white or yellowish white in places or occasionally entirely, fleshy, hard; surface matt, dry, sometimes as if powdered, hardly peeling. Stem 30–70 x 15–35mm, white or flushed pink or red in part or entirely, often club-shaped or swollen slightly in the middle, powdered. Flesh white. Taste mild, of cedarwood pencils, sometimes bitter, smell slightly fruity with a suggestion of menthol. Gills almost free, pale cream. Non edible.

***Russula nauseosa* (Pers. ex Secr.) Fr. (Fig.14)**

**Synonyms:** Geriefter Weichtäubling

**Diagnostic characters:** Red or redish or pink, 5-15cm, Flesh granular or brittle. White, cream or yellowish Convex to shield shaped, Simple stem, Cap 2–7cm across, convex, later flattening and finally with a shallow depression, wine coloured to red or often pale, washed-out colours, greyish rose, pale brownish, dull yellowish or tinged greenish, thin-fleshed, fragile, easily peeling; margin often shallowly warty and furrowed. Stem 20–75 x 5–15mm, white, often tinged brownish or yellowish, often narrow club-shaped, soft, fragile. Flesh white, stem often hollow. Taste mild or slightly hot. Gills almost free. Rare. Edible – possibly best avoided due to its hot taste.

***Ramaria stricta* (Fr.) (Fig.15)**

**Synonyms:** Upright Coral, straight branched coral.

**Diagnostic characters:** Orange. Flesh

discolours when cut, bruised or damaged. Mushroom has distinct or odd smell (non mushroomy). Fruit body 4–10cm high, 3–8cm wide, ochraceous tinged with flesh-colour becoming darker or brownish cinnamon with age, tips of branches at first clear yellow then concolorous; all parts bruising vinaceous, stem arising from white mycellum or rhizomorphs, passing into numerous dichotomous branches. Flesh white or pale yellow, tough. Edible.

***Scleroderma geaster* Fr (Fig.16)**

**Synonyms:** Earthstar Puffball

**Diagnostic characters:** Yellow to Brown in colour. Fruit body 5-10cm across, subglobose, flattened on top, tapering below into a stem-like base with a large basal mycelial mass binding together the soil into a large mass. Surface of the very thick cuticle a dirty tan-brown to ochre; roughened, granular, splitting into irregular star-like segments, soon peeling back to a varying extent, exposing the blackish cracked inner surface. Spore mass deep purple-brown; powdery. Inedible.

***Suillus bovinus* (Fr.) O. Kuntze (Fig.17)**

**Synonyms:** Bovine Bolete

**Diagnostic characters:** Yellow in colour. Convex to shield shaped. Mushroom slimy or sticky. Cap 3–10cm, clay-pink with cinnamon or ochraceous flush, with a distinct white margin, viscid with pale sticky covering. Stem 40–60 x 5–8mm, sienna-yellow, arising from pink mycelium. Flesh whitish or yellowed gradually becoming clay pink particularly in cap or the stem base, rusty-coloured in stem. Taste sweet, pleasant, smell fruity. Tubes grey vinaceous. Pores large, angular, compound. Edible.

In the present study, 17 macrofungal taxa belonging to 9 families were reported. All taxa belonged to Class-Basidiomycetes (Table 1). Further these macrofungi also can be divided into groups excellently edible, edible, inedible, and poisonous and medicinal species (Table.1). Dangi et al. (2010) collected 15 species of mushrooms from pine dominated forest of Binser Wild life Sanctuary in Almora. The litter shading of pine needles started in every year from April to June and make a dense carpet on the forest floor. That thick layer of pine litter might also helpful for containing suitable soil moisture and prevent evaporation from soil surface and maintain soil temperature during rainy season. Availability of suitable amount of nutrients in the decomposed litter by microbial activity, was also helpful for the growth of macrofungi. (Shubin et al. 1977; Visser 1995). But in the winter season this carpet increased acidity and along with low temperature and low humidity the growth of macrofungi also effects. They also cause the death of mycorrhizal roots and fungal hyphae, which may cut off the connection link between host and macrofungi. (Bowen and Theodorou 1973; Brundrett and Abbott 1994). From the above study we found that the maximum number of macrofungi were recorded in the rainy season from July- September (Table 2). That indicates the rate of decomposition is related with the macrofungi species because macrofungi takes all their nutrition from litter and by producing some ligninolytic enzyme (Baldrian, 2008 and Baldrin and Snajdr, 2011).

In nature mushrooms grow wildly in all type of habitat. Table 3 showed the macrofungi and their habitat where from we collected that mushroom. From the above study the highest 8 number of macrofungi found from the humid soil and 2 from leaf litter, 4 species from wood, 1 another species for

wood log, 1 from buried matter and only 1 from pine stem as a parasite. These distribution of macrofungi showed that the area is rich in mushroom species. The result shows that the humid soil provide great nutritional availability for the growth of fungi. Jha et al. (2012), Vishwakarma et al. (2012) and Joshi et al. (2013) also differentiated mushrooms according to their habitat.

Thus present work reveal few uncommon but edible and inedible macrofungi found native to the region of survey. Since the wild macrofungi plays an important ecological role for healthy maintenance of the ecosystem particularly that of pine forest ecosystem, besides their tremendous medicinal value, therefore it become necessary to explore, conserve and document this natural wealth. And they also helpful in the degradation of leaf litter of *Pinus longifolia* and helpful for the maintenance of ecological cycle. These species of macrofungi from the Chandak forest reported first time from the Pithoragarh district.

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