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Biodiversity among *Amanita* sp. in the Forests of Ranikhet, Uttarakhand, India

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Abstract The genus *Amanita* contains about 600 species of agarics including some of the most toxic known mushrooms found worldwide, as well as some well-regarded edible species. This genus is responsible for approximately 95% of the fatalities resulting from mushroom poisoning, with the death cap accounting for about 50% on its own. The most potent toxin present in these mushrooms is α–amanitin. Although a few species of *Amanita* are edible but many fungi experts advise against eating a member of *Amanita* unless the species is known with absolute certainty. Because so many species within this genus are so deadly toxic, if a specimen is identified incorrectly, consumption may cause extreme sickness and possible death. There found several species of macro fungi called mushrooms in the uncultivated areas like forests during rainy season. Out of these species collected, seven different species were identified belonging to genus *Amanita* and named as *A. caesarea, A. citrina, A. fulva, A. Musacaria, A. solitaria (A. echinocephala), A. vaginata* and *A. porphyria* and are described in the present paper.

Keywords Bio-diversity, *Amanita,* Macro-fungi, Forest.

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Introduction

The mushrooms in genus *Amanita* include some of the world's best known and most beautiful fungi. *Amanita* species are recognized by their (usually) pale gills, which are free from the stem, their white spore prints and the presence of universal veil that often creates a volva or other distinctive features on the stem. Uttarakhand forests,owing to enormous agro-climatic variations and peculiar physiography, harbor rich diversity in macro-fungi. During the surveys made, a large number of macro-fungi were collected. Thorough morphological examination followed by literature study of those samples resulted in a number of novel or interesting taxan. Bhatt et al. [1] enlisted 50 *Amanita* species from different parts of India and projected that this number may exceed 100. These species are taxonomically described for their macroscopic and microscopic details and compared with the details given in literature. Seven different species belonging to genus *Amanita* are described in the present paper and are named as *A. caesarea* (Scop.) Pers., *A. citrina* (Schaeff.) Pers., *A. fulva* (Schaeff.) Secr., *A. muscaria* (L.) Lam., *A. porphyria* (Alb. & schwein. Ex Fr.) Secr., *A. solitaria* (Vittad.) Qvel. and *A. vaginata* (Bull.) Lam.

Materials and Methods

The forest area of the district Ranikhet and Almora (Chaubatia) of the state Uttarakhand was surveyed during rainy season from July to September, 2011 and 2012 for the collection of macro fungi. Standard methods were followed for the collection, preservation and

Table 1. Comparison of morphological features of *Amanita* sp.

Name of species	Pileus color	Size (cm)	Stipe	Ring	Volva	Gills
A. caesarea	orange cap, smooth and margins striated	12-15	cylinder-shaped stipe, 8-15 cm tall and 2-3 cm wide	Present	Present	Free
A. citrina	pale yellow or off white, covered with grayish-white patches	4-10	6-8 cm, swollen at base	Present	Present	Free
A. fulva	light brown at inner side while dark brown at inner top of the cap	4-10	7-16 cm long, 0.5-1.5 cm thick, slightly tapered to apex	Absent	Present	Free
A. muscaria	bright yellow-orange with white patches on cap	10-15	slightly tapering towards apex, 15-20 cm long	Present	Present	Free
A. porphyria	grayish brown to brown, convex cap having a central bump	3-12	5-8 cm long, 1-15 cm thick, thickness same at both ends	Present	Present	Free
A. solitaria	whitish or dull white with spiny or warty cap surface	6-10	6-10 cm long, cylindrical, tapering towards apex, solid	Present	Present	Free
A.vaginata	gray or grayish brown cap, have furrows around the edge	5-10	8-15 cm long and 1 to 4 cm in diameter, thickness same at both ends	Absent	Present	Free

macro and microscopic studies of these fungi [2, 3]. The morphological details were recorded from fresh carpophores. The field characters pertaining to gross morphology, shape, color and size of pileus, stipe and lamellae, presence or absence of annulus and volva were noted down. Then the specimens were brought to the laboratory for the study of microscopic characterization viz. collection of spores (spore print) and morphology of spore under high resolution microscope. Identification was made on the basis of critical observations of the specimens and perusal of relevant literature [4, 5].

Habitat and distribution

Terrestrial, growing under various tree, widely distributed and common from 5500 ft to 7000 ft elevation from Ranikhet to Chaubatia places (longitude-79.43^0 E and latitude-29.64^0 N), the mid hill area of the Uttarakhand. These were ecto-mycorrhizal species that forms a symbiotic relationship with the forest trees like deodar *(Cedar deodara),* pine *(Pinus roxburghii),* blue pine *(P. wallichiana)*,spruce *(Picea smithiana)*,banj *(Quercus leucotrichophora)*, kaafal *(Myrica esculenta),* buransh *(Rhododendron arboreum),* tejpat *(Cinnamomum tamala)* and teak *(Tectona grandis)*. In these regions, a large number of macro fungi were found e.g. *Pleurotus, Auricularia, Clitocybe, Ganoderma, Morchella, Russula,* puff balls, earth stars including many attractive species of *Amanita.*

Results and Discussion

During the forest area surveyed in rainy season, the species were found in large numbers and was scattered throughout the forests. These species were categorized in different groups on the basis of their morphological features like shape, color and size of pileus, stipe and lamellae, attachment of gills with the cap, spore prints and spore characters. The species identified and characterized in the genus *Amanita* were further studied in detail and are described as below.

Amanita caesarea : Commonly known as Caesar's Mushroom in English. The most obvious feature of *A. caesarea* was its gorgeous color. It had a distinctive orange cap, yellow gills and stipe. The cap of the mushroom was initially hemispherical or convex at

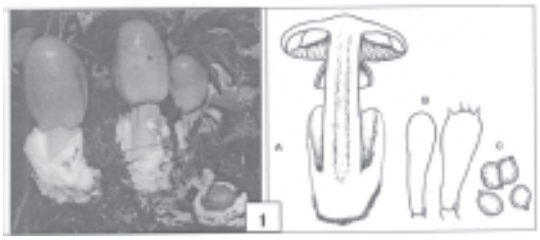

Fig. 1. (A).

young stage and finally flat at maturity. The surface was smooth and margins striated with 12-15 cm cap diameter.The free gills were pale to golden yellow. The cylinder-shaped stipe was 8-15 cm tall and 2-3 cm wide. The ring hangs loosely. The base of the stipe is thicker than the top, enclosed in a large, loose ovoid, grayish white bag like volva, a remnant of universal veil.The spores were white in mass, ellipsoid and smooth.

Amanita citrina : This species is also known as false death cap. It had a fleshy pale yellow or off

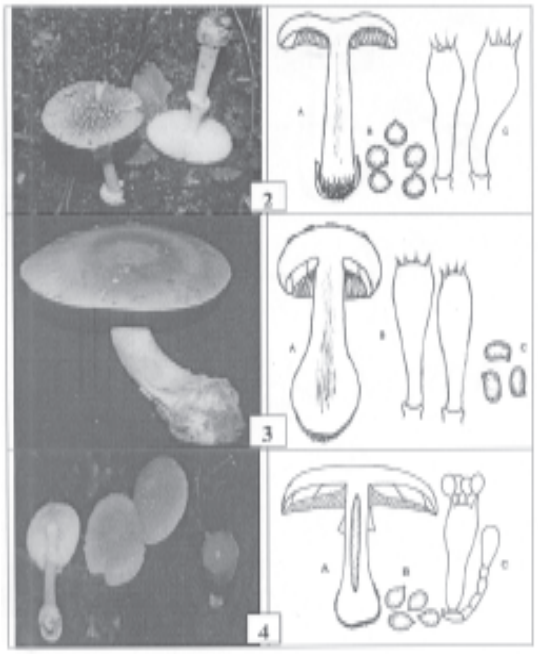

Fig. 1. (B).

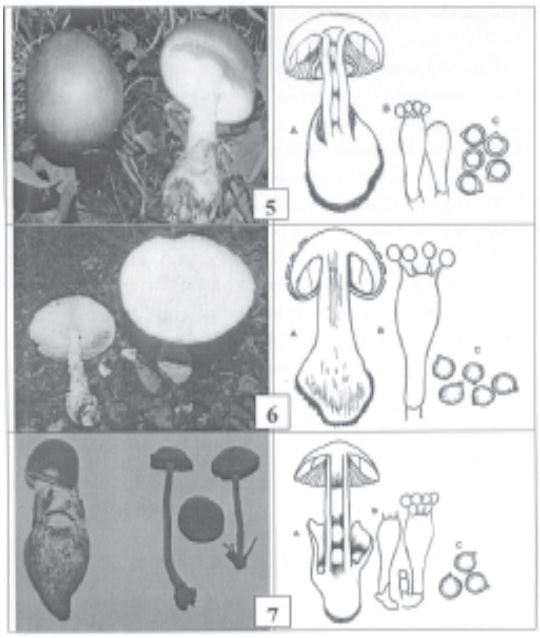

Fig. 1. (C).

Fig. 1. Species of *Amanita* in natural habitate, 1- *A. caesarea,,* 2- *A. citrina,,* 3- *A. fulva,* 4-*A. muscarea,* 5- *A. porphyrea*, 6- *Amanita soliteria,* 7- *A. veginata* (A- fruit body, B-basidia and C-basidiospores).

white cap, covered with grayish-white patches, sized about 4-10 cm in diameter. The cap was hemispherical when young and become flat as it matures. The gills were free from stem and white colored. The stipe was 6-8 cm tall, tapers upward from the large bulbous base called Volva. Stem also had a clear ring at around 2/3 of stem's length from the base. Spores were white in mass, subglobose, smooth and a myloid.

. *Amanita fulva :* It is a ring less species of the genus. Cap size varied in between 4-10 cm,.oval to convex, becoming broadly convex or nearly flat at maturity, light brown in color at outer ring while dark brown at inner top of the cap. The margins were regularly lined. Flesh was off white in color. Gills were free from the stem, whitish, close or nearly crowded. Stem was about 7-16 cm long, 0.5-1.5 cm thick,slightly tapered to apex without a ring. Base of the stem had a sac like structure called volva. Spores were white in color, smooth, globose or sub globose and inamyloid.

Amanita muscaria : Commonly known as Fly Agaric. It was the species showing bright yellow-orange color with white patches on cap. The size of cap was 10-15 cm in diameter. The young fruit bodies were slightly convex and the mature one was flat on the cap. The margins were striate in mature fruit bodies. Flesh was white or yellowish white when cut longitudinally. Stipe was slightly tapering towards apex, 15-20 cm long, have membranous ring. The basal bulb i.e. volva was also present. The center of stripe is hollow. Gills were white in color, free, broad and crowded. Spores were white in mass, ovoid and smooth with a distinct projection at one end.

Amanita porphyraia : The species was characterized by the presence of 3-12 cm convex cap having a central bunp, margins were notprominently lined, the color of cap was grayish brown to brown. Stem was 5-8 cm long, 1-15 cm thick, more or less equal at both the ends, loosly attached volva also present which gave asac like appearance. Gills were free from the stem, white, close and short. Spore print was white and spores were globose, smooth and amyloid.

Amanita solitarea : This species is also known as *A. echinocephala.* The fruiting bodies of the species were large, whitish or dull white in color with spiny or warty looking cap. The cap was convex when young but become flat at maturity. The size of cap varied from 6-10 cm in diameter. The stipe was 6-10 cm long, cylindrical, tapering towards apex, solid, ringed, whitish to pale straw yellow colored an ended with bulbous base. The gills were free, broad, crowded and creamish yellow in color. The spore print was white and spores were ellipsoid to clongate and amyloid.

Amanita vaginata : Commonly known as Grisette. This species also considered as ring less species.The cap was gray or grayish brown, 5-10 cm in diameter and had furrows around the edge. Initially the cap was oval and in mature fruiting bodies, it became convex or flattened. The flesh was white and thin. The stipe was 8-15 cm long and 1 to 4 cm in diameter, the thickess of the stem was same at both the ends and the base of the stipe was covered with very thin volva. The gills were white, free and crowded together. The spore print was white and spores were subglobose, smooth and inamyloid.

On the basis of the detailed study of the above *Amanita* species with respect to their macroscopic and microscopic features the species could be identified as *Amanita caesaria, A. citrina, A. fulva, A. muscaria, A. .porphyria, A. solitaria* and *A. vaginata* as per the features described by Colin and Lucas [4], Pacioni [6], Kumar et al. [2], Atri et al. [3] and Kirk et al [5] where they clearly depicted the identification clues with pictures. These *Amanita* species are found in the uncultivated vegetation of the forests are in support of the findings of Bhatt et al. [1] where they reported that more than 100 species of the genus *Amanita* could be explored from various regions of India, including Uttarakhand forests.These species were also reported by other workers from the Uttarakhand hill forests viz. Dhancholia et al.[7] illustrated *Amanita phalloides* from Almora hills, Bhatt and Bhatt [8] and Bhatt et al. [9] described seven species of *Amanita* from Garhwal Himalayas of Uttarakhand.Bhatt et al.[1] reported above described six species except *A..casaria*, in their list of 53 species of the genus *Amanita* collected from India. Most of the mushrooms belonging to the genus *Amanita* are regarded as death caps and are deadly poisonous due to presence of a toxin/cemical α–amanitin and thus the poper identification of the species is compulsory before going for its consumption. On the other hand this genus, if identified with certainty, could also be explored for the preparation of life saving drugs and could be a miracle species.

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