

Diversity of macrofungal genus *Russula* and *Amanita* in Hirpora Wildlife Sanctuary, Southern Kashmir Himalayas

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ABSTRACT

Pala SA, Wani AH, Mir RA. 2012. Diversity of macrofungal genus *Russula* and *Amanita* in Hirpora Wildlife Sanctuary, Southern Kashmir Himalayas. *Biodiversitas* 13: 65-71. The Hirpora Wildlife Sanctuary that extends over an area of 114 km² lies in the Pir Panjal range at a distance of 70 km in south-west of summer capital Srinagar. It is rich in biodiversity including macrofungal diversity. The Sanctuary has been subjected to high ecological and anthropogenic disturbance due to the construction of Mughal road which is major threat for its biodiversity. Since there is hardly any report of documentation of macrofungi from this sanctuary. In this back drop a survey was carried out during the year 2010 and 2011 to explore and inventory macrofungal diversity of the sanctuary. During the survey a no of macrofungi were documented, among which *Amanita* and *Russula* were dominant genus represented by 7 species each. All the 14 species viz. *Amanita ceciliae* (Berk. & Broome) Bas. *Amanita flavoconia* G.F. Atk., *Amanita muscaria* var. *formosa* Pers., *Amanita pantherina* (Fr.) Krombh., *Amanita phalloides* (Fr.) Link., *Amanita vaginata* (Bull. ex Fr.) Vitt., *Amanita virosa* (Fr.) Bertillon, *Russula aeruginea* Fr., *Russula atropurpurea* (Krombh.) Britz., *Russula aurea* Pers., *Russula cyanoxantha* (Schaeff.) Fr., *Russula delica* Fr. *Russula emetica* (Schaeff. ex Fr.) Gray. and *Russula nobilis* Velen. are ectomycorrhizal in nature and among them *Russula aeruginea* Fr. is reported first time from the Kashmir.

Key words: *Russula*, *Amanita*, Hirpora, macrofungi, Kashmir

INTRODUCTION

Mushroom is regarded as a macrofungus with a distinctive fruiting body that can be either epigeous or hypogeous and large enough to be seen with the naked eye and to be picked by hand (Chang and Miles 1992). Mushrooms belong to the kingdom fungi, which constitutes the most diverse group of organisms after insects on this biosphere. Defining the exact number of fungi on the earth has always been a point of discussion and several studies have been focused on enumerating the world's fungal diversity (Crous 2006). Current studies estimate that out of 1.5 million species of fungi existing on this biosphere, 140,000 species may be considered as mushrooms, but only 14,000 species are known to man, which accounts for 10% of the estimated mushroom species (Chang and Miles 2004). Only a fraction of total fungal biodiversity has been subjected to scientific scrutiny and mycologists continue to unravel the unexplored, hidden and fascinating fungal biodiversity as many macro-fungi are becoming extinct or facing threat of extinction because of habitat destruction and global climate change (Swapana et al. 2008). There are about 7750 macrofungal species known to have ectomycorrhizal nature (Rinaldi et al. 2008). The genus *Amanita* contains about 500 species, including some of the most toxic known mushrooms found worldwide (Zhang et al. 2004). This genus is responsible for approximately 95% of the fatalities resulting from mushroom poisoning, with death cap accounting for about 50% on its own. There are

around 750 worldwide species of mycorrhizal mushrooms which compose the genus *Russula* (Miller et al. 2006). The state Jammu and Kashmir is rich in macrofungal diversity due to wide agro-climatic variations diverse physiography and undulating topography, but understanding of the macro-fungal flora of the Kashmir is still in an exploratory stage and undoubtedly there are many more species to be recorded (Watling and Abraham 1992).

The present communication describes the brief morphological description, macro and microscopic details, seasonal occurrence and edibility of the 14 species of macrofungi belonging to genus *Russula* and *Amanita* collected from Hirpora wild life sanctuary.

MATERIALS AND METHODS

Regular field trips were carried to document the macrofungal diversity of Hirpora wildlife sanctuary (Figure 1) dominated by conifer forests. Usually 4-5 trips were carried out per month to cover as much species as possible. These field trips were organized according to the method given by Hailing (1996). Standard method of collection, preservation, macro and microscopic studies were followed (Kumar et al. 1990; Atri et al. 2003) and the shape, size, color of fresh specimen, time of collection and their edibility were recorded on the field notebook before brought to the laboratory for further observations



Figure 1. Map showing the collection site, Hirpora Wildlife Sanctuary, Southern Kashmir Himalayas of Jammu and Kashmir State, India.

and preservation for herbarium purposes. The spore prints were taken according to the guidelines given by Michel Kuo (2001), then their morphology, such as shape, size of spores, surface features of spores, presence or absence of oil drops and starch granules were recorded under the trinocular microscope at USIC (University Scientific Instrumentation centre) in Kashmir University. Reagents used for preparation of spore slides were 3% KOH, cotton blue, lactophenol and Melzer's reagent. To elicit the necessary information regarding their edibility local people were consulted. Photographs were taken in field using Cyber shot Sony 10.1 megapixel Camera. The fungal specimens were also preserved in formalin solution for

herbarium purposes, in fungal collection of KASH Herbarium of Plant Taxonomy, Division of Botany Kashmir University, Kashmir.

RESULTS AND DISCUSSION

During the survey to different places of Hirpora Wildlife Sanctuary, 14 ectomycorrhizal macrofungal species belonging to genus *Amanita* and *Russula* were collected and identified (Figure 2). Their detailed description along with photographs is as:

***Amanita ceciliae* (Berk. & Br.) Bas**

Synonym (s). *Amanita inaurata* Secr., *Amanita strangulata* (Fr.) Quel., *Agaricus ceciliae* Berk & Br.

Common name (s). Snakeskin grisette

Description

Cap. 5-10 cm in diameter, initially convex, expanding to planoconvex or flat with a shallow umbo, brown in color with slightly darker centre, usually covered with grayish patches, margins deeply lined at maturity.

Gills. Free, crowded, entire, white in color.

Stipe. 6-15 cm long, 0.7-1.5 cm thick, tapers towards the apex, whitish, finely hairy, brownish colored volva or patches of volva remnants dotted around stipe base. Annulus (ring) is absent.

Flesh. Thick, soft, white, not changing when sliced.

Spores. Globose, smooth, non-amyloid, 9-12 microns; Spore print white.

Habit and habitat. Mycorrhizal, growing alone or scattered under conifer trees.

Season. Summer

Edibility: Inedible, considered to be poisonous.

***Amanita flavoconia* G.F. Atk.**

Synonym (s). *Amplariella flavoconia* (Atk.) Gilbert, *Venenarius flavoconius* (G.F. Atk.) Murill

Common name (s). Orange Amanita or Yellow-dust Amanita

Description

Cap. 3 to 8 cm in diameter, initially ovoid, but with maturity becomes convex and finally flattened, orange to bright yellow-orange in color. The young specimens are covered with chrome yellow warts that may be easily rubbed off or washed away with rain,

Gills. Free, crowded, white to cream colored and initially covered with a yellowish partial veil.

Stipe. 4-12 cm long, 0.5 to 1.3 cm thick, equal or slightly tapered upward (bulbous), white to yellowish orange in color, mostly smooth sometimes covered with small scales. The persistent skirt-like ring (annulus) is present on the upper portion of stipe 1-2 cm below the cap and partially underground powdery yellow volva is present at the base.

Flesh. Thick, brittle, white in color.

Spores. Elliptical to globose, smooth, amyloid, 7-9 x 5-8 microns; Spore print white.

Habit and habitat. Mycorrhizal, growing either solitary or in groups under conifer trees.

Season. Summer and early autumn

Edibility. Inedible (poisonous)

***Amanita muscaria* var. *formosa* Pers.**

Synonym (s). *Amanita muscaria* var. *guessowii* Veesely

Common name (s). Fly agaric

Description

Cap. 5-11 cm in diameter, initially oval to convex or campanulate, but fattens or curve upward with maturity, yellowish to tannish with concentrically arranged white scales on entire cap surface

Gills. Free, broad, crowded, white in color.

Stipe. 4-12cm long, 1-2cm thick, white, bulbous with a ring on the upper half. Volva consisting of 2-3 concentric rings is present at the base of stipe.

Flesh. Thick, white in color.

Spores. Oval, smooth, non-amyloid, 9-13 x 6.5-9 microns; Spore print white.

Habit and habitat. Mycorrhizal, growing solitary or scattered under conifer trees.

Season. Late summer

Edibility. Inedible

***Amanita pantherina* (Fr.) Krombh.**

Synonym (s). *Amanitaria pantherina* (DC.) Krombh, *Agaricus pantherinus* DC.

Common name (s). Panther cap

Description

Cap. 4-12 cm in diameter, initially hemispherical but turns convex to plano-convex at maturity, color dark brown to yellowish brown, veil remnants forming pointed white warts on upper surface.

Gills. Free, crowded, white in color.

Stipe. 6-10 cm long, 0.8-2 cm thick, unequal, tapers towards the tip, white in color. The partial membranous veil is leaving a white ring at the upper portion of stipe and universal veil forms a single roll or collar on the basal bulb.

Flesh. Thick, white not discoloring on exposure or bruising.

Spores. Globose, smooth, non-amyloid, 8-12 x 6-8 microns; Spore print white.

Habit and habitat. Mycorrhizal, growing singly, scattered, or gregariously under pine trees.

Season. Summer and early autumn especially in rainy season.

Edibility. Inedible, poisonous but not deadly poisonous.

***Amanita phalloides* (Fr.) Link.**

Synonym (s). *Agaricus phalloides* Fr., *Amanita viridis* Pers., *Amanitina phalloides* (Fr.) Gilbert

Common name (s). Death cap

Description

Cap. 4-14 cm broad, initially oval, becoming convex, then broadly convex to flat with age, smooth, sticky when wet, shiny when dry; color ranging from olive-brown to yellowish-brown

Gills. Free, crowded, moderately broad, white to cream colored.

Stipe. 4-15 cm in length, 1-2 cm thick, more or less equal or tapering towards apex, smooth, white or with tints of the cap color; ring present in the upper part but is often lost; white volva encases the base.

Flesh. Thick near the disc, soft, white in color.

Spores. Globose, amyloid, 7-12 x 6-9 microns; Spore print white.

Habit and habitat. Mycorrhizal, growing singly or in small groups on the ground under coniferous trees.

Season. Summer and early autumn

Edibility. Deadly poisonous. It has been estimated that 30 gms or half a cap of this mushroom is enough to kill a human (Gopinath et al. 2011).

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

Synonym (s). *Amanitopsis vaginata* (Bull. Ex Fr.) Roze, *Amanita vaginata* var. *plumbea* (Bull.) Quel. & Bataille, *Agaricus plumbeus* Schaeff.

Common name (s). Grisette

Description

Cap. 4-10 cm broad, initially oval then convex and eventually flattens as it matures, sticky when wet, gray to grayish brown in color, mostly with a few scattered white to grayish patches on the surface. The margin is prominently lined or grooved that duplicate the gill pattern underneath.

Gills. Free or slightly attached to stipe, crowded, edges are minutely fringed, white in color.

Stipe. 7-14 cm long, 1-2 cm thick, more or less equal or bulbous, smooth or with a few grayish scales, ring absent. White sack-like volva encloses the base of the stem.

Flesh. Thin, white, and does not change color upon bruising or injury.

Spores. Globose, smooth, non-amyloid, 8-12 microns; Spore print white.

Habit and habitat. Mycorrhizal, growing singly or scattered in coniferous trees as well as on road side of Mughal road under broad leaved trees like *Populous*, *Salix* etc.

Season. Late spring and summer.

Edibility. Edible

***Amanita virosa* (Fr.) Bertillon**

Synonym (s). *Agaricus virosus* Fr.

Common name (s). Destroying angel

Description

Cap. 5-10 cm across, initially oval, becoming convex then expanded flat with age, white, smooth, margins not lined, viscid when moist.

Gills. Free, crowded, white in color

Stipe. 6-18 cm long, 0.6-2 cm thick, tapering towards the tip, white with surface often disrupted into shaggy fibrils, white sac like volva encases the base or collapses at early stage, ring collapses very early.

Flesh. Thick, soft, white in color

Spores. Globose, smooth, amyloid, 8-10 microns; Spore print white.

Habit and habitat. Mycorrhizal, growing, singly or scattered under broad leaved trees near road sides of Mughal road.

Season. Late spring and summer.

Edibility. Deadly poisonous, its poisonings are common in the area because of its resemblance with *Agaricus* sps

***Russula aeruginea* Fr.**

Synonym (s). *Russula graminicolor* (Gillet) Quel.

Common name (s). Grass-green Russula

Description

Cap. 4-8 cm in diameter, initially convex, becoming broadly convex to flat with a shallow depression, smooth, grayish green to yellowish green to pale green, margin often lined at maturity.

Gills. Almost free, crowded, forked, creamy to light yellow.

Stem: 4-6 cm long, 0.8-1.8 cm thick, cylindrical, smooth, white

Flesh. Thick, brittle, white in color, color does not change on bruising.

Spores. Globose, warty, 6-8 microns; Spore print creamy to light yellow.

Habit and habitat. Mycorrhizal, growing scattered, or gregariously under conifer trees or under *Salix* near roadsides of Mughal road.

Season. Summer to early autumn

Edibility. Edible

***Russula atropurpurea* (Krombh.) Britz.**

Synonym (s). *Russula krombholzii* Shaffer, *Russula undulate* Velen.

Common name (s). Blackish purple Russula or Purple brittlegill

Description

Cap. 4-9 in diameter, convex to flat with a shallow depression in centre or turns upward, smooth, purple violet in color with dark centre.

Gills. Adnexed, crowded, cream or pale straw in color.

Stipe. 2-7 cm long, 0.8-2 cm thick, cylindrical, brittle, smooth, white often becoming gray with age.

Flesh. Thick, brittle, white, with an odour of apple fruit.

Spores. Globose, warty, 6-8 microns; Spore print creamy to light yellow.

Habit and habitat. Mycorrhizal, growing singly or scattered under conifer trees.

Season. Summer

Edibility. Inedible

***Russula aurea* Pers.**

Synonym (s). *Agaricus auratus* With., *Russula aurata* (With.) Fr.

Common name (s). Golden Russula or Gilded brittlegill

Description

Cap. 5-9 cm in diameter, initially convex but flattens with age with a slight depression in the centre, reddish orange with yellow tinge near the margin, smooth, margin sulcate when mature, cuticle peeling halfway to center.

Gills. Free to adnexed, broad, fairly distant, yellow in color.

Stipe. 3-7 cm tall, 1-2 cm thick, cylindrical, smooth, light yellow in color.

Flesh. Thick, brittle, yellow in color.

Spores. Echinate, 7-9 microns; Spore print ochraceous.

Habit and habitat. Mycorrhizal, growing solitary or scattered under pine trees.

Season. Summer to autumn.

Edibility. Edible.

***Russula cyanoxantha* (Schaeff.) Fr.**

Synonym (s). *Agaricus cyanoxanthus* Schaeff., *Russula cutefracta* Cook, *Russula furcata* Sensus Auct.

Common name (s). Charcoal burner

Description

Cap. 5-12 cm in diameter, initially globose, becomes convex to flat at maturity with a central depression in the

centre, grayish purple to dark violet, slimy when moist. Cuticle can be separated up to half to the centre.

Gills. Subdecurrent to adnexed, intermediately spaced, flexible, greasy to touch, white.

Stipe. 4-7 cm long, 0.7-1.5 cm thick, cylindrical or slightly bulbous, smooth, white.

Flesh. Thick, brittle, white.

Spores. Ellipsoid, warty, 7-8 x 6-7 microns; spore print white.

Habit and habitat. Mycorrhizal, growing scattered to gregariously under conifer trees.

Season. Summer

Edibility. Edible

***Russula delica* Fr.**

Synonym (s). *Agaricus exsuccus* (Pers.) Anon., *Lactarius exsuccus* (Pers.) Sm.

Local name (s): Milk-white brittlegill

Description

Cap. 5-13 cm in diameter, initially convex with a depression in the centre or infundibuliform at maturity, margins inrolled, whitish often developing brownish discolorations, mostly contains leaf debris on the upper surfaces. Cuticle cannot be peeled off.

Gills. Decurrent, crowded, often forked, white.

Stipe. 2-4 cm long, 1.5-3 cm thick, cylindrical, smooth, white.

Flesh. Thick, brittle, white, not changing color on bruising.

Spores. Ovoid, warty, 8-11 x 7-9 microns; Spore print white.

Habit and habitat. Mycorrhizal, growing scattered on ground under Pine trees.

Season. Early autumn.

Edibility. Edible

***Russula emetica* (Schaeff. ex Fr.) Gray.**

Synonym. *Agaricus emeticus* Schaeff.: Fr., *Agaricus linnaei* var. *emeticus* (Schaeff.) Fr., *Russula clusii* Fr.

Common name (s). Sickener

Description

Cap. 3-8 cm in diameter, convex when young latter on flattened, sticky, bright scarlet to cherry red or blood red in color with finely ridged margins. The cuticle is readily peeled from the cap.

Gills. Free, crowded, cream or pale straw in color. *Stipe*. 2-9 cm in length, cylindrical, brittle, smooth, white.

Flesh. Thick, brittle, white in color.

Spores. Roughly spherical, covered with small spines, 6-8 microns; Spore print white

Habit and habitat. Mycorrhizal, growing singly or scattered under conifer trees.

Season. Summer

Edibility. Inedible

***Russula nobilis* Velen.**

Synonym (s). *Russula mairei* Singer, *Russula emetica* Schaeff., *Russula fagetorum* Bon

Common name (s). Beechwood sickener

Description

Cap. 4-9 cm in diameter, initially globular, becoming flattened and finally slightly depressed or sometimes turns upward, red to pink colored, sticky, very often damaged by slugs at places.

Gills. Adnexed, intermediately spaced, broad, creamy white

Stipe. 3-6 cm long, 1-1.5 cm thick, cylindrical, smooth, white

Flesh. Thick, brittle, white but pink beneath the cuticle.

Spores. Ovoid with warts, 7-8 x 6-7 microns; Spore print white

Habit and habitat. Mycorrhizal, scattered near the roadsides of Mughal road under broad leaved trees.

Season. Summer and autumn

Edibility. Poisonous, but some people use after cooking.

Discussion

A wide variety of ectomycorrhizal fungi are symbionts of many tree species in temperate climatic zones. In the recent years, however, anthropogenic activity has made different countries all over the world to show serious concern about the dwindling biodiversity of ectomycorrhizal macrofungal species being lost at the rate never known before. The present study confirms the remarkable species richness of the macrofungal genus *Amanita* and *Russula* in Hirpora Wild Life sanctuary. Fourteen species, seven of each *Russula* and *Amanita* were recorded from the selected area. Watling and Gregory (1980) recorded 119 taxa of macrofungi from Kashmir including many species *Russula* and *Amanita*. Watling and Abraham (1992) reported about 77 species of ectomycorrhizal macrofungi from coniferous forests of Kashmir with *Amanita* and *Russula* as dominant genus.

Dar et al. (2009, 2010) pointed out that coniferous forest of Jammu and Kashmir harbors some 260 species of macrofungi. They reported *Russula delica*, *Russula aurea*, *Russula atropurpurea* and *Russula paludosa* first time from coniferous forests of Kashmir. Laxmanpal (1996, 1997); Atri et al. (2000); Beig (2008) have also documented many species of *Russula* and *Amanita* from conifer forests of Kashmir. Gardezil and Ayoub (2003a) described eight species of *Russula* first time from Azad Kashmir. Gardezil and Ayoub (2003b) reported *Amanita muscaria* var. *alba*, *A. ceciliae*, *A. pantherina* and *Amanita virosa* from Azad Kashmir. Boda (2009) reported 44 different species of mushrooms from southern part of the Kashmir including *Russula emetica*, and *Amanita muscaria*.

Russula and *Amanita* represent two major genera having multifarious medicinal properties besides their mycorrhizal role. They have been found to live in symbiotic association with a wide variety of coniferous and deciduous trees. The compounds derived from these mushrooms avert diseases and boost up immune system thereby improving human health (Wasser 2002). Different species of *Russula* are known to possess antiviral, antibacterial, antiparasitic, anti-inflammatory, antioxidant, hepatoprotective, antidiabetic and anticancer activities (Turkoglu et al. 2009; Wasser 2010).



Figure 2. Diversity of *Russula* and *Amanita* in Hirpora, Kashmir. A. *Amanita ceciliae* (Berk. & Br.) Bas, B. *Amanita flavoconia* G.F. Atk., C. *Amanita muscaria* var. *formosa* Pers, D. *Amanita pantherina* (Fr.) Krombh., E. *Amanita phalloides* (Fr.) Link., F. *Amanita vaginata* (Bull. ex Fr.) Vitt., G. *Amanita virosa* (Fr.) Bertillon, H. *Russula aeruginea* Fr., I. *Russula atropurpurea* (Krombh.) Britz., J. *Russula aurea* Pers., K. *Russula cyanoxantha* (Schaeff.) Fr., L. *Russula delica* Fr. M. *Russula emetica* (Schaeff. ex Fr.) Gray., N. *Russula nobilis* Velen.

CONCLUSION

Since the wild macrofungi play an important ecological role for the healthy maintenance of the ecosystem particularly that of forest ecosystems, besides their tremendous medicinal value, therefore it becomes quite necessary to explore, document and conserve this natural wealth. Also the area is ecologically fragile, but has been subjected to high magnitude of disturbance due to construction of National highway through the wild life sanctuary which is a major threat for its biodiversity; therefore it becomes quite imperative to document its biodiversity. The present communication reports the fourteen species of ectomycorrhizal macrofungus from the area among which *Russula aeruginea* Fr. is reported first time from the Jammu and Kashmir.

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