



DIVERSITY, DISTRIBUTION AND ECOLOGY OF BOLETOID MUSHROOMS FROM GARHWAL HIMALAYA, UTTARAKHAND

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Abstract: The present investigation was carried out in different mixed broadleaf and coniferous forests of Garhwal Himalaya. Major associates trees are *Quercus*, *Rhododendron*, *Betula*, *Pinus*, *Cedrus* and *Cupressus* in the explored forest. The specimens were collected from these forests between July 2000 to September 2004, in the elevation range of 1600–3000 m above sea level from districts Chamoli, Pauri, Rudraprayag and Tehri. As a result of an extensive field survey and microscopic study in laboratory, 7 genera spread over into 35 taxa belonging to 3 families (*Boletaceae*, *Gyroporaceae* and *Suillaceae*) were identified. Of these, 7 taxa were known to be edible and consumed in various parts of Garhwal region.

Key words: *Boletaceae*, Ecology, Garhwal Himalaya, *Gyroporaceae*, *Suillaceae*.

Introduction

The Garhwal Himalaya in India is lying between the latitude 29°31'9"N and 31°26'5"N and longitude 77°35' 5"E and 80°6'0"E with a total area of 29,089 km². This area is covered by a large number of forests which are mainly dominated by species of trees like *Quercus*, *Rhododendron*, *Pinus*, *Myrica*, *Cedrus*, *Abies*, *Picea*, *Cupressus*, *Betula* etc. These forests support enormous diversity and development of fleshy macrofungi. Fleshy poroid mushrooms containing the families *Boletaceae*, *Gyroporaceae* and *Suillaceae* constitute one of the dominant and ectomycorrhizal macrofungi in Indian Himalaya. Currently these families are representing about over 1000 species belonging to nearly 75 genera (Li *et al.*, 2016). The present observation relates to the fruiting phenology, ecological distribution, seasonal variation, establishment of a relationship between species and forest types, associated trees and altitudinal ranges of the members of family

Boletaceae, *Gyroporaceae* and *Suillaceae* from the Garhwal Himalaya. The localities from Garhwal Himalaya considered for the present observation are District Chamoli, Pauri, Rudraprayag, and Tehri.

Materials and Methods

Frequent field work was undertaken during annual routine mycological forays to different localities of Garhwal Himalaya during the year 2000 to 2004. The study sites included the rich forested areas related randomly during each foray (10-15 days). The survey was conducted, mostly between July and September repeatedly for 4 to 5 days at each site. On the basis of limited surveys undertaken and the data available in hand and by personal experience and judgment, supported by the number of basidiomes encountered from each forest type the status of each species is assigned as



Rare, Common and Abundant. Mycorrhizal associations were confirmed by tracing the link of fungus to the root of the host tree (Young 1936, 1940; Zak 1971, 1973). Macromorphological characterization was undertaken from the fresh basidiomes. Micromorphological characters were recorded with the free hand sections obtained from the dry basidiomes. Details of basidiospores were mainly studied from spore prints of the respective species. Identifications were made based on the morphological features, ecological associations and the literature available.

Results and Discussion

In the present study a total of 7 genera spread over into 35 taxa of boletoid mushrooms are recorded from these parts of Garhwal Himalaya. A large number of species are found in mixed (combination of broadleaf and coniferous) forests followed by broadleaf and coniferous forests. Major associates among broadleaf trees are *Quercus* and *Betula* spp. Similarly, major coniferous ectomycorrhizae are *Pinus*, *Cedrus* and *Cupressus* in the explored forests. A total of 10 taxa grow in mixed forest (mixed coniferous and mixed angiospermic), 5 taxa in pure angiospermic forest, 4 taxa in coniferous forest, 3 taxa associated with Oaks and 3 taxa with *Betula*.

Strobilomyces annulatus, *S. floccopus*, *S. mollis*; *Suillus glandulosoides*; *Boletus affinis* var. *maculosus*, *B. pulverulentus*, *B. luridus* var. *erythropus*, *Bthierii* and *Gyroporus castaneus* have been found in mixed forest. *Boletus aestivalis*, *B. alutaceus* var. *simelensis*, *B. badius* var. *glaber*, *B. chrysenteron* var. *subnudipes*, *B. truncatus* and *B. vermiculosus* var. *thindii* are grown in angiospermic forest. *Boletus indoedulis*, *B. flammans* and *B. pseudosulphureus* are found in coniferous forest and *Leccinum areolatum*, *L. scabrum* var. *scabrum* and *L. oxydabile* are associated with *Betula* spp.

During this study it is also observed that *Quercus* is the most preferred host tree supporting the growth of 20 taxa, followed by *Rhododendron* (supporting the growth of 16 taxa), *Pinus* (supporting the growth of 13 taxa), *Cedrus*

(supporting the growth of 7 taxa), 7 taxa are known to be edible and appreciated by the local communities and 2 taxa are not worth taken due to comparatively unpleasant flavour or taste.

The information provided in the following pages is the result of intensive foraging into all forest types from selected areas of Garhwal Himalaya from 1600 m.s.l upto 3000 m.s.l. The data collected in the field was supplemented by the reports published by earlier workers: Chavalier (1826), Chakraborty *et al.*, (2017), Snell and Dick (1970), Singer (1975), Peglar (1977), Watling (1970), Smith and Thiers (1971), Smith (1973), Shaffer (1975), Grund and Harrison (1976), Singer (1981), Lakhpal and Sharma (1988), Young (1936, 1940), Zak (1971, 1973). A summary of forest types, mycorrhizal hosts, range of distribution and frequency of occurrence for all the recorded species is presented in Table-1.

Fruiting Phenology: During the course of study, the fruiting period of 35 taxa of these boletoid mushrooms was recorded. There is a set of taxa which grow throughout the rainy season (July to September). Four taxa like, *Strobilomyces annulatus*, *Gyroporus castaneus*, *Suillus glandulosoides* and *Boletus badius* var. *glaber* have this wide range of fruiting period. 14 taxa like *Leccinum areolatum*, *L. oxydabile*, *L. scabrum* var. *scabrum*, *B. affinis* var. *maculosus*, *B. alutaceus*, *B. alutaceus* var. *simelensis*, *B. chrysenteron* var. *subnudipes*, *B. luridus* var. *erythropus*, *B. pallidus*, *B. pseudosulphureus*, *B. subglabripes*, *B. truncatus*, *B. vermiculosus* var. *thindii* and *B. vermiculosoides* prefer to grow early (July to August) in the rainy season. 10 taxa *Strobilomyces floccopus*, *Boletus aestivalis*, *B. indoedulis*, *B. illudens*, *B. inedulis*, *B. parasiticus*, *B. patriceae*, *B. pulverulentus*, *B. thierii* and *B. subaestivalis* prefer to grow during the mid to late (August to September) of the rainy season. Two taxa viz., *Strobilomyces mollis* and *Boletus flammans* have no choice and grow either early or late of the season and three taxa namely *Boletus ananas*, *Tylopilus plumbeviolaceus* and *Boletus bicolor* var. *bicolor* are very specific and only found to grow in the month of August.

**Table 1.** A summary of forest types, mycorrhizal hosts, range of distribution and frequency of occurrence for the recorded species

Name of the genus	Name of the species	Locality with altitude	Forest type and associated trees	Growing period	Edibility	Frequency of occurrence (abundant/common/rare)
<i>Strobilomyces</i>	<i>S. annulatus</i> , Corner	Pauri (Chobattakhal, Buakhal, Khirsu) 1800-2150m.s.l	(Mixed forest) <i>Cedrusdeodara, Quercus leucotricophora, Rhododendron arboreum</i>	July- Sep.	Not Known	Common
	<i>S. floccopus</i> (Vahl ex.Fr.) Karst	Pauri (Kuinkaleshwar, Gandra) 1650-2000 m.s.l	(Mixed forest) <i>Q. leucotricophora, Pinus roxburghii, R. arboretum</i>	Aug- Sept.	Edible but young specimens	Common
	<i>S. mollis</i> Corner	Pauri (Kuinkaleshwar, Khirsu) Chamoli (Mandal) 1850-2500 m.s.l	(Broadleaf forest) <i>Quercus</i> spp.	July- Sep.	Not Known	Common
<i>Boletellus</i>	<i>B. ananas</i> (Curtis) Murill	Pauri (Nautha) 1650-1750 m.s.l	(Mixed) <i>Pinus</i> and <i>Quercus</i>	Aug.	Not Edible	Rare
<i>Gyroporus</i>	<i>G. castaneus</i> (Fries) Quel.	Pauri (Human Mandir Forest, Gandra, Phedkhal, Chobattakhal) 1650-2200 m.s.l	Mixed angiospermic <i>Q. leucotricophora, R.arborium, P. roxburghii</i>	July-Sep.	Edible	Abundant
<i>Tylopilus</i>	<i>T.plumbeoviolaceus</i> (Snell and Dick) Singer	Pauri (Nagdev, Jhandidhar) 1850-2200 m.s.l	<i>C.deodara, Cupressus torulosa</i>	Aug	Bitter Not Edible	Common
<i>Leccinum</i>	<i>L. areolatum</i> Smith and Thiers	Pauri (Bharsar) Chamoli (Chopta, Mandal) 2000-2900 m.s.l	<i>Betula, Rhododendron</i>	July- Aug	Not Edible	Common
	<i>L. oxydabile</i> Singer	Pauri (Bharsar) Chamoli (Mandal) 2000-2900 m.s.l	<i>Betula utilis</i>	July-Aug	Edible but not worth wile	Common
	<i>L. scabrum</i> var. <i>scabrum</i> (Fr.) S.F.Gray	Pauri (Bharsar) Chamoli (Mandal) 2000-2900 m.s.l	<i>Betula, Rhododendron</i>	July-Aug	Edible but not worthwhile	Common
<i>Suillus</i>	<i>S. glandulosoides</i> Thiers and Smith	Pauri (Kuinkaleshwar, Nagdev) 1850-2200 m.s.l	<i>Pinus roxburghii, Q. leucotricophora</i>	July-Sep.	Not known	Common



<i>Boletus</i>	<i>B. aestivalis</i> Fries	Pauri (Khirsu, Chobattakhal, Buakhal, Gandra) 1650-2200 m.s.l	<i>Q. leucotricophora</i> , <i>Rhododendron arboreum</i>	Aug-Sept	Not known	Common
	<i>B. affinis</i> var. <i>maculosus</i> Peck	Pauri (Kandoliya, Bharsar, Nagdev, Lwali) 1600-2900 m.s.l	(Mixed forest)	July- Aug	Not known	Common
	<i>B. alutaceus</i> Morgan	Pauri (Khirsu, Khandusain, Ghorikhal) 1600-2200 m.s.l	Slopy and burnt places	July-Aug	Not known	Common
	<i>B. alutaceus</i> var. <i>simlensis</i> Lakhanpal and Sagar	Pauri (Phedkhal, Chobattakhal) 1900-2200 m.s.l	<i>Q. leucotricophora</i> , <i>R. arboreum</i> , <i>Myricaesculenta</i>	July- Aug	Not known	Rare
	<i>B. badius</i> var. <i>glaber</i> Grund and Harison	Pauri (Buakhal Phedkhal, Tekka) 1800-2200 m.s.l	<i>Q. leucotricophora</i> <i>M. esculenta</i> , <i>R. arboreum</i>	July-Sep.	Not known	Common
	<i>B. bicolor</i> var. <i>bicolor</i> Peck	Pauri (Buakhal, Tekka) Rudraprayag (Kund, Jakhdhar) 1800-2150 m.s.l	Angiospermic mixed forest	Aug	Edible	Common
	<i>B. chrysenteron</i> var. <i>subnudipes</i> Smith and Thiers	Pauri (Lwali, Ransi, Dandapani) 1600-2000 m.s.l	<i>Q. leucotricophora</i> , <i>R. arboreum</i> , <i>P. roxburghii</i>	July- Aug	Not known	Common
	<i>B. indoedulis</i> Bull ex. Fries	Pauri (Gandra, Phedkhal, Kuinkaleshwar Hanuman mandir Forest) 1650-2200 m.s.l	<i>Cedrus deodara</i> , <i>P. roxburghii</i> , <i>Cupressus torulosa</i>	Aug-Sept	Edible	Abundant
	<i>B. luridus</i> var. <i>erythropus</i> Fries	Pauri (Lwali) Tehri (Dhanaulti), Chamoli (Mandal) 1600-2500 m.s.l	<i>C. deodara</i> , <i>P. roxburghii</i> , <i>Q. leucotricophora</i> , <i>R. arboreum</i>	July- Aug	Not known	Common
	<i>B. flammans</i> Dick and Snell	Pauri (Kandoliya Kuinkaleshwar) Chamoli (Mandal) 1750-2500 m.s.l	<i>C. deodara</i> , <i>P. roxburghii</i> , <i>Cupressus torulosa</i>	July -Sept.	Not known	Common



	<i>B. gertrudiae</i> Peck	Pauri (Phedkhal), Tehri (Dhanaulti) 1900-2300 m.s.l	<i>Q. leucotricophora</i> , <i>R. arboreum</i> , <i>P. roxburghii</i>	July	Not known	Rare
	<i>B. glabellus</i> Peck	Pauri (Chobattakhal), Rudraprayag (Kund) 1800-2150 m.s.l	Angiospermic mixed forest	July	Not known	Rare
	<i>B. illudens</i> Peck	Pauri (Lwali, Kandoliya) 1600-1750 m.s.l	Mixed /coniferous sometimes under Oak	Aug- Sept	Edible	Rare
	<i>B. inedulius</i> Murill	Pauri (Khirsu Gandra,) 1650-2200 m.s.l	<i>Q. leucotricophora</i> <i>R. arboreum</i> , <i>M. esculenta</i> , <i>C. deodara</i> , <i>P. roxburghii</i>	Aug- Sept	Not known	Rare
	<i>B. pallidus</i> Frost	Pauri (Human Mandir Forest, Kandoliya, Ransi, Gandra), Chamoli (Mandal) 1650-2500 m.s.l	Mixed/Coniferous	July-Aug.	Edible	Abundant
	<i>B. parasiticus</i> Fries	Pauri (Tekka), Rudraprayag (Kund) 1800-2000 m.s.l	Basidiocarps of <i>Scleroderma citrinum</i>	Aug- Sept	Not known	Rare
	<i>B. patriciae</i> Smith and Thiers	Pauri (Khirsu), Rudraprayag (Jakhdhar) 1800-2200 m.s.l	Under Oaks	Aug- Sept	Not known	Rare
	<i>B. pseudosulphureus</i> Kellenbach	Pauri (Tekka), Chamoli (Mandal) 1800-2500 m.s.l	Coniferous woods	July-Aug.	Not known	Rare
	<i>B. pulverulentus</i> Opatowski	Pauri (Kuinkaleshwar, Adwani, Bharsar), 1850-2900 m.s.l	Angiospermic/ Mixed forest	Aug- Sept	Edible	Common
	<i>B. subaestivalis</i> Sagar and Lakhanpal	Pauri (Tekka, Kuinkaleshwar, Chobattakhal) 1800-2200 m.s.l	In plant debris mycorrhiza with oaks	Aug- Sept	Not known	Common
	<i>B. subglabripes</i> Peck	Pauri (Chobattakhal, Gandra, Tekka), 1650-2150 m.s.l	Near to Oak trees	July-Aug	Not known	Common



	<i>B. thierii</i> Lakhanpal and Sagar	Pauri (Danadapani, Chaurikhal, Lwali) 1600-3000 m.s.l	<i>Q. leucotricophora</i> , <i>R. arboreum</i> , <i>P. roxburghii</i>	Aug- Sept	Not known	Common
	<i>B. truncatus</i> (Singer Snell and Dick) Pouzar	Pauri (Hanuman Mandir forest, Khandusain) 1650-1850 m.s.l	<i>Q. leucotricophora</i> , <i>R. arboreum</i> , <i>P. roxburghii</i>	Jul-Aug	Not known	Rare
	<i>B. vermiculosus</i> var. <i>thindii</i> (Peck) Lakhanpal and Sharma	Pauri (Hanuman Mandir forest, Buakhal, Phedkhal) 1850-2200 m.s.l	<i>Q. leucotricophora</i> , <i>R. arboreum</i>	July-Aug	Not known	Common
	<i>B.vermioculosoides</i> Smith and Thiers	Pauri (Dandapani, Phedkhal) 1790-2200 m.s.l	<i>P. roxburghii</i> , <i>C. deodara</i> , <i>Q. leucotricophora</i> <i>R. arboretum</i>	July-Aug.	Not known	Rare



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