Int.J.Curr.Microbiol.App.Sci (2018) *7*(6): 1694-1713

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 06 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.706.201

Distribution of Boleteceous Mushrooms in India, Some New Records from Sal Forest of Central India

R. K. Verma and Vimal Pandro*

Forest Protection Division, Tropical Forest Research Institute, Jabalpur - 482 021, Madhya Pradesh, India

**Corresponding author*

Keywords

Agaricomycetes, Basidiomycota, Boletales, distribution, ecto-mycorrhiza, edible mushroom

Article Info

Accepted:
18 May 2018
Available Online:
10 June 2018

A B S T R A C T

An account of Boleteceous mushrooms reported from different part of India is given. Total 84 species of Boletaceae were compiled from literature with records of habitat, distribution and references. *Boletus* spp. are the most common (37 species) followed by *Strobilomyces* (9 species), *Tylopilus* (7 species), *Boletellus* (6 species), *Xerocomus* (5 species), *Suillus* (3 species), *Chalciporus*, *Retiboletus* and *Pulveroboletus* (2 species each), *Australoboletus*, *Borofutus*, *Hemileccinum*, *Hortiboletus*, *Leccinum*. *Octaviania*, *Phylloporus*, *Retiboletus*, *Rhodactina*, *Suillellus*, *Xerocomellus* (one species each). Among Indian states, Himachal Pradesh and Sikkim represent the most boletes mushroom (16 species each) followed, Meghalaya (13), West Bengal (11), Madhya Pradesh and Uttarakhand (7 each), Jammu & Kashmir (5) Chhattisgarh and Kerala (4) and rest of states showed 3 or less number of species. Six species of boletes namely: *Boletellus ananas*, *B. chrysenteroides*, *B. dissiliens*, *B. pseudochrysenteroides*, *B. corneri* and *Boletus edulis* were recorded for the first time from sal forest of central India (Chhattisgarh and Madhya Pradesh). These fungi are known to form ectomycorrizal association with sal trees.

Introduction

Basidiomycetes places in family Boletaceae are mushrooms which are primarily characterized by developing their spores in small pores, instead of gills, as are found in agarics. Among these mushrooms, *Boletus edulis* which is also known as the king mushroom is of high demand by mushroom hunters. Typical members of the family are generally known as boletes. These are a relatively safe group of mushrooms for human consumption, as none of these are known to be deadly poisonous to adults. These are little confused with deadly mushrooms, like various *Amanita* agarics, which are the most poisonous mushrooms in the world. Due to absence of gills boletes can be easily distinguished from gilled mushrooms. These are also easily recognized having colorful caps, pores and thick stems. Most species in Boletaceae produce large fleshy mushrooms with a central stipe. In most of species, flesh that is bruised or cut turned blue as a result of the oxidation of pulvinic acid derivatives (Nelson, 2010). Boletes were first described by the French botanist François Fulgis Chevallier in 1826 in a family, distinct from

Agaricaceae. According to the *Dictionary of the Fungi* (Kirk *et al.*, 2008), 35 genera are recognized in boletaceae, which collectively contain 787 species. In the comprehensive work of (Wu *et al.*, 2014), seven major clades at subfamily level and 59 generic lineages were uncovered, including four new subfamilies (*Austroboletoideae*, *Chalciporoideae*, *Leccinoideae*, and *Zangioideae*) and 22 new potential genera have been described. Boletes are found worldwide, on every continent except Antarctica. These fungi are well-known reported from temperate regions of northern hemisphere; newer research has also shown significant diversity in tropical and southern hemisphere regions as well. A large number of boletes are delicious or at least edible. On the other hand poisonous or inedible species also exist, however, such as the unpalatable bitter species, for example *Boletus calopus* and *Tylopilus felleus* (bitter bolete). Some orange-capped species of *Leccinum* are also inedible. Several guidebooks recommend avoiding all red-pored boletes, but both *B. erythropus* (*Neoboletus luridiformis*) and *Suillellus luridus* are edible when well-cooked. Some of the boletes genera were separated based on basidiospores morphology, for example *Boletellus* have olive brown elongate to fusoid with longitudinally grooves and winged basidiospores (almond like) while *Boletus* have smooth spores (Pegler and Young, 1981).

The present article reports distribution of 84 boletaceous mushroom in different states of India. Six boletes (*Boletellus ananas, B. chrysenteroides, B. dissiliens, B. pseudochrysenteroides, B. corneri* and *Boletus edulis*) were also reported for the first time from sal forest of central India.

Materials and Methods

Specimens of bolete mushrooms were collected from sal forest of Madhya Pradesh and Chhattisgarh states in rainy seasons from forest floor under sal trees. Some parts of collected samples were preserved in 70% alcohol just after collection for microscopic study. The fruit bodies of fungi were dried under the sun or in the wooden box lighted with 100W electric bulb. Microscopic slides were prepared by using stain, mountant, clearing and softening chemicals. Micro slides were observed under advanced research microscope (Leica, Germany) using 5x, 10x, 20x, 40x objectives and 10x and 15x eyepieces. Observations under phase contrast and dark field were also made whenever required. Photomicrography was done with the help of a digital camera (make, Leica) attached to the advanced microscope. Identification of fungi have been done with the help of published literature, monographs, books, keys, etc. (Ahmad 1950; Berkeley 1851a; b; 1852a; b; 1854a; Bhavanidevi and Nair 1983; Chaouhan *et al.*, 2010; Cunningham, 1942; Dar *et al.*, 2010; De, 2006; Harsh and Bisht, 1983, 1985; Kumar and Sharma, 2011; Lakhanpal and Sagar, 1989; Lakhanpal, 1996; Murrill, 1909; Pyasi *et al.*, 2011; Shajahan and Samajpati, 1995; Sharma *et al.*, 1978; Sharma and Lakhanpal, 1988; Singer and Singh, 1971; Singer, 1948; Singer and Singh, 1971; Tiwari *et al.*, 2013; Verma *et al.*, 2008; Wu *et al.*, 2014, 2015; Zang *et al.*, 2001).

Results and Discussion

Taxonomic description

Boletellus ananas (M.A. Curtis) Murrill (Figure 1-6)

≡*Boletus ananas* M.A. Curtis

Pileus, convexo-plane, dry, dull crimson to rose red, often fading to pale fawn drab, finely tomentose, cracking in to large floccose squamules, 60-75mm in diameter and 22 mm

thick. Margin far exceeding the pores and covering them as a false veil, then splitting radially and stellately, appendiculate. Stem, central, 120 x12 mm, subcylindric, base often enlarged and villous with thick white mycelium, tomentose, tan buff or buff-white, base and apex of pinkish shade. Flesh, 10mm thick at the centre of the pileus, 4-5 mm halfway to the margin, creamish white with patches con-colorous with the pileus patches, soft to touch.

Hymenium, yellow, pores 1/mm, angular, pore tube 12mm long, yellow. Basidiospores, vinaceous chocolate brown, boletoid, longitudinally striate in the hyaline exospores, slightly curved, oblique main striae disappearing at the ends of the spore apiculate, 17.0-21.0 x 7.5-9.0µm. Basidia, long clavate, 41.5-53.0 x 12.5-15.0µm, sterigmata 3.5-5.5µm. Cystidia, ventricose with obtuse wide apex, some with a subcylindric appendage, thin walled, hyaline. Tramal hyphae, hyaline thick-walled septate, 5.0-7.5µm wide.

Collections examined

In humus of *Shorea robusta*, Nagadand forest, Sarguja, Chhattisgarh, 22/9/2011, Tropical Forest Research Institute TF 3196.

***Boletellus chrysenteroides* (Snell) Snell (Figures 7-10)**

=*Boletus chrysenteroides* Snell

Cap 4-11cm, convex to broadly convex with age, dry, finely velvety to nearly bald; sometimes becoming cracked with age; dark brown to nearly black at first, becoming medium brown or eventually pale brown. Stem, 2-10cm long; up to 1.5cm thick; more or less equal, at first punctuated by brownish, *Leccinum*-like scabers that later become aggregated into hairy or sub-scaly clusters that sometimes approximate the appearance of reticulation; yellowish to brownish at first, becoming reddish to purplish red in the mid-portion with age. Pore surface: bright to dull yellow, becoming olive yellow; bruising slowly blue and eventually brown; pore 1-2/ mm round to angular, tubes up to about 1cm deep. Flesh pale yellow to whitish, or with age reddish in the mid-portion of the stem and around damaged areas; changing to bluish or blue when sliced.

KOH reaction, black on cap, brownish on flesh, iron salts olive on flesh. Spore print, olive-brown. Basidiospores 10-17 x 5-8µm; longitudinally twisted-grooved; ellipsoid; yellow in KOH. Pileipellis a trichoderm; terminal elements often cystidioid, with sub-terminal elements sometimes somewhat inflated.

Collection examined

On soil surface in sal forest of Chada, Dindori, Madhya Pradesh, 25/07/2017, Tropical Forest Research Institute, TF 4041.

***Boletellus corneri* Klofac & Krisai (Figures 11-15)**

=*Boletellus fallax* (Corner) Watling

Pileus convex, pale rose red to pinkish brown, bearing rough angular cracks on its dorsal surface exposing white creamy flesh, bearing yellow angular pore tubes 3-5 mm long. Stalk long 9-15 x 1-1.5cm, hard, characteristically bent, red rose to faint pink may be pinkish yellow with white mycelial tufts base. Spores 12.5-20 x 5-10µm, boletoid, round to elongate, oblong with small apicules, longitudinally striated with slender ridges 7-10 in side view. Basidia 27.5-40 x 8.75-12.5µm, sterigmata 4, (2.5-3.5µm long). Cystidia 45-160 x 12.5-15.5µm ventrucose with prolong base 3.5-6.0µm wide and a projecting neck with obtuse to sub capitate apex 3-9µm wide.

Collection examined

On forest floor of sal, Amarkantak, Madhya Pradesh, 23/08/2011, Mycology Herbarium, Tropical Forest Research Institute, Jabalpur TF 2649.

***Boletellus dissiliens* (Corner) Pegler & T.W.K. Young (Figures 16-21)**

≡*Boletus dissiliens* Corner

Pileus: 45 mm pale pinkish buff cap, yellow cyanescent flesh, yellow, dull pinkish tan, sub-tomentose, dry, cracking into large flag patches, margin at first greatly extending the pores, covering them as a veil, splitting radically, stellately. Stem: 70 mm long, solid and 8 mm wide near the apex, 12 mm at base, at the thickened base villose with the white mycelium, hard, concolourous with the pileus, apex pallid. Pore tube: 5 mm long, sinuato adnate, ventricose, golden yellow then brownish ochraceous, cyanescent: pore angular, concolours, cyanescent. Flesh: 6 mm thick in the centre of the pileus. 3-4 mm halfway to the margin, white, pale yellowish over the tube. Basidia 40-41 x 9-14.5µm, pyriform, sterigmata, 5.0-5.25µm. Cystidia: 41.5 x 17.68µm Basidiospores: olive brown in mass, ellipsoid boletoid, almond shape, rather coarsely striate with ridges, 13.5-17.5 x 5.5 - 8.5µm.

Collection examined

On ground near base of *Shorea robusta* tree, Nagadand forest, Sarguja, Chhattisgarh, 22/9/2011, Tropical Forest Research Institute TF 3198.

***Boletellus pseudochrysenteroides* A.H. Sm. & Thiers (Figures 22-28)**

Growing alone, scattered, or gregariously. Cap convex, becoming broadly convex, 5-6cm; dry; soft; felty to velvety, becoming cracked, dark brick red, fading to pinkish brick red. Pore surface, yellowish at first, becoming olive, pores angular, 2-3 mm wide; pore-tubes up to 0.6-1.2 cm deep. Stem: 14 -16 cm long; 1.6-1.8cm thick; more or less equal; dry; solid; finely hairy; colored like the cap or paler, yellow at the apex; basal mycelium dense and whitish to yellowish. Flesh pale to bright yellow in the cap. Basidia, clavate, hyaline, 4-sterigmate, rounded in sterigmatal part, measuring 17.5-26 x 14-16.5µm, sterigmata 2.5-3.7µm. Spore-print, brown to dark olive brown. Basidiospores, 17.5-22.5 x 7-15µm; longitudinally striate, with 5-9 ridges, ellipsoid or nearly so, golden brown in KOH. Diagnostic characters: The distinctive cap is brick red and soon prominently cracked up. The spores are ribbed or lined, which is characteristic of genus *Boletellus*. Similar species include reddish forms of *Xerocomellus chrysenteron* and *Xerocomellus rubellus*, *Boletus chrysenteron*, *Boletellus chrysenteroides* and *Boletellus intermedius*.

Collection examined

Growing under *Shorea robusta* tree, Amarkantak, Madhya Pradesh, 25/07/2017, Tropical Forest Research Institute TF 3986.

***Boletus edulis* Bull. (Figures 29-30)**

=*Leccinum edule* (Bulliard) Gray =*Dictyopus edulis* (Bulliard) Forquignon

Sporocarp small to medium sized. Pilus 5-3cm. diam., convex when young, broadly convex with age; surface dry, viscid when wet, glabrous, smooth, uneven colour brown, margin regular, smooth, incurved when young. Tubes 4-9 mm deep, adnexed but depressed around the stipe, violaceous grey when young. Pores minute, round, stuffed when young, pinkish brown to pale brown in age, unchanging on bruising.

Fig.1-6 *Boletellus ananas* (1-2) Habit, fruitbody near sal tree (3) cystidia (4) hyphae (5) basidia with developing basidiospores on sterigmata (6) basidiospores

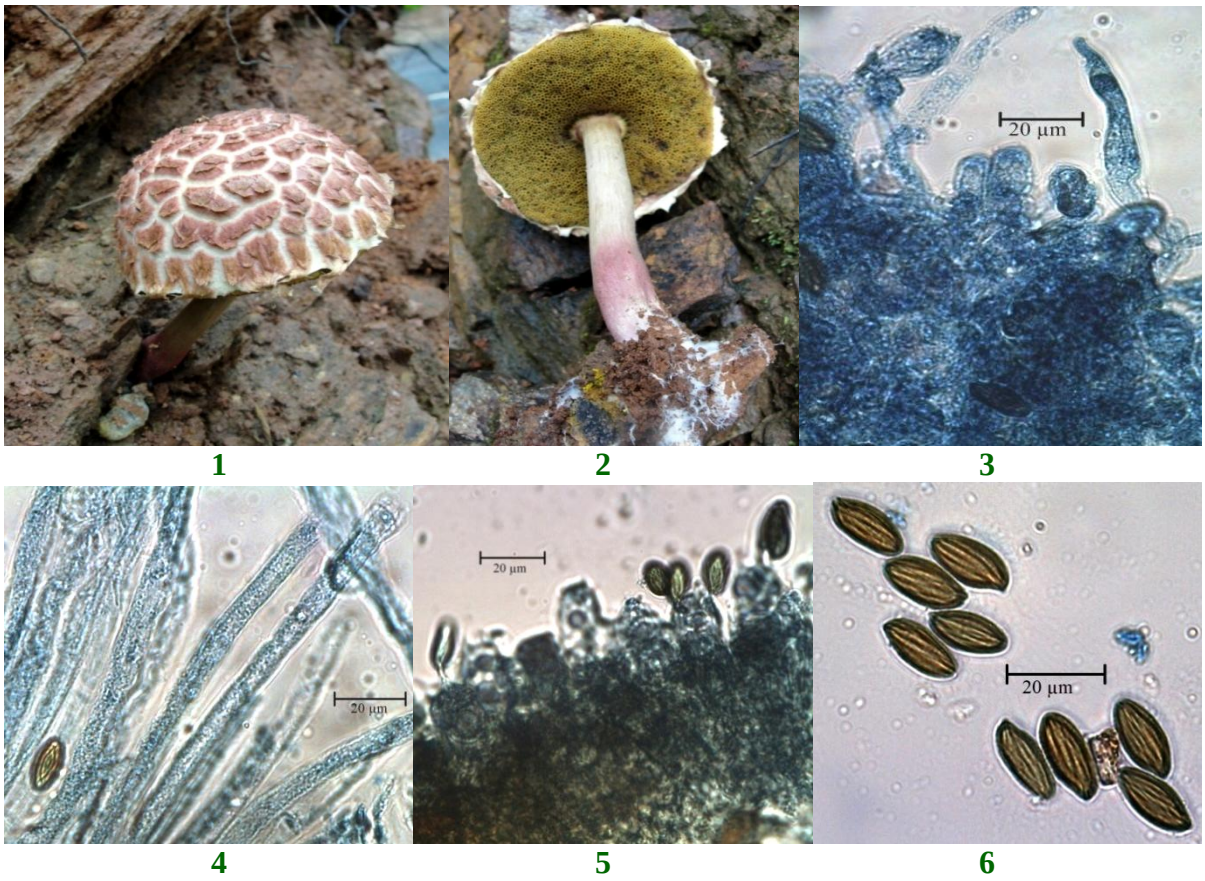
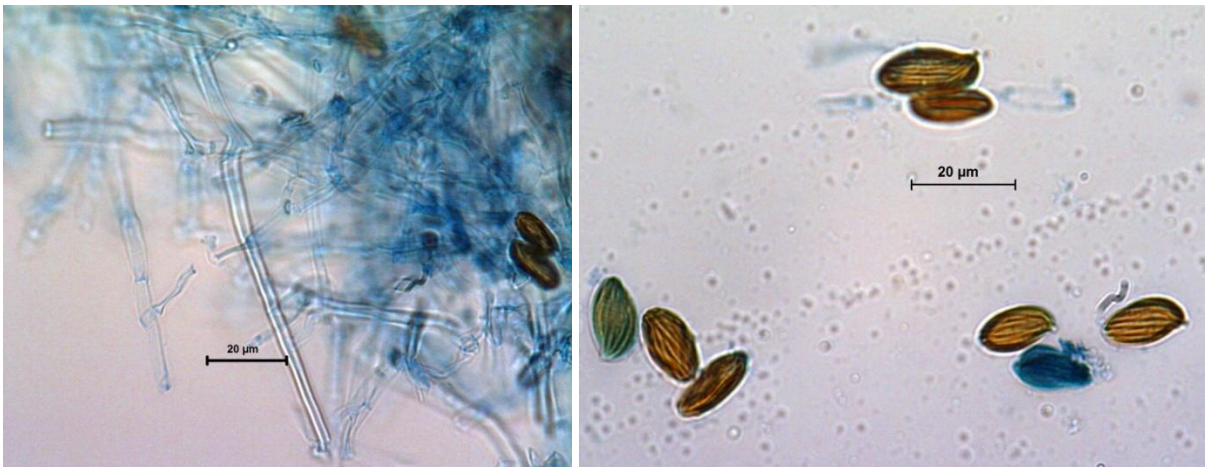


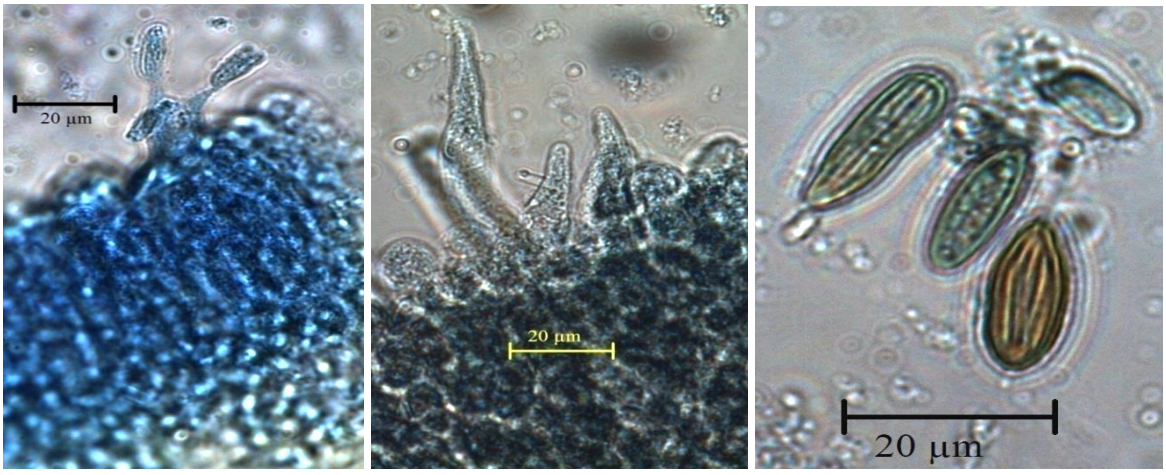
Fig.7-10 *Boletellus chrysenteroides* (7) habit, (8) sporophore showing pore surface, stipe and volva (9) basidiospores and hyphae and (10) basidiospores



9 **10**

Fig.11-15 *Boletellus corneri* (11) fruitbody under sal tree (12) fruitbody pore surface, stioe and vulva (13) basidia with developing basidiospores (14) cystidia (15) basidiospores

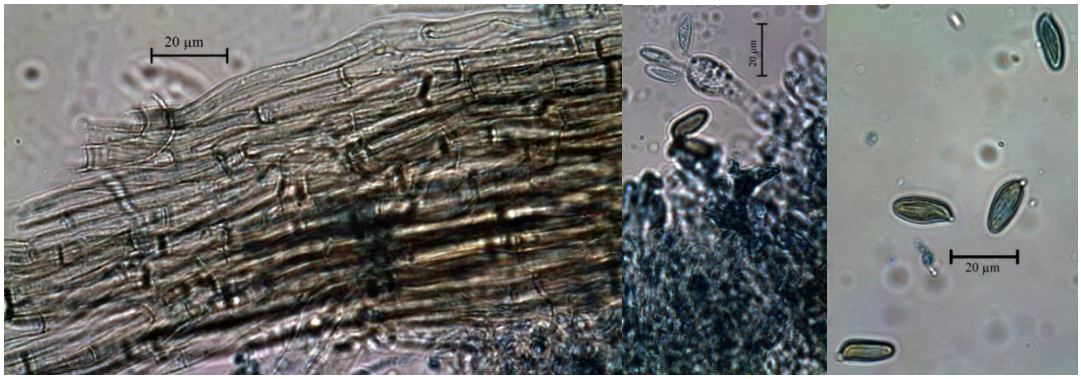
11 **12**



13 **14** **15**

Fig.16-21 *Boletellus dissiliens* (16) habit (17-18) sporphores under sal tree (19) hyphae (20) basidia with developing basidiospores (21) basidiospores

16 **17** **18**



19 **20** **21**

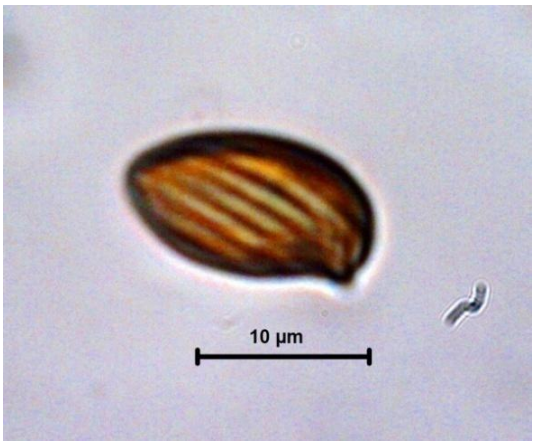
Fig.22-28 *Boletellus pseudochrysenteroides*. (22-24) habit (showing pileus, stem and pore surface covered with veil) (25) basidium (26) basidium attached with developing basidiospores and cystedia (27-28) basidiospores

22 **23** **24**

25

26

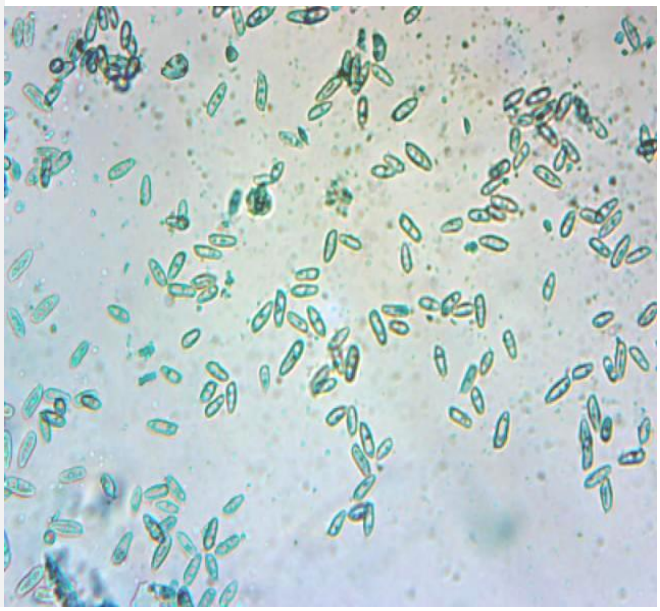
27



28

Fig.29-30 *Boletus edulis* (28) sporophore and (29) basidiospores

29



30

Fig.31 Distribution of Boletaceous mushroom fungi in India

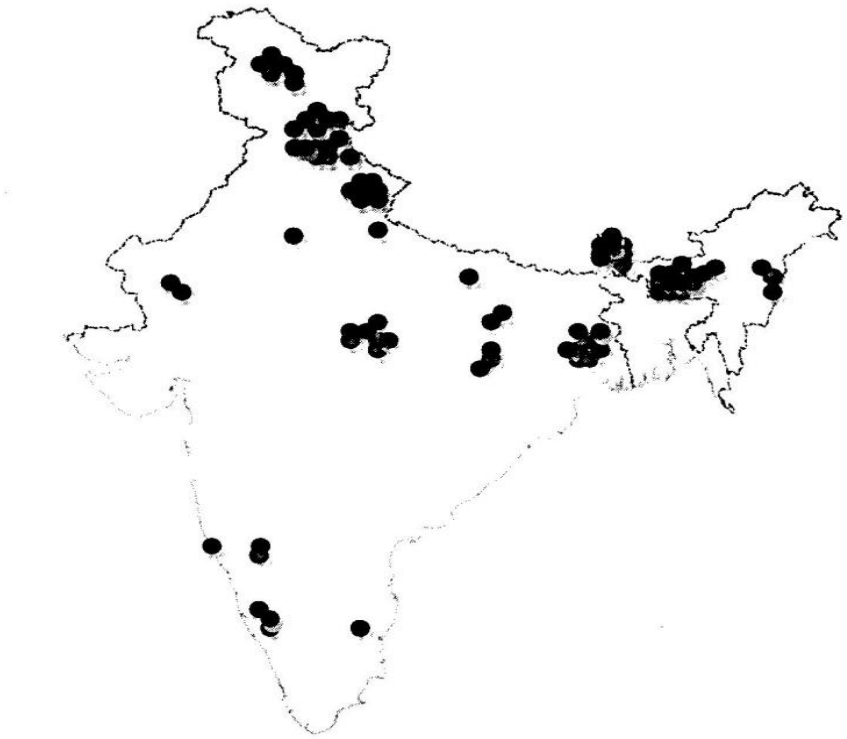


Table.1 Distribution of Boletaceous mushrooms in India

S.N.	Species	Habitat	Distribution	Reference
1.	*Austroboletus olivaceoglutinosus* K. Das & Dentinger	On soil associated with *Tsuga dumosa*	Sikkim	*Das and Dentinger (2015)*
2.	*Boletellus ananas* (M.A. Curtis) Murrill	In humus of sal forest and on base of *Holigarna arnottiana*	Nagadand, Sarguja, Chhattisgarh and Thiruvananthapuram, Kerala	This article Vrinda, Pradeep (2014)
3.	*Boletellus chrysenteroides* (Snell) Snell	On soil surface in sal forest	Chada, Dindori, Madhya Pradesh	This article
4.	*Boletellus corneri* Klofac & Krisai	On forest floor of sal	Amarkantak, Madhya Pradesh	This article
5.	*Boletellus dissiliens* (Corner) Pegler & T.W.K. Young	On ground near base of sal tree	Nagadand, Sarguja, Chhattisgarh	This article
6.	*Boletellus emodensis* (Berk.) Singer ≡*Boletus emodensis* Berk.	On forest soil	Khasi Hills, Meghalaya; Darjeeling. West Bengal and Sikkim	Berkeley (1851a,b; 1852; 1854)
7.	*Boletellus pseudochrysenteroides* A.H. Sm. & Thiers	Growing under *Shorea robusta* tree	Amarkantak, Madhya Pradesh	This article
8.	*Boletus aestivalis* Fr.	On ground in forest	Himachal Pradesh	Lakhanpal and Sagar

				(1989)
9.	*Boletus alexandri* Sagar & T.N. Lakh.	On ground in forest	Himachal Pradesh	Lakhanpal (1996)
10.	*Boletus alutaceus* Morgan =*Boletus alutaceus* var. *simlensis* T.N. Lakh. & Sagar	On brunt soil, and on forest ground; ectomycorrhizal with *Ficus benghalensis*	Simla, Himachal Pradesh ; Goa	Lakhanpal (1996) Kamat *et al.*, (2009)
11.	*Boletus areolatus* Berk.	Open pastures.	Kala-Panee, Khasi Hills, Meghalaya	Berkeley (1852a)
12.	*Boletus chrysenteron* Fries	Ecto-mycorrhizal with *Holigarna arnotiana*	Thiruvananthapuram, Kerala	Vrinda, Pradeep (2014)
13.	*Boletus cinerascens* Schwein., =*Boletus cyanescens* Bull. =*Gyroporus cyanescens* (Bull.) Quél.	On open places of earth	Darjeeling, West Bengal	Berkeley (1851b)
14.	*Boletus craspedius* Massee	On soil under oak forest	Kumaon, Uttarakhand	Harsh and Bisht, (1982b)
15.	*Boletus delphinus* Hook.f. =*Boletus delphinus* Berk.	On soil	Darjeeling, West Bengal	Berkeley (1851a)
16.	*Boletus dissiliens* Corner	On soil under oak forest	Kumaon, Uttarakhand	Harsh and Bisht, (1982b)
17.	*Boletus edulis* Bull.	Mycorrhizal on sal, growing on humicolous soil in coniferous forest and under *Syzygium cuminii;* coniferous forest; on dead wood logs	Amarkantak-Achanakmar, Madhya Pradesh and Chhattisgarh and Chishoti, Kishtwar, J&K; forest of Khunti, Jharkhand ; Nagaland; Assam	This article Kumar and Sharma (2011b) Srivastava *et al.*, (2012) Ao *et al.*, (2016) Sarma *et al.*, (2010)
18.	*Boletus emodensis* Berk.	On the ground	Darjeeling, West Bengal	Berkeley (1851a)
19.	*Boletus fallax* Corner	On forest floor of sal forest	Amarkantak-Achanakmar, Madhya Pradesh & Chhattisgarh	Pyasi *et al.*, (2012)
20.	*Boletus formosus* Corner	Growing in coniferous mixed and broad leaved forest	Dugga, Bhadarwah, Jammu & Kashmir	Kumar and Sharma (2011b)
21.	*Boletus frostii* J.L. Russell	On soil in pasture and deodar tree	Chail, Simla, Himachal Pradesh	Sharma *et al.*, (1978)
22.	*Boletus furfuraceus* Berk.	On clay-banks	Moflong, Khasi Hills, Meghalaya	Berkeley (1852a)
23.	*Boletus gigas* Berk.	On soil and copses of *Andromeda* and Birch	Khasi Hills, Meghalaya and Lachen river, Sikkim	Berkeley (1852a); Horak (1980)
24.	*Boletus gracilis* Peck.	On soil rich in humus mixed forest	Chambaghat, Solan, Himachal Pradesh	Sharma *et al.*, (1978)
25.	*Boletus granulatus* L.	Growing on humicolous soil in scattered coniferous forest	Dugga, Bhadarwah, Jammu & Kashmir	Kumar and Sharma (2011b)
26.	*Boletus griseus* Frost	On soil	Kandaghat, Solan, Himachal Pradesh	Sharma *et al.*, (1978)
27.	*Boletus hongoi* T.N. Lakh. & Sagar	On ground in forest	Himachal Pradesh	Lakhanpal (1996)

28.	*Boletus illudens* Peck	On grassland	West Bengal	De (2006b)
29.	*Boletus lakhanpalii* K. Das, D. Chakr., Baghela, Sanjay K. Singh & Dentinger	On soil, associated with *Larix griffithiana*	Sikkim	Das *et al.*, (2015)
30.	*Boletus luridus* Schaeff	Growing on humicolous soil in scattered mixed forest	Bhadarwah, Jammu & Kashmir	Kumar and Sharma (2011b)
31.	*Boletus niveus* Jullien ex Vill.	On soil, mixed forest	Kandaghat, Solan, Himachal Pradesh	Sharma *et al.*, (1978)
32.	*Boletus parvulus* (Paulet) Lév.	On soil rich in humus mixed forest	Chambaghat, Solan, Himachal Pradesh	Sharma *et al.*, (1978)
33.	*Boletus pusillus* Berk. ≡*Suillus pusillus* Kuntze	On ground	Moflong, Khasi Hills, Meghalaya	Berkeley (1854a)
34.	*Boletus rhodoxanthes* (Krombh) Kallenb.	From moist humus soil under conifer dominated forest	Gulmarg, Kashmir	Dar *et al.*, (2010)
35.	*Boletus rubripes* Thiers	Growing under *Picea spinulosa* Forest	North district, Dombang valley, Sikkim,	Das (2013a)
36.	*Boletus scaber* Bull.	On soil	Himachal Pradesh	Sharma *et al.*, (1978)
37.	*Boletus scrobiculatus* Berk.	On soil in open places and rotten wood	Moflong, Khasi Hills, Meghalaya, Darjeeling, West Bengal	Berkeley (1852a) Horak (1980)
38.	*Boletus squamatus* Berk. =*Boletellus squamatus* (Berk.) Singer	In woods	Myrung, Khasi Hills, Meghalaya	Berkeley (1852a)
39.	*Boletus subaestivalis* Sagar & T.N. Lakh.	Growing among plant debris	Himachal Pradesh	Lakhanpal (1996)
40.	*Boletus thiersii* T.N. Lakh. & Sagar	On clear soil	Himachal Pradesh	Lakhanpal (1996)
41.	*Boletus ustalis* Berk.	On rotten tree trunk	Darjeeling, West Bengal	Berkeley (1851a)
42.	*Boletus variipes* Peck =*Boletus variipes* var. *variipes* Peck	Growing solitary or gregariously in angiosperms forest soil	Shimla, Himachal Pradesh	Lakhanpal and Sagar (1989)
43.	*Boletus vermiculosus var. thindii* T.N. Lakh. & Sagar	Associated with *Quercus* sp.	Himachal Pradesh	Lakhanpal (1996)
44.	*Boletus verrucarius* Berk. =*Boletellus verrucarius* (Berk.) Singer	On ground	Sikkim	Berkeley (1854a)
45.	*Boletus* spp.	On ground and and in moist deciduous forest	Namakkal, Tamil Nadu; Shimoga, Karnataka	Raja *et al.*, (2011) Swapna *et al.*, (2008)
46.	*Borofutus dhakanus* Hosen & Zhu L. Yang	Under sal and deciduous forest	Koderma, Jharkhand	Parihar *et al.*, (2014)
47.	*Chalciporus piperatus* (Bull.) Bataille ≡*Boletus piperatus* Bull.,	Ectomycorrhizal on sal, growing solitary in sal forest	Balibhasa, West Bengal	Shajahan and Samajpati (1995)
48.	*Chalciporus rubinellus* (Peck) Singer ≡*Boletus rubinellus* Peck	growing gregariously on ground in coniferous forests and amongst grasses under tree,	Mandi, Himachal Pradesh and Jodhpur, Rajasthan	Lakhanpal and Sagar (1989); Chaouhan *et al.*, (2010)
49.	*Hemileccinum subglabripes*	On soil	Moflong, Khasi Hills,	Berkeley (1854a)

	(Peck) Halling=*Pulveroboletus flavipes* (Berk.) E. Horak ≡*Boletus flavipes* Peck		Meghalaya	
50.	*Hortiboletus indorubellus* K. Das, D. Chakr., Baghela, S.K. Singh & Dentinger	On ground in forest, under *Betula alnoides*	Sikkim	Das, *et al.*, (2016)
51.	*Leccinum ustale* (Berk.) E. Horak ≡*Boletus ustalis* Berk.	On soil	Khasi Hills, Meghalaya and Sikkim	Berkeley (1851a,b); Horak (1980)
52.	*Octaviania longiana* S. Ahmad	On ground amongst grasses	Rohtak, Haryana	Ahmad (1950)
53.	*Phylloporus septocystidiatus* C.K. Pradeep & K.B. Vrinda	In tropical forest under *Hopea parviflora* and *Xanthophyllum arnottianum*	Palode, Trivandrum, Kerala	In Pradeep *et al.*, (2015)
54.	*Pulveroboletus fragicolor* (Berk.) Singer =*Phaeogyroporus fragicolor* (Berk.) E. Horak ≡*Boletus fragicolor* Berk.	From mountain	Nunklow, Khasi Hills, Meghalaya	Berkeley (1852a) Horak (1980)
55.	*Pulveroboletus shoreae* Singer & B. Singh	Ectomycorrhizal on sal, growing solitary in sal forest,	Dehradun, Uttarakhand and Gidhani West Bengal	Singer and Singh, 1971; Shajahan and Samajpati (1995)
56.	*Retiboletus kauffmanii* (Lohwag) N.K. Zeng & Zhu L. Yang ≡*Boletus kauffmanii* Lohwag	Under *Lithocarpus* sp., broadleaf forest	East Distr., Maenam Top, alt. 2315m, Sikkim	Chakraborty *et al.*, (2017)
57.	*Retiboletus ornatipus* (Peck) Manfr. Binder & Bresinsky	On ground	North West of Sikkim	Das (2013b)
58.	*Rhodactina himalayensis* Pegler & T.W.K. Young	on soil under leaf litter, in association with roots of sal	Uttar Pradesh	Pegler and Young (1989)
59.	*Strobilomyces echinocephalus* Gelardi & Vizzini	Growing in *Quercus semecarpifolia* and wild *Punica granatum* forest	Jammu and Kashmir, Poonch, Haveli, Kanuyian	Kour *et al.*, (2013)
60.	*Strobilomyces floccopus* (Fr.) Karsten	On broad-leaved or coniferous woods	Thiruvananthapuram, Kerala	Vrinda, Pradeep (2014)
61.	*Strobilomyces kalimpongensis* Bose	On dead wood	Kolkata, West Bengal	Bose (1946)
62.	*Strobilomyces mollis* Corner	Growing on humicolous soil under *Pinus roxburghii* and *P. wallichiana*.	Jammu & Kashmir, Poonch, Haveli, Krishna Ghati	Kour *et al.*, (2013); Lakhanpal (1996)
63.	*Strobilomyces montosus* Berk.	On soil	Khasi Hills, Meghalaya	Berkeley (1851a,b)
64.	*Strobilomyces nigricans* Berk.	On soil	Darjeeling, West Bengal and Khasi Hills, Meghalaya	(Berkeley, 1852)
65.	*Strobilomyces polypyramis* Hook. f.	On rotten wood and soil	Darjeeling, West Bengal and Sikkim	Horak (1980)
66.	*Strobilomyces strobilaceus* (Scop.) Berk.	Grows in association with coniferous trees	Nagaland	Ao *et al.*, (2016)
67.	***Strobilomyces velutipes***	On ground	From Mussoorie,	Lloyd (1925)

	Cooke & Massee =*Strobilomyces indicus* Lloyd		Uttarakhand and Saharanpur, Uttar Pradesh	
68.	*Suillellus luridus* (Schaeff.) Murrill ≡*Boletus luridus* Schaeff.	Growing in leaf litter	Southern Rajasthan	Doshi and Mohammad (2015)
69.	*Suillus furfuraceus* (Berk.) E. Horak ≡*Boletus furfuraceus* Berk.	On ground under Andromeda (*Pieris* sp.) and *Betula*	Lachen, Sikkim and Meghalaya	Berkeley, 1852); (Horak, 1980)
70.	*Suillus luteus* (L.) Roussel ≡*Boletus luteus* L.	On elephant dung	Assam	Sarma *et al.*, (2010)
71.	*Suillus spraguei* (Berk. & M.A. Curtis) Kuntze ≡*Boletus spraguei* Berk. & M.A. Curtis	On ground, semi evergreen and moist deciduous forest	Amarkantak, Madhya Pradesh	Dwivedi *et al.*, (2012)
72.	*Tylopilus areolatus* (Berk.) Henn. ≡*Boletus areolatus* Berk.	Growing in open pasture	Kala-Panee, Khasi Hills, Meghalaya	Berkeley (1852b); Manjula (1983)
73.	*Tylopilus chromapes* (Frost) A.H. Sm. & Thiers ≡*Boletus chromapes* Frost	Growing on grassland	West Bengal	De (2006b)
74.	Tylopilus himalayanus D. Chakr., K. Das & Vizzini	Under *Pinus* sp. in mixed forest and under *Cedrus deodara* in coniferous forest	East District, Upper Chandmari, Sikkim and Champawat and Pauri, Uttarakhand	Chakraborty *et al.*, (2018)
75.	*Tylopilus indecisus* (Peck) Murrill	Growing on soil under oak forest	Kumaon, Uttaralhand	Harsh and Bisht, (1982b)
76.	*Tylopilus neofelleus* Hongo	Under *Castanopsis* sp. in temperate broadleaf forest	East district, Fambonglo WLS, Sikkim	Chakraborty *et al.*, (2018)
77.	*Tylopilus plumbeoviolaceus* (Snell & E.A. Dick) Snell & E.A. Dick ≡*Boletus plumbeoviolaceus* Snell & E.A. Dick	On ground in a pasture surrounded by *Cedrus deodara* forest	Kullu, Himachal Pradesh	Sharma and Lakhanpal (1988)
78.	Tylopilus pseudoballoui K. Das, D. Chakr & Vizzini	Under *Quercus* spp.	South District, Maenam WLS, Sikkim	Chakraborty *et al.*, (2018)
79.	*Xerocomellus chrysenteron* (Bull.) Šutara =*Xerocomus chrysenteron* (Bull.) Quél.	On ground, semi evergreen and moist deciduous forest; sub-tropical semi-evergreen forests	Amarkantak, Madhya Pradesh Nagaland	(Dwivedi *et al.*, 2012) Ao *et al.*, (2016)
80.	*Xerocomus bakshii* Singer & B. Singh	On soil connected with roots of *Pinus roxburghii*	Dehradun, Uttarakhand	Singer and Singh, (1971)
81.	*Xerocomus delphinus* (Hook. f.) Manjula	On open places of earth	Darjeeling, West Bengal	Berkeley (1951b); Manjula (1983)
82.	*Xerocomus doodhcha* K. Das, D. Chakr., Baghela, S.K. Singh & Dentinger	On ground in broadleaf forest, of *Lithocarpus pachyphyllus*	Sikkim	Das, *et al.*, (2016)
83.	*Xerocomus indicus* Singer	-	from India	Butler and Bisby (1960); Singer (1948)
84.	*Xerocomus longistipitatus* K. Das, A. Parihar, D. Chakr. & A. Baghela	On soil under under *Lithocarpus* sp., broadleaf forest	Rabangla, alt. 1985m, Sikkim	Chakraborty *et al.*, (2017)

Stipe central 4-6 x 1-2cm across, bulbous at base or almost parallel, pale greyish violet in apical part, whitish brown at base, reticulate in the upper half, base sub-radiating, flesh firm, white unchanging. Basidia 26-28 x 5-7µm clavate, 4-spored, hyaline. Pleurocystidia scattered 36-42 x 6-9µm, narrowly fusoid ventricose, smooth, thin walled; cheilocystidia similar to pleurocystidia. Hyphae 7-10µm wide; subcutis composed of interwoven hyphae, stipe cuticle of loosely interwoven clavate to ventricose, thin-walled, clamp-connection absent. Basidiospores olive brown, 5-2.5 x 2-1.2µm, ellipsoid, subfusiform, smooth walled, hilum distinct.

Collection examined

Mycorrhizal on sal, Amarkantak-Achanakmar Biosphere Reserve, Madhya Pradesh and Chhattisgarh, 24/07/2012, Mycology Herbarium, Tropical Forest Research Institute, Jabalpur TF 2786.

Total 84 species of family boletaceae reported from India were compiled and presented in Table 1 including 37 species of *Boletus* excluding two unidentified species. The next common genus is *Strobilomyces* represented by 9 species followed by *Tylopilus* (7 species), *Boletellus* (6 species), *Xerocomus* (5 species each), and *Suillus* (3 species) *Chalciporus* and *Pulveroboletus* (2 species each). *Austroboletus malacensis* var *autroboletus* was reported from *Quercus* sp., *Pinus wallichiana* and *Cedrus deodara* forest, Jammu & Kashmir (Kumar and Sharma, 2011b); *Chalciporus piperatus*, an ecto-mycorrhizal fungus from sal forest, West Bengal (Shajahan and Samajpati, 1995) while *Chalciporus rubinellus* was reported from coniferous forests of Mandi, Himachal Pradesh (Lakhanpal and Sagar, 1989) and Jodhpur, Rajasthan (Chaouhan *et al.*, 2010). *Octaviania asterosperma* and *Octaviania longiana* were reported from Rohtak (Cunningham, 1942; Ahmad, 1950). *Pulveroboletus shoreae*, an ectomycorrhizal bolete with sal, was reported from Dehradun, Uttarakhand and Gidhani, West Bengal (Singer and Singh, 1971; Shajahan and Samajpati, 1995) and *Rhodactina himalayensis* from Uttar Pradesh (Pegler and Young, 1989). *Tylopilus areolatus*, and *Tylopilus chromapes* were reported from Meghalaya (Berkeley, 1852b; Manjula, 1983) and West Bengal (De, 2006b) while *Tylopilus indecisus* and *Tylopilus plumbeoviolaceus* were reported from Uttaralhand (Harsh and Bisht, 1982b) and Himachal Praedesh (Sharma and Lakhanpal, 1988). *Xerocomus bakshii*, *X. delphinus* and *X. indicus* were also reported from India (Berkeley, 1951b; Butler and Bisby, 1960; Singer, 1948; Singer and Singh, 1971; Manjula, 1983).

There is no record of occurrence of bolataceae in Andhra Pradesh, Maharashtra and Karnataka but local communities in these states and also of Goa, Kerala and Tamil Nadu cultivate popular edible mushrooms including Boletaceae which are safe for human consumption (www.maria-online.com (Boletus). Along with other popular edible mushrooms the ectomycorrhizhal boletes also reported from Western Ghats (Maharashtra, Karnataka, Goa, Kerala and Tamil Nadu) (www.nzdl.org/gsdlmod?).

Fungi accommodated in family Boletaceae were reported from different places of India, a list of 82 species is presented in Table 1. Boletaceous mushroom fungi were distributed in Himachal Pradesh followed by Meghalaya, West Bengal, Uttarakhand, Madhya Pradesh, Chhattisgarh, Sikkim, Jammu and Kashmir, Kerala, Nagaland, Uttar Pradesh, Haryana and Rajasthan (Figure 31). *Boletellus ananas* reported from Kerala growing under *Holigarna arnottiana* (Vrinda and Pradeep, 2014) for the first time it is being reported from sal forest of CG. This species is earlier

reported growing beside old log of *Pinus* and oaks in South Carolina (Murrill, 1909) and also as forming ect0-mycorrhizal associations with eucalypts in Australia (Gardner and Malajczuk 1988). Other places of distribution include Malaya, Singapore, Borneo, Kinabalu and Mesilau (Corner, 1972; Mayor *et al.*, 2008; McNabb, 1967; Yeh *et al.*, 1982; Zhishu, 1993). Although this mushroom is used as a food in Mexico (Boa, 2004) but another field guide listed it as inedible or not recommended for eating (Bessette *et al.*, 2007).

Boletellus chrysenteroides, probably ecto-mycorrhizal and reported to be associated with oaks and eastern hemlock and often found growing near well decayed oak stumps, usually growing alone. This fungus is widely distributed in North Carolina, USA, Aylmer and Ontario in Canada (Snell, 1936, 1941) and also for the first is being reported from Madhya Pradesh and Chhattisgarh. However, *Boletellus corneri* was earlier reported as *Boletus fallax* from sal forest of Amarkantaka, Madhya Pradesh (Pyasi *et al.,* 2012). This mushroom is reported to be distributed in Malaya (Singapore) (Corner, 1972). *Boletellus dissiliens* was reported growing on soil or ground near base of Myrtaceae and Fagaceae and distributed in Singapore and Australia (Corner, 1972). *Boletellus pseudochrysenteroides* is reported mycorrhizal with hardwoods of beech and oaks and distributed in USA **(**Illinois, Michigan and Arizona) (Smith and Thiers, 1971).

Genus *Boletus* is very common amongst mushroom of family boletaceae and out of 50 known species from world 37 species are reported from India (Table 1). *Boletus edulis* was reported growing on humicolous soil in coniferous forest of Jammu & Kashmir (Kumar and Sharma 2011b). It was reported as forming ectomycorrhizal association with sal, *Syzygium cuminii* and growing on dead wood logs in Madhya Pradesh, Chhattisgarh, Jammu & Kashmir, Jharkhand, Nagaland and Assam (Kumar and Sharma, 2011b; Srivastava *et al.,* 2012; Ao *et al.,* 2016; Sarma *et al.,* 2010). The present article reports it for the first from sal forest of Madhya Pradesh and Chhattisgarh. *Boletus lakhanpalii* is recently reported from Sikkim (Das *et al.,* 2015). Besides sal, other known tree species reported in literature under which this mushroom can grow and form ecto-mycorrhizal associations includes, *Hopea ponga, H. parviflora, Vateria indica, and Diospyros malabarica. B. edulis* is distributed worldwide and also reported from moist deciduous forests of India as well as in the forests of Arunachal Pradesh (Adhikary *et al.,* 1999).

Austroboletus olivaceoglutinosus forming ecto-mycorrhizal association with *Tsuga dumosa* in forest of Sikkim (Das and Dentinger, 2015), it is the only species of the genus reported from India. Genus *Chalciporus* is represented by two species in India, *C. piperatus* which form ectomycorrhiza with sal in forest of West Bengal (Shajahan and Samajpati, 1995) and the another species, *C. rubinellus* is reported growing gregariously in coniferous forests and amongst grasses under tree from Mandi, Himachal Pradesh and Jodhpur, Rajasthan (Lakhanpal and Sagar, 1989; Chaouhan *et al.,* 2010). *Hemileccinum subglabripes* is the only species under this genus recorded from Moflong, Khasi Hills, Meghalaya (Berkeley, 1854a). The species was earlier known as *Pulveroboletus flavipes* and *Boletus flavipes*. One species of *Leccinum, L. ustale* was reported from Khasi mountain, Meghalaya and from Sikkim (Berkeley (1851a, b; Horak, 1980) the species was earlier known as *Boletus ustalis*. *Octaviania longiana* was the only species of boletes reported from Rohtak, Haryana (Ahmad, 1950) while *Phylloporus*

septocystidiatus is reported from tropical forest under *Hopea parviflora* and *Xanthophyllum arnottianum* from Palode, Thiruvanthapuram, Kerala (in Pradeep *et al.*, 2015). Two species of *Pulveroboletus*, namely *P. fragicolor* and *P. shoreae* were reported India. *P. fragicolor* is reported from Nunklow, mountain Khasi, Meghalaya (Berkeley, 1852a; Horak, 1980). *P. shoreae* was reported to form ectomycorrhizal association with sal in forest at Dehradun, Uttarakhand (Singer and Singh, 1971) and the species is growing solitary in sal forest of Gidhani, West Bengal (Shajahan and Samajpati, 1995). Two species of *Retiboletus*, *R. kauffmanii* earlier known as *Boletus kauffmanii* was reported from broadleaf forest under *Lithocarpus* sp., from Maenam, Sikkim (Chakraborty *et al.*, 2017) while second species was *R. ornatipus* which also occurred in Sikkim (Das, 2013b). One species, *Rhodactina himalayensis* was recorded growing in leaf litter and in association with sal trees in a forest of Uttar Pradesh (Pegler and Young, 1989).

Strobilomyces species have wide distribution from north to southern India and nine species have been reported including some recent reports. *S. echinocephalus* occur under *Quercus semecarpifolia* and wild *Punica granatum* forest and *S. mollis* grew on humicolous soil under *Pinus roxburghii* and *P. wallichiana* in Jammu and Kashmir (Kour *et al.*, 2013; Lakhanpal, 1996). *S. floccopus* was reported from broad-leaved forests or coniferous woods from Thiruvananthapuram, Kerala (Vrinda and Pradeep, 2014). *S. kalimpongensis* occur on dead wood in Kolkata, West Bengal (Bose, 1946). *S. montosus* and *S. nigricans* were reported from Khasi Hills, Meghalaya and Darjeeling, West Bengal (Berkeley, 1851a, b; 1852). *S. polypyramis* was found on rotten wood and soil in Darjeeling, West Bengal and Sikkim (Horak, 1980). *S. strobilaceus* was recently reported growing in association with coniferous trees in Nagaland (Ao *et al.*, 2016). *S. velutipes* was reported from Mussoorie, Uttarakhand and Saharanpur, Uttar Pradesh (Lloyd, 1925).

Suillellus luridus, earlier known as *Boletus luridus* was reported growing in leaf litter in forest of Southern Rajasthan (Doshi and Mohammad, 2015). Three species of *Suillus* were reported from Sikkim, Meghalaya, Assam and Madhya Pradesh including *S. furfuraceus* grew under *Pieris* and *Betula*, *S. luteus* on elephant dung and *S. spraguei* from semi evergreen and moist deciduous forest (Berkeley, 1852; Dwivedi *et al.*, 2012; Horak, 1980; Sarma *et al.*, 2010).

Seven species of genus *Tylopilus* were reported from northern and north eastern India these include: *T. areolatus* grew in open pasture at Khasi Hills in Meghalaya (Berkeley, 1852b; Manjula, 1983), *T. chromapes* from grassland of West Bengal (De, 2006b), *T. himalayanus* from *Pinus* sp. and *Cedrus deodara* forests of Sikkim and Uttarakhand; *T. neofelleus* grew under *Castanopsis* sp. and *T. pseudoballoui* under *Quercus* spp., Sikkim (Chakraborty *et al.*, 2018). *T. indecisus* collected from soil surface under oak forest of Kumaon, Uttarakhand (Harsh and Bisht, 1982b) and *T. plumbeoviolaceus* from pasture surrounded by *Cedrus deodara* forest Himachal Pradesh was reported (Sharma and Lakhanpal, 1988).

Xerocomellus chrysenteron was recorded from semi evergreen and moist deciduous forest of Amarkantak, Madhya Pradesh and Nagaland (Dwivedi *et al.*, 2012; Ao *et al.*, 2016). *X. bakshii* was connected with roots of *Pinus roxburghii* in forest at Dehradun, Uttarakhand (Singer and Singh, 1971). *X. delphinus* was recorded from open places of earth from Darjeeling, West Bengal (Berkeley, 1951b; Manjula, 1983). Two

species were recently described from Sikkim; *X. doodhcha* from broadleaf forest of *Lithocarpus pachyphyllus* and *X. longistipitatus* from the soil under *Lithocarpus* sp. (Das, *et al.*, 2016; Chakraborty *et al.*, 2017). *Xerocomus indicus* was also recorded from India (Butler and Bisby, 1960; Singer, 1948).

Total 84 species of Boletaceae were recorded from India. *Boletus* species are the most common followed by *Strobilomyces*, *Tylopilus*, *Boletellus*, *Xerocomus*, *Suillus*, *Chalciporus*, *Retiboletus* and *Pulveroboletus*. The most common bolete mushroom representing state is Himachal Pradesh in India followed by Sikkim, Meghalaya, West Bengal, Madhya Pradesh, Chhttisgarh and Kerala. *Boletellus ananas, B. chrysenteroides, B. dissiliens, B. pseudochrysenteroides, B. corneri* and *Boletus edulis* were recorded for the first time from Sal forest of Central India (Chhattisgarh and Madhya Pradesh).

Acknowledgement

The authors are thankful to Dr. G. Rajeshwar Rao, Director, Tropical Forest Research Institute, Jabalpur for providing the research facilities. The work presented was conducted under project ID No. 224/TFRI/2016/Patho-1(22) funded by Indian Council of Forestry Research & Education (ICFRE), Dehradun.

References

Adhikary RK, Baruah P, Kalita P, Bordoloi D (1999). Edible mushrooms growing in forests of Arunachal Pradesh. *Advances in Horticulture and Forestry*. 6: 119–23.

Ahmad S (1950). Studies on Gasteromycetes V. *Sydowia* 4(1-6): 124-129.

Ao T, Seb J, Ajungla T, Deb CR (2016). Diversity of wild mushrooms in Nagaland, India. *Open Journal of Forestry* 6: 404-419.

Berkeley MJ (1851a). Decades of fungi. Decades XXXII, XXXIII. Sikkim Himalaya fungi, collected by Dr. J.D. Hooker. Hooker's *Journal of Botany and Kew Garden Miscellany* 3: 39-49.

Berkeley MJ (1851b). Decades of fungi. Decades XXXIV. Sikkim Himalaya fungi, collected by Dr. J.D. Hooker. *Hooker's Journal of Botany and Kew Garden Miscellany* 3: 77-84.

Berkeley MJ (1852a). Decades of fungi. Decades XXXVII-XXXVIII. Sikkim and Khassya fungi. *Hooker's Journal of Botany and Kew Garden Miscellany* 4: 97-107.

Berkeley MJ (1852b). Decades of fungi. Decades XXXIXI-XL. Sikkim and Indian fungi. *Hooker's Journal of Botany and Kew Garden Miscellany* 4: 130-142.

Berkeley MJ (1854a). Decades of fungi. Decades XLI- XLIII. Indian fungi. *Hooker's Journal of Botany and Kew Garden Miscellany* 6: 129-143.

Bessette AE, Roody WC, Bessette AR (2007). Mushrooms of the Southeastern United States. *Syracuse, NY: Syracuse University Press*. p. 208.

Bhavanidevi S, Nair MC (1983). Addition to Indian Agaricales. In: Indian Mushroom Science-II (eds TN Kaul, BM Kapoor). *CSIR, New Delhi*, 271– 274.

Boa E. (2004). Wild edible fungi: A global overview of their use and importance to people (Non-Wood Forest Products). *Food & Agriculture Organization of the UN*. pp. 118–19.

Bose SR (1946). Polyporaceae of Bengal XI. *Journal of the Departmental Science Calcutta University*. 2: 53-87

Butler EJ, Bisby GR (1960). The Fungi of India (*revised by R.S. Vasudeva*). Page(s): 1-552

Chakraborty D, Das K, Parihar A, Adhikari S, Mukherjee SK, Karmakar J, Bandyopadhyay TK (2017) Morphology and phylogeny of *Retiboletus kauffmanii* (boletaceae): a new record of wild mushroom from Indian Himalaya. *Indian Journal of Plant Sciences* 6(1):5-11

Chakraborty D, Parihar A, Nikita Mehta, Baghela A and Das K (2017). A new species *Xerocomus* (Boletaceae) from India. *Mycosphere* 8(1): 44–50.

Chakraborty D, Vizzini A, Das K (2018).Two new species and one new record of the genus *Tylopilus* (Boletaceae) from Indian Himalaya with morphological details and phylogenetic estimations, *MycoKeys* 33: 103-124.

Chaouhan R, Kaur S, Gehlot P (2010). Some new records of Mushroom from India. *Journal of Mycology and Plant Pathology* 40(4): 550-554.

Corner EJH (1972). Boletus in Malaysia. Singapore: Botanic Gardens

Corner EJH, Lim Bian Han (1972). *Boletus fallax* sp. nov. Boletus in Malaysia, *Government Printer*, 263 Pp.

Cunningham GH (1942). The Gasteromycetes of Australia and New Zealand. *Printed privately by John McIndoe, 76 Vogel Street, Dunedin, New Zealand.*

Dar GH, Ganai NA, Beig MA, Ahangar FA, Sofi TA (2010). Biodiversity of macro-fungal conifer dominated forests of Kashmir, India. *Journal of Mycology and Plant Pathology* 40(2): 169-171.

Das K (2013a). *Boletus rubripes* Thiers, a new record of wild mushroom from Sikkim (India). *Taiwania* 58(2): 136-139.

Das K (2013b). New distribution record of *Retiboletus ornatipus* (Peck) Manfr. Binder & Bresinsky (Boletaceae) from North West of Sikkim. *Indian Journal of Plant Science* 2(1): 1-5. 11–19.

Das K, Chakraborty D, Baghela A, Singh SK, Dentinger BTM (2015). *Boletus lakhanpalii*, a new species in Boletaceae from Sikkim (India) with uncertain phylogenetic placement. *Sydowia* 67: 11–19.

Das K, Chakraborty D, Baghela A, Singh SK, Dentinger BTM (2016). New species of xerocomoid boletes (Boletaceae) from Himalayan India based on morphological and molecular evidence. *Mycologia*. 108(4):753-764

Das K, Chakraborty D, Vizzini A (2017) Morphological and phylogenetic evidences unveil a novel species of *Gyroporus* (Gyroporaceae, Boletales) from Indian Himalaya. *Nordic Journal of Botany* 35: 669–675.

Das K, Dentinger BT (2015). *Austroboletus olivaceoglutinosus*, a new mushroom species from Sikkim, India with a distinctive green, glutinous pileus. *Kew Bulletin* 70: 15: 1-7.

De AB (2006). Two new additions to Indian Boletaceae. *Journal of Natural History* 2(1): 11-16.

Doshi A and Mohammad I (2015). Litter decomposing fungi in the forest of southern Rajasthan, India. Department of Plant Pathology, *Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan* 1p.

Dwivedi S, Tiwari MK, Chauhan UK and Pandey AK (2012). Biodiversity of mushrooms of Amarkantak Biosphere Reserve Forest of Central India. *International Journal of Pharmaceutical and Life Sciences* 3(1): 1363-1367.

Florence EJM (2004). Biodiversity Documentation for Kerala, Part 2: Microorganisms (Fungi). KFRI Handbook No.17. *Kerala Forest Research Institute, Peechi, Kerala, India*.

Gardner JH, Malajczuk N (1988). Recolonisation of rehabilitated bauxite mine sites in Western Australia by mycorrhizal fungi. *Forest Ecology and Management* 24: 27–42

Harsh NSK, Bisht NS (1982b). Boletaceae of Kumaun Hills, India. *Current Science* 52: 316-317.

Harsh NSK, Bisht NS (1985). Boletaceae of Kumaun Hills, India-II. *Mycologia Helvetica* 1: 443-445.

Kamat NM, Phadte KR, Kalangutkat JR, D 'silva NV (2009). Ecological, phonological, biochemical significance of biomodal fruiting of *Boletus alutaceus* Morgan an ectomycorrhizal partner of *Ficus benghalensis* L. *Nature Proceedings* doi:10.1038/npre.2009.2835.1

Kirk PM, Cannon PF, Minter DW, Stalpers JA (2008). Ainsworth and Bisby's Dictionary of the Fungi 10th Edition. 9th Edition ed. *Wallingford, UK: CABI Publishing*

Kour H, Kumar S, Sharma YP 2013 – Two species of *Strobilomyces* from Jammu and Kashmir, India. *Mycosphere* 4(5), 1006–1013

Kumar S, Sharma YP (2011b). Additions to Boletales from Jammu and Kashmir. *Journal of Mycology and Plant Pathology* 41(4): 579-583.

Lakhanpal TN (1996) Mushrooms of India: Boletaceae, vol. I. APH Publishing Corporation, New Delhi, 170 pp.

Lakhanpal TN, Sagar A (1989). Fleshy fungi of N.W. Himalayas – XIV. Three species of *Boletus* new to India. *Kavaka* 17(1-2): 32-37.

Lloyd CG (1925). Mycological Notes 74. *Mycological Writings* 7(74):1333-1348.

Manjula B (1983). A revised list of the agaricoid and boletoid Basidiomycetes from India and Nepal. Proceedings of the *Indian Academy of Sciences* (Plant Sciences) 92(2): 81-213.

Mayor JR, Fulgenzi TD, Henkel TW, Halling RE (2008). *Boletellus piakaii* sp nov and a new distribution record for *Boletellus ananas* var. *ananas* from *Guyana*. *Mycotaxon*. 105: 387–98

McNabb RFR (1967). "The Strobilomycetaceae of New Zealand". *New Zealand Journal of Botany*. 5 (4): 532–47

Mohanan C (2011). *Macrofungi of Kerala*. Kerala Forest Research Institute, Hand Book # 27, *Kerala, India*, 597pp.

Murrill WA (1909). The Boletaceae of North America - 1. *Mycologia* 1(1): 4-18

Nelson SF. (2010). Bluing components and other pigments of Boletes. Fungi. 3(4): 11–14

Parihar A, Hembrom ME, Das K (2014). *Borofutus dhakanus* (Boletaceae) - an addition to Indian Mycobiota. *NELUMBO* 56: 342-345.

Pegler DN, Young TWK (1981) A natural arrangement of the Boletales, with reference to spore morphology. Transactions of the *British Mycological Society* 76(1): 103-146

Pradeep CK, Vrinda KB, Shibu P, Varghese, Arun Kumar TK (2015). A new species of *Phylloporus* (Agaricales, Boletaceae) from India. *Phytotaxa* 222: 269-274.

Pyasi A, Soni KK, Verma RK (2012). A new record of *Boletus fallx* from India. *Journal of Mycology and Plant Pathology* 42(1): 172-173.

Raja A, Nandakumar K, Gowrisankar K, Sivashanmungam M, Jayabalan N (2011). A check list of terrestrial fungi in and around Cauvery River bed of Velur Namakkal District Tamil Nadu, India. *Journal of Basic and Applied Biology* 5(1&2): 209-213.

Sarma TC, Sarma I, Patiri BN (2010). Wild edible mushrooms used by some ethnic tribes of Western Assam. *The Bioscan* 3: 613-625.

Shajahan M, Samajpati N (1995). Ectomycorrhizal fungi of *Shorea robusta* Gf from West Bengal. *Journal of Mycopathological Research* 33(2): 105-117.

Sharma AD, Jandaik CL, Munjal RL, Seth PK (1978). Some fleshy fungi from Himachal Pradesh -I. *Indian Journal of Mushroom* 4: 1-4.

Sharma R, Lakhanpal TN (1988). Fleshy fungi of N.W. Himalayas – XVII. The genus *Tylopilus* (Boletaceae). *Kavaka* 16(1-2): 36-39.

Singer R (1948). New and interesting species of Basidiomycetes. II. *Papers of the Michigan Academy of Sciences* 32: 103-150.

Singer R, Singh B (1971). Two new ectotroph-forming boletes from India. *Mycopathologia et Mycologia applicata* 43: 25-33.

Smith AH, Thiers HD (1971). The *Boletes* of Michigan. Pp.1-428

Snell WH (1936). Notes on boletes - V. *Mycologia* 28(5): 463–75.

Snell WH (1941). The genera of the Boletaceae. *Mycologia* 33 (4): 415–23

Srivastava AK, Prabhat Fr, Kennedy Soreng SJ (2012). An effort to domesticate wild edible mushrooms growing in the forest of Jharkhand. *International Journal of Recent Trends in Science and Technology* 3(3): 88-92.

Swapna S, Syed Abrar and Krishnappa M. (2008). Diversity of macrofungi in semi-evergreen and moist deciduous forest of Shimoga district-Karnataka, India. *J Mycol Pl Pathol* 38(1): 21-26.

Tiwari CK, Parihar J, Verma RK, Prakasham U (2013) Atlas of wood decaying fungi of central India. *Tropical Forest Research Institute, Jabalpur*, 166p.

Verma RK, Sharma Nidhi, Soni KK, Jamaluddin (2008) Forest Fungi of Central India. *International Book Distributing Co. Lucknow*, 418p.

Vrinda KB, Pradeep CK (2014). Wild edible mushrooms from Kerala forests-a source of food & income. Final project report submitted to department of planning & economic affairs, WGDP, Govt. Of Kerala, Thiruvanthapuram, Kerala, 124p + IX colored plates.

Wu G, Feng B, Xu J, Zhu X-T, Li Y-C, Zeng N-K, Hosen MI, Yang ZL (2014). Molecular phylogenetic analyses redefine seven major clades and reveal 22 new generic clades in the fungal family Boletaceae. *Fungal Diversity*. 69 (1): 93–115.

Wu G, Zhao K, Li Y-C, Zeng N-K, Feng B, Halling R, Yang ZL (2015). Four new genera of the fungal family Boletaceae. *Fungal Diversity*. 81: 1-24.

www.maria-online.com (*Boletus*) page visited on 03/05/2018

www.nzdl.org/gsdlmod? Biodiversity in the Western Ghats: An information kit. 6.7 Edible mushrooms (page visited 0n 04/05/2018)

Yeh K-W, Chen Z-C (1982). "The Boletes of Taiwan 3". Taiwania. 27: 52–63.

Zang, Mu, Tai-Hui Li & Ronald H. Petersen (2001). Five new species of Boletaceae from China. *Mycotaxon* 80: 481-487.

Zhishu B, Zheng G, Taihui L (1993). The Macrofungus Flora of China's Guangdong Province (Chinese University Press). *New York: Columbia University* Press. pp. 461–62.

How to cite this article:

Verma R. K. and Vimal Pandro. 2018. Distribution of Boleteceous Mushrooms in India, Some New Records from Sal Forest of Central India. *Int.J.Curr.Microbiol.App.Sci.* 7(06): 1694-1713. doi: https://doi.org/10.20546/ijcmas.2018.706.201