Preliminary checklist of the *Boletales* in Pakistan

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ABSTRACT —This is the first attempt to make a comprehensive checklist of the boletes that exist in Pakistan. The families are arranged in alphabetical order (*Boletaceae*, *Diplocystidiaceae*, *Gomphidiaceae*, *Paxillaceae*, *Sclerodermataceae*, *Suillaceae*, *Tapinellaceae*), with the genera arranged alphabetically within each family. Each species is given with its distribution. A total of 54 taxa are presented.

KEY WORDS — conifers, deciduous, evergreen, humidity, rainfall

Introduction

Pakistan lies between latitudes 24–37°N and longitudes 61–75°E, comprising four provinces: Punjab, Sindh, Khyber Pakhtunkhwa (KPK), and Balochistan. It stretches over 1600 km from north to south and 885 km from east to west with a total area of 796,095 km^2. It is bordered by India to the east, China to the northeast, Afghanistan to the north, Iran in the southwest and the Arabian Sea in the south. The land ranges from coastal areas in the south to some of the highest peaks in the world of the north giving the country wide agro-ecological variation. It is located in a region where three mountain ranges overlap, the Himalayan, Hindu Kush, and Karakoram. The lesser Himalayan and Hindu Kush ranges extend deep into the country and form huge complex of mountains and plateau. About 60% area of Pakistan is covered by mountainous complex (Pakistan online encyclopedia 2004). In this mountainous complex, the Himalayan forests have been reported as one of the thirty five hotspots for biodiversity in the world (Myers et al. 2000; Zachos & Christian 2011).

In Pakistan, boletes have been found mainly in coniferous forests in moist temperate regions (Ahmad 1980; Ahmad et al. 1997). The reason for non/less occurrence of boletes in provinces other than KPK may be due to less exploration of these sites. The evergreen forests of conifers frequently mixed with oak and deciduous broad-leaved trees fall within this category. Their undergrowth is rarely dense, and consists of both evergreen and deciduous species. These forests occur between 1500 m and 3000 m elevation. Rainfall ranges between 650–750 mm or sometimes to about 1500 mm annually. Average aerial humidity is 57% and the mean daily temperature peak in June is 12.5 °C dropping to a minimum of 3 °C in January (Siddiqui 1997).

These coniferous forests are divided into a lower and an upper zone, in each of which definite species of conifers and/or oaks dominate. In the lower zone, *Cedrus deodara* Loudon, *Pinus wallichiana* A.B. Jacks., *Picea smithiana* Boiss., and *Abies pindrow* Royle are the main conifer species in order of increasing altitude, with *Quercus incana* Roxb. at lower altitudes and *Q. dilatata* Royle above 2130 m. In the upper zone *Abies pindrow* and *Q. semecarpifolia* Sm. are the dominant tree species. There may be pockets of deciduous broad-leaved trees, mainly edaphically conditioned, in both the zones. *Alnus* spp. colonize new gravels and sometimes *Pinus wallichiana*, does the same (Siddiqui 1997). Many mushrooms like boletes form symbiotic association with the roots of these plants for their better growth in these forests (Ahmad et al. 1997).

The first contribution to the fungi of Pakistan was published by Ahmad et al. (1997) in a book named "FUNGI OF PAKISTAN", where some species of boletes were reported from different areas of Pakistan. A comprehensive checklist of all boletes species present or described in Pakistan does not exist. The checklist presented here is the first attempt in that direction, providing a compilation of the available data on the boletes reported from, or known to occur in Pakistan.

MYCOTAXON LINK PAGE 121: 500
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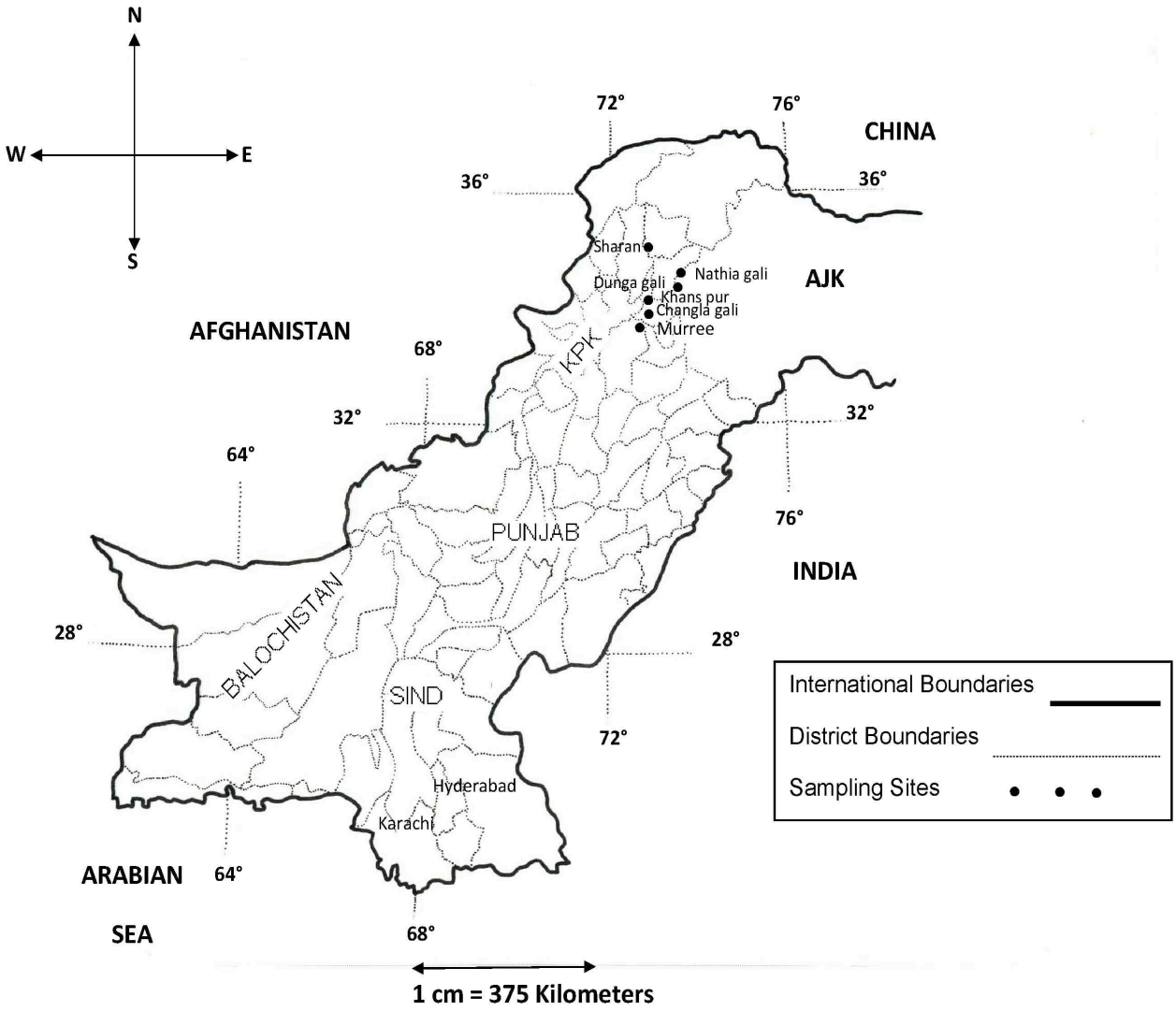

FIG. 1: Map of Pakistan showing sampling sites

The aim of this checklist is to summarize and present the correct names of the species currently known from Pakistan, as well as to list their synonymous names mentioned in the available literature on the fungi of Pakistan. We hope that this paper will be a guide for future studies about the diversity of this group of fungi and a helpful source for a creation of a database about the Pakistan mycota.

Materials & methods

The checklist is based on literature data, after consulting all publications available until nowadays. The taxa are presented in alphabetical order, followed by author names, species habitat and distribution and the literature. For some taxa some information was not found in literature. Index Fungorum was used for taxonomic positions. Nomenclature and classification followed Watling (2008) and Kirk et al. (2008). Species treatment and nomenclature also follow recent monographs and particular articles on *Boletales*. The author's names were abbreviated according to Kirk & Ansell (1992). Because several species have been published under different names, a thesaurus of synonyms is separately listed with references to the correct names used in the main list. A list of excluded records, providing reasons for their exclusion, is also appended.

A list of accepted names of *Boletales* in Pakistan

Boletaceae Chevall.

Aureoboletus Pouzar

Aureoboletus gentilis (Quél.) Pouzar, Česká Mykol. 11: 48. 1957.
Habitat: usually in small groups, on soil in old fire sites.
Distribution: Mushkin forest, District Astore.
Literature: Razaq (2007).

Boletus Fr.

Boletus append iculatus Schaeff., Fung. Bavar. Palat. 4: 86. 1774.
Habitat: near broadleaved trees.
Distribution: Kund, Kaghan Valley.
Literature: Iqbal & Khalid (1996).

Boletus barrowsii Thiers & A.H. Sm., Mycotaxon 3(2): 262. 1976.
Habitat: under *Abies pindrow*.
Distribution: Nathiagali, Khyber Pakhtunkhwa.
Literature: Niazi (2008).

Boletus calopus Pers., Syn. meth. fung. 2: 513. 1801.
Habitat: on ground, under *Populus ciliata* in coniferous forest, *Abies pindrow* and associated vegetation underneath.
Distribution: Nathiagali, Rawalpindi.
Literature: Murakami (1993), Iqbal & Khalid (1996), Niazi (2008).

Boletus edulis Bull., Herb. France 2: tab. 60. 1782.
Habitat: under *Picea, Pinus excelsa, Pinus wallichiana, Abies pindrow* and herbaceous vegetation.
Distribution: Malakundi, Muzaffarabad, Dungagali, Kuzagali, Khairagali, Nathiagali, Khanspur.
Literature: Shibata (1992), Iqbal & Khalid (1996), Niazi (2008).

Boletus erythropus Pers., Syn. meth. Fung.: 513. 1801.
Habitat: under conifers and broadleaved trees, *Abies pindrow*, *Cedrus deodara* and herbs.
Distribution: Nathiagali, Malakundi, Sharan, Dungagali, Khanspur.
Literature: Iqbal & Khalid (1996).

Boletus fraternus Peck, Bull. Torrey Bot. Club 24: 144. 1897.
Habitat: on the ground under *Quercus* in mixed forest.
Distribution: Murree.
Literature: Murakami (1993).

Boletus lupinus Fr., Epicr. Syst. Mycol.: 418. 1838.
Habitat: on soil.
Distribution: Kamalban.
Literature: Sultana et al. (2011).

Boletus luridus Schaeff., Fung. Bavar. Palat. 4: 78. 1774.
Habitat: in mixed woods, under conifers, e. g. *Pinus excelsa*.
Distribution: Khanspur, Kuzagali, Sudhan Gali, Hajinpir.
Literature: Iqbal & Khalid (1996), Gardezi (2003).

Boletus pulverulentus Opat., Vergl. Morph. Biol. Pilze 2: 27. 1836.
Habitat: on ground under *Abies pindrow*.
Distribution: Sharan.
Literature: Iqbal & Khalid (1996).

Boletus queletii Schulzer, Hedwigia 24: 143. 1885.
Habitat: on ground.
Distribution: Murree, Sharan.
Literature: Ahmad (1980).

Boletus reticulatus Schaeff., Fung. Bavar. Palat. 4: 78. 1774.
Habitat: under *Abies pindrow*.
Distribution: KPK, Ayubia, Dichal nala, District Astore.
Literature: Niazi (2008), Razaq (2007).

Boletus subvelutipes Peck., Rept. N. Y. State Mus. 2(8): 142. 1889.
Habitat: on ground in coniferous forests.
Distribution: Shogran.
Literature: Murakami (1993).

Chalciporus Bataille

Chalciporus piperatus (Bull.) Bataille, Bull. Soc. Hist. Nat. Doubs 15: 39. 1908.
Habitat: under *Pinus excelsa*.
Distribution: Sharan, Shogran.
Literature: Iqbal & Khalid (1996), Sultana et al. (2011).

Leccinum Gray

Leccinum crocipodium (Letell.) Watling, Trans. Proc. Bot. Soc. Edinb., 39(2): 200. 1961.
Habitat: usually in small groups, on soil under oaks.
Distribution: Mushkin, District Astore.
Literature: Razaq (2007).

Leccinum aurantiacum (Bull.) Gray, Nat. Arr. Brit. Pl. 1: 646. 1821.
Habitat: solitary or in small groups, on soil under birch.
Ditribution: Dichal nala (Dashkin), District Astore.
Literature: Razaq (2007).

Leccinum pseudoscabrum (Kallenb.) Šutara, Česká Mykol. 43(1): 6. 1989.
Habitat: usually in small groups, on soil in coniferous forests.
Distribution: Dichal nalla, District Astore.
Literature: Razaq (2007).

Leccinum scabrum (Bull. Fr.) Gray, Nat. Arr. Brit. Pl. 1: 646. 1821.
Habitat: solitary or in small groups, under old birches and small trees.
Distribution: Dichal nalla, District Astore.
Literature: Razaq (2007).

Leccinum ustale (Berk.) E. Horak, Sydowia 33: 97. 1980.
Habitat: on the ground.
Distribution: Murree.
Literature: Ahmad (1980).

Phylloporus Quél.

Phylloporus rhodoxanthus (Schwein.) Bres., Fung. Trident. 2(14): 95. 1900.
Habitat: on soil, under broadleaved trees.
Distribution: Sharhan.
Literature: Sultana et al. (2011).

Porphyrellus E.-J. Gilbert

Porphyrellus porphyrosporus (Fr.) E.-J. Gilbert, Les Bolets: 99. 1931.
Habitat: coniferous, deciduous and mixed forests.
Distribution: Hunza, District Gilgit, Shogran.
Literature: Murakami (1993), Razaq (2007).

Strobilomyces Berk.

Strobilomyces strobilaceus (Scop.) Berk., Hooker's J. Bot. Kew Gard. Misc. 3: 78. 1851.
Habitat: on ground under *Betula*.
Distribution: Kashmir, Malakundi.
Literature: Murrill (1924), Shibata (1992).

Tylopilus P. Karst.

Tylopilus felleus (Bull.) P. Karst., Revue Mycol., 3(9): 16. 1881.
Habitat: usually in small groups, on soil under coniferous trees.
Distribution: Lashtang forest (Dashkin), District Astore.
Literature: Razaq (2007).

Xanthoconium Singer

Xanthoconium separans (Peck) Halling & Both, Bull. Buffalo Soc. Nat. Sci. 36: 240. 1998.
Habitat: solitary, scattered or gregarious on ground under woods, associated mainly with conifers.
Distribution: Sudhan gali, Las Dana.
Literature: Gardezi (2003).

Xerocomus Quél.

Xerocomus chrysenteron (Bull.) Quél., Fl. Mycol. France: 418. 1888.
Habitat: under broadleaved trees.
Distribution: Dunga gali, Malakandi.
Literature: Iqbal & Khalid (1996), Sultana et al. (2011).

Xerocomus dryophilus (Thiers) Singer, Agaric. Mod. Tax., 4th Ed.: 763. 1986.
Habitat: solitary or in groups in humus under oaks.
Distribution: Hullar, Samani.
Literature: Gardezi (2003).

Xerocomus ferrugineus (Schaeff.) Alessio, Fungi Europ. 2: 282. 1985.
Habitat: under woods.
Distribution: not known.
Literature: Iqbal & Khalid (1996).

Xerocomus indicus Singer, Pap. Mich. Acad. Sci. 32: 104. 1946.
Habitat: on ground under *Saccharum ravennae*.
Distribution: Ladhar.
Literature: Ahmad (1980).

Xerocomus parasiticus (Bull.) Quél., Fl. Mycol. France: 418. 1888.
Habitat:not known.
Distribution: not known.
Literature: Iqbal & Khalid (1996).

Xerocomus rubellus (Krombh.) Quél., Compt. Rend. Assoc. Franç. Avancem. Sci. 24(2): 620. 1896.
Habitat: under *Pinus wallichiana*.
Distribution: KPK, Hazara, Ayubia.
Literature: Niazi (2008).

Xerocomus subtomentosus (L..) Quél., Fl. Mycol. France: 418. 1888.
Habitat: usually in small groups, on soil under broad-leaved trees and mixed woods.
Distribution: Dashkin, District Gilgit, Kaghan Valley.
Literature: Razaq (2007), Sultana et al. (2011).

Diplocystidiaceae Kreisel

Astraeus Morgan

Astraeus hygrometricus (Pers.) Morgan, J. Cincinnati Soc. Nat. Hist. 12: 20. 1889.
Habitat: on ground in pine forests.
Distribution: Shedandi, Margala hills, Murree, Kaghan Valley.
Literature: Ahmad (1978), Sultan et al. (2001).

Gomphidiaceae Maire ex Jülich

Chroogomphus (Singer) O.K. Mill.

Chroogomphus helveticus (Singer) M.M. Moser, in Gams, Kl. Krypt.-Fl., Edn 3, 2b/2: 51. 1967.
Habitat: on ground.
Distribution: Khanspur.
Literature: Iqbal & Khalid (1996).

Chroogomphus rutilus (Schaeff.) O.K. Mill., Mycologia 56(4): 543. 1964.
Habitat: on ground.
Distribution: Shogran.
Literature: Murakami (1993).

Gomphidius Fr.

Gomphidius glutinosus (Schaeff.) Fr., Epicr. Syst. Mycol.: 319. 1838.
Habitat: not known.
Distribution: Shogran.
Literature: Murakami (1993), Iqbal & Khalid (1996).

Paxillaceae Lotsy

Gyrodon Opat.

Gyrodon lividus (Bull.) Sacc., Syll. Fung. 6: 52. 1888.
Habitat: usually in groups, on soil among grasses.
Distribution: Mushkin, District Astore.
Literature: Razaq (2007).

Sclerodermataceae Corda

Pisolithus Alb. & Schwein.

Pisolithus tinctorius (Mont.) E. Fisch., Nat. Pflanzenfam. 1(1**):338. 1900.
Habitat: near *Eucalyptus* sp.
Distribution: Karachi.
Literature: Razzaq & Shahzad (2004).

Scleroderma Pers.

Scleroderma bovista Fr., Syst. Mycol. 3(1): 48. 1829.
Habitat: on soil among grasses.
Distribution: Dashkin, Rama, Distr. Astore, Murree.
Literature: Ahmad (1956), Razaq (2007).

Scleroderma cepa Pers., Syn. Meth. Fung. 1: 155. 1801.
Habitat: not known.
Distribution: Murree, Rawalpindi.
Literature: Yoshimi & Hagiwara (1992).

Scleroderma citrinum Pers., Syn. Meth. Fung. 1: 153. 1801.
Habitat: on soil among moss, in damp places.
Distribution: Lashtang forest, District Lahore.
Literature: Razaq (2007).

Scleroderma sinnamariense Mont., Annls Sci. Nat., Bot., sér. 2, 14: 331. 1840.
Habitat: not known.
Distribution: Kaghan valley, Mansehra.
Literature: Yoshimi & Hagiwara (1992).

Scleroderma verrucosum (Bull.) Pers., Syn. Meth. Fung. 1: 154. 1801.
Habitat: not known.
Distribution: Changla gali, Nathia gali, Kaghan valley, Swat, Gokina Chowki, Margalla hills, Murree.
Literature: Ahmad (1952, 1956), Sultan et al. (2001), Ahmad (1978).

Suillaceae Besl & Bresinsky

Suillus P. Gray

Suillus bovinus (L.) Roussel, Fl. Calvados, Edn 2: 34. 1806.
Habitat: on soil close to coniferous trees.
Distribution: Mushkin forests, District Astore.
Literature: Razaq (2007).

Suillus collinitus (Fr.) Kuntze, Revis. Gen. Pl. 3(2): 536. 1898.
Habitat: on grassy ground under pines.
Distribution: Shogran, Naran.
Literature: Sultana et al. (2011)

Suillus grevillei (Klotzsch) Singer, Farlowia 2: 259. 1945.
Habitat: on ground.
Distribution: Khanspur.
Literature: Iqbal & Khalid (1996).

Suillus granulatus (L.) Roussel, Fl. Calvados, Edn 2: 34. 1806.
Habitat: on ground in coniferous forest, with pines.
Distribution: Murree, Malakundi, Pirchinasi.
Literature: Ahmad (1969), Shibata (1992), Murakami (1993).

Suillus luteus (L.) Roussel, Fl. Calvados, Edn 2: 34. 1806.
Habitat: on soil, along sides of canals.
Distribution: Dashkin, District Astore.
Literature: Razaq (2007).

Suillus placidus (Bonord.) Singer, Farlowia 2: 42. 1945.
Habitat: on ground in a mixed forest with *Juglans regia*, *Pinus wallichiana* and *Abies pindrow.*
Distribution: Dhirkot (AJK), Sharan, Nathiagali, Dungagali.
Literature: Murakami (1993), Iqbal & Khalid (1996).

Suillus sibiricus (Singer) Singer, Farlowia 2: 260. 1945.
Habitat: on ground under *Abies pindrow* and *Pinus wallichiana*.

Distribution: KPK, Ayubia, Kuzagali, Banjoosa (AJK), Batakundi, Pirchinasi.
Literature: Ahmad (1962), Murakami (1993), Niazi (2008).

Suillus tomentosus (Kauffman) Singer, Mycologia 51(4): 570. 1960.
Habitat: on ground in coniferous forest, under *Abies pindrow* and herbaceous vegetation.
Distribution: Nathiagali, Malakundi, Dungagali.
Literature: Shibata (1992), Iqbal & Khalid (1996), Niazi (2008).

Suillus viscidus (L.) Roussel, Fl. Calvados, Edn 2: 34. 1806.
Habitat: in mycorrhizal relationship with various trees especially pine trees.
Distribution: Mushkin forests, District Astore.
Literature: Razaq (2007).

Tapinellaceae C. Hahn.

Tapinella E.-J. Gilbert

Tapinella atrotomentosa (Batsch) Šutara, Česká Mykol. 46(1–2): 50. 1992.
Habitat: not known.
Distribution: Lahore.
Literature: Ahmad (1962).

Tapinella panuoides (Batsch) E.-J. Gilbert, Les Bolets:68. 1931.
Habitat: not known.
Distribution: Lahore, Patriata, Shogran.
Literature: Ahmad (1962), Murakami (1993).

List of synonyms

Aureoboletus cramesinus = ***Aureoboletus gentilis***
Boletus aestivalis = ***Boletus reticulatus***
Boletus chrysenteron = ***Xerocomus chrysenteron***
Boletus dryophilus = ***Xerocomus dryophilus***
Boletus elegans = ***Suillus grevillei***
Boletus parasiticus = ***Xerocomus parasiticus***
Boletus piperatus = ***Chalciporus piperatus***
Boletus placidus = ***Suillus placidus***
Boletus rubellus = ***Xerocomus rubellus***
Boletus spadiceus = ***Xerocomus ferrugineus***
Boletus subtomentosus = ***Xerocomus subtomentosus***
Boletus ustalis = ***Leccinum ustale***
Krombholziella oxydabilis = ***Leccinum scabrum***
Krombholziella scabra = ***Leccinum scabrum***
Leccinum carpini = ***Leccinum pseudoscabrum***
Paxillus atrotomentosus = ***Tapinella atrotomentosa***
Paxillus panuoides = ***Tapinella panuoides***
Porphyrellus pseudoscaber = ***Porphyrellus porphyrosporus***
Tylopilus porphyrosporus = ***Porphyrellus porphyrosporus***

Excluded names

"*Boletus inaequalaterus*" Gardezi, Sarhad J. Agric. 19: 251. 2003. [nom. inval., no Latin]
Habitat: solitary to widely scattered or in small groups on ground under hardwood and conifers.
Distribution: Sudhan gali, Hajipir, Las Dana.
Literature: Gardezi (2003).
Note. Type materials said to reside in the Herbarium of Department of Plant pathology, University College of Agriculture, Rawalakot, Azad Jammu and Kashmir.

"*Boletus ratonjoghensis*" Gardezi, Sarhad J. Agric. 19: 252. 2003. [nom. inval., no Latin]
Habitat: solitary to gregarious on ground under hardwoods and conifers.
Distribution: Sudhan gali, Hajinpir.
Literature: Gardezi (2003).
Note. Type materials said to reside in the Herbarium of Department of Plant pathology, University College of Agriculture, Rawalakot, Azad Jammu and Kashmir.

"*Strobilomyces reticulatus*" Gardezi, Arch. Phytopathol Plant Protect 40: 373 [nom. inval., no Latin]
Habitat: in humus in hardwood, especially oaks.
Distribution: Hullar, Nomanpura.
Literature: Gardezi & Sabir (2007)
Note. Type material said to reside in the Herbarium of Department of Plant pathology, University College of Agriculture, Rawalakot, Azad Jammu and Kashmir.

"*Suillus bekshus*" Gardezi, Arch. Phytopathol Plant Protect 40: 370. [nom. inval., no Latin]
Habitat: on the ground under pines.
Distribution: Anyaree, Baibekh.
Literature: Gardezi & Sabir (2007).
Note. Type materials said to reside in the Herbarium of Department of Plant pathology, University College of Agriculture, Rawalakot, Azad Jammu and Kashmir.

"*Suillus shardasus*" Gardezi, Arch. Phytopathol Plant Protect 40: 371. 2007. [nom. inval., no Latin]
Habitat: solitary to gregarious on ground under hardwoods and conifers.
Distribution: Anyaree, Mujahidabad.
Literature: Gardezi & Sabir (2007).
Note. Type materials said to reside in the Herbarium of Department of Plant pathology, University College of Agriculture, Rawalakot, Azad Jammu and Kashmir.

"*Tylopilus shaukatii*" Gardezi, Arch. Phytopathol Plant Protect 40: 368. 2007. [nom. inval., no Latin]
Habitat: on the ground in hardwood and coniferous forests.
Distribution: Hullar, Nomanpura.
Literature: Gardezi & Sabir (2007).
Note. Type materials said to reside in the Herbarium of Department of Plant pathology, University College of Agriculture, Rawalakot, Azad Jammu and Kashmir.

Xerocomus versicolor E.-J. Gilbert, Les Bolets: 138. 1931.
Habitat: On the ground.
Distribution: Murree.
Literature: Ahmad (1980).
Note. The application of this name by Pakistani authors is currently unresolved.

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