# Boletales of West Bengal, India. I. Sclerodermataceae: *Pisolithus* and *Scleroderma*

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**Abstract:** Three members of Sclerodermataceae were collected from, various areas of West Bengal. *Pisolithus arhizus* and *Scleroderma cepa* are hereby reported for the first time from West Bengal, whereas *Scleroderma macrorhizon* is a new addition to the Indian Mycoflora.
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**Key words:** India, Macrofungi, new record, *Pisolithus arhizus, Scleroderma cepa, Scleroderma macrorhizon,* West Bengal

## 1. Introduction

Fungi belong to one of the "mega-diverse" group of organisms (Gaston 2000; Hawksworth and Kalin-Arroyo 1995). The general estimate of the fungal species on earth is a conservative 1.5 million but only 5% of it has been explored (Hawksworth and Rossman 1997) and in this horde India is generating highest number of new species *ca* 913 (Hawksworth 2001). West Bengal treasures diverse ecological domains with wide array of altitudinal, climatic and edaphic configurations, creating ample prospects for flourishing diverse assemblage of organisms including macrofungi and this virgin sphere is anticipating scientific pursuit and inventorisation. In this direction, our laboratory is engaged in surveying different areas of West Bengal from the past few years and collected many unreported macrofungi from the state and India itself (Acharya and Acharya 2001; Acharya and Bhutia 2003; Acharya *et al*. 2003, 2004a, 2004b, 2004c, 2005, 2009, 2010a, 2010b; Dutta *et al*. 2011; Pradhan *et al*. 2011; Rai *et al.* 2005). In this communication, we are reporting *Pisolitus arhizus* and *Scleroderma cepa* for the first time from West Bengal, and *Scleroderma macrorhizon* for the first time from India. Earlier, *Pisolithus arhizus* (syn: *Pisolithus tinctorius*) was reported from Muttukaddu, Tamilnadu, India (Natarajan *et al.* 1988). *Scleroderma cepa* was reported from South India (Bottomley 1948; Lloyd 1898-1925, 1904-1919); Dehradun, Uttar Pradesh (Thapa *et al*. 1967); and Amboli, Maharashtra (Patil 1978; Patil *et al*. 1978). However, there is no record of *Scleroderma macrorhizon* from India (Bilgrami 1991).

## 2. Materials and methods

The study materials were collected during the field trips of various forested regions of West Bengal (2008–2011). The morphological and ecological features were noted and colour photographs were taken in the field. After the specimens were brought to the laboratory, microscopic features were determined by using Carl Zeiss AX10 Imager A1 phase contrast microscope. Specimens were identified according to Arora (1986), Ellis and Ellis (1990) and Ramsey (2003). The voucher specimens has been deposited with the accession code AMFH in the Mycological Herbarium of University of Calcutta, Kolkata, West Bengal, India.

## Observation

**_Pisolithus arhizus_ (Scop.) Rauschert, _Z. Pilzk._ 25(2): 50 (1959)**
**MB303705**
Basionym: *Lycoperdon arrizon* Scop., *Delic. Fl. Faun. Insubr.* 1: 40 (1786)
Synonyms:
*Lycoperdodes arrhizon* (Scop.) Kuntze, *Revis. gen. pl.* (Leipzig) 2 (1891)
*Lycoperdodes capsuliferum* (Sowerby) Kuntze, *Revis. gen. pl.* (Leipzig) 2 (1891)
*Lycoperdon arrizon* Scop., *Delic. Fl. Faun. Insubr.* 1: 40 (1786)
*Lycoperdon capsuliferum* Sowerby, *Col. fig. Engl. Fung. Mushr.* (London) 3: pl. 425 a/b (1809)
*Pisocarpium arhizum* (Scop.) Link, *Mag. Gesell. naturf. Freunde*, *Berlin* 8: 44 (1816)
*Pisolithus arenarius* Alb. & Schwein., *Consp. Fung.*: 82 (1805)
*Pisolithus tinctorius* (Pers.) Coker & Couch, *Gasteromycetes E. U.S. Canada* (Chapel Hill): 170 (1928)
*Pisolithus tinctorius* f. *olivaceus* (Fr.) Pilát, *Fl. ČSR*, Gasteromycet.: 582 (1958)
*Pisolithus tinctorius* f. *pisocarpium* (Fr.) Pilát, *Fl. ČSR*, Gasteromycet.: 581 (1958)
*Polypera arenaria* (Alb. & Schwein.) Pers., *Traité sur les Champignons Comestibles* (Paris): 116 (1818)
*Polysaccum olivaceum* Fr., *Syst. mycol.* (Lundae) 3(1): 54 (1829)

*Polysaccum pisocarpium* Fr., *Syst. mycol*. (Lundae) 3(1): 54 (1829)
*Scleroderma arhizum* (Scop.) Pers., *Syn. meth. fung*. (Göttingen) 1: 152 (1801)
*Scleroderma tinctorium* Pers., *Syn. meth. fung*. (Göttingen) 1: 152 (1801)
Position in classification: Fungi, Basidiomycota, Agaricomycotina, Agaricomycetes, Agaricomycetidae, Boletales, Sclerodermataceae, *Pisolithus*, *Pisolithus arhizus*

**Source:**
http://www.indexfungorum.org/Names/NamesRecord.asp?RecordID=276857 (Accessed on 23.08.2011)
http://www.mycobank.com/MycoTaxo.aspx?Link=T&Rec=303705 (Accessed on 23.08.2011)

Basidiocarp columnar, with peridium and stipe (Fig. 1a-c), either solitary or caespitose, peridium yellowish to greyish brown, surface smooth then cracking with maturity starting at the attachment of peridium and stipe. Peridium 2-10.5 cm in diameter, globose to subglobose becoming clavate. Stipe 1.5-7 cm, sterile, surface concolorous with the pileus, smooth then partly squamulose, mostly conic, solid, arising from a fibrous base with whitish to yellowish rhizomorph mostly bound deeply in the soil. Immature gleba firm, composed of angular, globose to ovoid, yellow to yellowish brown and smooth peridioles (spore sacs) of 1-6 × 1-2 mm size, which at maturity forms powdery mass by the breakdown of thin wall. Young peridioles composed of network of septate, branched, hyaline to yellowish brown hyphae 3.94-4.73 µm with swollen, subglobose-obovoid tip 11.43-7.88 × 7.49-5.91 µm. Basidiospores globose (Fig 1d), cinnamon-brown to fulvous in mass, echinulate, (6.90-) 8.24 ± 0.66 (-9.46) µm, spines equal and straight, 1.18-1.65 µm, reticulum absent, spores intermixed with yellowish brown, septate and branched hyphae, 0.98-1.38 µm broad. Basidia and Cystidia not observed.

**Specimen examined:** India, West Bengal: Birbhum, Rampurhat, Lalpahari 24º.11.043'N, 87º.43.972'E; 68 meter amsl. Terrestrial, under *Eucalyptus globulus* and *Acacia auriculiformis* plantation. 19th June 2008, *Prakash Pradhan, AMFH 420*; West Midnapur, Kailibandh, 22º.55.077'N, 87º.21.849'E; 56 meter amsl Terrestrial, under *Eucalyptus globulus* and *Acacia auriculiformis* plantation. 5th July 2009, *Prakash Pradhan and Krishnendu acharya AMFH 23*; West Midnapur, Vairabsol, 22º.49.010'N, 87º.25.843'E; 56 meter amsl. Terrestrial, under *Eucalyptus globulus* plantation. 5th July 2009, *Prakash Pradhan and Krishnendu Acharya AMFH 418*; South 24-parganas, Gosaba, 22º.09.959'N, 88º.48.225'E; 7 meter amsl Terrestrial, under *Eucalyptus globulus* plantation. 2nd August 2010, *Arun Kumar Dutta and Nilanjan Chakraborty AMFH 184*; South 24-Parganas, Sagar, 21º.49.708'N, 88º.07.487'E; 8 meter amsl Terrestrial, under *Eucalyptus globulus* and *Acacia auriculiformis* plantation. 13th August 2010, *Prakash Pradhan and Arun Kumar Dutta AMFH 276*.

**Ecology:** Growing solitary or scattered in the ectomycorrhizal association with the man made forests of Eucalyptus (*Eucalyptus globulus* Labill.) and Akashmoni/ Sonajhuri (*Acacia auriculiformis* A.Cunn. ex Benth.) in the Lateritic region of West Bengal. Absent in the Sal (*Shorea robusta* Gaertn. f.) forest ecosystem but present relatively in few numbers in the ecotone with natural hosts.


Figure 1. *Pisolithus tinctorius* (Scop.) Rauschert (a) Immature Basidiocarp in association with the host, bar=30 mm; (b) L.S.through the Basidiocarp showing peridioles, bar=30 mm; (c) Mature Basidiocarp with the spore mass, bar=30 mm; (d) Basidiospores, bar=30 µm.

**Discussion:** *Pisolithus* is widely distributed globally (Marx 1977) and forms ectomycorrhizal associations with a broad range of woody plants including members of Myrtaceae, Mimosaceae, Pinaceae, Fagaceae, Cistaceae, Dipterocarpaceae and Caesalpiniaceae and has been recorded in a range of environments including road margins, forests and plantation sites, eroded soils and mining sites (Marx 1977; Gardner and Malajczuk 1988). *Pisolithus arhizus* is found to be associated with at least 15 species of *Eucalyptus* (Smith and Pope 1934; Neumann 1959; Chilvers 1973; Mullette 1976; Marx 1977). Isolates of *Pisolithus arhizus* finds use in forestry inoculation programmes, for its role in growth stimulation and plantation survival which are evident in several tree species including eucalypts, pines and acacias (Marx *et al*. 1985; Chilvers *et al*. 1986; Garbaye *et al*. 1988; Cairney and Chambers 1997; Duponnois and Ba 1999) and is particularly effective in improving

plant growth on drier soils with high soil temperature (Momoh and Gbadegesign 1980; Marx *et al*. 1985). Isolates of this fungus also helped alleviate Al sensitivity in *Pinus* (Cumming and Weinstein 1990). Besides that it also reduces the severity of fungal diseases of *Pinus sylvestris* caused by *Fusarium moniliforme*, *Rhizoctonia solani* and *Cylindrocarpon destructans* (Chakravarty and Unestam 1987a, 1987b) and can also be used as bioremediating agent in Cadmium polluted sites (Sell *et al*. 2005). The buoyant spores of *Pisolithus* are efficient in long distance dispersal by means of air flow (Moyersoen *et al*. 2004).

***Scleroderma cepa* Pers., Syn. meth. fung. (Göttingen) 1: 155 (1801)**
**MB191651**

Synonyms:
*Scleroderma cepioides* Gray, Nat. Arr. Brit. Pl. (London) 1: 582 (1821)
*Scleroderma verrucosum* var. *cepa* (Pers.) Maire, Fungi Catalaunici: Contributions à l'étude de la Flore Mycologique de la Catalogne: 112 (1933)
*Scleroderma vulgare* var. *cepa* (Pers.) W.G. Sm., Syn. Brit. Basidiomyc.: 480 (1908)

Position in classfication: Fungi, Basidiomycota, Agaricomycotina, Agaricomycetes, Agaricomycetidae, Boletales, Sclerodermataceae, *Scleroderma*, *Scleroderma cepa*
**Source:**
http://www.speciesfungorum.org/Names/SynSpecies.asp?RecordID=191651 (Accessed on 16.09.2011)
http://www.mycobank.com/MycoTaxo.aspx?Link=T&Rec=191651 (Accessed on 16.08.2011)

Basidiocarp 1.6 cm high, 1.6-2 cm broad (Fig. 2a-b), subglobose to subpyriform, sessile or with rudimentary stipe. Peridium thick and rigid when young and fresh, becoming thinner (1 mm) at maturity and/or drying. Peridium surface cream-yellow and slightly smooth when young, becoming dark lemon yellow with coarsely cracked, minute dark vinaceous buff squamules. Dehiscence of mature fruitbody apical and irregular with multiple ruptures. Gleba at first whitish, soon becoming hazel with violaceous tints, finally greyish brown to olivaceous and pulverulent. Clamp-connexions absent. Basidiospores 10.638-12.214 (-12.608) µm diam. (excluding ornament), (Q=1) globose, brownish, thick-walled, with a surface ornament of isolated spines, 1.773 µm high (Fig. 2c). Peridium composed of 3.94-4.334 µm broad, hyaline, septate hyphae with 0.591 µm thick wall (Fig. 2d).

**Specimen examined:** India, West Bengal: West Midnapur, Ramnagar II, Kasaphaltala, 21º.43.162'N, 87º.31.090'E; 10 meter amsl. Terrestrial, under *Eucalyptus globulus* trees. 24th July 2011, *Krishnendu Acharya, Prakash Pradhan and Arun Kumar Dutta*, *AMFH 340*; Birbhum, Ballavpur Wildlife Sanctuary, 23º.41.356'N, 87º.40.518'E; 60 meter amsl. Terrestrial, under *Eucalyptus globulus* plantation 19th July 2009, *Prakash Pradhan AMFH 422*. South 24-Parganas, Jharkhali, 22º.01.242'N, 88º.41.067'E; 4 meter amsl Terrestrial, under *Eucalyptus globulus* tree 17th September 2011, *Prakash Pradhan and Arun Kumar Dutta AMFH 349*.

**Habitat:** Terrestrial, growing gregariously and scattered under *Eucalyptus globulus* trees.

Figure 2. *Scleroderma cepa* Pers. (a-b) Basidiocarp, bar=1 cm; (c) Basidiospores, bar=20 µm; (d) Peridial hyphae, bar=25 µm.

**Discussion:** Like other members of the genus *Scleroderma*, *S. cepa* has a thick, tough peridium. This character along with a firm, dark-greyish purple gleba that is never soft, or semi-liquid, helps to separate it from members of the "true puffballs," i.e. *Calvatia*, *Lycoperdon*, etc. *Scleroderma cepa* is characterized by a smooth, white peridium that becomes pinkish-brown, to ochraceous-brown, dark brown when handled or in age. The surface is then often cracked or areolate, but not with raised warts as in *Scleroderma citrinum* which can be further distinguished by reticulate rather than spinulose spores.

***Scleroderma macrorhizon* Wallr. (1833)**
**MB180535**

Position in classification: Fungi, Basidiomycota, Agaricomycotina, Agaricomycetes, Agaricomycetidae, Boletales, Sclerodermataceae, *Scleroderma*, *Scleroderma macrorhizon.*

**Source:**
http://www.indexfungorum.org/Names/NamesRecord.asp?RecordID=180535 (Accessed on 16.08.2011)
http://www.mycobank.com/MycoTaxo.aspx?Link=T&Rec=180535 (Accessed on 16.08.2011)

Basidiocarp 11.9 cm high and 4.5 cm broad (Fig. 3a-b), club shaped, with globular peridial head and stipe like base. Peridium surface with hazel coloured squamular cracks upon luteous background, skin hard, 1.9-2 cm thick, composed of broad, hyaline, septate, branched hyphae 4.334-7.88 µm broad, with 0.394 µm thick wall and 0.591 µm thick septa (Fig. 3d). Portion between lower peridium to base of the stipe whitish. Stipe like base mostly solitary, sometimes caespitose, with ridges and furrows and adhering soil particles, attached to the ground with dark vinaceous buff mycelial structure. Stipe composed of 4.334-7.88 µm broad hyaline, septate hyphae with 0.985 µm thick wall. Base with mycelial pad. Basidiospores (8.668-) 9.45-12.214 × 11.032-11.82 µm, globose, brownish, reticulate (Fig. 3c).

**Specimen examined:** India, West Bengal: West Midnapur, Ramnagar II, Kasaphaltala, 21º.43.308'N, 87°.31.089' E; 10 meter amsl. In sand dune, 24th July 2011, *Arun Kumar Dutta and Prakash Pradhan*, *AMFH 339*.

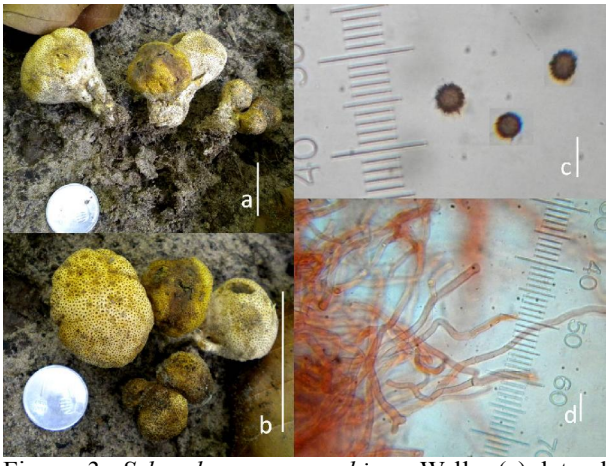

Figure 3. *Scleroderma macrorhizon* Wallr. (a) lateral view of basidiocarp, bar=5 cm; (b) Apical view of Basidiocarp, bar=5 cm; (c) Basidiospores, bar=20 µm; (d) Peridial hyphae, bar=20 µm.

**Discussion:** *Scleroderma macrorhizon* (often misspelled as *S. macrorrhizon*) is a synonym for the combination of *S. septentrionale* and *S. meridionale*., Then *S. macrorhizon* possesses the characters of both the species i.e., rhizomorphic stem of both whitish and yellowish type, spines on spores in the range of 1-4 µm and its distribution in both northern and southern hemisphere.

**Key to the genera and species described:**
Gleba heterogenous, divided into pea-like structures in which spores are produced, peridium thin……....*Pisolithus*

Sporocarp columnar, 5 to 25 cm high and 4 to 15 cm wide, usually with a thick fibrous yellowish rooting base, rarely sessile. Outer peridium wall thin and breaking away to expose pea-like peridioles. Peridioles yellowish to brownish, powdery at maturity. Spore mass stains hands and clothing during handling……...…*Pisolithus arhizus*

Gleba more or less homogenous, not divided into peridioles and with a distinct thick peridium……....*Scleroderma*

Mycelial base longer than sporocarp, spore case golden yellow

Sporocarp 2.5 to 8 cm across and 8 to18 cm tall (including mycelial base), smooth to furfuraceous; stellate to irregular opening from apex. Peridium 1-3 mm thick; pseudostipe often transversely cracked. Gleba purple brown. Habit solitary, occasionally gregarious. Habitat occasional in sandy soils and dunes in vicinity of deciduous and coniferous trees. Spores (11-) 13-18 (-20) µm, including spines that are 0.5-1.5 µm long, reticulate…….....*Scleroderma macrorhizon*

Base sessile; spore case colour other than golden

Sporocarp 2 to 6 cm across; base not extended but rhizoidal. Peridium thin (1-2 mm) smooth, except large irregular scales over apex by cracks of surface, yellow to orange, opening stellately. Gleba violet with yellow threads. Habit mostly gregarious. Habitat common in semi-arid lands and among deciduous and coniferous trees. Spores (7.5) 8.8-12 (13.6) µm including spines which are 1-2 µm long, category spiny……....*Scleroderma cepa*

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