

**Research article**

Calvatia booniana A.H. Sm. (Giant puffball) - New record for India

Girish Gogoi* and Rajesh Kumar

Rain Forest Research Institute, Sotai, Jorhat-785001, Assam, India

*Corresponding Author: gogoirish@rediffmail.com

[Accepted: 30 March 2022]

Abstract: *Calvatia booniana* commonly known as Western giant puffball is described from the Botanical garden of Rain Forest Research Institute, Jorhat, Assam as a new record in India. The identification of the species was supported by the morphological characteristics of the specimens which were compared with the specimen collection from Europe (Spain) and Asia (Iran and Nepal) and Oregon (USA).

Keywords: Agaricaceae - Edible mushroom - Gasteroid mushroom - Northeast India.

[Cite as: Gogoi G & Kumar R (2022) *Calvatia booniana* A.H. Sm. (Giant puffball) - New record for India. *Tropical Plant Research* 9(1): 44–48]

INTRODUCTION

The gasteroid mushroom species, *Calvatia booniana* was described as a new species in 1964 by Dr. Alexander H. Smith (Zeller & Smith 1964), mycologist, the renowned University of Michigan, in honour of William Judson Boone, the first president of the College of Idaho. The distribution of this species was reported from Oregon (USA), Europe (Spain) and Asia (Iran and Nepal) by Gabriel *et al.* (1998). It was also described from the Upper Peninsula of Michigan (USA) by Richter & Morse (2008). Very less number of literatures were found that shows the distribution of the gasteroid mushroom in the globe.

The giant puffball is a saprotrophic, decomposer of cellulosic plant materials (Richter & Bruhn 1989) that produces its basidiocarps (sporophores) on the ground. *Calvatia gigantea* (Batsch ex. Pers.) Lloyd commonly called the Eastern giant puffball occurs throughout Eastern North America (Miller & Miller 2006) and Europe (Breitenbach & Kranzlin 1986). *Calvatia booniana* commonly occurs throughout Western United States and it is bigger in size so, it is commonly called as Western giant puffball. Arora (1986) also described both the *Calvatia* species, namely *C. gigantea* from Eastern North America and Europe, and *C. booniana* from Western USA.

In India, many mycologists worked on wild mushrooms including gasteroid mushrooms and described many species (Butler & Bisby 1931, 1954, Gupta *et al.* 1974, Natarajan 1978, Bilgrami *et al.* 1979, Bilgrami *et al.* 1981, Thind & Thind 1982, Manjula 1983, Verma *et al.* 1987, Bilgrami *et al.* 1991, Sing & Sing 1993, Verma *et al.* 1995, Boruah *et al.* 1997, Deshmukh 2004, Bisht *et al.* 2006, Singh & Chhetry 2010, Gogoi & Parkash 2014, 2015, Gunasekaran *et al.* 2018, Verma *et al.* 2018) but the present species had not previously been reported in India. Our present work on *Calvatia booniana* constitutes a new species for India.

MATERIALS AND METHODS

The specimen/puffball was collected from grassland of the Botanical garden of Rain Forest Research Institute (RFRI), Jorhat (Fig. 1A–F) on 5 April 2018 that grows on the soil attached with rhizomorph. The geo-coordinates of the Botanical garden ranges from 26° 46' 50.64'' – 26° 46' 58.67'' N latitude and 94° 17' 17.09'' – 94° 17' 25.66'' E longitude with 96 m (above mean sea level) altitude.

It was collected just after the first shower of rainfall in April and photographed the puffball in its natural habitat before collection at different development stages starting from the immature to mature stage (Fig. 1A–F). Different development stages were observed minutely and recorded colour, odour, texture, substratum, size of the basidiocarps in the field required for identification. Colour notations in the macroscopically descriptions were taken from Kornerup & Wanscher (1978). One immature specimen was cross-sectioned to observe the internal features of the puffball. The thickness of the exoperidium and endoperidium of the basidiocarp were

measured and mature gleba was also observed. The specimen was brought to the Mycology Laboratory, RFRI, Jorhat for macroscopic and microscopic study and one specimen was preserved for further study. The specimen was allotted an accession number as RFRI-GG-18-11 (Holmgren *et al.* 1990). A small piece of the dried specimen was sent to Department of Physics, Tezpur University Napam, Assam for Scanning Electron Microscopic (SEM) analysis.

Dimensions of basidiospores were measured which included minimum, maximum and arithmetic mean of length (L) and width (W) considering twenty basidiospores (\pm SD) under light microscope. The quotients ($Q=L/W$) of basidiospores for minimum, maximum and mean (Q_m) of length and width (Das & Zhao 2013) also calculated.

RESULTS AND DISCUSSION

Calvatia booniana A.H. Sm. *Lloydia* 27 (3): 148–186, 1964

The basidiocarps (Fig. 1A–F) of *C. booniana* was globose to depressed globose, sharply tapering at the base that was more or less spherical without a distinct basal stem-like area but attached to the ground with a thick cord-like rhizomorph (Fig. 1E) consists of white fungal hyphae. The mature basidiocarps were found 15–20 cm across and 10–15 cm height. At initial stage the basidiocarp was round, white with smooth surface (Fig. 1B). Exoperidium was thick (2–3 mm), white to off-white at first, becoming olive-brown (4E5-8) with age, breaking up into polygonal or irregular-shaped knob and plates (Fig. 1D) (2–3 cm diameter) like the back of a tortoise with a wrinkled surface, frequently sloughing off to reveal the endoperidium. Endoperidium white to grayish yellow (4B4), glabrous, up to 1.5 mm thick. At first gleba was white to off-white and solid, becoming pulverulent, olive-yellow (3C8) to olive-brown (4E5-8) at maturity. The gleba consists of capillitia (specialized hyphae) and basidiospores. Sub-gleba white to off-white and very short confined to the area of the rhizomorph. The ostiole was lacking and the gleba exposed by breaking down the peridia apart in patches. During the observation of different developmental stages of *C. booniana*, it was noticed that it took 12–14 days from the date of sprouting of the basidiocarps to the formation of mature gleba. Morphological comparison of *Calvatia booniana* with three allied species is given in table 1

Scanning Electron Microscopic (SEM) study: Basidiospores appeared glabrous in light microscope (Fig. 2A) but ornamented (Fig. 2B–D) under SEM, very small 3.8–5.2 μ m in length, 3.2–4.2 μ m in width (Mean= $4.2 \pm 0.3 \times 3.7 \pm 0.4 \mu$ m, $Q_m = 1.1$), globose to sub-globose in shape and spore-wall very finely roughened with very short pedicel (1 μ m). Capillitial threads were found 2.5–7.0 μ m in diameter, thick-walled, branched septate and glabrous with abundant small-sized pores. Paracapillitial threads absent.

Ecological and Morphological study: The puffball was found saprobic, terrestrial, growing in a group of five basidiocarps in grassland (rich in organic matter).

Table 1. Morphological comparison of *Calvatia booniana* A.H. Sm. with three allied species.

Morphological features	<i>Calvatia booniana</i>	<i>Calvatia gigantea</i>	<i>Gastropila fragilis</i>	<i>Calvatia lepidophora</i>
Basidiocarp dia. (cm)	15–20	20–30	6–17	9–20
Base	Tapered at the base, Subgleba very short confined to the rhizomorph.	Shaped like a ball, without a subgleba.	Sharply tapered, frequently, deeply plicate, without subgleba.	more or less spherical, subgleba absent or rudimentary.
Exoperidium	Thick (2–3 mm).	Thin (less than 1 mm).	Thin (less than 1 mm).	Thick (2 mm).
Endoperidium	Thin (up to 1.5 mm).	Thin (less than 1 mm).	1–4 mm thick.	Thin.
Mature gleba	olive-brown.	olive-brown.	yellow brown to umber brown.	dull olive-brown.
Capillitium	Usually pitted.	occasionally pitted.	with frequent pits.	not pitted.
Basidiospores	3.8–5.2 \times 3.2–4.2 μ m, globose to subglobose in shape and spore-wall smooth to very finely roughened (punctate) with very short (1 μ m) pedicel.	2.5–4.0 μ m; subglobose to globose, with or without a short pedicel, smooth, thick-walled.	4.0–6.0 \times 3.5–5.0 μ m, subglobose to ovoid, smooth, with pedicel <1.0 μ m.	5.5–6.5 \times 5.5–6.0 μ m, subglobose to broadly ovate, densely verruculose, pedicel inconspicuous.

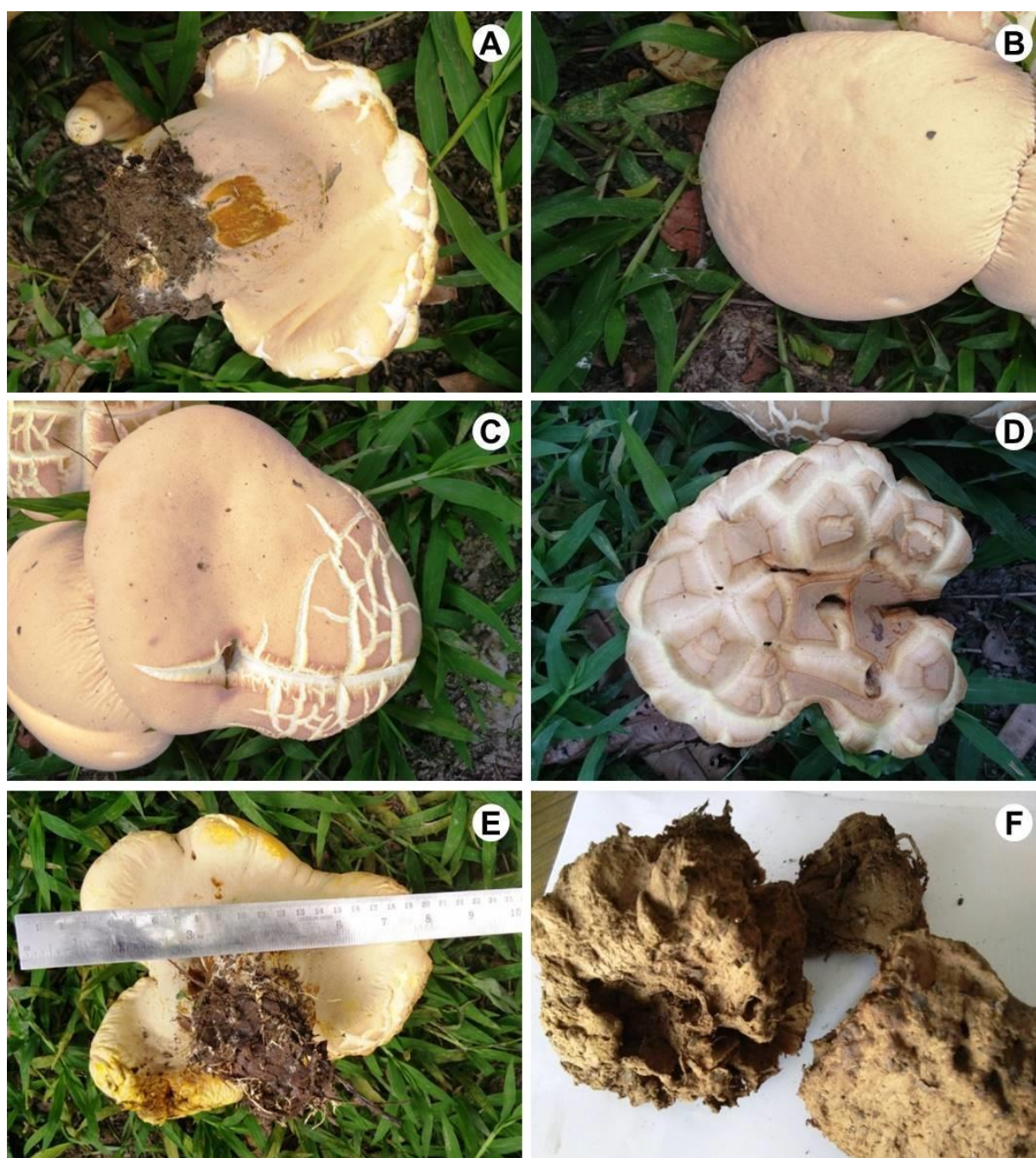


Figure 1. Developmental stages of *Calvatia booniana* A.H. Sm.: **A**, Sprouting and a mature basidiocarp; **B**, An immature basidiocarp; **C**, Basidiocarp starting formation of knobs; **D**, Mature basidiocarp with knobs; **E**, basidiocarp with rhizomorphs; **F**, Maturegleba of basidiocarp.

CONCLUSION

The main characteristic feature of the *Calvatia booniana* is that it's larger in size; peridium thick, breaks into polygonal or irregular-shaped knobs and plates like the back of a tortoise. Sub-gleba very short and confined to the area of the rhizomorph. The ostiole is lacking and the gleba exposes by breaking down the peridia apart in patches. Basidiopores glabrous under light microscope but ornamented in SEM. Thus, the morphological characteristic of the species is similar with the original description of Dr. Alexander H. Smith (Zeller & Smith 1964) also the description given by Gabriel *et al.* (1998) and Richter & Morse (2008).

ACKNOWLEDGMENTS

We would like to express our sincere thanks to the Department of Physics, Tezpur University Napam, Assam for the Scanning Electron Microscope (SEM) analysis of the sample. The specification of the SEM instrument is Make: JEOL, JAPAN; Model: JSM 6390LV; Software: JEOL SOFTWARE (WINDOWBASED).

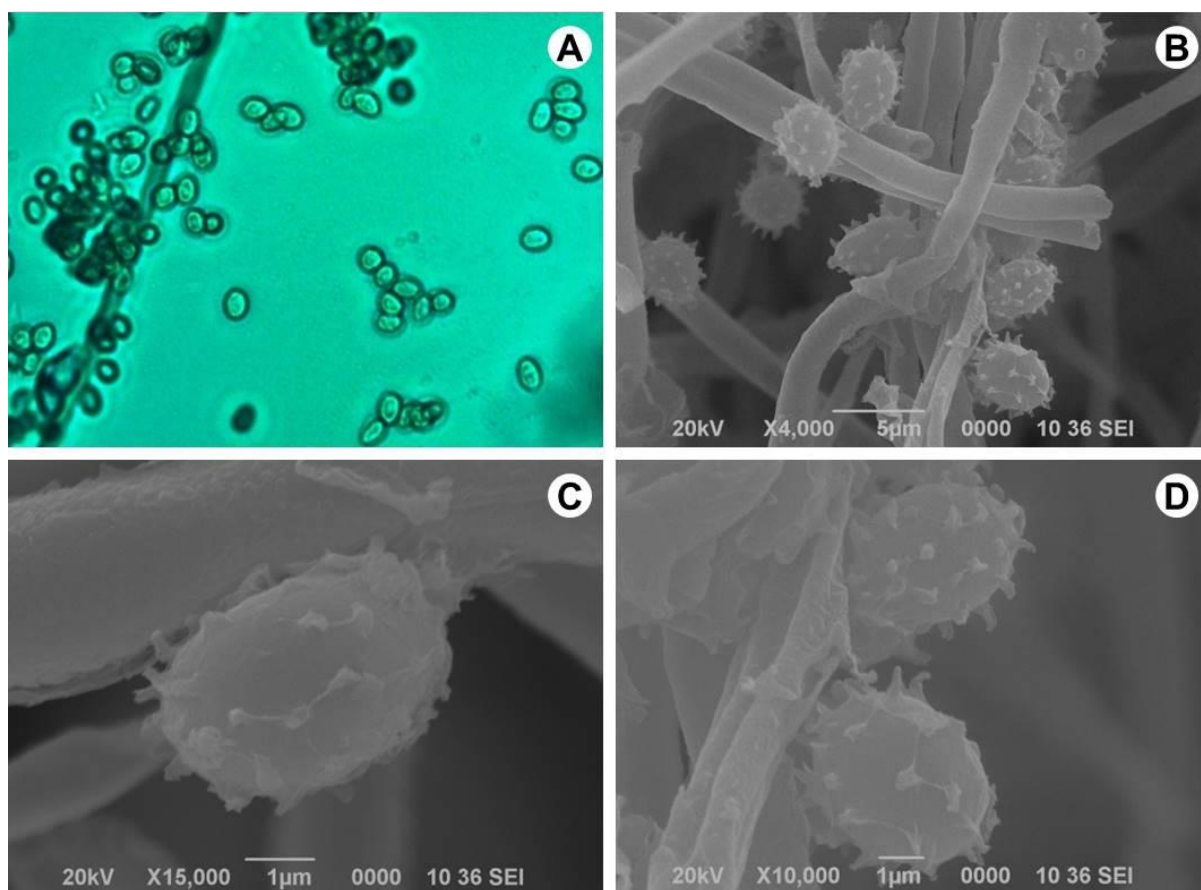


Figure 2. Basidiospores of *Calvatia booniana* A.H. Sm.: **A**, Basidiospores and capillitium under light microscope; **B–D**, Ornamentations of basidiospores and capillitia under SEM.

REFERENCES

- Arora D (1986) *Mushrooms Demystified: A Comprehensive Guide to the Fleshy Fung, 2nd edition*. Ten Speed Press, Berkeley, California, USA, 959 p.
- Bilgrami KS, Jamaluddin & Rizwi MA (1979) *Fungi of India-I: List and References*. Today's and Tomorrow's Printers and Publisher, New Delhi, 467 p.
- Bilgrami KS, Jamaluddin & Rizwi MA (1981) *Fungi of India-II: Host Index and Addenda*. Today's and Tomorrow's Printers and Publisher, New Delhi, 128 p.
- Bilgrami KS, Jamaluddin & Rizwi MA (1991) *Fungi of India: List and References*. Today's and Tomorrow's Printers and Publisher, New Delhi, 798 p.
- Bisht D, Sharma JR, Kreisel H & Das K (2006) A new species and a new record of Lycoperdaceae from India. *Mycotaxon* 95: 91–96.
- Boruah P, Kalita P, Bordoloi D, Gogoi P & Adhikary RK (1997) Some fleshy fungi of ethnobotanic use from North East India. *Advances in Forestry Research in India* 16: 165–171.
- Breitenbach J & Kranzlin F (eds) (1986) *Fungi of Switzerland, Vol 2. Non gilled fungi - Heterobasidiomycetes, Aphyllophorales, Gasteromycetes*. Verlag Mykologia, Lucerne, Switzerland, 412 p.
- Butler EJ & Bisby GR (1931) *The Fungi of India*, Imperial Council of Agriculture Research, Indian Science Monograph-I, 18, 237 p.
- Butler EJ & Bisby GR (1954) *Fungi of India* (Revised by R.S. Vasudeva). Indian Agricultural Research Institute, New Delhi, 552 p.
- Das K & Zhao RL (2013) *Nidula shingbaensis* sp. nov., a new bird's nest fungus from India. *Mycotaxon* 125: 53–58.
- Deshmukh SK (2004) Biodiversity of tropical basidiomycetes as sources of novel secondary metabolites. In: Jain PC (ed) *Microbiology and Biotechnology for Sustainable Development*. CBS Publishers and Distributors, New Delhi, pp. 121–140.
- Gabriel M, Alte A & Kreisel H (1998) *Calvatia booniana* (Lycoperdaceae) new from Europe and Asia. *Feddes Repertorium* 109(1–2): 41–49.

- Gogoi G & Vipin P (2015) Diversity of Gasteroid Fungi (Basidiomycota) in Hollongapar Gibbon Wildlife Sanctuary, Jorhat, Assam, India. *Current Research in Environmental & Applied Mycology* 5(3): 202–212.
- Gogoi G & Parkash V (2014) Some New Records of Stinkhorns (Phallaceae) from Hollongapar Gibbon Wildlife Sanctuary, Assam, India. *Journal of Mycology* 2014: Article ID 490847. [DOI: 10.1155/2014/490847]
- Gunasekaran S, Chinnarajan R & Parasnis A (2018) Notes on Indian species of *Calvatia* and *Langermannia* including *Calvatia natarajanii* sp. nov. *Phytotaxa* 362(2): 160.
- Gupta KK, Agarwal RK, Kumar S & Seth PK (1974) Gasteromycetes of Himachal Pradesh. *Indian Phytopathology* 27: 45–48.
- Holmgren NH, Holmgren PK & Barnett LC (eds) (1990) *Index Herbariorum Part 1: The Herbaria of the world, 8th edition*. Series: Regnum Vegetabile: 120, New York x.693 p.
- Kornerup A & Wanscher JH (1978) *Methuen Handbook of Colour, 3rd edition*. Eyre Methuen Ltd. London, UK, 252 p.
- Manjula B (1983) A revised list of the agaricoid and boletoid basidiomycetes from India and Nepal. *Proceedings of Indian Academy of Sciences (Plant Science)* 92(2): 81–213.
- Miller OK Jr & Miller HH (2006) *North American Mushrooms: A Field Guide to Edible and Inedible Fungi, 1st edition*. Falcon, 592 p.
- Natarajan K (1978) South Indian Agaricales- IV, *Kavaka* 6: 65–70.
- Richter DL & Morse BL (2008) The Western giant puffball (*Calvatia booniana* A. H. Smith) in Northern Michigan. *The Michigan Botanist* 47: 49–56.
- Richter DL & Bruhn JN (1989) *Pinus resinosa* ectomycorrhizae: Seven Host-Fungus combinations synthesized in pure culture. *Symbiosis* 7: 211–228.
- Sing NI & Sing SM (1993) Edible fleshy fungal flora of Manipur. *Bioveel* 4(2): 153–158.
- Singh MN & Chhetry GKN (2010) Biodiversity of macrofungi in Imphal, India-I. *Indian Phytopathological Society* 63(1): 414–421.
- Thind KS & Thind IPS (1982) The Gasteromycetes of Himalayas-II. *Journal of Indian Botanical Society* 61: 19–32.
- Verma RN, Singh GB & Bilgrami KS (1987) *Fleshy fungal flora of N.E.H. India -I*. Manipur and Meghalaya. *Indian Mushroom Science* 2: 414–421.
- Verma RN, Singh GB & Singh MS (1995) Mushroom flora of North-Eastern hills. In: Chadha KL & Sharma SR (eds) *Advances in Horticulture, Vol.3: Mushroom*. Malhotra Publishing House, New Delhi, pp. 329–349.
- Verma RK, Mishra SN, Pandro V & Thakur AK (2018) Diversity and Distribution of *Calvatia* Species in India: A New Record from Central India. *International Journal of Current Microbiology and Applied Sciences* 7(9): 2540–2551.
- Zeller SM & Smith AH (1964) *The genus Calvatia in North America*. Reprinted from *Lloydia* 27(3): 148–186.