



A new generic record of Boletaceae for Indian mycobiota

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Abstract

One genus of tubulose fleshy mushrooms belonging to the family Boletaceae, i.e., *Rugiboletus* is reported for the first time from Sikkim (India) with its macro- and micromorphological descriptions, distribution and supporting illustrations.

Key words – *Abies* – Boletales – macrofungi – *Picea* – *Rugiboletus* – Sikkim – taxonomy

Introduction

Members of Boletaceae are the most dominating fleshy poroid/tubulose ectomycorrhizal mushrooms in subtropical to subalpine Himalaya. Systematic position and circumscription of its members are changing day by day with the aid of molecular phylogenetic analysis. The family is hitherto represented by 64 genera namely, *Afroboletus*, *Alessioporus*, *Aureoboletus*, *Australopilus*, *Austroboletus*, *Buchwaldoboletus*, *Butyriboletus*, *Boletochaete*, *Boletellus*, *Boletus*, *Borangia*, *Bothia*, *Caloboletus*, *Chalciporus*, *Chamonixia*, *Corneroboletus*, *Crocinoletus*, *Exsudoporus*, *Fistulinella*, *Gastroboletus*, *Gastroleccinum*, *Gymnogaster*, *Harrya*, *Heliogaster*, *Hemileccinum*, *Heimioporus*, *Imleria*, *Lanmaoa*, *Leccinellum*, *Leccinum*, *Mucilopilus*, *Mycoamaranthus*, *Neoboletus*, *Notholepiota*, *Octaviana*, *Parvixerocomus*, *Phylloboletellus*, *Phyllobolites*, *Phylloporus*, *Porphyrellus*, *Pseudoaustroboletus*, *Pseudoboletus*, *Pulchroboletus*, *Pulveroboletus*, *Retiboletus*, *Rhodactina*, *Rossbeevera*, *Royoungia*, *Rubinoletus*, *Rubroboletus*, *Rugiboletus*, *Sinoboletus*, *Soliococcus*, *Spongiforma*, *Strobilomyces*, *Suillellus*, *Sutorius*, *Tubosaeta*, *Tylopilus*, *Veloporphyrellus*, *Xanthoconicum*, *Xerocomellus*, *Xerocomus*, *Zangia* (Chiu 1948; Li et al. 2011, 2015; Hosen et al. 2013; Arora & Frank 2014; Gelardi et al. 2014; Vizzini 2014 a, b, c; Wu et al. 2014, 2015; Zhao et al. 2014; Zhu et al. 2014). Amongst them only 11 genera (*Austroboletus*, *Boletellus*, *Boletus*, *Borofutus*, *Leccinum*, *Phylloporus*, *Pulveroboletus*, *Retiboletus*, *Strobilomyces*, *Tylopilus*, *Xerocomus*) are so far reported from India (Singer & Singh 1971, Ray & Samajpati 1979, Lakhanpal 1996, Das 2012, Das et al. 2012, 2014, Parihar et al 2014, Das & Dentinger 2015), one of the 17 megadiverse countries of the world.

During repeated macrofungal surveys to the North and East district of Sikkim (one of the small Himalayan states), we repeatedly came across one interesting member of Boletaceae from Dombang valley, Shingba Rhododendron Wildlife Sanctuary of North district and Memainchu (Maimenchu) of East district in Sikkim. After thorough macro- and micromorphological examination, they appeared as one recently established but hitherto unrecorded genus from India namely, *Rugiboletus* (Wu et al 2015).

The genus *Rugiboletus* G. Wu & Zhu L. Yang, is featured as: wrinkled/convoluted and glutinous surface of pileus, yellow tubes, dot like squamules or scabers on stipe surface and an ixotrichodermis nature of pileipellis. It is represented by two species, *Rugiboletus brunneiporus* G.Wu & Zhu L. Yang and *R. extremiorientalis* (Lj.N. Vassiljeva) G.Wu & Zhu L. Yang, (Wu et al. 2015).

Present communication provides a detailed description along with the morphological illustrations of *Rugiboletus brunneiporus* for the first time from India.

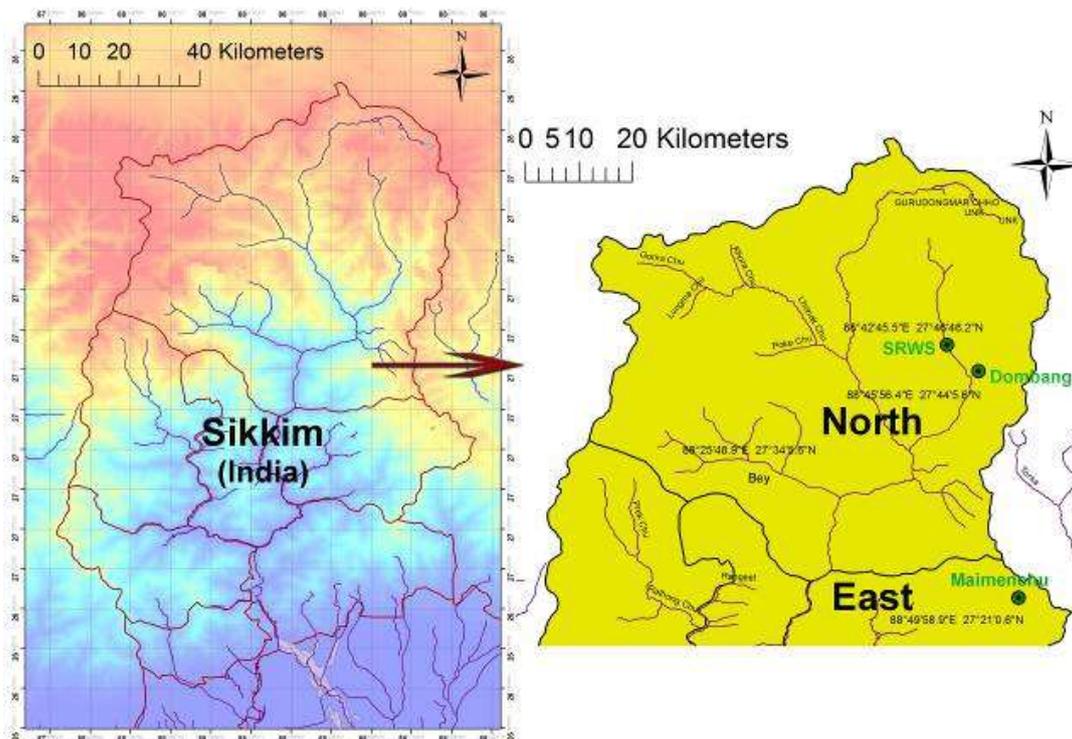


Fig. 1 – A map showing the geographical distribution of *Rugiboletus brunneiporus* (green spots) in Sikkim (India).

Materials & Methods

Routine macrofungal forays were undertaken during the rainy season (July to September) of 2011 to 2014 exploring subtropical to subalpine forests (1400m to 4000m) of North and East district of Sikkim. Macromorphological characterization was made from the fresh basidiomata in the field, including macrochemical (with KOH, FeSO₄ and Guaiacol) color-reactions, prior to drying with a portable dryer. Photographs of fresh basidiomata and microphotographs were taken with a Nikon D300s, Olympus C-5060 and Nikon-DS-Ni1 (dedicated to Nikon Eclipse Ni-U compound microscope) cameras. Color codes and terms mostly follow Methuen Handbook of Color (Kornerup & Wanscher, 1978). Micromorphological characters were recorded with the help of compound microscopes (Olympus CX 41, Nikon Eclipse Ni-U) and a Stereo Zoom Dissecting Microscope (Nikon SMZ 1500) from free hand sections of dry materials mounted in 5% KOH, or stained in a mixture of 5% KOH and phloxin and mounted in 30 % glycerol and Melzer's reagent. Drawings were made with a drawing tube (attached to an Olympus CX41 microscope) at 1000×. Basidium length excludes length of sterigmata. Spore-measurements were recorded in profile view from twenty basidiospores. Spore-size measurements and length/width ratios (Q) are given as: minimum–mean–maximum. Herbarium code follows Holmgren *et al.*, 1990. Scanning Electron Microscope (SEM) images of basidiospores were obtained from dry spores being directly mounted on a double-sided adhesive tape pasted on a metallic specimen-stub and then were scanned with gold coating of 5 nm at different magnifications in high vacuum mode (20 KV) to observe patterns of spore-ornamentation. SEM work was carried out with a ZEISS EVO 40EP model imported from Germany and installed at Wadia Institute of Himalayan Geology, Dehradun, India.

Rugiboletus brunneiporus G. Wu & Zhu L. Yang

Figs 2–4

Pileus 60–195 mm. diam.; spherical to hemispherical when young, becoming convex when mature; surface rough to subvelvety, glutinous, wrinkled when young, become distinctly areolate and cracked when mature, in combination of reddish yellow to greyish yellow, brown (4A6, 4B5, 7D8), or darker; margin with sterile flap of tissue, sometimes interrupted with age. Pore surface yellow with reddish brown mouth (8E6), turning blue after bruising; pore 4–7/mm, simple, round. Tube 15 mm long, adnexed-sinuate, yellow, becoming blue immediately after bruising. Stipe 22.5–140 × 5–32 mm, central, with reddish brown to greyish brown (9F6, 8E7, 9F3) or darker projected squamules or scabers on maize yellow (4A6) background. Context solid in pileus and stipe; in pileus, initially light yellow (3A5), in combination with ochraceous, deep yellow to orange yellow (4A8–4B8) or brown, turning blue when cut, turning brownish orange to brown (7C8–7D8) with KOH, olive brown (4D4) with FeSO₄ and deep yellow (4A8) with guaiacol. Spore print olive brown.



Fig 2 – *Rugiboletus brunneiporus*. A, B, C, D Fresh basidiomata in field. E Pore surface. F Stipe surface. G Context. H Pileus surface of young basidiomata. I Pore. J, K Dark greyish brown squamules or scabers on stipe surface. – Bars: I, K = 1000 μ m; J = 5000 μ m.

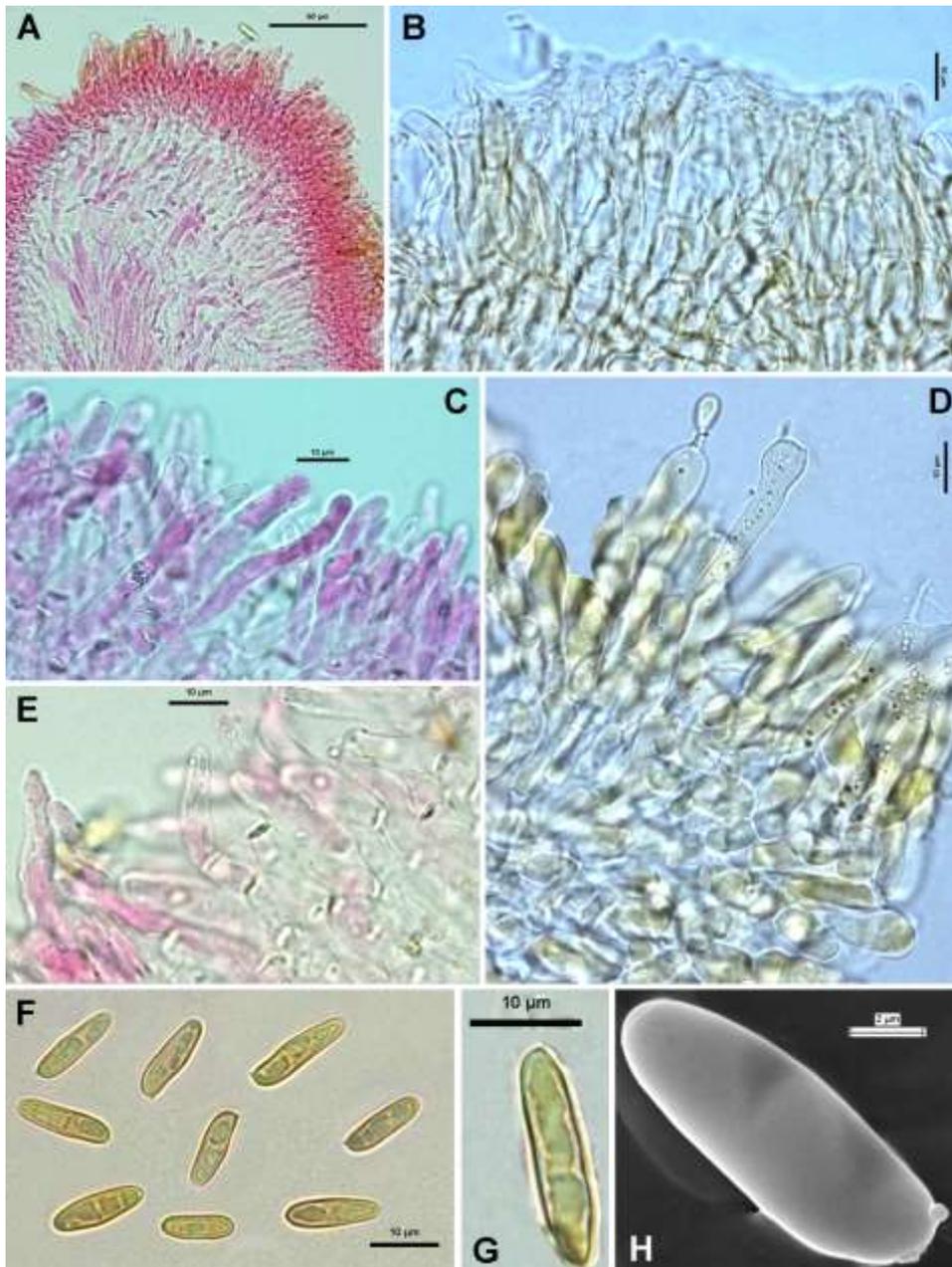


Fig 3 – *Rugiboletus brunneiporus*. A Tube edge. B Pileipellis showing ixotrichodermis nature. C, E Terminal encrusted cells of pileipellis. D Stipitipellis showing caulocystidia and caulobasidia. F, G Basidiospores. H Scanning electron micrograph of a basidiospore. – Bars: A = 50 µm; B, C, D, E, F, G = 10 µm; H = 2 µm.

Basidiospores $10.9\text{--}12.8\text{--}14.2 \times 3.9\text{--}3.9\text{--}4.3$ µm ($n = 20$, $Q = 2.75\text{--}3.21\text{--}3.52$), oblong, inequilateral, smooth under light microscope and under SEM, olive-cious brown. Basidia $30\text{--}38 \times 8.5\text{--}10.5$ µm, 4 spored, sometime 2 spored, clavate to subclavate; sterigmata up to 4 µm high. Pleurocystidia $27\text{--}47 \times 5.5\text{--}8.5$ µm, emergent 8–18 µm, less common, subfusiform to ventricose-rostrate, content dense granular. Tube edge fertile, composed of basidia and cheilocystidia. Cheilocystidia shorter than pleurocystidia, common, slightly emergent, cylindrical to subventricose to ventricose. Hymenophoral trama divergent. Pileipellis 230 µm thick, ixotrichoderm, composed of densely packed, erect, septate, incrustated hyphae (up to 13 µm wide); terminal cell cylindrical to fusoid or ventricose with rounded to slightly appendiculate apices. Stipitipellis 100–130 µm thick, fertile, composed of hyphae, basidia and cystidia; caulocystidia $22\text{--}40 \times 5\text{--}9$ µm, subfusoid to ventricose with rounded to appendiculate apices, content dense; caulobasidia $19\text{--}29 \times 7\text{--}9$ µm, slightly narrower than tube basidia. Clamp connections absent.

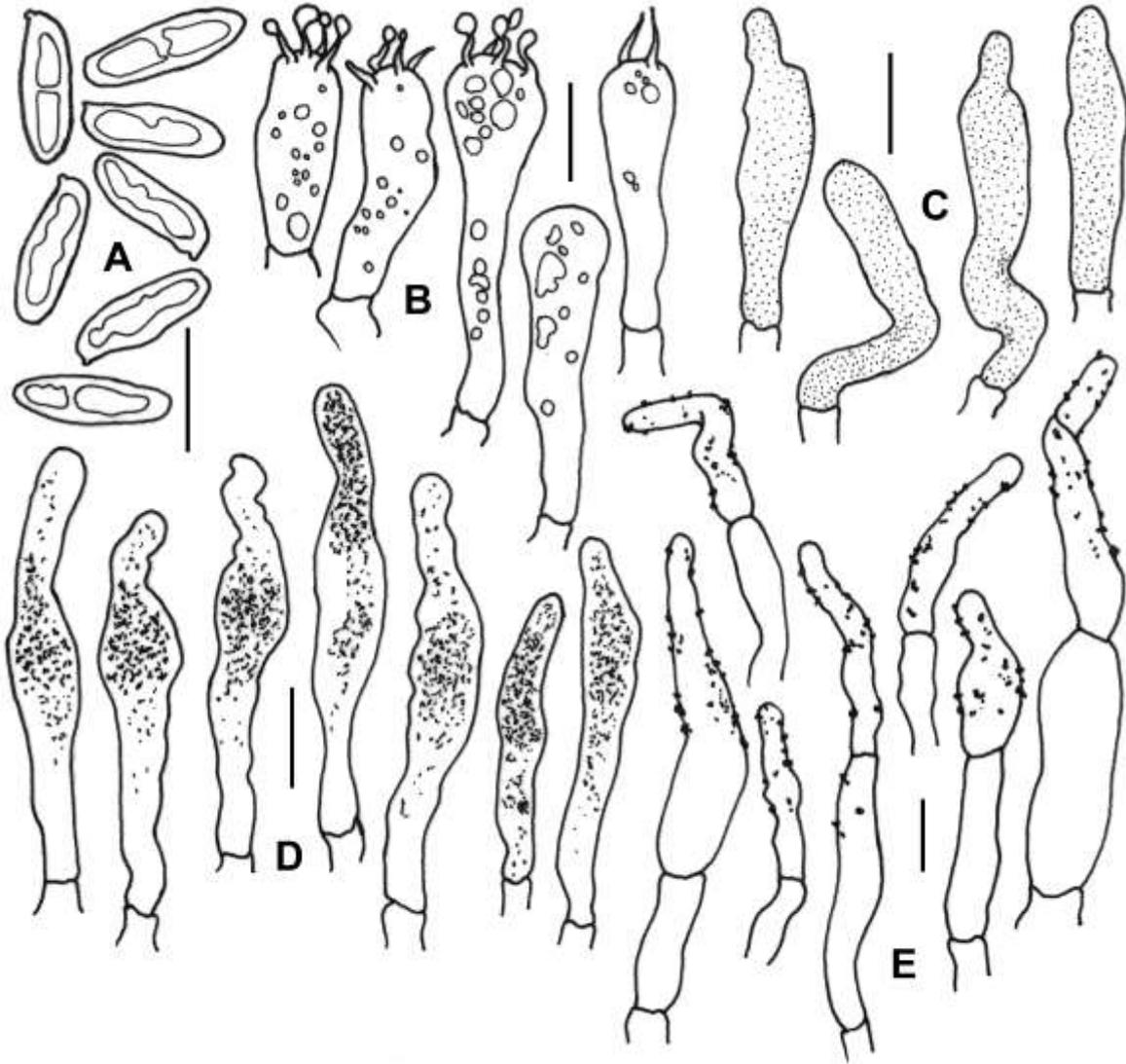


Fig. 4 – *Rugiboletus brunneiporus*. A Basidiospores. B Tube- and caulobasidia. C Caulocystidia. D. Pleurocystidia. E Terminal encrusted cells of pileipellis. – Bars = 10 μ m.

Distribution – Southwestern China, India (Sikkim).

Materials examined – India, Sikkim, North District, Dombang, 2897 m, N27°44'05.6" E88°45'56.4", under *Picea spinulosa* (Griff.) A. Henry, 20 August 2011, K. Das, KD 11-033 (CAL); *ibid.*, North District, Shingba Rhododendron Sanctuary, 3556 m, N27°46'46.2" E88°42'45.5", under *Abies densa* Griff., 26 July 2011, K. Das, KD 13-050 (CAL); India, Sikkim, East District, Memainchu (Maimenchu), 3601 m, N27°21'0.6" E88°49'58.9", *A. densa*, 2 August 2014, D. Chakraborty, DC 14-022 (CAL).

Notes – Morphologically, *Rugiboletus brunneiporus* is very much close to *R. extremiorientalis* and quite confusing in field but the latter one can be separated from the former by its unchanging (on exposure) yellow tube and pore surface (which is reddish brown and bluing immediately in *R. brunneiporus*), smaller (11–13 μ m long) spores. Moreover, *R. extremiorientalis* is always found in association with members of Fagaceae (*Quercus* sp., *Castanopsis* sp., *Lithocarpus* sp.) (Wu et al. 2015).

Indian collections are in conformity of all the morphological characters with its Chinese counterpart except the the basidiospores with are longer (up to 21 μ m) in the samples collected from Memainchu (Fig. 3 g).

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