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Notes on three promising wild edible mushrooms from Western Ghats of Kerala

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Frequent surveys conducted in the Western Ghats region of Kerala resulted in the collection and identification of 85 taxa of wild edible mushrooms. Of these, three promising wild edible species-*Pleurotus giganteus* (Berk.) Karunarathna & K.D. Hyde, *Macrocybe lobayensis* (R.Heim) Pegler & Lodge and *Macrocybe titans* (H.E. Bigelow & Kimbr.) Pegler, Lodge & Nakasone, needs special mention. These giant mushroom species represented by relatively large fruiting bodies are redescribed based on fresh collections from Western Ghats and are added to the known list of Indian edible mushrooms. The taxonomic literature on these tricholomatoid species is briefly discussed.

Key words: Biodiversity, taxonomy, tropical fungi

INTRODUCTION

Wild edible mushrooms are one of the higher valued non-timber forest products. However, they can be found only during the wet seasons. In India, mushroom is a unique non-traditional cash crop grown indoors, both as a seasonal crop and round-the-year under controlled environmental conditions. Climatic conditions in India are favourable for natural occurrence of mushrooms and some of them are regularly collected and used as food by the natives particularly those belonging to the tribal communities. In India, commercially grown species are the button mushrooms (*Agaricus bisporus*), the paddy straw mushrooms (*Volvariella volvacea*), the oyster mushrooms (*Pleurotus sajor-caju*) and the milky mushrooms (*Calocybe indica*). Of these *A. bisporus* is the most widely and economically cultivated variety throughout the world. The concentrated areas of production in India are the temperate regions for the button mushroom, tropical and subtropical regions for the oyster, paddy straw and milky mushrooms. In Kerala, only oyster and milky mushrooms are grown commercially. Moreover, scope for intense diversification by cultivation of other edible mushrooms are additional opportunities.

As part of our continuing research on agaric flora of Kerala, we have documented 85 taxa of wild edible mushrooms from Kerala forests. Of these, three were found to be highly suitable for cultivation in the tropical Kerala climate. They are *Pleurotus giganteus, Macrocybe lobayensis* and *Macrocybe titans*. All the three mushrooms are

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grouped among world's largest mushrooms. A single fruit body of *L. giganteus* collected from TBGRI campus, weighed up to 2.6 kg where as that of *M. lobayensis* was up to 1.5 kg. Edibility of all the three species were tested and confirmed by the mushroom research team at JNTBGRI. Among these, *Pleurotus giganteus* was rated as the best as it has an excellent flavour and taste. *Macrocybe lobayensis* and *Macrocybe titans* tastes similar to the milky mushroom. Both *M. lobayensis* and *M. titans* have a strong cyanic odour and so parboiling and thorough cooking is recommended.

MATERIALS AND METHODS

Gross morphological descriptions are based exclusively on fresh materials collected from Kerala State, India. Colour terminology used is that of Methuen (Kornerup & Wanscher, 1978). Microscopic characters were studied from free-hand sections mounted in 10% KOH stained with 1% Congo red and examined under a Leica DME 1000 compound microscope. Voucher materials were prepared by drying in a hot-air oven at 40-50° C. Specimens examined are deposited at the Mushroom Herbarium of JNTBGRI [TBGT (M)].

RESULTS AND DISCUSSION

Pleurotus giganteus (Berk.) Karunarathna & K.D. Hyde, Mycotaxon 118: 57-71 (2011)

≡ *Lentinus giganteus* Berk., Lond. Journ. Bot. 6: 493 (1847)

≡ *Pocillaria gigantea* (Berk.) Kuntze, Revis. Gen. Pl. 2:866 (1891)

≡ *Velolentinus giganteus* (Berk.) Overeem, Bull. Jard. Bot. Buitenz, 3 ser., 9: 12 (1927).

≡ *Panus giganteus* (Berk.) Corner, Beih. Nova Hedwigia 69:69 (1981)

Pileus 5-60 cm diam., convex becoming applanate, finally infundibuliform; surface initially uniformly dark fuscous brown then fading with age to 'brownish orange' (5C3), remaining darker at the centre, moist to dry, disrupted in to small, fuscous, appressed, concentrically arranged 'hair brown' (5E4) squamules, denser at the centre, scattered elsewhere; margin thin, slightly sulcate-striate, finely serrate, strongly involute then straight, upturned in older specimens. Lamellae decurrent, creamy white, up to 1.5 cm wide, often interveined, crowded with lamellulae of different lengths; edge concolorous with the sides, entire. Stipe 5–61×0.7–6 cm, central, solid, thick and fleshy, tapering in to a radicant base below ground; surface concolorous with the pileus, with 'hair brown' (5E4) squamulose towards the apex, soon becoming glabrous. Veil forming floccose remnants on the margin in young specimens, but never forming an annulus on the stipe. Context white, thick and fleshy, consisting of a dimitic hyphal system with skeletal hyphae. Generative hyphae 3–11.5 µm diam., inflating with a thick or slightly thickened wall, with clamp-connections. Skeletal hyphae 2–5.5 µm in diam., thick-walled with a narrow lumen, tending to taper apically. Spores 6–8.5×4.5–5.5 µm, broadly ovoid to oblong ellipsoid, white in mass, smooth, thin-walled, hyaline, with one large oil drop or multiguttualate, inamyloid. Basidia 27–32.5×6–7.5 µm, clavate, bearing four sterigmata. Lamella-edge sterile; cheilocystidia 15–25.5×6–7.5 µm, lecythiform with a ventricose base and small capitellum subtended by a narrow neck, hyaline, thin-walled. Pleurocystidia scattered, similar to the cheilocystidia. Hymenophoral trama pseudoparenchymatous. Stipitipellis with tufts of caulocystidia; caulocystidia 22.5–39×4.5–7.5 µm, more or less similar to the cheilocystidia.

Solitary or scattered on ground, growing from buried rotten wood.

Specimens examined

India, Kerala State, Thiruvananthapuram Dist.: TBGRI campus: 11 June 1993, TBGT(M)256; Kallar: 23 June1995, TBGT(M) 2198; TBGRI campus: 30 June1995, TBGT(M)2365; 13 Nov.1995, TBGT(M)2690; 4 Sept. 1996, TBGT(M)2800; Kallar: 18 April 1996, TBGT(M)2916; TBGRI campus: 23 April 1996, TBGT(M)2953; 28 Oct. 1997, TBGT(M) 4222; Varkala: 26 June 2004, TBGT(M) 7356; TBGRI campus: 25 April 2005, TBGT(M)8728; Thannimoodu: 7 Aug. 2005, TBGT(M)9077; TBGRI campus: 9 April 2007, TBGT(M)10513; 4 Aug. 2008, TBGT(M)10848; 13 June 2008, TBGT(M)11108; 5 Nov.2009, TBGT(M)12446; 27 July 2009, TBGT(M)12801; 8 June 2009, TBGT(M)12827; 17 Sept. 2009, TBGT(M)12926; 4 June 2010, TBGT(M)13153; 19 April 2012, TBGT(M)13977; Jawahar colony: 26 June 2012, TBGT(M)14122; TBGRI campus: 7 Sept. 2012, TBGT(M)14179; Kollam Dist. Amayambalm Pacha: 9 April 2012,

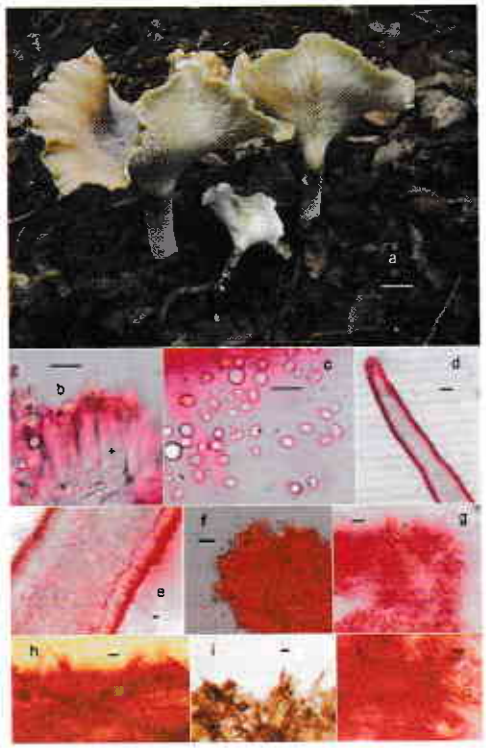

Fig. 1 : *Lentinus giganteus*: a. Habit *in situ*; b. Basidia; c. Spores; d-e. Hymenophoral trama; f-g. Cheilocystidia; h. Pileipellis; i-j. Caulocystidia. Scale bar- a = 10 mm, b-j = 10 µm.

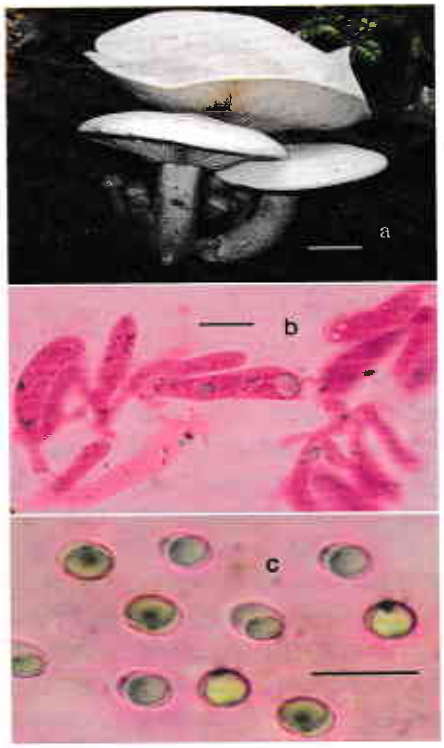

Fig. 2 : *Macrocybe lobayensis*: a. Habit *in situ*; b. Basidia; c. Spores. Scale bar- a = 10 mm, b-c = 10 µm.

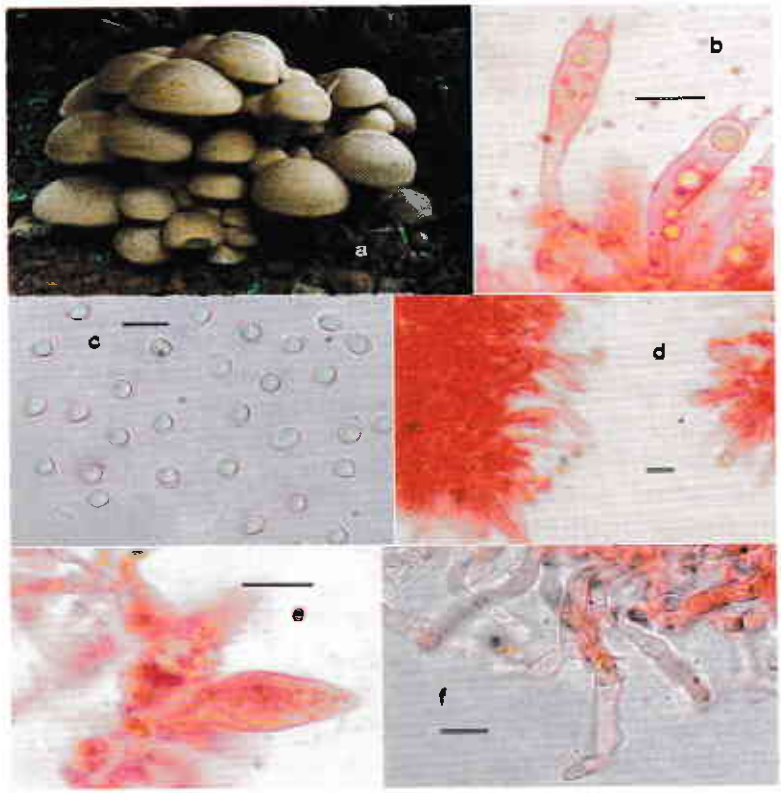

Fig. 3 : *Macrocybe titans*: a. Habit *in situ*; b. Basidia; c. Spores; d. Cheilocystidia; e. Pleurocystidia; f. Caulocystidia. Scale bar- a = 10 mm, b-f = 10 µm.

TBGT(M)14236; Thiruvananthapuram Dist.: Ex.colony: 15 Nov. 2012, TBGT(M)14433; Nedumangad: 15 Nov. 2013, TBGT(M)14877; TBGRI campus: 19 June 2014, TBGT(M)15081; 26 June 2014, TBGT(M)15117; 2008 July 2014, TBGT(M)15170.

Pleurotus giganteus, originally described from Sri Lanka (Berkeley, 1847) as *Lentinus giganteus*, is one of the larger agaricoid fungi of South-east Asia and Australia, recognized by the dark pileal surface and obconical radicant stipe. *Lentinus giganteus* was formerly placed in the genus *Panus* (Corner, 1981). Corner proposed it as the type and only species of a new subgenus, *Gigantopanus* Corner, of the genus *Panus*. Later, Pegler (1983) transferred subgenus *Gigantopanus* as a section to *Lentinus* as *Lentinus* Sect. *Gigantopanus* (Corner) Pegler. Members of the genus *Lentinus* are normally wood decaying basidiomycetes, characterized by decurrent lamellae, dimitic tissues and hyaline, ellipsoid to cylindric basidiospores. *Lentinus giganteus* possess many structures which are not typical of the genus *Lentinus* and the taxonomic position remains problematical (Pegler, 1986). In *L. giganteus*, even though the largest spores become oblong ellipsoid, mature spores are not cylindrical but somewhat broadly ellipsoid. The oil guttule found within the spore is atypical for *Lentinus*. The generative hyphae are broad with a tendency to inflate, whilst the skeletal hyphae show some degree of tapering. The lamella-edge is distinct with a broad, well defined, sterile layer of lecithiform cheilocystidia similar to those found in some *Pleurotus* species. The lamellae are broad and well spaced and the development is metavelangiocarpic (Pegler, 1986).

Molecular studies conducted by Karunarathna *et al.* (2011), indicated that *Lentinus giganteus* is better placed in *Pleurotus* than *Lentinus*. Morphological characters like soft texture of the basidiome with a short life span; broader well spaced lamellae and metavelangiocarpic development support this statement. Karunarathna and co-workers have maintained *Pleurotus giganteus* (Berk.) Karyunarathna & K.D. Hyde, as a single variable species, represented by relatively large fruiting bodies, more related to *Pleurotus* than to *Panus* and *Lentinus*.
Lentinus giganteus referred to as "uru paha" in Sri Lanka, is one of the largest edible mushrooms and has been treated as a special food since ancient times as mentioned in Buddhist literature (Udugama & Wickramaratna, 1991). Saprobic on buried well-rotten wood in forests, *P.giganteus* is widely consumed in Sri Lanka (Karunarathna *et al.*, 2011).

P.giganteus is a culinary mushroom that is gaining popularity for its organoleptic properties and commercial prospects (Phan *et al.*, 2012). In fact, consumption of this used-to-be wild mushroom has long been a tradition in the indigenous villages in Peninsular Malaysia (Lee *et al.*, 2009).The fruiting bodies of *P. giganteus* is found to have high carbohydrate, dietary fiber, potassium, phenolic compounds and triterpenoids. It has been recently proved that *P. giganteus* contain bioactive compounds that mimic nerve growth factor and are responsible for neurite stimulation (Phan *et al.* 2012). Hence this mushroom may be developed as a nutraceutical for the mitigation of neurogenerative diseases like Alzheimer's disease and Parkinson's disease. The high potassium level in the fruiting bodies and presence of bioactive compounds (mainly triterpenoids) could be responsible for the neuro-activity (Phan *et al.*, 2012).

In this context domestication of this mushroom is very important.

Macrocybe lobayensis (R.Heim) Pegler & Lodge, Mycologia 90(3): 494-504. 1998a" *Tricholoma lobayense* Heim in Rev. Mycol. 34:346, 1970

Pileus 8-30 cm diam., fleshy, convex to applanate; surface chalky white, smooth and glabrous, dry; margin lobate, inrolled, nonstriate. Lamellae adnexo-adnate to sinuate, creamy white with a pinkish tinge, up to 2 cm thick, moderately crowded with lamellulae of varying lengths; edge concolorous with the sides, entire. Stipe 7–14×2–8 cm, central, rarely excentric, cylindric to obclavate, often with a swollen base, solid, finally fistulose; surface dull white, discolouring brownish grey when handled, smooth or sometimes disrupting in to small reflex squamules in dry weather with white cottony mycelia at the base. Odour strongly cyanic. Context thick, fleshy, white, up to 2 cm thick, unchanging, composed of thin-walled, hyaline, 3–16 µm wide hyphae, with clamp-connections.

Spores 5.5–6.6 (7.2)×4.4–5 µm, ovoid to ellipsoid, thin-walled, hyaline, containing a single, large, refractive guttule. Basidia 25.3–34.1×6.6–7.7 µm, usually 4-spored, occasionally also 1- or 2- spored. Lamella-edge fertile, cystidia none. Hymenophoral trama regular, hyaline with thin-walled, 2.2–8.8 µm

wide hyphae. Subhymenium interwoven. Pileipellis an epicutis of interwoven, thin-walled, hyaline, 1.5–5 µm wide hyphae, with oleaginous contents and clamp connections.

Solitary, scattered or in tufts on ground at the base of coconut trees, richly manured flower beds in the garden or among grass.

Specimens examined

India, Kerala State, Thiruvananthapuram Dist.: TBGRI campus: 8 June 1994, TBGT(M) 873; Njakkad, 16 Jan. 1997, TBGT(M) 3737; Poojappura: 26 June 2000, TBGT(M)5094; Pulimkudy, 26 Aug. 2003, TBGT(M) 6611; Kollam Dist.: Sankili: 5 Oct. 2005, TBGT(M) 8837; Kollayil: 30 Nov. 2005, TBGT(M) 9600; Thiruvananthapuram Dist.: 21 June 2006, TBGT(M)9758; TBGRI campus: 5 Feb. 2007, TBGT(M)10245; 6 March 2008, TBGT(M)6611; 4 July 2008, TBGT(M)10835; 7 Oct. 2008, TBGT(M)5379; Nedumangad: 25 June 2012, TBGT(M)14120.

The species was originally described from the Central African Republic as *Tricholoma lobayense* (Heim, 1969), and was redescribed as *Macrocybe lobayensis* from Ghana (Pegler *et al.*, 1998). Based on morphological and ecological characters plus ribosomal DNA sequences support, seven related tropical species of the genus *Tricholoma* were removed and a new genus *Macrocybe* was erected by Pegler and co-workers (1998) in the family Tricholomataceae to accommodate those apparently non-mycorrhizal species that have abundant clamp-connections on all hyphae but lack siderophilous granulation in the basidia. *M.lobayensis* occurs either solitary or in groups. The species may be recognized in the field by the pure white, large, basidiomes having a strong cyanic smell. Another closely related species *Macrocybe gigantea* (Massee) Pegler & Lodge, with large, fleshy, white fruiting bodies is recorded from Kerala (Manimohan *et al.*, 2007). *M.gigantea* can be separated by the straw yellow coloured lamellae, cylindrical stipe and lack of strong cyanic smell.

M.lobayensis is harvested and consumed by several indigenous tribes of Kerala. A single fruit body weighing up to 1.5 kilograms has been picked in a forest near Palode. Parboiling and thorough cooking is recommended.

Macrocybe titans (H.E. Bigelow & Kimbr.) Pegler, Lodge & Nakasone in Mycologia 90(3): 494-504, 1998.

≡ *Tricholoma titans* H.E,Bigelow & Kimbr. in Mycotaxon 11:426. 1980.
≡ *Tricholoma cystidiosum* Cifuentes & Guzman in Bol. Soc. Mex, Micol. 16: 38. 1981,
≡ *T.'cystidiosa'*, non *T.cystidiosum* A.H. Smith 1941.
≡ *Tricholoma cifuentesii* Courtec. in Docum. Mycol. 16 (61): 49. 1985.

Basidiomata thick and fleshy. Pileus 5–13 cm diam., hemispherical at first, convex and then plano-convex, often with a broad obtuse umbo, finally expanded to depressed, with undulating margin; surface 'greyish orange' (5B3), 'clay' (5D5), 'brown' (5D5), 'leather brown' (6E5) or 'tan' (6E6) at the centre, paler or even more whitish elsewhere towards the margin, moist when wet soon dry, nonhygrophanous; margin incurved and inrolled at first, undulate or lobate later.Lamellae sinuate, whitish, or with pale brown tints, up to 8 mm wide, crowded, with lamellulae of different lengths; lamellae often bifurcated towards the margin; edge concolorous to the sides, entire. Stipe 10–26×1.5–4 cm, central, cylindric to obclavate, solid, curved, tapering up, often grooved, swollen at the base; surface whitish or with brownish tints, fibrillose, with appressed to recurved squamules at the extreme apex, dry. Context tough, thick, white, up to 2 cm thick, soft, composed of thin-walled, hyaline hyphae, 3–7.5 µm diameter, with clamp-connections. Spores 5.5–6×3.5–4.5 µm, ovoid to short ellipsoid, smooth, inamyloid. Basidia 27–33×6–7.5 µm, clavate bearing four sterigmata, with basal clamp-connections. Gill edge fertile. Pseudocystidia scattered, 30–37.5×7.5–11.5 µm, fusoid with narrow, tapering apex, broadly fusoid to rostrate, protruding above basidia. Hymenophoral trama regular, of parallel, thin-walled, hyaline hyphae, 3–12 µm wide, with small inconspicuous clamp-connections. Sub-hymenium interwoven. Pileipellis an epicutis of interwoven hyphae, with clamp-connections. Caulocystidia arising as recurved end cells at the stipe apex, cylindric or sphaeropedunculate, smooth, thin-walled, hyaline.

In caespitose clusters on sandy soil attached to buried rotten wood.

Macrocybe titans was originally described (as *Tricholoma titans*) from grassy areas in northern Florida (Bigelow & Kimbrough, 1980) and was de-

scribed again ads *T. cystidiosum* from Mexico (Cifuentes & Guzman, 1981). Later, Courtecuisse (1985) renamed *T.cystidiosum* as *T.cifuentesii* because the former was a homonym, and Singer (1990) synonymized it with *T.titans*. Pegler and co-workers created the new genus *Macrocybe* Pegler & Lodge, to accommodate those genera with large, pale, tricholomatoid basidiomata that have abundant clamp-connections and are apparently non-ectomycorrhizal. *M.titans* was treated as the type species of the genus *Macrocybe* (Pegler *et al.*, 1998). Its defining features include the presence of bent-back scales on the stem, and, under the microscope, the presence of refractive pseudocystidia on the faces of the gills. (However, the scales are not always prominent, and the pseudocystidia can be difficult to observe). The species may be recognized in the field by its tufted habit and robust nature.

Specimens examined

India, Kerala State, Kollam Dist.: Chithara, 14 May 2013, TBGT(M) 14475; 15 May 2013, TBGT(M) 14484; Thiruvananthapuram Dist.: TBGRI campus: 13 Sept. 2013, TBGT(M) 14815; Thiruvananthapuram Dist.: Nedumangad: 10 Nov. 2013, TBGT(M) 14831

CONCLUSION

The use of fungi by people results from knowledge and experience accumulated over time. Ultimately this provides the basis for commercial exploitation/ exploration of the resource. The market for functional foods remains bullish. In this modern society, functional food demands for products that help build and maintain good health. Functional foods contain special ingredients with the unique beneficial effects from cardiovascular to mental health function and immunity. The list of contemporary health issue of public concern is growing rapidly. The continuous demand for nutraceuticals creates new opportunities and commercial pressures. Hence the nutrition industry is always looking for potential functional ingredients. Cultivated *L.giganteus* has a huge potential to be exploited in this area.

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