
A new species of *Entoloma* s. l. associated with earthworm casts

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Anil Raj KN, Manimohan P 2012 – A new species of *Entoloma* s. l. associated with earthworm casts. Mycosphere 3(3), 331–334, Doi 10.5943 /mycosphere/3/3/6

Entoloma lomavrithum sp. nov. from Kerala State, India is described, illustrated and discussed. It is tentatively placed in subg. *Leptonia* sect. *Rhamphocystotae*. It seems to grow only on earthworm casts.

Key words – Agaricales – Basidiomycota – Entolomataceae – mycota – taxonomy

Article Information

Received 30 April 2012

Accepted 2 May 2012

Published online 13 May 2012

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Introduction

Entoloma sensu lato (Entolomataceae, Agaricales, Basidiomycota) has a worldwide distribution and is extremely rich in species. Recent molecular studies indicate that the genus is monophyletic (Co-David et al. 2009). The pinkish spore print and the angular spores make the genus easy to identify. The genus is well studied in all continents and more than 1000 species are currently known (Noordeloos 2004). However, new species continue to be discovered. During our studies on the *Entoloma* species of Kerala State, India, we came across, on several occasions, a remarkable species growing exclusively on earthworm castings and it is described here as a new species.

Methods

Conventional morphology based taxonomic methods were employed for this study. Microscopic observations were made on material stained with 1% aqueous solutions of Congo red and phloxine and mounted in 3% aqueous KOH. For evaluation of the range of spore size, twenty basidiospores each from one specimen of each collection cited were measured. In the case of quadrate spores, the measurements represent the length and width

of the quadrate profile taken from corner to corner. All spore measurements include both the mean and the standard deviation for both the length and the width, together with the range of spore quotient (Q, length/width ratio) and its mean value (Qm). Colour codes used in the description are from Kornerup & Wanscher (1978). The examined collections are deposited at Kew (Mycology) Herbarium and the Kew accession numbers (e.g., K(M)175511) are indicated. The infrageneric taxonomy of *Entoloma* followed is that of Noordeloos (2004).

Results

Entoloma lomavrithum K.N.A. Raj & Manim. Fig. 1
MB 800258 (<http://www.mycobank.org>).

Etymology – *lomavrithum* (Sanskrit), covered with hairs.

Characterised by small brownish, omphalinoïd basidiomata; sulcate-striate, tomentose pileus; subdecurrent to decurrent lamellae; solid, tomentose stipe; predominantly quadrate basidiospores; versiform cheilocystidia with brown plasmatic pigment; and clampless hyphae. Differing from *Entoloma infundibuliforme* Petch in having smaller and

slenderer basidiomata, tomentose pileal and stipe surfaces, and larger spores.

Basidiomata small, omphalinoid. Pileus 3–12 mm in diam., convex, with or without a very slight central depression; somewhat sulcate-striate, dark brown (6F6, 7F4, 7F5, 7F6) at the centre and on the striations, brown (6E6, 6E7) elsewhere, finely tomentose all over, densely so towards the centre; margin entire, slightly incurved when young, becoming straight to almost plane with age, rather wavy. Lamellae subdecurrent to decurrent, subdistant, up to 4 mm wide, with lamellulae of 1–3 lengths, whitish when young, becoming pale brown (6B3) or brownish orange (6C3) or reddish grey (7B2) with age; edge entire to slightly crenate, concolorous with the sides or rarely with a brownish tinge. Stipe 9–23 mm × 1–2 mm, central, terete, almost equal, solid; surface finely tomentose, dark brown (8F4); base paler, rarely almost translucent, with profuse basal mycelium. Odour and taste not distinctive.

Spores 7–10(–11) × 6–10 ($8.2 \pm 0.81 \times 7.4 \pm 0.90$) μm , $Q = 1\text{--}1.5$, $Q_m = 1.12$, quadrate or rarely pentagonal in profile. Basidia 24–34 × 10–15 μm , clavate, thin-walled, hyaline, 4-spored; sterigmata up to 4 μm long. Lamella-edge typically sterile or rarely heterogeneous. Cheilocystidia 17–61 × 7–22 μm , versiform: lageniform, broadly lageniform, clavate, utriform, fusiform, ovoid or obovoid, thin- to slightly thick-walled, with dense yellowish brown or brown plasmatic pigment. Pleurocystidia none. Lamellar trama subregular; hyphae 2–9 μm wide, thin-walled, hyaline to very pale brown; subhymenium inconspicuous. Pileus trama interwoven; hyphae 2–13 μm wide, thin walled, hyaline to pale yellowish brown or brown. Pileipellis a cutis disrupted by trichodermial patches; hyphae 6–22 μm wide, with cystidioid terminal elements, 24–69 × 12–26 μm , versiform: lageniform, broadly lageniform, utriform, fusiform, clavate or flexuose, thin to slightly thick-walled, with dense brownish or yellowish brown plasmatic pigment. Stipitipellis a cutis disrupted by trichodermial patches; hyphae 2–15 μm wide, thin-walled, hyaline or very pale brownish yellow, with cystidioid terminal cells; terminal cells 23–66 × 5–18 μm , versiform: lageniform, narrowly clavate,

clavate or flexuose, thin to slightly thick-walled, with a pale yellowish brown to brown plasmatic pigment. Caulocystidia absent. Clamp connections not observed on any hyphae.

Habitat – Exclusively on earthworm casts, on forest floor, scattered or in small groups.

Known distribution – Known only from the type locality in Kerala State, India.

Material examined – INDIA, Kerala State, Kollam District, Thenmala, Shenduruni Forest Division, Kattilapara, 10 November 2010, K.N. Anil Raj AR465 (K(M)175509); *ibid.*, 11 November 2010, K.N. Anil Raj AR494 ((K(M)175511, holotype); *ibid.*, K.N. Anil Raj AR499 (K(M)175510).

Discussion

Entoloma lomavrithum is characterised by small brownish, omphalinoid basidiomata; sulcate-striate, tomentose pileus; subdecurrent to decurrent lamellae; solid, tomentose stipe; predominantly quadrate basidiospores; versiform cheilocystidia with brown plasmatic pigment; and clampless hyphae. The combination of characters such as the small, omphalinoid basidiomata, the large, protruding, predominantly lageniform cheilocystidia, the clampless hyphae, and the pileipellis that is a transition between a cutis and a trichoderm with intracellular pigment is indicative of sect. *Rhamphocystotae* of subg. *Leptonia* although the quadrate basidiospores are an oddity. Preliminary molecular phylogenetic studies, however, has indicated that the current infrageneric classification of *Entoloma* s. l. needs drastic revision (Co-David et al. 2009). At the moment we are not sure where this species will eventually be placed when the infrageneric taxonomy of the genus is revised based on molecular phylogeny.

Several keys (Horak 1980, Manimohan et al. 1995, 2006) lead the present species to *E. infundibuliforme* Petch as that species also has brownish basidiomata with subdecurrent lamellae, predominantly quadrate basidiospores, cheilocystidia with brown plasmatic pigment and clampless hyphae. *Entoloma infundibuliforme*, however, has large and robust basidiomata, squammulose pileal surface, fibrillose stipe surface, and smaller

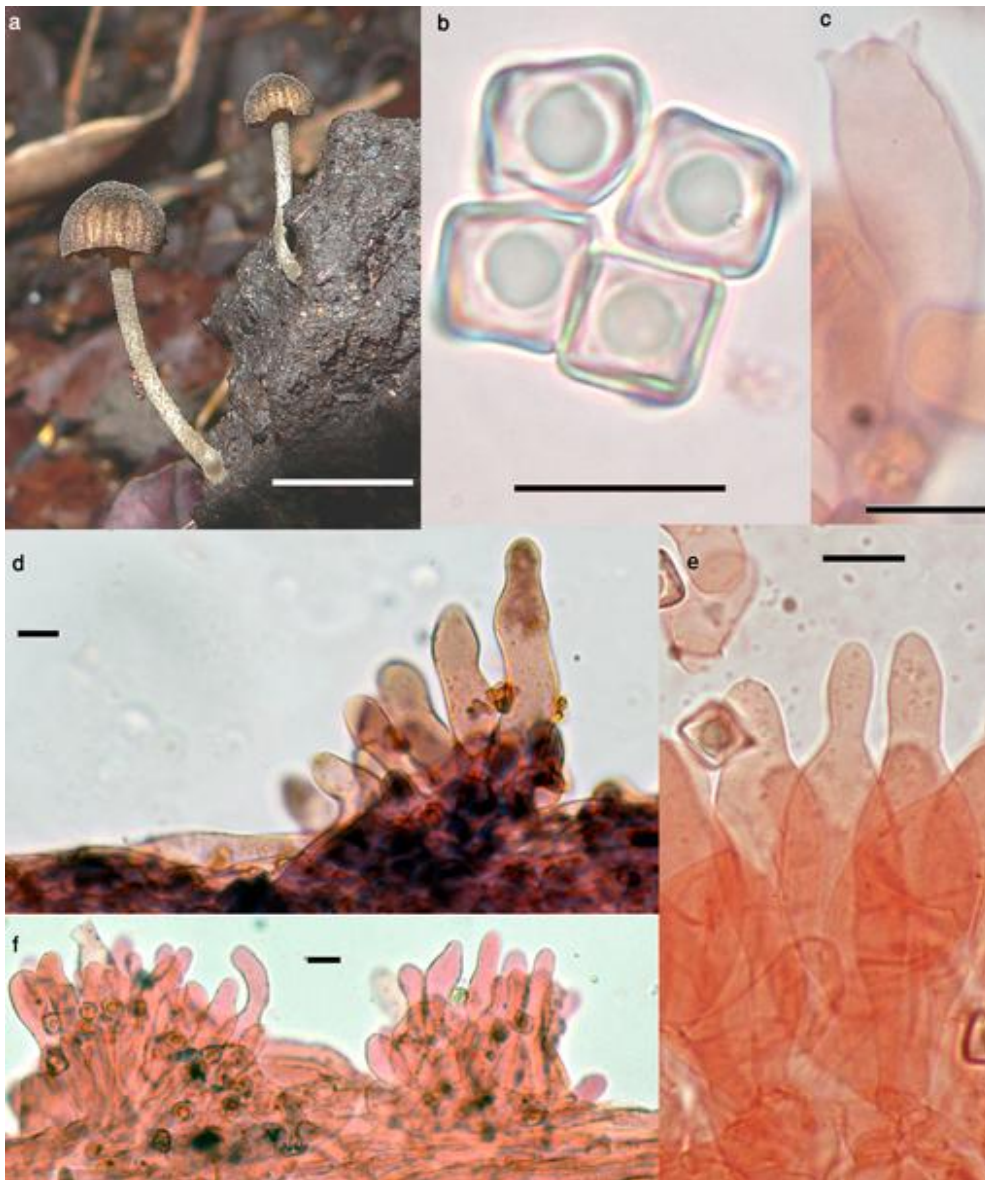


Fig. 1 – *Entoloma lomavrithum*. **a** Basidiomata. **b** Basidiospores. **c** Basidium. **d** Pileipellis. **e** Cheilocystidia. **f** Stipitipellis. Bars a = 10 mm, b–f = 10 μ m.

spores. Horak's (1976) key to the cuboid/quadrated spored species of *Entoloma* indicates *E. brunneum* Petch originally described from Sri Lanka. Both *E. brunneum* and the present species have almost similar-sized, quadrated basidiospores and brown plasmatic pigment in the cheilocystidia. *Entoloma brunneum* however, has larger basidiomata, conical, umbonate, squammulose pileus, adnexed lamellae, and cylindric-clavate cheilocystidia. The Javan species *E. overeemi* E. Horak (Horak 1977) has similar small basidiomata, decurrent lamellae, and clampless hyphae. But that species has whitish to pale yellow, smooth pileus, and clavate cheilocystidia. *Entoloma brunneostriatum*

Dennis known from Trinidad and Malaysia (Dennis 1953, Horak 1980) is a small fragile brownish species with convex to umbonate pileus and is morphologically somewhat similar to the present species. However, it has smaller spores, clamp connections on the hyphae and fertile lamella-edge. The Tasmanian species, *E. choanomorphum* G.M. Gates & Noordel. (Gates & Noordeloos 2007) also is similar to *E. lomavrithum* owing to its brown pileus, decurrent lamellae, fusiform to lageniform cheilocystidia with plasmatic pigments, and clampless hyphae. But it has larger basidiomata with strong sulphurous odour, glabrous, radially fibrillose hygrophalous pileus, larger, 6–7 angled basidio-

spores, and cutis-type pileipellis.

Entoloma lomavrithum seems to be adapted to a fairly specific ecological niche, fruiting only on earthworm casts on forest floor. As far as we know, there are no previous reports of any agaric fruiting in nature exclusively on this substrate although it has been shown repeatedly that when used as a component of casing layer, earthworm casts stimulate basidiomata formation (Grappelli et al. 1987, Galli et al. 1990). Earthworms feed on organic matter and excrete a large part of these consumed materials in a half digested form. Casts are a humus-like product with a flourishing microflora that produces metabolites capable of stimulating basidiomata formation (Grappelli et al. 1987, Galli et al. 1990). The presence of fungal propagules in the gut and casts of earthworms has been known for some time (Parle 1963). It has been demonstrated that earthworm are vectors of viable propagules of VAM fungi and some ectomycorrhizal fungi with hypogeous fruiting structures and that the spores are usually more concentrated in casts than in the surrounding soils (Reddell & Spain 1991, Gange 1993). However, it would be premature to comment on the relationship between *E. lomavrithum* and earthworm casts based on our preliminary observation.

Acknowledgements

One of us (KNAR) acknowledges support from the University Grants Commission, New Delhi, for the award of a Rajiv Gandhi National Fellowship (RGNF).

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