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## MACROFUNGI IN THE LATERITIC SCRUB JUNGLES OF SOUTHWESTERN INDIA

A.A. Greeshma<sup>1</sup>, K.R. Sridhar<sup>2</sup> & M. Pavithra<sup>3</sup>

<sup>1,2,3</sup>Department of Biosciences, Mangalore University, Mangalagangothri, Mangalore, Karnataka 574199, India  
<sup>1</sup>greeshu.resh@gmail.com, <sup>2</sup>kandikere@gmail.com (corresponding author), <sup>3</sup>pavithraravi2586@gmail.com

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**Abstract:** A pilot study on macrofungi in scrub jungles (with and without fire-impact) in lateritic region of southwestern coast of India was carried out. Out of 11 species in 10 genera recovered, six and five species were confined to scrub jungle and fire-impacted scrub jungle, respectively. An ectomycorrhizal *Amanita* sp. was the most frequent in scrub jungle associated with exotic (*Acacia auriculiformis* and *A. mangium*) and plantation (*Anacardium occidentale*) trees. Based on traditional knowledge, it is a highly edible and nutritional delicacy in the coastal regions. *Astraeus odoratus* was another common ectomycorrhizal fungus in native trees *Hopea ponga*, which was recovered from the fire-impacted scrub jungle and is possibly edible. Edible termite mound mushroom *Termitomyces striatus* was also common in the fire-impacted scrub jungle. *Chlorophyllum molybdites* was the most frequent mushroom in the fire-impacted scrub jungle.

**Keywords:** Diversity, ectomycorrhizal fungi, edible, forest-fire, lateritic soil, macrofungi, scrub jungle.

Macrofungi have a wide dimension in different ecosystems involving in plant detritus decomposition, nutrient cycle, pathogenesis and mutualistic association with a wide variety of tree species. Nowadays, macrofungi have become a centre of attraction for research due to their edible, ectomycorrhizal, medicinal, toxic and hallucinogenic properties. Global estimates of macrofungi based on plant/macrofungal ratio ranges

between 53,000 and 110,000 (Mueller et al. 2007). Up to 850 macrofungi have been reported mainly from the Himalayan and Western Ghats regions of India (Manoharachary et al. 2006). Recent checklists documented 616 and 178 species (in 112 and 68 genera) of agarics from the Western Ghats of Kerala and Maharashtra states, respectively (Farook et al. 2013; Senthilarasu 2014). A recent illustrated monograph encompasses descriptions of 330 species (in 166 genera and 51 families) from the state of Kerala (Mohanani 2011).

The southwestern coast of India predominantly consists of lateritic soil, which harbours a variety of herbs, shrubs and tree species. These scrub jungles are prone to fire during summer (February–May). Relatively, studies on macrofungi in lateritic regions of the western coast are scanty (e.g., Karun & Sridhar 2014). Similar to the lateritic belt of southwestern India, lateritic regions of the eastern part start from Chota Nagpur plateau and extend up to Bihar, Odisha, Chhattisgarh, Jharkhand and West Bengal (Manna & Roy 2014). A wide variety of macrofungi have been reported from the lateritic part of eastern India especially from

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Jharkhand, Odisha and West Bengal (e.g., Pradhan et al. 2010, 2012, 2013; Hembrom et al. 2014; Manna & Roy 2014). Several tribals are dependent on the edible and medicinal macrofungi for their livelihood during the wet season (Pradhan et al. 2010; Manna & Roy 2014). Due to scanty studies on macrofungi in the lateritic regions of southwestern India, a pilot study was undertaken.

### STUDY AREA AND OBSERVATIONS

A survey was carried out in scrub jungle and fire-impacted scrub jungle in Konaje Village (90m elevation), adjacent to Mangalore University Campus (Dakshina Kannada District, Karnataka) (12°49'N & 74°55'E). West facing elevated slopes possess patchy scrub jungles as it is highly influenced by strong winds. In addition, these scrub jungles often face threat of fire during summer. Several native tree species (e.g., *Careya arborea*, *Holigarna* sp., *Hopea ponga*, *Macaranga peltata*, *Sapium insigne*, *Syzygium cumini* and *Terminalia paniculata*), exotic tree species (e.g., *Acacia auriculiformis* and *A. mangium*) and plantation tree species (*Anacardium occidentale*) dominate this region. In addition, open places are occupied by grasses (*Heteropogon contortum*, *Pennisetum polystachyon* and *Themeda tremula*) and a dominant weed *Eupatorium odoratum*. The floor of the jungle has predominantly rocky escarpments with loamy, sandy, gravel, pebble-rich lateritic soil.

The survey was carried out employing opportunistic mode of sampling during monsoon (June–August 2014). Macro- and micro-morphological features of macrofungi recovered in the scrub jungle and fire-impacted scrub jungle were documented and their characteristics were compared with literature for identification (Sathe & Daniel 1980; Sathe & Deshpande 1980; Jordan 2004; Phosri et al. 2004; Phillips 2006; Mohanan 2011; Hembrom et al. 2014). Field photographs (Sony DSC-HX100V and Nikon D40) and microscopic photographs (Olympus CX41RF) were obtained. Macrofungi collected were preserved in the herbarium (Department of Biosciences) by transferring blotted specimens on to a fixative (water-ethanol-formaldehyde: 14:5:1) in airtight containers.

### RESULTS

This pilot survey revealed occurrence of 11 species of macrofungi belonging to 10 genera. Out of them six and five species were confined to scrub jungle and fire-impacted scrub jungle, respectively without overlap (Table 1). Ectomycorrhizal *Amanita* sp. was frequent in scrub jungle in association with three tree species (exotic: *Acacia auriculiformis* and *A. mangium*;

plantation: *Anacardium occidentale*). *Hygrocybe astatogala* and *Lepiota* sp. were also common in scrub jungle. The other three rare species include *Hygrocybe aurantioalba*, *Phellinus* sp. and *Ramaria versatilis*. Out of five mushrooms in the fire-impacted region, *Chlorophyllum molybdites* was frequent, while *Astraeus odoratus* (ectomycorrhizal in native tree species, *Hopea ponga*) and a termite mound fungus *Termitomyces striatus* were common. The other two species *Agaricus crocospilus* and *Nectria cinnabarina* were rare. Brief descriptions of macrofungi in scrub jungle as well as the fire-impacted region of scrub jungle are provided.

### Scrub jungle

***Amanita* sp.** (Amanitaceae: Basidiomycotina) (Image 1A–D) (# MUBSGAAKRSMF-NF2).

Fruit body small to medium size, fleshy agaric, cap greyish-white, white gills and stipe (Image 1A–D); annual, solitary, partolous, ectomycorrhizal, mild odour and edible. Pileus: 1.2 (1.5–4.2) 4.7 cm (n=28), greyish fibrils on white background, slimy during wet, smooth when dry, fibrillose, persistence of partial veil on surface, initially white spongy egg-shape tends to slightly solid dumbbell shape, cap emerges out cracking universal veil, at first conical turning convex then flattened, margin entire and incurved (Image 1C). Lamellae: white, free, narrow and crowded (Image 1D). Stipe: 3.5 (3.8–8) 8.4 x 0.4 (0.5–1.2) 1.4 cm (n=28), white, concolorous, equal, cylindrical, bulbous, hallow, slightly fleshy and warty (arrows, Image 1B). Spores: 0.2 (0.5–1.0) 1.3 x 0.2 (0.5–0.7) 1.0 µm (n=20), hyaline, ellipsoidal, smooth and thin-walled.

Fresh weight of mature fruit bodies 10.05g (4.9–15.1 g) (n=20) and immature fruit bodies 3.37g (0.2–6.4 g) (n=20). Substrate: Emerges in between rocky pebbles, ectomycorrhizal in exotic tree species (*Acacia auriculiformis* and *A. mangium*) and dominant plantation crop (*Anacardium occidentale*).

Occurrence and distribution: Frequent in early monsoon in scrub jungle (June and early July) in the present study. Recorded in coastal sand dunes near Mangalore (Ghate et al. 2014) and in different locations of Kerala (Arippa, Kuruva, Perumboor, Wayanad) (Mohanan 2011). Recently, this mushroom has also been recovered in bulk quantity from the fire-impacted scrub jungle near Mangalore University (A.A. Greeshma unpub. obs. 2014).

***Hygrocybe astatogala*** (R. Heim) Heinem. (Hygrophoraceae: Basidiomycotina) (Image 1E–H) (# MUBSGAAKRSMF-NF5)

**Table 1. Macromycetes recorded in scrub jungles of the western coast of India**

| Taxon   | Substrate  | Economic value             |
|---|--|----------------------------|
| <b>Scrub jungle</b>                             |  |                            |
| <i>Amanita</i> sp. (Image 1A–D)***              | Soil; ectomycorrhizal ( <i>Acacia auriculiformis</i> , <i>A. mangium</i> and <i>Anacardium occidentale</i> ) | Edible and Ectomycorrhizal |
| <i>Hygrocybe astatogala</i> (Image 1E–H)**      | Soil in lawn   | -                          |
| <i>H. aurantioalba</i> (Image 1I–K)*            | Soil in lawn   | -                          |
| <i>Lepiota</i> sp. (Image 2A–C)**               | Black soil   | -                          |
| <i>Phellinus</i> sp. (Image 2D, E)*             | Twigs and coarse wood  | Lignocellulase             |
| <i>Ramaria versatilis</i> (Image 2F,G)*         | Coarse sandy soil  | -                          |
| <b>Fire-impacted scrub jungle</b>               |  |                            |
| <i>Agaricus crocospilus</i> (Image 3A–C)*       | Pebble-rich laterite soil  | -                          |
| <i>Astraeus odoratus</i> (Image 3D,E)**         | Ectomycorrhizal ( <i>Hopeaponga</i> )  | Edible and Ectomycorrhizal |
| <i>Chlorophyllum molybdites</i> (Image 4A–C)*** | Coarse laterite soil   | -                          |
| <i>Nectria cinnabarina</i> (Image 4D,E)*        | Twigs and coarse wood  | Lignocellulase             |
| <i>Termitomyces striatus</i> (Image 4F–J)**     | Termite mound  | Edible                     |

\* - rare; \*\* - common; \*\*\* - frequent

Fruit body medium to large basidiome, fleshy agaric, orangish black cap, white gills, orangish grey stipe (Image 1E–G); annual, solitary, particolous, odour indistinctive and inedible. Pileus: 8(8.2–9) 10.5cm (n=5), reddish-orange with blackish radial fibrils, slimy during wet and smooth in dry season, initially conical with acute umbo then expanding with prominent obtuse umbo, margin entire without splitting (Image 1F,G). Lamellae: white, free, narrow and moderately crowded (Image 1H). Stipe 5.7 (6–10) 11.9 x 0.3 (0.4–0.8) 1.2cm (n=5), orangish-cream partly greyish, clavate, cylindrical, solid and fibrillose (Image 1E). Spores: 5 (5.9–7.8) 8 x 4.5 (5.2–5.5) 5.9µm (n=5), hyaline, ellipsoidal, smooth and found in mass.

Fresh weight of mature fruit bodies 12.4g (5.13–16 g) (n=5). Substrate: usually found in lawn soils, camouflage between the lawn grasses.

Occurrence and distribution: Common in scrub jungle in the present study. Recorded in different locations of Kerala (Kuruva, Malabar, Peechi, Thrissur and Wayanad) (Leelavathy et al. 2006; Mohanan 2011) and Maharashtra (Lingamala) (Senthilarasu 2014).

***Hygrocybe aurantioalba*** Leelav., Manim. & Arnolds

(Hygrophoraceae: Basidiomycotina) (Image 1I–K) (# MUBSGAAKRSMF-NF6)

Fruit body small to medium, fleshy agaric, bright yellowish orange cap, white gill, pale yellow stipe (Image 1I); annual, solitary, particolous, indistinctive odour and inedible. Pileus: 1.2 (1.4–1.7) 2cm (n=4) orangish-yellow dense at umbo lighter towards margin, slimy during wet and smooth in dry conditions, initially conical becoming plano-convex with umbo, striate, margin incurved and often splitting (Image 1I,J). Lamellae: white, free, narrow and not crowded (Image 1K). Stipe: 2 (2.8–3) 4 x 0.2–0.4cm (n=4), straw yellow, equal, cylindrical, smooth and fragile (Image 1I). Spores 5 (5.9–8.5) 10.5 x 3.4 (4–5.2) 5.9µm (n=4), hyaline, ellipsoidal and smooth.

Fresh weight of mature fruit bodies 0.43g (0.4–0.5 g) (n=4). Substrate: Found in lawn soil, where the soil is rich in moisture and humus.

Occurrence and distribution: Rare in scrub jungle in the present study. Recorded in different locations of Kerala (Chandakkunnu, Idukki, Kollum, Malappuram, Mannavanshola, Munnar and Nilambur (Leelavathy et al. 2006; Mohanan 2011).

***Lepiota* sp.** (Agaricaceae - Basidiomycotina) (Image 2A–C) (# MUBSGAAKRSMF-NF7)

Fruit body small to medium basidiome, fleshy agaric, yellow gill, creamish stipe (Image 2A–C); annual, solitary, particolous, indistinctive odour and inedible. Pileus: 2.2 (2.3–3.3) 3.9cm (n=12), light creamish-yellow surface, brownish at the umbo, smooth in both wet and dry condition, fibrillose, initially conical becoming plano-convex and then flattened, margin entire, regular without splitting (Image 2A,B). Lamellae: yellow, free, narrow and crowded (Image 2C). Stipe: 3.5 (4–4.9) 5 x 0.3 (0.35–0.5) 0.6cm (n=12), equal, cylindrical, smooth and fibrillose (Image 2A,C). Spores: 5.2 (6.5–7.8) 8.8 x 3.28 (3.9–4.8) 5.26µm (n=12), hyaline, ellipsoidal and smooth.

Fresh weight of mature fruit bodies 0.34g (0.3–0.4 g) (n=12). Substrate: usually found in soil, requires high moisture content humus soil. It is also found in non-fire regions including botanical gardens other than study area.

Occurrence and distribution: Common in scrub jungle in the present study. Recorded in different locations of Kerala (Iringole Kavu and Perumbavoor) (Mohanan 2011)

***Phellinus* sp.** (Hymenochaetaceae: Basidiomycotina) (Image 2D, E) (# MUBSGAAKRSMF-NF9)

Fruit body medium to large size, resupinate, brown,



**Image 1.** Different stages of *Amanita* sp. (A–D), warty stipe (arrows in B), plano-convex pileus (C) and crowded lamellae (D); different stages of *Hygrocybe astatogala* (E–G), reddish-orange pileus with acute umbo with black fibrils (F, G) and moderately crowded lamellae (H); Different stages of *Hygrocybe aurantioalba* (I–K), yellowish-orange pileus with yellow stipe (I), plano-convex umbo (I, J) and narrow uncrowded lamellae (K) (scale bar: 1cm). (Photo credit: M. Pavithra & N.C. Karun)

pore bearing surface (Image 2D); annual, gregarious, lignicolous, indistinctive odour and inedible. It is known for production of industrially important lignocellulase. Stromata variable in diameter 1.2–4.9 cm (n=5), cinnamon-brown, creamish near margin, smooth, texture velvety, almost irregular shapes, highly porous, pores spherical, flesh concolorous and thin (Image 2D, E). Spores: 4–5 x 2–3  $\mu\text{m}$  (n=7), hyaline, ellipsoidal and

smooth.

Fresh weight of mature fruit bodies 1.42g (1.1–2.1 g) (n=5). Substrate: On dead wood logs or twigs. Found as patches on fallen trees and logs.

Occurrence and distribution: Rare in scrub jungle in the present study. Recorded in different locations of Kerala (Iringole Kavuu, Nilambur and Perumbavoor) (Mohanan 2011).



Image 2. Different stages of *Lepiota* sp. (A–C), creamish stipe (A, C), plano-convex umbo (A, B), narrow and crowded lamellae (C); Upper (D) and lower (E) side of *Phellinus* sp., cinnamon-brown and creamish margin (D, E); coral-like violet to purple *Ramaria versatilis* with highly branched thick stromata (F, G) (scale bar: 1cm). (Photo credit: M. Pavithra & N.C. Karun)

***Ramaria versatilis*** Quél. (Gomphaceae: Basidiomycotina) (Image 2F,G) (# MUBSGAAKRFMF-NF10)

Fruit body small to medium size, coral fungus, purplish (Image 2F,G); annual, gregarious, particulous, indistinctive odour and inedible. Stromata: 3 (4–7) 8 x 2–5 cm (n=6), violet to purple, tips whitish, flesh white, creamish at the base, soft in young hard and leathery in later stage, tips are blunt, highly branched and thick-walled (Image 2F,G). Spores: 5.2 (6.5–7.8) 8.5 x 3.1 (3.9–

5.2) 5.7  $\mu$ m (n=8), light brown, ellipsoidal, smooth and thin walled.

Fresh weight of mature fruit bodies 0.28g (0.13–0.3 g) (n=6). Substrate: In coarse soil, found as bunches emerged from soil, prefers shady areas.

Occurrence and distribution: Rare in scrub jungle in the present study. Recorded in different locations of Kerala (Chandhakkunnu & Nilambur) (Mohanan 2011).



Image 3. *Agaricus crocopeplus* showing orange brown pileus (A, B), creamish orange stipe with narrow crowded lamellae (C); tender, mature and spent fruit bodies of *Astraeus odoratus* (D, E), intact and cut open immature fruit bodies amidst charcoal debris (arrows in D) and star-like lobes with mature and spent gleba (E) (scale bar: 1cm). (Photo credit: M. Pavithra & N.C. Karun)

#### Fire-impacted scrub jungle

*Agaricus crocopeplus* Berk. & Broome (Agaricaceae: Basidiomycotina) (Image 3A–C) (# MUBSGAAKRSMF-FR1)

Fruit body small to medium size, fleshy agaric, cap orange-brown, gills dark-brown, stipe creamish orange (Image 3A–C), particulous, solitary, annual, odour indistinctive and inedible. Pileus: 3(3.4–5) 6.6cm (n=5),



**Image 4.** Immature and mature fruit bodies of *Chlorophyllum molybdites* (A–C), creamish brown pileus with brown umbo (A, B), creamish crowded lamellae with double-edged annulus (arrow in C); Gregarious perithecia of *Nectria cinnabarina* on wood log (D, E); Greyish-white cap of *Termitomyces striatus* with dark-brown umbo (F, H, I), slender pseudorrhiza in stipe (arrow in G) and broadly crowded lamelle (J) (scale bar: 1 cm). (Photo credit: M. Pavithra & N.C. Karun)

yellowish orange in centre, brownish-black towards the margin, smooth under dry and wet conditions, initially convex becoming flattened, incurved margin extending beyond the gills and splitting rarely (Image 3A,B). Lamellae: dark-brown, free, narrow and crowded (Image 3C). Stipe: 4 (4.5–5) 6.10 x 4–0.6cm (n=5), creamish orange, cylindrical, almost equal, solid and fibrillose (Image 3C). Spores: 6 (6.3–7.8) 8.1x3.2–4.6 $\mu$ m (n=5), hyaline, ellipsoidal and thick walled.

Fresh weight of mature fruit bodies 6.1g (5.4–6.6 g) (n=5). Substrate: Found usually in pebble-rich laterite soil or the soil accumulated adjacent to the rocks with charcoal and ash debris (Image 3A,B).

Occurrence and distribution: Rare in fire-attacked scrub jungle in the present study. Recorded in different locations of Kerala (Thrissilery, Thrissur and Wayanad) (Mohanan 2011).

***Astraeus odoratus*** Phosri, Walting, M.P. Martin & Whalley (Astraeaceae: Basidiomycotina) (Image 3D,E) (# MUBSGAAKRSMF-FR3)

Fruit body small size basidiome, bulbous eventually splits like rays with centred gleba, creamish brown in colour (Image 3D,E); annual, gregarious, particolous, ectomycorrhizal, butter odour and edible (Mortimer et al. 2012). Stromata immature stage 1 (1.1–1.8) 2.9x1.2 (1.7x3.5) 3.9cm (n=25), creamish becoming brown, solid, white fleshy, globose to subglobose, spore sac found, almost regular stud-like (Image 3D,E), matured stage 2.2(3.4–5.4) 5.7x4.4 (4.5–7.5) 7.7cm (n=25), dark brown to blackish, solid rough, white turns purplish and then brown powder like, splits vertically like star with gleba at the centre, incurved, rough, leathery and scar-like rays (Image 3E). Spores: 7.5–11  $\mu$ m (n=20), brown, almost spherical, warty and found in mass.

Fresh weight of mature fruit bodies 11.6g (3.4–5.6 g) (n=20) and immature fruit bodies 7.8 g (3.2–10.4) (n=25). Substrate: Partly embedded in soil, ectomycorrhizal association with *Acacia mangium*, mostly found in soil where moisture content is high.

Occurrence and distribution: Common in fire-impacted scrub jungle in early monsoon as ectomycorrhizal with native tree species (*Hopea ponga*) in the present study (note charcoal debris in Image 3D). Recorded in different locations of Kerala (Nilambur and Sholayar) (Mohanani 2011). It has also been reported from Jharkhand (Rajmahal Hills, sacred grove of Mandro fossil park and forests of Dalahari Village) consists mainly scrub vegetation and likely ectomycorrhizal in forest tree species *Shorea robusta* (Hembrom et al. 2014).

***Chlorophyllum molybdites*** (G. Mey.) Masee (Agaricaceae: Basidiomycotina) (Image 4A–C) (# MUBSGAAKRSMF-FR4)

Fruit body medium to large size basidiome, fleshy agaric, cap creamish-brown, cream gills and stipe (Image 4A–C); solitary, annual, paricolourous and inedible. Pileus: 7(8–8.5) 9cm (n=11), cream surface with the brown umbo, brownish squamules smooth, spongy, initially hemispherical becoming flattened, margin moderately incurved and small splitting throughout the margin (Image 4A,B). Lamellae: creamish-white, free, broad towards the margin and crowded (Image 4C). Stipe: 8(8.8–10) 10.5x0.5–2 cm (n=11), white, slightly tapered towards base, clavate, smooth and fleshy with double-edged annulus (arrow in Image 4C). Spores: 8(8.5–9.2)9.8x6 (6.5–7) 7.2µm (n=7), hyaline, ellipsoidal, smooth and thick-walled.

Fresh weight of mature fruit bodies 5.19g (2–7.4 g) (n=7). Substrate: In coarse soil usually they are found gregariously under bright sunny areas.

Occurrence and distribution: Frequent in fire-impacted scrub jungle in the present study. Recorded in different locations of Kerala (Ernakulam, Idukki, Peechi, Thrissur, Thiruvananthapuram and Vettikkal) (Mohanani 2011; Farook et al. 2013) and Maharashtra (Pune) (Sathe & Rahlkar 1976; Sathe & Deshpande 1980, 1982).

***Nectria cinnabarina*** (Tode) Fr. (Nectriaceae: Ascomycotina) (Image 4D,E) (# MUBSGAAKRSMF-FR8)

Fruit body very small, brownish studs, fleshy (Image 4D, E); gregarious, lignicolous and inedible. *Stromata* 0.2–0.4 x 0.2–0.5 cm (n=20), initially pink turning to light brown becoming cinnabar, dense mass of perithecia, solid, fleshy turns rough, globose, sessile and dense on wood logs (Image 4D,E). It is known for production of

industrially valued lignocellulase. Spores: 4.7 (4.9–8.4) 10.7x2.8 (3.4–4.9) 5.2µm (n=16), hyaline, ellipsoidal, smooth and thin-walled.

Fresh weight of mature fruit bodies 0.14g (0.1–0.24 g) (n=20). Substrate: on the dying wood log or twig. As the fruiting body matures, the wood log or twig decomposes gradually.

Occurrence and distribution: Rare in fire-impacted scrub jungle in the present study. Frequently collected on logs of *Shorea robusta* from different wood depots of Odisha (Tiwari et al. 2013)

***Termitomyces striatus*** (Beeli) R. Heim (Lyophyllaceae: Basidiomycotina) (Image 4F–J) (#MUBSGAAKRSMF-FR11)

Fruit body medium to large size basidiome, fleshy agaric; greyish-white cap with white gills, concolorous stipe with pseudomycorrhiza (Image 4F–J); solitary, annual, odour indistinctive and edible. Pileus: 4 (4.3–6.7) 8cm (n=10), greyish-white, dark-brown umbo, greyish radial fibrils, slimy during wet, smooth in dry condition, initially cone shaped becoming bluntly umbonate, finely striate, margin incurved becoming straight and then uplifted and often splitting (Image 4H,I). Lamellae: white, free, broad and crowded (Image 4J). Stipe: 6.9 (7.1–11.2) 12.3x0.9 (1.0–1.4) 1.5cm (n=10), creamish-white, concolorous, cylindrical, tapering at the base into a slender pseudomycorrhiza, solid and fibrillose (Image 4F,G). Spores: 5.2 (5.5–7.8) 8.1x3.9 (4.2–5.2) 6µm (n=10), hyaline, broadly ellipsoidal and thin walled.

Fresh weight of mature fruit bodies 10.6g (9.3–15.4 g) (n=10). Substrate: On termite mounds, usually these mounds are buried in soil thus the specimen appears embedded in the soil.

Occurrence and distribution: Common in fire-impacted scrub jungle in the present study. This mushroom was also recorded in nearby scrub jungle without fire-impact (A.A. Greeshma unpub. obs. 2014). Recorded in different locations of Kerala (Chandakkunnu, Malappuram, Nilambur and Wayanad) (Leelavathy et al. 1983; Mohanani 2011).

## DISCUSSION

Compared to the western lateritic region of India, extensive studies have been conducted on macrofungi in the laterite plateau in the eastern region of India (e.g., Pradhan et al. 2010, 2012, 2013; Manna & Roy 2014). A variety of ectomycorrhizal, bryophilous, lignicolous, humicolous, coprophilous, termitomycetes, saprotrophic and parasitic macrofungi have been reported (Pradhan et al. 2012, 2013). Nearly 4–29% of macrofungi in eastern lateritic region are ectomycorrhizal especially in forest

tree species *Shorea robusta* (Pradhan et al. 2012, 2013). A variety of mushrooms were harvested as nutritional and as a medicinal source by the ethnic groups for their livelihood (Pradhan et al. 2010, 2012, 2013; Manna & Roy 2014). Up to 30 species of wild edible macrofungi have been recognized in the laterite plateau in the eastern part of India, out of them 10 species are widely consumed and marketed (Manna & Roy 2014).

In our study two species were frequent or common ectomycorrhizal (*Amanita* sp. and *Astraeus odoratus*) in different tree species and interestingly both of them are traditionally edible in the immature stage. However, there is a mixed opinion on the edibility of *A. odoratus* among the coastal dwellers. Besides these mushrooms, highly edible *Termitomyces striatus* was also common especially in fire-impacted scrub jungle. *Amanita* sp. (also called 'motte anabe' in Kannada: meaning 'egg mushroom') exists in immature stage underneath the lateritic soil or coastal sand dunes (Ghate et al. 2014). In slightly advanced stage, it becomes dumbbell shaped (bulbous base with bulbous cap with intact or partially teared universal veil). Egg and dumbbell stages are most edible according to traditional knowledge of the coastal dwellers.

In summary, this pilot study resulted in the occurrence of 11 macrofungi in the lateritic scrub jungle of southwest India. According to traditional knowledge, three species (*Amanita* sp., *Astraeus odoratus* and *Termitomyces striatus*) were edible. Out of them *Amanita* sp. and *A. odoratus* were ectomycorrhizal in native and exotic tree species and *T. striatus* was termite mound dependent. All these species are common or frequent in scrub jungle or fire-impacted scrub jungle. Further attention is warranted to assess the lateritic coastal biomes of southwestern India in search of edible and ectomycorrhizal macrofungi as alternative nutritional source, medicinal source and future silvi-culture. More specific attention needs to be focused on the impact of fire on macrofungi in lateritic scrub jungles along the west coast of India.

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