

Taxonomic Documentation of *Termitomyces* spp. from Nagpur District, Maharashtra, India

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Abstract: *Termitomyces* is a genus of termite-associated macrofungi belonging to the family Lyophyllaceae of the order Agaricales and includes several edible species. However, the diversity and taxonomic documentation of *Termitomyces* in Nagpur District of Maharashtra remain poorly explored. The present study aims to document and identify *Termitomyces* species using exclusively morphological characters. Field surveys were carried out during the rainy season. Fresh specimens were collected and detailed field observations were recorded. Macromorphological characters including pileus size, shape, colour, surface, margin, lamellae attachment and spacing, stipe size, shape, colour and surface, annulus, volva, context, and other diagnostic features were studied. Micromorphological characteristics such as basidiospores, basidia, cystidia, pileipellis and hyphal structures were examined using appropriate microscopic preparations and staining techniques. The collected specimens were identified using standard taxonomic literature and identification keys, along with comparisons with previously described species. The study is expected to provide baseline information on the morphological diversity, occurrence and distribution of *Termitomyces* species in Nagpur District and contribute to the taxonomic knowledge of termite-associated macrofungi of the region.

Keywords: *Termitomyces*, Agaricales, morphological taxonomy, macrofungi, termite-associated fungi, Nagpur District, Maharashtra.

I. INTRODUCTION

The genus *Termitomyces*, first described by Heim in 1942, is well known for its close and obligate symbiotic relationship with Macrotermitinas subfamily of termites. Termites cultivate fungus combs inside their nests, where *Termitomyces* contributes to lignocellulose degradation, nutrient recycling, and soil fertility. Morphologically, species are characterized by smooth, inamyloid basidiospores, pale to pinkish spore prints, and a perforatorium in many taxa. Globally, *Termitomyces* exhibits remarkable diversity, with 18 species reported from Nigeria (Oyetayo, 2012), 25 species from Tanzania (Tibuhwa et al., 2010), and 16 species from Côte d'Ivoire (Koné et al., 2018). In Asia, surveys have documented nine species in Thailand (Sangvichien & Taylor-Hawksworth, 2001), while new taxa continue to be described from China and Southeast Asia (Tang et al., 2020).

India is recognized as a region of considerable diversity of *Termitomyces*, with several species reported from different parts of the country. Regional studies have documented considerable diversity of *Termitomyces* including Punjab, Kerala, Goa, the Western Ghats, Himachal Pradesh, Karnataka, and Maharashtra (Patil et al., 1979; Atri et al., 2005; Kumari et al., 2012; Borkar et al., 2015). Despite these records, the Vidarbha region of Maharashtra remains relatively underexplored. Although limited studies from the Amravati and Marathwada regions provide valuable insights, comprehensive documentation from Nagpur District remains lacking. Addressing this gap, the present study aims to characterize three *Termitomyces* taxa collected from Nagpur, focusing on their macro- and micromorphological traits.



Review of Literature

Previous investigations have highlighted the ecological and nutritional importance of *Termitomyces*. Globally, studies have demonstrated their roles in termite symbiosis and nutrient recycling (Aanen et al., 2002; Kirk et al., 2008). Diversity surveys have reported extensive species richness: 25 species in Tanzania (Tibuhwa et al., 2010), 18 species in Nigeria (Oyetayo, 2012), and 16 species in China (Ye et al., 2019). Ethnomycological accounts further emphasize their cultural significance, with vernacular naming systems and folk taxonomy documented in Africa and Asia (Tibuhwa, 2012; Aryal & Budhathoki, 2016).

In India, *Termitomyces* diversity has been documented from Punjab, Kerala, Goa, the Western Ghats, and Karnataka (Atri et al., 2005; Karun & Sridhar, 2013; Kamat, 2013). Goa alone has yielded 35 species, including unique taxa such as *T. gomantakiensis* and *T. petaloides* (Kamat, 2013). Maharashtra records remain limited, with early reports of *T. robustus* and *T. mammiformis* from Kolhapur (Patil & Thite, 1978), and more recent documentation of five species from the Konkan region (Borkar et al., 2015).

Recent studies have expanded regional records: Deshmukh & Hande (2025) documented wild *Termitomyces* in Amravati, focusing on morphology and nutritional richness, while Kakde & Musale (2026) identified *T. heimii*, *T. clypeatus*, and *T. microcarpus* in Marathwada. Mulani & Wakode (2015) reported *T. heimii* and *T. clypeatus* as dominant ectomycorrhizal fungi in Nanded, reinforcing their ecological importance in nutrient mobilization.

Together, these findings underscore the ecological, nutritional, and cultural significance of *Termitomyces*, while highlighting the need for further documentation in underexplored regions such as Vidarbha.

Materials and Methods

Study area:

The study was conducted in Nagpur District, which is in the eastern portion of Maharashtra in central India. The district extends approximately between 20°35'–21°44' N latitude and 78°15'–79°40' E longitude, with an area of approximately 9,930 km². The region exhibits distinct seasonal variation, including a hot summer, monsoon rainfall and comparatively cool winter conditions. An actual rainfall of 665.8 mm was recorded, compared with a normal average of 918.8 mm during the monsoon season, representing a deficit of about 28%. Field surveys were conducted in habitats suitable for macrofungal growth, including forest areas, grasslands, agricultural areas, termite-associated habitats, gardens and plantations, urban and semi-urban green spaces.

Field Survey and Collection

The survey was conducted during the mushroom fruiting season, particularly following rainfall during the monsoon period June–September. Fresh basidiomata were carefully collected along with a portion of the associated substrate where possible. Field observations included the date and locality of collection, habitat, association with termite mounds or termite activity, substrate and macromorphological characters. Photographs were taken in the natural habitat before collection and during laboratory examination. GPS coordinates and altitude were recorded where available. The mushrooms were finally packed in moisture-proof cellophane paper packets along with the collection number.

Morphological identification was carried out based on macroscopic and microscopic characteristics: Macroscopic features of the collected materials, including pileus diameter, shape, colour, surface, texture and margin; lamellae attachment, spacing, colour, edge; and stipe dimensions, colour, surface and texture, were observed and recorded from the fresh material and documented using the field key for mushroom collectors (Atri and Saini 2000, Atri et al. 2005). Hand cut sections of various parts of carpophore, such as pileus, gills, and stipe along with basidiospores details, were studied under the microscope after rehydrating portions of the dried specimens in 10% KOH solution and staining the sections in Phloxine.

Taxonomic identification

Identification was based on comparison of macro- and micromorphological characters with standard taxonomic literature, regional studies and identification keys. The correct names, basionyms and synonyms of the investigated taxa



are according to the latest version of Dictionary of Fungi (Kirk et al. 2008) and the information available on MycoBank (www.mycobank.org). The preparations were examined under a compound microscope.

Results:

Three distinct species of *Termitomyces* were documented from Nagpur District during the monsoon season. Collections were made from moist, organic-rich soils in shaded grassy patches and leaf-littered habitats. All specimens exhibited typical saprophytic habit, emerging directly from soil enriched with decomposing plant matter.

The specimens were identified based on macromorphological traits such as pileus size, shape, surface features, stipe anatomy, lamellae arrangement, and presence or absence of pseudorrhiza and perforatorium.

Table 1. Comparative morphological characteristics of the three *Termitomyces* taxa recorded from Nagpur District.

Character	<i>T. eurrhizus</i>	<i>T. badius</i>	<i>T. clypeatus</i>
Specimen No.	DD-18	DD-19	DD-020
Basidiocarp	Small, solitary, fleshy	Medium-sized, solitary, fleshy	Medium-sized, paired, fleshy
Pileus	About 2.5 cm, umbonate, pale gray-brown to buff, darker umbo, rimose margin	About 3.8 cm, umbonate-convex, cream-beige with blackish-brown umbo, incurved margin	About 5 cm, plano-convex, dark brown centre, cream-white margin, radial cracks
Lamellae	Free, white-cream, close, thin, smooth	Free, pale cream-light brown, crowded, smooth	Free-adnexed, pale cream-light brown, crowded, thin, smooth
Stipe	About 5.2 cm, cylindrical, bulbous base, whitish-light brown, hollow to fibrous	About 5.4 cm × 0.5 cm, cylindrical, tapering apex, solid, smooth	About 4.7 cm × 0.8 cm, cylindrical, tapering upward, solid, firm, pseudorrhiza present
Veils	Absent	Not observed	Not observed
Ecology	Solitary on moist soil with grasses, saprophytic	Solitary on moist soil with leaf litter, saprophytic	Paired on soil with leaf litter and twigs, saprophytic
Diagnostic Notes	Small pileus, rimose margin, hollow stipe	Dark umbo, incurved margin, solid stipe,	Larger pileus with radial cracks, pseudorrhiza

DESCRIPTION

A. Termitomyces eurrhizus (Berk.) R. Heim

Specimen Examined: 64/1, Red Cross Rd, Opposite Institute of Science, Civil Lines, Nagpur, Maharashtra 440001, India; habitat: growing on moist soil of leaf litter waste; Latitude 21.147049° Longitude 79.074827°, 10/08/2026; Doifode, D. H; Specimen No. DD-018.

The specimen identified as *T. eurrhizus* was characterized by its small, solitary basidiomata with a pileus measuring about 2.5 cm in diameter. The pileus was pale gray-brown to buff with a darker umbo and rimose margin, while the lamellae were free, white-cream, and closely spaced. The stipe was relatively short, hollow to fibrous, and bulbous at the base.

Microscopically, the basidiospores are oval to ellipsoid measuring 6.5-9.5×5.5-1.0µm. The basidia are club-shaped typically bearing two sterigmata, each supporting a spore. The hyphal system is monomitic, composed of generative hyphae with clamp connections. The species was collected from moist soil enriched with grasses, indicating its saprophytic habit.

The association of the minute basidiocarp, pale grey to buff pileus with a dark umbo and rimose margin, closely packed free lamellae and bulbous stipe, along with the microscopic features described above, led to the identification of the fungus as *Termitomyces eurrhizus*.





Fig.1. *Termitomyces eurrhizus*: A. Natural habitat of carpophore; B. Longitudinal view of Stipe; C. Basidia with attached two sterigmata and spores along with cystidia; D. Hyphal structure with clamp connections; E. Basidiospores.

B. *Termitomyces badius* Otieno

Specimen Examined: 43wg+r73, Red Cross Rd, Sitabuldi, Nagpur, Maharashtra 440002, India; habitat: growing on moist soil of leaf litter waste; Latitude 21.146819° Longitude 79.075749°, 11/08/2026; Doifode, D. H; Specimen No. DD-019.

The basidiocarp is medium-sized, solitary, and fleshy basidiomata arising from moist soil enriched with leaf litter. The pileus measured about 3.8 cm, umbonate-convex in form, cream-beige in color, with a distinct blackish brown umbo and an incurved margin. The lamellae are free, pale cream to light brown, crowded, and smooth. The stipe is cylindrical, measuring approximately 5.4×0.5 cm, tapering toward the apex, solid, and smooth in texture, with veils not observed. Ecologically, the species occurs solitarily on moist soil with leaf litter, and appear to have a saprophytic mode of nutrition.



Microscopically, *T. badius* is distinguished by its ellipsoid spores, smooth walls, measuring $7-9 \times 5-6 \mu\text{m}$ and a pale pink spore print. The basidia are typically four-spored and club-shaped, while the hyphal system is monomitic with clamp connections. Hymenophoral cystidia are also present, ranging from pyriform to clavate in shape.

The combination of features particularly the dark umbo, solid stipe, incurved pileus margin, and the presence of pyriform-clavate cystidia serve as diagnostic traits that separate *T. badius* from other members of the genus.

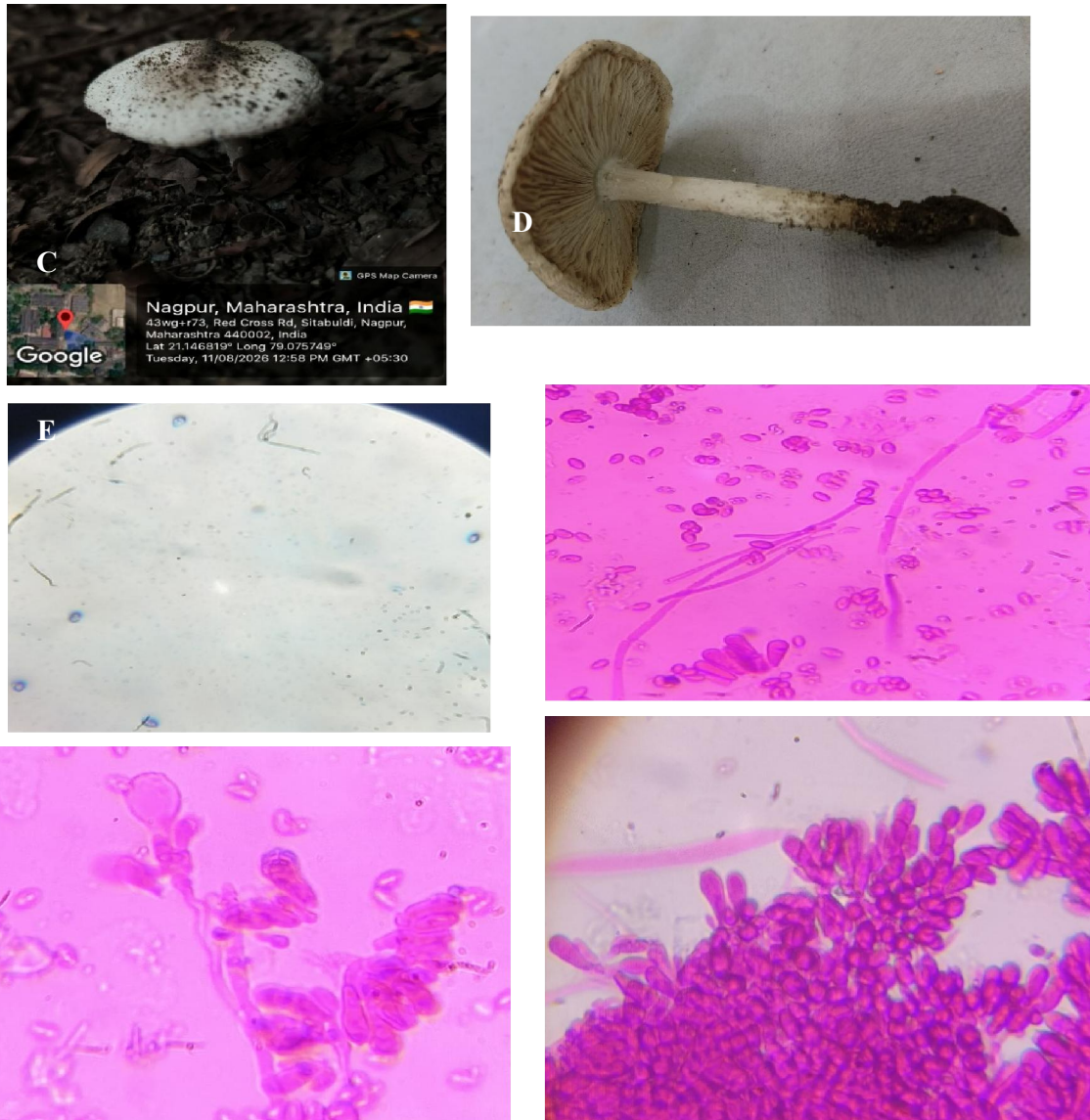


Fig.2. *Termitomyces badius* A. Basidiocarp; B. Longitudinal view of stipe; C. Basidiospores; D. Septate hyphae along with spores; E. Hymenophoral cystidia; F. Basidia with two sterigmata with supporting cystidia.



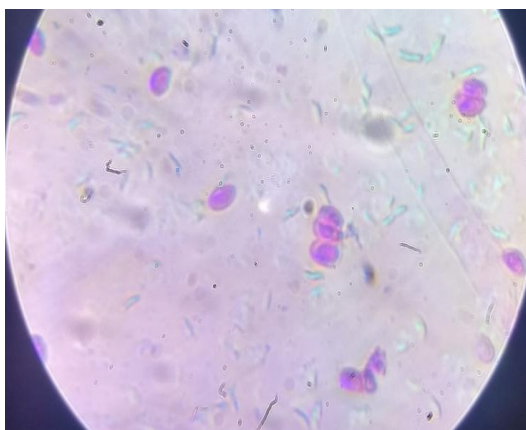
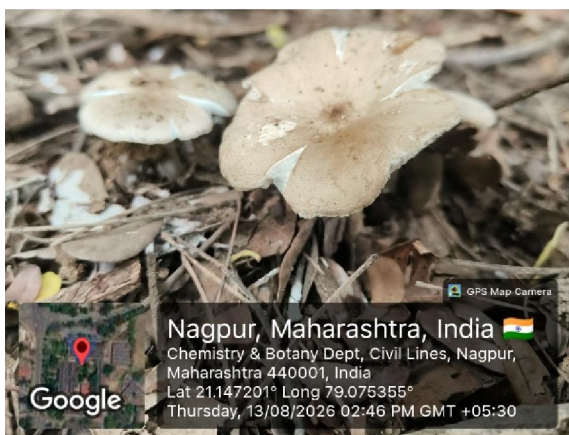
C. Termitomyces clypeatus R. Heim (Fig. 2)

Specimen Examined: Chemistry & Botany Dept, Civil Lines, Nagpur, Maharashtra 440001, India; habitat: growing on moist soil of leaf litter waste; Latitude 21.147201° Longitude 79.075355°, 13/08/2026; Doifode, D. H; Specimen No. DD-020.

The basidiocarp of *Termitomyces clypeatus* is medium-sized, fleshy, and typically occurs in pairs on soil with leaf litter and twigs. The pileus measures about 5 cm, plano-convex in shape, with a dark brown center and cream-white margin, often showing radial cracks that give it a distinctive appearance. Lamellae are free to adnexed, pale cream to light brown, crowded, thin, and smooth. The stipe is cylindrical, about 4.7×0.8 cm, tapering upward, solid, and firm, with a well-developed pseudorrhiza at the base. Veils are not observed. Ecologically, the species is saprophytic, fruiting in paired clusters on soil with leaf litter and twigs.

Microscopically, *T. clypeatus* produces ellipsoid to ovoidal spores measuring $7-9 \times 5-6 \mu\text{m}$, smooth-walled. Basidia are club-shaped and typically four-spored (tetrasporic), while the hyphal system is monomitic with clamp connections, septate (divided by cross-walls) and relatively thin-walled. Hymenophoral cystidia are present, predominantly pyriform to clavate in form.

Together, these macroscopic and microscopic traits—particularly the larger pileus with radial cracks, firm stipe with pseudorrhiza, and the presence of pyriform-clavate cystidia—clearly distinguish *T. clypeatus* from other members of the genus.



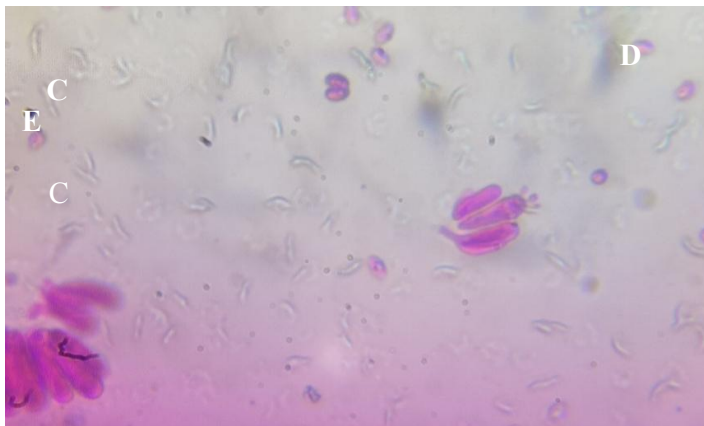


Fig.3. Termitomyces clypeatus: A. Natural habitat of carpophore; B. Longitudinal view of stipe; C. Basidiospores; D. hyphae; E. Basidia with four sterigmata along with three spores.

II. CONCLUSION

The present study documented three termite-associated macrofungi, namely *Termitomyces badius*, *T. clypeatus* and *T. eurrhizus*, from Nagpur District, Maharashtra, India.

The species were differentiated using a combination of macro- and micromorphological characters. Important diagnostic characters included pileus morphology, perforatorium, lamellar arrangement, stipe characteristics, presence or absence of pseudorrhiza and annulus, basidiospore morphology, basidia and cystidia.

The study provides baseline taxonomic information on *Termitomyces* diversity in Nagpur District and contributes to the regional documentation of Agaricales in Maharashtra.

Key to the Three Species Recorded from Nagpur District

A preliminary morphological key is provided below:

1a. Basidiomata small; stipe relatively short and hollow; pileus pale gray-brown to buff, rimose margin; perforatorium pointed; pseudorrhiza absent → *Termitomyces eurrhizus*

1b. Basidiomata medium to large; stipe solid; pseudorrhiza present → 2

2a. Pileus medium-sized, cream-beige with blackish brown umbo; margin incurved; perforatorium prominent; stipe cylindrical, tapering toward apex, solid → *Termitomyces badius*

2b. Pileus larger (≈5 cm), plano-convex with radial cracks, centre dark brown; pseudorrhiza well developed; perforatorium spiniform; stipe firm, solid → *Termitomyces clypeatus*

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