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Diversity Analysis of Macrofungi in Kalwan and Dindori Tahsils of Nashik District, Maharashtra, India

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Macrofungi represent an ecologically significant group of fungi, mainly belonging to the phyla Basidiomycota and Ascomycota, and are characterized by conspicuous fruiting bodies with considerable morphological diversity. The present study aimed to assess the diversity and taxonomic composition of macrofungi in the Kalwan and Dindori Tahsils of Nashik District, Maharashtra, India, a region that has received limited mycological attention despite its favorable climatic conditions. The study area is characterized by high annual rainfall, heterogeneous vegetation, and diverse substrates, which collectively support rich fungal biodiversity. Systematic field surveys were conducted across different habitats during the favorable fruiting season. Macrofungal specimens were collected from soil, leaf litter, and decaying woody substrates. Identification was carried out using detailed macro and micro-morphological characters, supported by standard taxonomic literature and authenticated fungal databases. A total of 22 genera representing 17 families were documented during the study, indicating substantial macrofungal diversity in the region. The conclusions provide baseline information on macrofungal diversity from the western part of Nashik District and focus the ecological richness of Kalwan and Dindori Tahsils. This study contributes to regional fungal biodiversity documentation and may serve as a valuable reference for future ecological, taxonomic, and conservation-oriented investigate.

Keywords : Ascomycota, Basidiomycota, biodiversity, macrofungi

INTRODUCTION

Fungi play a crucial role in maintaining ecosystem structure and function, particularly through nutrient cycling, decomposition, and symbiotic interactions.

They exhibit remarkable diversity in terms of morphology, size and colour.Macrofungi, commonly referred to as mushrooms, are fungi that produce conspicuous fruiting bodies visible to the naked eye. Based on their ecological roles, macrofungi are broadly classified into saprophytes, symbionts (mycorrhizal fungi), and parasites.These fungi predominantly belong to the divisions Basidiomycota and Ascomycota. Among these, basidiomycetesplay a significant role in improving soil fertility through the decomposition of plant litter and woody debris, leading to the accumulation of organic matter in soil ecosystems (Floudas *et al.* 2012). The diversity and distribution of macrofungi are strongly influenced by ecological factors such as soil temperature, rainfall, humidity, vegetation type, and availability of suitable substrates.

Globally, it is estimated that approximately 1.5 to 5.1 million fungal species exist, of which only about species have been formally described. Among these, nearly 41,000 macrofungal species have been identified worldwide; however, only about 2% of these have been reported from India, indicating a significant knowledge gap in fungal diversity studies. Several studies have documented the diversity, distribution, and ecological significance of macrofungi in different

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forest ecosystems. Research conducted in the Western Ghats and other regions of India has reported rich macrofungal diversity and highlighted the influence of habitat type, seasonal variation, and environmental factors on fungal distribution (Swapna *et al*. 2008; Mohanan, 2014; Senthilarasu, 2014; Ranadave*et al*. 2022; Singh *et al*.2024). At the global level, Mueller *et al.* (2007) discussed patterns of macrofungal diversity and distribution, while Paulus *et al.* (2006) demonstrated the ecological role of fungi in forest litter decomposition. Collectively, these studies highlight the importance of systematic surveys for understanding macrofungal biodiversity and ecosystem functioning.Due to the short lifespan of sporocarps and their high sensitivity to climatic variations, many macrofungal species remain unexplored and under-documented. Therefore, systematic surveys and documentation are essential for understanding their diversity and ecological significance. The present study aims to explore the macrofungal diversity of different regions in the western part of Nashik District, with a focus on documentation and conservation through the preparation of spore prints and detailed records. This study is expected to provide baseline data that will be valuable for future taxonomic, ecological, and conservation-oriented research.

MATERIALS AND METHODS

Study Area

The study was conducted in Kalwan and Dindori Tahsils of Nashik District, Maharashtra, India. This region is characterized by diverse geographical features, favourable climatic conditions, and substantial forest cover, which collectively support the growth and distribution of macrofungi. Diversity, high rainfall, moderate temperatures, and varied vegetation types provide suitable substrates for macrofungal colonization and fruiting.

Collection of macrofungal samples

Macrofungal specimens were collected during the peak fruiting season, primarily in the monsoon months (June to September) and extending into the early winter months (October and November). Extensive field surveys were conducted across different habitats in the western part of Nashik District. Fresh and mature sporocarps were carefully collected from soil, leaf litter, decaying wood, and other organic substrates.

For the collection of fruiting bodies, standard field equipment such as forceps, sharp knives, magnifying lenses, collection boxes, polythene bags and zip-lock bags were used to ensure minimal damage to specimens. Each collected sample was properly labeled and preserved for further examination.

Photographic documentation

Photographic documentation of macrofungal specimens was carried out both in situ and ex situ to record natural habitat conditions and morphological features. High-resolution photographs were taken using a digital camera, and GPS coordinates were recorded for each collection site.

Identification of macrofungi

Identification of macrofungal specimens was based on a combination of sporeprintanalysis, morphological characteristics, and taxonomic literature. Spore print color was used as an important diagnostic feature for species identification. For spore print preparation, the stipe was removed and the pileus was placed with the gill or pore surface facing downward on whiteand gelatin paper. A small piece of wet cotton was placed near the pileus, and the setup was covered with a glass jar and left undisturbed for several hours or overnight. The resulting spore print color was recorded and preserved for reference and conservation purposes.

Detailed macromorphological observations of fresh fruiting bodies were recorded in the field and laboratory, including pileus shape, size, color, surface characteristics, margin, hymenophore type (gills, pores, or teeth), stipe dimensions and features, context, odor, and texture. Microscopic examination was carried out using hand-cut sections of relevant tissues mounted in distilled water and suitable staining reagents. Diagnostic characters such as spore size, shape,

ornamentation, basidia, cystidia, hyphal system, and the presence or absence of clamp connections were examined under a compound microscope and measured using standard mycological procedures. Identification of specimens was done using standard taxonomic keys and reference literature, including Illustrated Genera of Wood Decaying Fungi and publications by Leif Ryvarden on polypore taxonomy. Additional identification was supported by relevant regional and national mycological literature. Scientific names and current nomenclature were verified using the online databasesto ensure taxonomic accuracy and updated classification.

RESULTSAND DISCUSSION

A large no. of macrofungi, belonging to different families are reported below. Family-wise composition of these in the studied Kalwan and Dindori Tahsils, Nashik District, Maharashtra have been enumerated in Table 1 & Fig.1.

Enumeration and description of macrofungal species

Termitomyces microcarpus (Berk. & Broome) R. Heim

It is an agaricoid mushroom belonging to the family Lyophyllaceae. It is a wild, edible macrofungus commonly recorded from forested regions of Nashik District, Maharashtra, India. The pileus measures approximately 1.5–2.5 cm in diameter, is white, convex, smooth in texture, and has an entire margin. The species emits a slightly acrid odour and typically grows in dense clusters. The stipe is central, hollow, white, and ranges from 4–8 cm in length; an annulus is absent. The lamellae are white, closely spaced, and decurrent.

Tricholoma acerbum (Bull.) Quél.

It is a gilled macrofungus belonging to the family Tricholomataceae. It is an ectomycorrhizal species commonly found in woodland habitats, where it forms a symbiotic association with broad-leaved trees.The pileus measures approximately 6–10 cm in diameter and is umbonate in shape. The stipe is 4–13 cm long. The fruiting body emits a slightly fruity odour and has a distinctly sour taste. The lamellae are white, smooth, closely spaced, and free. The spore print is white.

Clitocybe vibecina (Fr.) Quél.

It belongs to the family Tricholomataceae. The pileus is depressed at the center with a downturned margin, brownish-gray in moist conditions, measuring approximately 2.5–3.5 cm in diameter, and emits a rancid odour. The species name vibecina refers to the slightly raised striations on the cap surface. The stipe is dark brown, ringless, 6–8 cm long, and 0.5 cm thick. The lamellae are free, close, smooth, and off-white to creamy. The spore print is white.

Laccaria laccata (Scop.) Cooke

It is belongs to the family Hydnangiaceae and is commonly found in forest ecosystems. It is a soil-inhabiting macrofungus that typically grows solitarily. The fruiting body is small and orange-brown in colour.The pileus measures approximately 1–2.5 cm in diameter, while the stipe is about 3 cm long. The lamellae are scaly, short, distant, and decurrent.

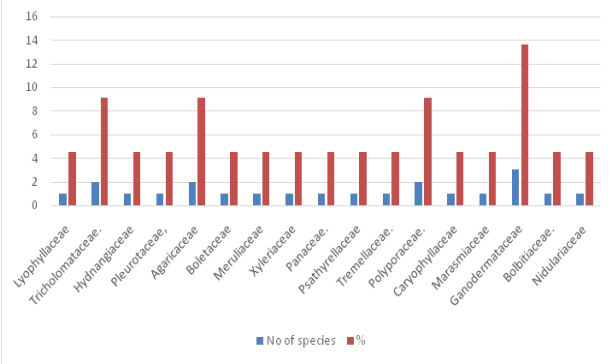

Fig 1: Family-wise composition of different macrofungi indicating no. of genera and speciesrecorded from Kalwan and Dindori Tahsils, Nashik District

Pleurotus pulmonarius (Fr.) Quél.

It is a macrofungus belonging to the family Pleurotaceae, commonly known as the lung oyster mushroom. This species typically grows on deciduous tree trunks and fallen or decaying wood logs. The basidiocarps occur in dense, overlapping clusters. The sporocarp measures approximately 5–6 cm in height, with a pileus diameter of 5–13 cm. The lamellae are white to

Fig. 2: Some of the macrofungi described and Kalwan and Dindori Tahsils, Nashik District. **A**- *Coprinopsislogopus* **B-** *Hexagonia tenuis* **C-***Marasmiushaematocephalus* **D-***Ganoderma applanatum* **E-** *Clitocybe vibecina* **F-** *Conocybetenera* **G-***Leucoagaricus meleagris* **H-** *Macrolepiota mastoidea* **I-** *Cyathus striatus* **J-** *Trametes gibbosa*

off-white, smooth, and decurrent. The spore print is white. *Pleurotus pulmonarius* is a well-known edible mushroom of nutritional and economic importance.

***Macrolepiota mastoidea* (Fr.) Singer**

It is a fleshy macrofungus belonging to the family Agaricaceae. The pileus is white and umbonate, with a dark brown central disc. The cap measures approximately 3–6 cm in diameter and bears brown scales, which are remnants of the universal veil. The lamellae are broad, white, smooth, and free. The stipe is 5–7 cm long, with a distinct, movable ring. The stipe colour varies from white to dark brown. This species is an edible fungus commonly found growing in grassy areas adjacent to woodland habitats. The spore print is white, and the spores are ellipsoid in shape.

***Leucoagaricus meleagris* (Sowerby) Singer**

It belongs to the family Agaricaceae. This lepiotoid mushroom typically grows on wood chips or compost heaps, often in dense clusters. The pileus is white with a dark brown central disc and dark brown scales, measuring up to 10 cm in diameter. The margin is entire with marginal striations, and the cap edge is ribbed. The stipe is brown, finely fibrillose, scaly, thickened toward the base, measuring up to 13 cm long and 1–1.5 cm wide. The lamellae are free, pale yellow, smooth, and crowded. The spore print is white.

***Leccinum percandidum* (J. Blum)**

It is an ectomycorrhizal macrofungus belonging to the family Boletaceae. The pileus is white to pale cream in color and measures approximately 6–10 cm in diameter. The stipe is 7–13 cm long, white, ringless, and bears fine scabrous projections. It is broader at the base and gradually narrows towards the pileus. The hymenophore consists of white, smooth pores.

***Podoscypha petalodes* (Berk.) Boidin**

It belongs to the family Meruliaceae. This macrofungus is commonly found in woodland

Table 1 : Family-wise Composition of Macrofungi in Kalwan and Dindori Tahsils, Nashik District

Family	No of species	Percentage (%)
Lyophyllaceae	1	4.5
Tricholomataceae.	2	9.1
Hydnangiaceae	1	4.5
Pleurotaceae,	1	4.5
Agaricaceae	2	9.1
Boletaceae	1	4.5
Meruliaceae	1	4.5
Xyleriaceae	1	4.5
Panaceae.	1	4.5
Psathyrellaceae	1	4.5
Tremellaceae.	1	4.5
Polyporaceae.	2	9.1
Clyophyllaceae	1	4.5
Marasmiaceae	1	4.5
Ganodermataceae	3	13.6
Bolbitiaceae.	1	4.5
Nidulariaceae	1	4.5

habitats and produces distinctive rosette-like fruiting bodies, which gives it the common name “ruffled paper fungus.” The basidiocarps are approximately 2–5 cm in height and 1–2 cm in diameter, light brown to chestnut brown in colour, with darker concentric zones. The margins of the basidiocarps are curled inward. The stipe is short and brown.

***Xylaria telfairii* (Berk.) Sacc.**

It belongs to the phylum Ascomycota and the familyXylariaceae , commonly referred to as sac fungi. This saprophytic macrofungus grows on decaying wood logs, either solitarily or in groups. The fruiting body is 2–4.5 cm in length and 1–2 cm thick, resembling a finger with a rounded tip. Its colour ranges from dark brown to black, while the stipe is long or sometimes very short, black in colour. The inner tissue is white, tough, and fibrous.

***Panus neostrigonus* Drechsler-Santos & Wartchow**

It is a macrofungus belonging to the phylum Basidiomycota and the family Panaceae. This species typically grows on dead hardwood, producing a brown to tan fruiting body that is densely covered with short hairs. The pileus is

funnel-shaped, measuring approximately 2–3 cm in diameter, with hairs 1–2 mm long. The cap margin is inrolled and entire, maintaining the funnel shape. The lamellae are decurrent, short, close, and pale brown. The stipe is 1–2 cm long, off-center, dry, and densely hairy, with a coloursimilar to the cap.

***Coprinopsis lagopus* (Fr.) Redhead**

It belongs to the family Psathyrellaceae and is commonly known as the inky cap mushroom. The pileus measures 1–4 cm when expanded, with a gray to black coloration. The cap margin rolls upward with age, eventually turning black. The stipe is 10–13 cm long and 3–5 mm in diameter, white, hollow, delicate, without an annulus, densely hairy at the base, and tapering toward the apex. The lamellae are adnexed to the stipe, gray to blackish, and deliquesce, liquefying into black ink as the mushroom matures. Acts as a saprotroph, decomposing decaying organic matter and contributing to nutrient cycling in forest ecosystems. Provides a microhabitat for soil microorganisms and aids in soil health maintenance.

***Tramella mesenterica* Retzius: Fries**

It belongs to the family Tremellaceae. It is a common jelly fungus and a parasitic species, typically growing on deadwood, especially sticks with attached bark. The fruiting bodies are 0.5–2 cm in diameter, orangish-yellow, and have a gelatinous, brain-lobed appearance.

***Trametes gibbosa* (Pers.) Fr.**

It belongs to the family Polyporaceae. It is a saprophytic macrofungus that grows on dead hardwood, either solitarily or gregariously. The pileus is bean-shaped, measuring 3–7 cm across and 0.5–1.5 cm thick, with distinct green and white zonation. The surface is hairy, leathery, and convex. The pore surface is white to pale brown, with thick, maze-like pores 2–5 mm deep. The stipe is absent, slightly swollen at the point of attachment to the wood, and the fruiting body emits a strong odour.

***Hexagonia tenuis* (Hook.) Fr.**

It belongs to the family Polyporaceae. The fruiting body is solitary, flat, sessile, and broadly attached to the branch, with a fan-shaped, flexible structure. It is annual to perennial, tough, and displays distinct zonation on the pileus. The cap is brown with a thin, wavy, entire white margin. The pore surface is bluish, with hexagonal, angular pores. The fruiting body measures approximately 4.5 cm broad, 3.5 cm wide, and 1–3 mm thick.

***Termitomyces tylerianus* R. Heim**

It belongs to the family Lyophyllaceae. The pileus is smoky white with a dark brown umbonate centre, growing in dense clusters near termite nests in deciduous forests. On maturity, the cap flattens and the margin often splits. The cap measures approximately 2.5–5 cm in diameter and bears smooth lamellae. The stipe is 4.5–9.5 cm long, 0.5 cm wide, cylindrical, equal from top to bottom, white to pale brown, and ringless.

***Marasmius haematocephalus* (Mont.) Fr.**

It belongs to the family Marasmiaceae and is commonly known as the parachute mushroom. It is a saprophytic fungus that typically grows on decaying wood. The pileus is broad, umbonate, sub-hemispherical to convex, measuring approximately 2.5–3.5 cm in diameter, glabrous, and deep reddish-brown with an entire margin. The stipe is 3–4 cm long, central, rigid, smooth, cylindrical, shining, and blackish-brown. The lamellae are widely spaced, creamy white to off-white, and free.

***Ganoderma applanatum* (Pers.) Pat.**

It belongs to the family Ganodermataceae. It is a saprophytic and parasitic macrofungus that grows on living and dead trees. The species is perennial, producing thick, hard, woody fruiting bodies measuring approximately 2–10 cm in width, 3–32 cm in length, and 1–3 cm in thickness. The pileus is dark brown with a white margin.

***Ganoderma sessile* Murrill**

It belongs to the family Ganodermataceae. It is a parasitic and saprophytic macrofungus, typically growing solitarily or in overlapping clusters. It is commonly found at the base of living deciduous trees, on dead wood and roots. The pileus

measures approximately 5–12 cm in width, with a dark reddish-brown to orangish-red, shiny upper surface and a white, glabrous margin. The stipe is generally absent, but when present, it is short, thick, central, 3.5–4 cm wide, 2 cm thick, and hard.

***Ganoderma lucidum* (Curtis) P. Karst.**

It belongs to the family Ganodermataceae. This species is commonly associated with deciduous trees and occurs as a parasitic fungus, growing at the base of living trees or on stumps. The sporocarp attains up to 5 cm in height, with a pileus diameter ranging from 2–30 cm. The basidiocarp is hard and woody in texture and emits an unpleasant odour. The spore print is reddish-brown.

***Conocybe tenera* (Schaeff.) Fayod**

It belongs to the family Bolbitiaceae. The fruiting body has a dark brown to rust-brown cap, measuring approximately 1–2 cm in diameter. The cap is initially conical, later becoming bell-shaped, with an entire margin showing light striations and a smooth surface. The stipe is straight, slender, 4–6 cm long, 2–3 mm in diameter, rusty brown, hollow, delicate, and ringless. The lamellae are adnexed to the stipe, pale ochre, moderately spaced, with edges paler than the gill face.

***Cyathus striatus* (Huds.) Willd.**

It belongs to the family Nidulariaceae. It is a saprophytic macrofungus that typically grows on forest debris or exposed wood and is perennial. The fruiting body is funnel-shaped, measuring approximately 5–7 mm in width and 6–10 mm in length. The outer surface of the cap bears dark brown, woolly tufts of hair, while the inner surface shows distinct grooves and a shiny appearance. The peridioles (“eggs”) are ellipsoid, 2–3 mm wide, sheathed, and attached to the nest by cords. The stipe is very short.

Previous studies have demonstrated the importance of systematic sampling and detailed morphological characterization for macrofungal identification and diversity assessment. In Maharashtra, a total of 178 macrofungal species representing 68 genera, 23 families, and 5 orders have been documented (Senthilarasu, 2014). Lodge *et al.* (2004) provided standardized methods for the collection and description of macrofungi, while Mangalagangotri (2016) highlighted the rich diversity and seasonal distribution of macrofungi in the Western Ghats of India. Studies by Pradhan *et al.* (2013) and Tapwal*et al*. (2013) further emphasized habitat specificity and the association of macrofungi with tropical forest ecosystems. These studies, along with the present study serve as important references for macrofungal taxonomy and biodiversity research.

CONCLUSION

During field surveys conducted in various parts of Kalwan and Dindori Tahsils of Nashik District, a total of 22 genera of macrofungi belonging to 17 families and two phyla were recorded, with exact GPS locations documented for each collection site. The fungal community was dominated by members of Basidiomycotina, while Ascomycotina was represented by only one species (*Xylaria telfairri*), indicating a strong majority of basidiomycetous fungi in the study area. Among these, Ganodermataceae showed the highest diversity with three species, indicating its strong adaptation and ecological dominance in the study area. Families such as Tricholomataceae, Agaricaceae, and Poly-poraceae each contributedwith two species, suggesting moderate distribution and ecological significance. The remaining families were represented by only one species each, showing low abundance and restricted occurrence. This irregular distribution of species among families shows differences in habitat, available substrate, and environmental conditions that affect macrofungal diversity. However, field observations discovered a significant loss of macrofungal diversity due to human activities, including deforestation, overharvesting, and habitat disturbance. This shows the urgent need for effective conservation methods to protect fungal diversity. The dominance of wood-decaying and saprophytic fungi suggests favourable ecological conditions for fungal growth and highlights the ecological importance of fungi in nutrient cycling and decomposition within the

study area. These findings stress the importance of conservation, habitat protection, and additional seasonal studies to understand and preserve macrofungal biodiversity in the area.

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DECLARATION

Conflict of Interest. Authors declare no conflict of interest.

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