

Morphological and Microscopic Characterization and Identification of fam. Polyporaceae (order Polyporales) from Nagpur District, Maharashtra, India

A. S. Bagde¹ and Yemul N. B.²

Research Scholar, Department of Botany¹

Assistant Professor, Department of Botany²

Institute of Science, Nagpur

iamanchal22@gmail.com

Abstract: India exhibits rich diversity of wild mushrooms and macro-fungi which plays a crucial role in the maintenance of the forest ecosystem. The present study revolves around systematic surveys, standard characterization and documentation of macro-fungal diversity, specifically wood-rotting Polyporales. Polyporales is one of the largest orders of class Agaricomycetes within phylum Basidiomycota, with more than 2500 known species. The Central India region including the Nagpur district is yet to be documented thoroughly with respect to these fungi. Therefore, field surveys around Hingna, Ramtek, Champa (Umred) and Wadi, Nagpur were conducted which leads to the collection of total 30 polypore fungi belonging to diverse genera and families, suggesting a significant diversity of Polyporales. The spore print, morphological, macroscopic and anatomical characteristics were documented and identification was made using standard mycological keys and literature references. The result showed high variation among the fungi even after belonging to the same order and indicated that most of the collected polypore fungi belong to family Polyporaceae. The evaluation led to the identification of 5 different genera and among the rest 25 fungi, genus or family were not accurately identified; which concluded that 25 out of 30 polypore fungi (83.33%) required more than mere morphological and anatomical evaluation. In addition, these fungi are documented by former researchers for their bioactive properties, thus paving a path in the pharmaceutical, industrial and agricultural field. Therefore, further analysis and research is still in progress.

Keywords: Polyporales, Basidiomycota, Wood rotting fungi, Nagpur.

I. INTRODUCTION

The term “polypore” refers to the large number of pores on the underside of cap (Darlis *et al.*, 2019). The polyporoid fungi are known for their distinctive shelf-like basidiocarp with characteristic pore-bearing poroid or lamellate hymenial surface producing variable basidiospores and therefore commonly referred to as “polypores”. Polyporoid fungi are ubiquitous; some of the members are necrotrophs whereas most members are saprotrophic fungi (Lestari *et al.*, 2018). These polyporoid fungi are known to significantly influence wood degradation processes by their ability to colonise the lingo-cellulosic substrates of the wood due to secretion of distinct extra-cellular ligno-cellulose degrading enzymes (Berrin *et al.*, 2012). They even engage in complex ecological interactions with other organisms, thereby facilitating carbon cycling and contributing to the survival and regeneration of the forest ecosystem (Xu *et al.*, 2015) (Floudas *et al.*, 2012).



Polyporales, one of the largest orders of class Agaricomycetes within the phylum Basidiomycota, comprises more than 2,500 species belonging to 255 genera and 18 families. In 2008, Kirk *et al.* provided a revised checklist with roughly 1,800 species of Polyporales worldwide, classified into about 216 genera and 13 families. Barely a decade later, a comprehensive outline by He *et al.* (2019) updated those figures to approximately 2,500 species in 285 genera, organized into 18 families (Liu *et al.*, 2023). As of May 2025, a total of 4,026 polyporoid species have been described worldwide (Zhao *et al.*, 2025) (Nayka *et al.*, 2025).

The family Polyporaceae exhibits the highest macro-fungal global diversity within the order Polyporales. However, there exists a large unexplored mycota within the family Polyporaceae which hasn't been identified and validly documented from the varied territories of the Central India. Hence, the present study has been undertaken to initiate an effort to survey and collect Polypores from selected area of Nagpur district and identify the collected Polypore samples using standard mycological literature.

II. LITERATURE REVIEW

The pioneer work in the domain of polyporoid fungi was introduced through “*Nova Plantarum Genera*” by Dr. P. A. Micheli in 1729, in which Micheli described 14 stipitate, pileate species having pores on the hymenial surface of their fructifications and grouped them under the novel genus *Polyporus*. However, this taxonomic classification was initially considered illegitimate as Linnaeus (1753) didn't agree with Micheli and merged genus *Polyporus* into *Boletus*.

In the beginning, the taxonomic approaches for the studies of polyporoid fungi relied completely on gross morphological characteristics (Runnel *et al.*, 2021). Polyporaceae Fr. ex Corda is the oldest and first validly published family in Polyporales, which was proposed by Fries (1838) to include all fungi with poroid hymenophores (Liu *et al.*, 2023). The systematic position of the polyporoid fungi has been debated from time to time. The historical mycologists placed these fungi within family Polyporaceae of order Aphyllophorales but later elevated to the independent order Polyporales (Gäumann, 1926). Based on morphological characters, he further classified the order into ten families including Polyporaceae. Hawksworth *et al.* (1983) further supported this elevation of order Polyporales for the classification of polyporoid fungi and included most of these fungi in the family *Polyporaceae*.

G.H. Cunningham made significant contributions that represent the taxonomic evolution from traditional morphological characters to microscopic anatomical basis in the study of polyporoid fungi. In 1927, he classified Polyporales into two families i.e. Boletaceae and Polyporaceae, based on gross morphology. However, Cunningham (1965) in his publication “*The Polyporaceae of New Zealand*” segregated the family Polyporaceae into two sub-families (*Fomitoidae* and *Polyporoideae*) based on the features pertaining to the hyphae in the context region of the basidiome. This historic shift occurred after the introduction of the microscopic anatomical characterization of the basidiocarp provided by Corner (1932).

Later, Jülich (1981) introduced 29 new family names for the diversity of wood-decay fungi; however, most of his proposed families were ignored until the origin of DNA sequencing. Kirk *et al.* (2008) in his publication “*Dictionary of Fungi*” further refined Basidiomycota into three subphyla—Pucciniomycotina, Ustilaginomycotina, and Agaricomycotina, splitting the latter into three distinct classes Tremellomycetes, Dacrymycetes, and Agaricomycetes. The class Agaricomycetes was spread across 10 orders including Polyporales. He recognized 13 families within the order Polyporales.

Based on the phylogenetic analysis, Justo *et al.* (2017) provided a revised family-level classification of Polyporales with **18 distinct families including** three new families (Cerreaceae fam. nov., Gelatoporiaceae fam. nov., Panaceae fam. nov.) The rest fifteen families included previously established 8 families by Jülich (Dacrybolaceae, Fomitopsidaceae, Grifolaceae, Hyphodermataceae, Incrustoporiaceae, Ischnodermataceae, Laetiporaceae, Meripilaceae) and newly proposed 7 families (Meruliaceae, Phanerochaetaceae, Podoscyphaceae, Polyporaceae, Sparassidaceae, Steccherinaceae, Irpicaceae.).

After multiple revisions, today researchers recognized 18–20 families within Polyporales including Polyporaceae. Recently, two new families i.e. Climacocystaceae and Gloeoporellaceae have been added (Liu *et al.*, 2023). Over the



past decade, significant advances in the molecular phylogenetics have further reorganised the taxonomy and classification of polypore fungi (Xu *et al.*, 2025) (Hibbett *et al.*, 2014) (Nayka *et al.*, 2025).

III. RESEARCH METHODOLOGY

Field Survey of Study Area: To accomplish the objectives set in the present work, extensive field survey have been conducted around Hingna, Ramtek, Champa (Umred) and Wadi of the Nagpur District, Maharashtra state, India during the period of July 2025- July 2026.

Collection of Polyporales and On-field analysis of the study area: The basidiocarp of polypore fungi have been collected at various growing stages. The critical information and photographs regarding the date of collection, locality, and type of host and pattern of attachment with the host have been taken.

Evaluation of Fungal Specimens:

The evaluation of collected polyporoid fungi was made as per the methods given by Ryvarden & Melo (2014).

Spore print slide preparation: The spore prints were taken by keeping hymenial surface of fresh basidiocarp on the glass slides. A moist blotting paper was kept on the upper surface of pileus along with a little weight on the blotting paper was kept overnight on the glass slide. In the morning, the basidiocarp was removed and glass slide with spore print was observed under the microscope.

Macro-morphological characterization such as crust form, nature, shape, colour, size by scale measurements, texture, smell, rot type, pattern of attachment to the host, pore surface and reaction with KOH of basidiocarp of Polypore fungi have been studied.

Microscopic and anatomical characteristics such as hyphal system, clamp connections, basidia, cystidia or setae of basidiocarp have been studied by mounting a thin section of context and tube layers with 1% phloxine and 3% KOH.

Identification of the specimen: Both morphological and anatomical characters have been studied and analysed thoroughly to identify the correct genus and family of polyporoid fungi specimen. The accurate identification of studied fungal specimen has been evaluated by comparing it with the standard mycological keys and literature references.

IV. RESULTS AND DISCUSSION

The field surveys led to the collection of 30 polyporoid fungal specimens. The analysis of these collected specimens showed high variation among the fungi even after belonging to the same order and indicated that most of the collected polypore fungi belong to family Polyporaceae. The evaluation led to the identification of 5 different genera i.e *Microporus xanthopus*, *Hexagonia nitida*, *Neofavolus alveolaris*, *Trametes gibbosa* and *Lenzites acuta*, among the rest 25 fungi, genus or family were not accurately identified.

All the identified polypore fungi were found on dead wooden logs and showed white rot symptoms.

S-01: *Microporus xanthopus*

Annual, solitary; basidiocarp abhymenial surface rusty orange, coriaceous, laccate, infundibuliform, zonate; hymenial surface white to pale brown, poroid, pores round, 38-45 per mm; pileus 6.5cm diameter, 2mm thick; margins white, entire, sterile; centrally stipitate, stipe bright yellow, solid, woody; trimitic hyphal system; smooth; white, cylindrical to allantoid basidiospores; clavate, club-shaped cystidioles; basidia not observed; no chemical reaction with 5% KOH.

Key identifying character: Bright yellow stipe contrasting to rusty orange infundibuliform basidiocarp and thus commonly named as "Yellow-footed Polypore".

S-02: *Hexagonia nitida*

Annual, solitary; basidiocarp abhymenial surface white, dimidiate, zonate; hymenial surface poroid, pores hexagonal that give honeycomb like-appearance, 1-2 per mm; pileus 4.5 × 3.5 × 0.5cm; context 0.5mm, homogenous; tube length 1mm; margins white, entire, sterile; dimitic hyphal system- generative and skeletal hyphae observed; smooth, white, allantoid basidiospores; smooth, tubular cystidioles; basidia not observed; context turned black on chemical reaction with 5% KOH.



Key identifying character: Dimidiate basidiocarp with poroid hexagonal hymenophore giving honeycomb-like appearance.

S-03: *Neofavolus alveolaris*

Annual, solitary to groups; basidiocarp abhymenial surface cream colored, smooth, longitudinal slits, azonate; hymenial surface poroid, pores diamond-shaped; pileus $6 \times 4.2 \times 0.5$ cm; homogenous context; margins concolorous, fertile; laterally stipitate, stipe 0.7cm long, 0.4cm thick; dimitic hyphal system— generative and skeletal hyphae; hyaline, white, sub-cylindrical basidiospores; smooth, spatulate cystidioles; rod-shaped, curved, bi-tegmic basidia; turned yellow on chemical reaction with 5% KOH.

Key identifying character: Poroid hymenophore with diamond-shaped pores.

S-04: *Trametes gibbosa*

Annual, solitary to groups; basidiocarp abhymenial surface white, dimidiate, zonate, laccate; abhymenial surface white, poroid, pores radially elongated, 9-10 per mm; pileus $6 \times 3 \times 0.7$ cm; context 0.3cm, homogenous; tube length 0.1cm; margins white, sterile; trimitic hyphal system; smooth, white, cylindrical to ellipsoid basidiospores; clavate, club-shaped cystidioles; basidia not observed; turned yellow on chemical reaction with 5% KOH.

Key identifying character: White, dimidiate basidiocarp with poroid hymenophore with radially elongated pores.

S-05: *Lenzites acuta*

Annual, solitary to groups; basidiocarp abhymenial surface white to cream, dimidiate, corky, zonate; hymenial surface cream coloured, mixed type poroid at centre to dichotomously forked lamellae toward the periphery, pores 1-2 per mm; context 0.1mm, homogenous; tube length 2-4mm; margins concolorous, fertile; trimitic hyphal system; smooth, white, cylindrical to allantoid basidiospores; cystidioles and basidia not observed; no chemical reaction with 5% KOH.

Key identifying character: Dimidiate basidiocarp with mixed type poroid to dichotomously forked lamellate hymenophore.

Sample code	Chemical reaction with 5% KOH
S-01	-
S-02	+
S-03	+
S-04	+
S-05	-

Table no. 1: Chemical reaction of identified polyporoid fungal specimens with 5% KOH

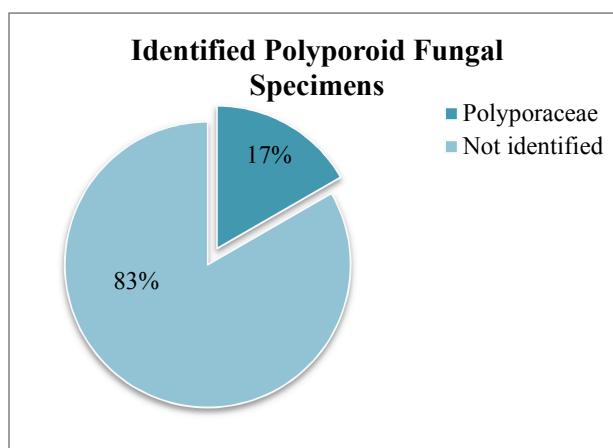


Fig. 2: Percentage of identified polyporoid fungal specimens



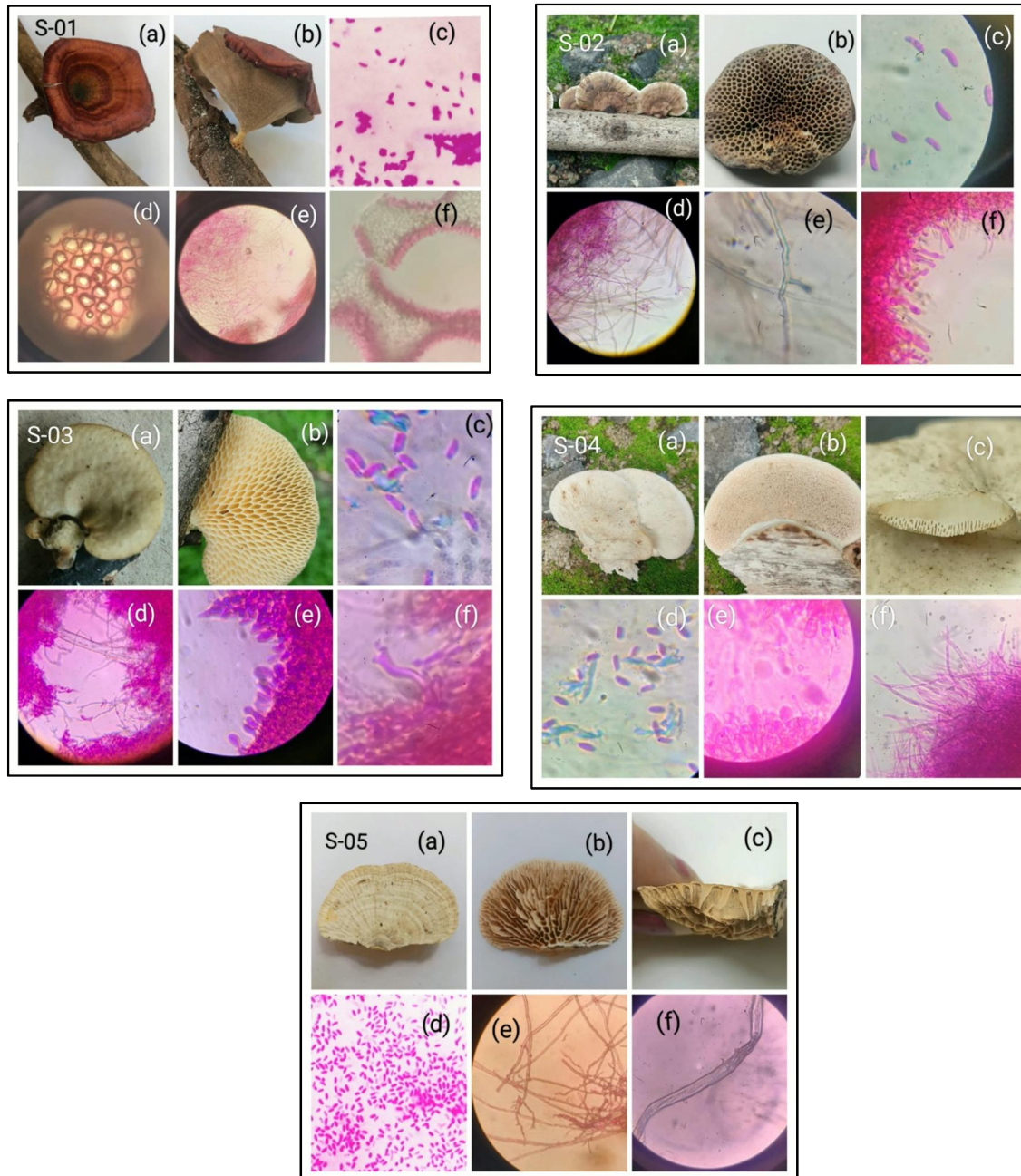


Fig. 1: Polypore fungi

-01: *Microporus xanthopus* -(a) Abhymenial surface of basidiocarp, (b) Hymenial surface of basidiocarp, (c) Basidiospores, (d) Pores per mm, (e) Hyphal system, (f) Cystidioles.

S-02: *Hexagonia nitida*-(a) Abhymenial surface of basidiocarp, (b) Hymenial surface of basidiocarp, (c) Basidiospores, (d) Hyphal system, (e) Branched generative hyphae, (f) Cystidioles.



S-03: Neofavolus alveolaris- (a) Abhymenial surface of basidiocarp, (b) Hymenial surface of basidiocarp, (c) Basidiospores, (d) Hyphal system, (e) Cystidioles, (f) Bitegmic basidia.

S-04: Trametes gibbosa - (a) Abhymenial surface of basidiocarp, (b) Hymenial surface of basidiocarp, (c) Context and tube layers, (d) Basidiospores, (e) Cystidioles, (f) Generative hyphae.

S-05: Lenzites acuta - (a) Abhymenial surface of basidiocarp, (b) Hymenial surface of basidiocarp, (c) Context and tube layers, (d) Basidiospores, (e) Generative hyphae, (f) Skeletal hyphae.

V. CONCLUSIONS

The field surveys showed the presence of rich unexplored polypore macro-fungal diversity across the Nagpur region. The evaluation of collected fungi led to the identification of only 5 different genera which concluded that 25 out of 30 polypore fungi (83.33%) required more than mere morphological and anatomical evaluation for accurate identification of polyporoid fungi up to species level. The present study provides foundational data to strengthen the literature for taxonomic studies of fungal diversity in the Central India region and thus further research in phylogenetic and bioactive analysis can bring a potent outcome.

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