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Taxonomic and ecological insights into ganodermataceae and hymenochaetaceae: a study of poroid fungi in the Melghat Region, Maharashtra, India

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Abstract

This study delves into the ecological and taxonomic aspects of poroid fungi, particularly within the Hymenochaetaceae family, in the Melghat region of Maharashtra, India. Fungi of this family are known for their diverse roles, from causing diseases in trees to possessing medicinal and nutritional significance. The research, conducted through meticulous field collection and laboratory examinations, focuses on four key species: Phellinus rimosus, Phellinus torulosus, Ganoderma applanatum, and Ganoderma lucidum. The morphological descriptions of these fungi encompass macroscopic features such as basidiocarp characteristics, color variations, and structural details, as well as microscopic elements including hyphal systems, basidia, and basidiospores. The findings highlight the adaptability and ecological versatility of these fungi, thriving on both living and dead hardwood trees. The study emphasizes the need for continued research to uncover the intricate ecological roles of these fungi and their broader impact on forest ecosystems. Additionally, the documentation of medicinal and nutritional importance adds a layer of complexity to the understanding of these fungal species. Overall, this research contributes valuable insights into fungal diversity, serving as a resource for mycologists, ecologists, and conservationists working towards a comprehensive understanding and preservation of fungal ecosystems.

Keywords:

Introduction

Family Hymenochaetaceae (Agaricomycetes, Hymenochaetales) is characteristic in having resupinate to pileate, smooth to poroid basidiocarps, xanthochroic tissue, hyphae without clamps, presence/absence of setae, two to four sterigmate basidia and thin- to thick-walled basidiospores. Several taxa of the family are reported to be implicated in many diseases of broad-leaved and coniferous trees, causing various types of rots and diseases. A large number of the species have medicinal and nutritional importance. Fungi play a vital role in forest ecosystems, whether their impact is positive or negative[1].

They exhibit remarkable adaptability, thriving in various climatic conditions[2]. Fungi constitute the second-largest group of terrestrial organisms, inhabiting all ecosystems worldwide. While an estimated 1.5 million fungal species exist, only 69,000 have been identified, including 46,124 Basidiomycetes and Ascomycetes species. Phellinus species are responsible for causing white rot, breaking down both lignin and cellulose. These fungi can be parasitic, perthophytic, or saprobic, as documented in studies[3,4].

They have a broad host range, infecting both angiosperms and gymnosperms, leading to heart rot disease in live, standing trees[5].

The genus Ganoderma P. Karst., includes poroid wood degrading macrofungi with cosmopolitan distribution mainly in tropical and sub-tropical forests. These mushrooms normally grow as parasites or saprophytes on living trees or sometimes associated with logs of wood and tree stumps. Species of Ganoderma are known to cause different types of rots by decomposing lignin as well as cellulose and other related polysaccharides in both angiosperm and gymnosperm hosts. Root rot and stem rot caused by different Ganoderma species result in the decline of numerous forest tree species[6-8].

The current study focuses on the morphological description of the poroid fungi from Melghat, Amravati.

Materials and Methods

Area of Study: The research material was sourced from the Melghat region, situated in the northern part of the Amravati District within the Maharashtra State of India. Melghat is geographically positioned at coordinates 21°26′45″N latitude and 77°11′50″E longitude. This region is renowned for its favorable conditions, which make it an ideal habitat for a

diverse array of poroid fungi species. Numerous specimens belonging to the poroid fungi category were meticulously collected from the Melghat area for further study and analysis.

Collection of Sample: During the rainy and early dry seasons, we gathered selected poroid fungi from various spots within the Melghat forest. To harvest these wild mushrooms, we employed a hand lens, forceps, a sharp knife, and an axe. The fresh mushrooms, thriving in their natural environment, were documented through photography.

For subsequent macro and microscopic examinations, we carefully transported the mushrooms to the laboratory, ensuring they remained separated in individual polythene bags to avoid any mixing. Each time, we recorded essential details on a piece of notepaper, which was then attached to the package containing the collection. These details included a concise description of growth habits, habitat, location, altitude, collection number, date of collection, and forest type. We preserved these collections for later microscopy studies, following the identification of taxonomically significant macroscopic features using the field key mentioned above.

Sample Identification: The taxonomic identification of the specimen involved a comprehensive examination utilizing various tools and references. Visual inspection of the specimens, coupled with the use of optical microscopy to observe their spores, served as a fundamental starting point. Additionally, we relied on reference materials such as those found in Leif Ryverden and Ireneia Melo's books, as well as online databases like Index fungorum and Mycobank to aid in the identification process.

The macroscopic analysis encompassed a detailed description of several key aspects. This included an assessment of the habit and habitat of the basidiomata, an examination of the pileus involving an analysis of its shape, surface characteristics, edge definition, and size. Furthermore, we considered factors like the coloration and the number of pores per millimeter.

Moreover, the stipe, when present, underwent a thorough evaluation. Parameters such as its shape, color, consistency, surface attributes, apex configuration, base characteristics, and size were all meticulously documented.

For a more in-depth analysis, the collected specimens were subjected to further scrutiny within the laboratory setting. Here, we employed hand lenses and microscopes to investigate various microscopic features. These examinations focused on aspects like spore characteristics, hyphae morphology, setae presence, and other microscopic details, following the methodology outlinedis suudied[9].

Results and Discussion

Phellinus rimosus: **Description:** The Basidiocarps are cap-shaped, lasting for a long time, usually solitary, and can be either flat or three-sided with a sloping cap. They typically reach sizes of up to 12cm in width and 3-8cm in thickness at the base. Some specimens can be even larger. They are very hard and woody, with a sharp to rounded edge. Initially, their upper surface is mostly smooth and may have a narrow marginal zone. They vary in color from fulvous to dark brown, and they might be smooth or have a few wide grooved areas. They can be somewhat warty or have irregular bumps near the base. As they age, the upper layer becomes black and cracks, forming coarse polygonal shapes. Older specimens often have a greyish covering near the margin, indicating new growth.

The pore surface is yellow-brown in actively growing specimens, with thin-walled pores. In older specimens, the pores become more round and have thicker walls. The context (the inner flesh) is rusty to snuff brown, radially fibrous, and somewhat shiny when broken. It can be 0.5-3cm thick. The layers of tubes within the cap are fulvous brown and usually well-defined, with a thickness of up to 7cm. They can be easily cut.

Hyphal System: The hyphal system is described as "dimitic." Generative hyphae are variable in width (2.5-4.0µm) and are thin-walled, ranging from yellow to pale ruddy brown. They are simple-septate and moderately branched, mainly found in the tubes. In the context, there are also some hyphae with distinctly thickened septa and moderate branching, which are also considered generative hyphae. These hyphae are rusty brown and up to 7µm in diameter. Skeletal hyphae are 3-5µm in diameter, nearly solid in the trama (central portion), and somewhat wider in the context. It's challenging to distinguish between these hyphal types in the context.

Setae and Other Hymenial Elements: No setae or similar sterile hymenial elements are present.

Basidia: The basidia are broadly clavate, measuring 15-16µm in length and 7-8µm in width, with setrasterigmatic (rod-shaped) characteristics.

Basidiospores: Basidiospores are abundant, ranging from 5.5-7 µm in length and 4.5-6µm in width. They are broadly ellipsoid to subglobose in shape, with thick walls and a rusty brown color.

Substrate: These fungi can be found on both dead and living hardwood trees. In tropical areas, they are commonly associated with Fabaceae species, although they are also known to grow on various other tree types.

Remarks: This species is distinctive in Europe due to its southern distribution, unique black and cracked basidiocarps with relatively large pores, deeply colored globose spores, and the absence of setae. However, in tropical regions, the

identification can be more complex, leading to the proposal of numerous names for similar taxa[9].

Phellinus torulosus: **Description:** The description provided appears to be related to a species of fungi, likely in the Polyporus genus, specifically *Polyporus torulosus*. Here's a concise summary of the information:

Basidiocarps: These are the fruiting bodies of the fungus. They are perennial, meaning they last for a long time, and have a specific shape – triangular in vertical sections, with the upper surface horizontal and the lower surface at a 45-degree angle. They are thick and have dimensions of 46 cm wide, 28cm deep, and 11cm thick. The margin is rounded and up to 2cm thick. The upper surface is pale brown and can become blackened with age. The pore surface is yellowish-brown with 5-7 pores per millimeter.

Context: The inner tissue of the basidiocarp is yellowish-brown and turns black in KOH solution. It is hard and woody and can have multiple black layers.

Hyphal System: The fungus has a dimatic hyphal system. Contextual generative hyphae are thin-walled, hyaline to pale yellowish, and septate. Contextual skeletal hyphae are moderately thick-walled, bright yellowish-brown, and infrequently branched.

Setae: These are structures found on the fungus, measuring 2050x6-11µm. They are infrequent, thick-walled, and yellowish-brown.

Basidia: These are club-shaped structures measuring 14-16x5-6 µm, with four sterigmata.

Basidiospores: The spores produced by this fungus are 4-6x3-4 µm in size, ovoid to ellipsoid, hyaline, and smooth.

Substrata: The fungus is found on a range of hardwood trees.

Remarks: Polyporus torulosus basidiocarps grow at the base of tree trunks or on exposed roots, often covered by mosses and lichens. It is characterized by its fairly large setae and perennial, woody, rusty-brown basidio[9].

Ganoderma applanatum: **Description: Perennial Basidiocarps**: These structures are long-lasting and attached to the substrate. They have a woody to corky texture, often flat but occasionally irregular or hoof-shaped, with a crustose surface ranging from greyish to black or brown. The tops are covered in chocolate-brown spores, appearing dusty, and the margins are thin and white.

Pore Surface: Initially creamy white, it turns brown upon handling and dull buff as the basidiocarps age. Circular pores number 4-6 per millimeter.

Internal Tissue: The interior tissue is purplish brown with whitish streaks and patches, having a corky texture.

Tube Layers: Tube layers match the context tissue's color and are separated by context tissue, with each layer up to 13.5 millimeters thick.

Hyphal System: The hyphal system is trimitic, comprising inconspicuous generative hyphae, thick-walled contextual skeletal hyphae, and occasional binding hyphae. The upper crust consists of arboriform skeletal hyphae in a dense, agglutinated dark brown matrix.

Cystidia and Sterile Hymenial Elements: These elements are absent.

Basidia: Basidia are typically 18-25 micrometers long and 8-10 micrometers wide, broadly clavate with a star-like structure, and may have a narrow base. They arise from intercalary positions on the subhymanial hyphae and possess a basal clamp.

Basidiospores: Basidiospores are ovoid, measuring 6-8.5 micrometers in length and 4.5-6 micrometers in width, truncated at the distal end, with two walls connected by inner-wall pillars. They are brown and do not react with Melzer's reagent.

Substrata: This fungus acts as a saprotroph, feeding on dead standing trees, stumps, and logs, and occasionally behaves as a parasite, growing at the base of living trees from various hardwood genera.

Remarks: This fungus is easily identifiable in the field, often referred to as the "artist's fungus" because drawings can be made on the fresh pore surface using a sharp instrument. When the tissue is bruised, it immediately oxidizes and turns permanently brown[9].

Ganoderma lucidum: **Description: Characteristics of Basidiocarps:** Annual growth, stalked with a central to lateral arrangement, flat, fan-shaped to semi-circular, reaching 15 cm or more in width. Upper surface starts yellow at the margin in actively growing specimens, then turns orange-red to dark reddish-brown, eventually becoming deep bay typically covered with a powdery layer of basidiospores carried by air currents. Margin is sharp, and the lower part is narrowly sterile. Pore surface starts creamy white, turns light buff, and stains dark purple-brown when bruised. Pores are circular to angular, with 4-5per mm, and have thick separations. The context becomes dark purple-brown with age, up to 3cm thick at the base. Tube layer is purple-brown, clearly distinct from the context, and up to 1cm thick.

Hyphal System: Dimitic hyphal system. Contextual generative hyphae are 2-2.5µm in diameter, hyaline, thin-walled, with clamps. Contextual skeletal hyphae range from hyaline to pale golden brown, thick-walled, nonseptate, with frequent dendritic branching. Laccate crust on the pileus surface is 40-70µm thick, with reddish-brown, thick-walled, amyloid hyphal end cells. Tramal skeletal hyphae are pale brown, thick-walled, nonseptate, 2-3.5µm in diameter. Tramal generative hyphae are 2-2.5µm in diameter, hyaline, thin-walled, with clamps.

Cystidia and Sterile Hymenial Elements: Cystidia or other sterile hymenial elements are absent.

Basidia: Basidia are 12-23x10-11µm, broadly ellipsoid to barrel-shaped, tetrasterigmatic, with a basal clamp.

Basidiospores: Basidiospores are 7-11x6-8µm, often variable in length within the same collection, ellipsoid, truncate at the apex. Pale brown in KOH. Spore wall has two layers: a thick, brown endosporium separated by interwall pillars from a thin, hyaline exosporium with shallow depressions. Negative reaction in Melzer's reagent.

Remarks: Ganoderma species with annual basidiocarps exhibit wide variation in macroscopic characteristics. The darker wood-colored to purplish-brown context is a distinguishing feature of this species[9].

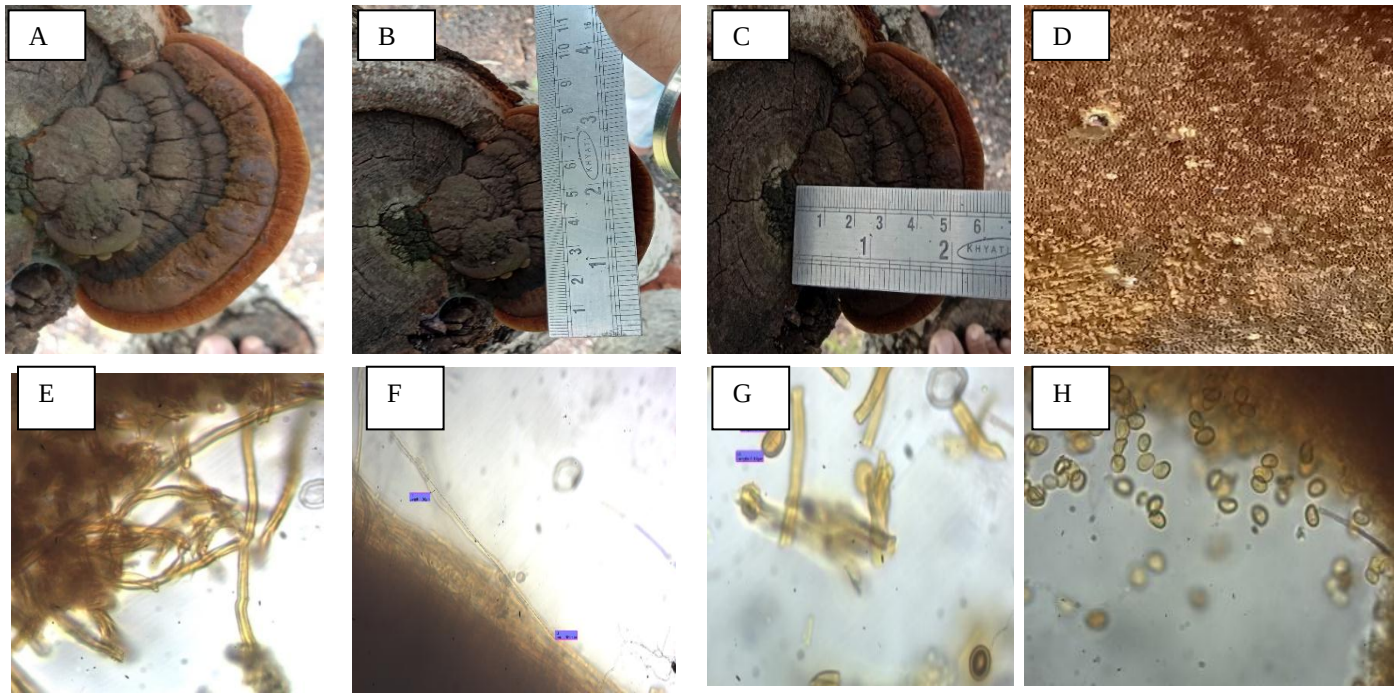

Figure-1: Phellinus rimosus: A to C – Basidiocarp, D- Pore Side, E to F- Hyphae[10], G to H - Basidiospore[10].

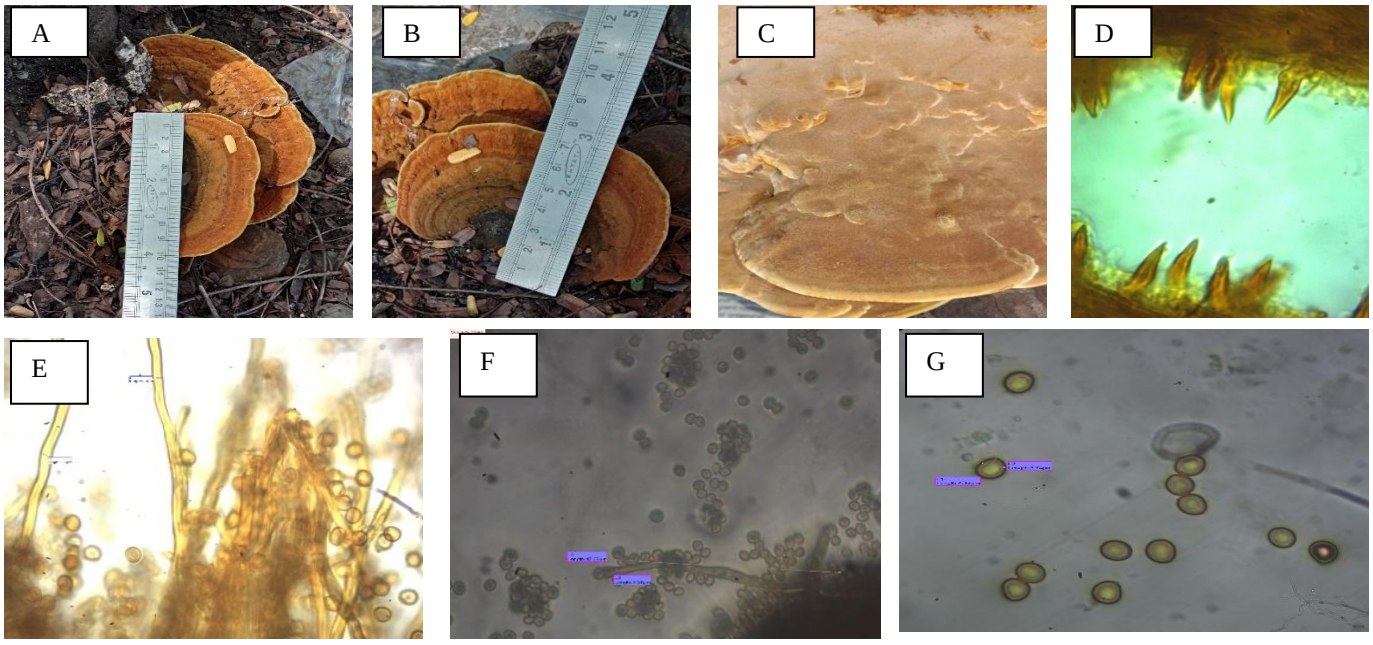

Figure-2: Phellinus torulosus: A to B – Basidiocarp, C- Pore Side, D- Setae[10], E to F- Hyphae[10], G - Basidiospore[10].

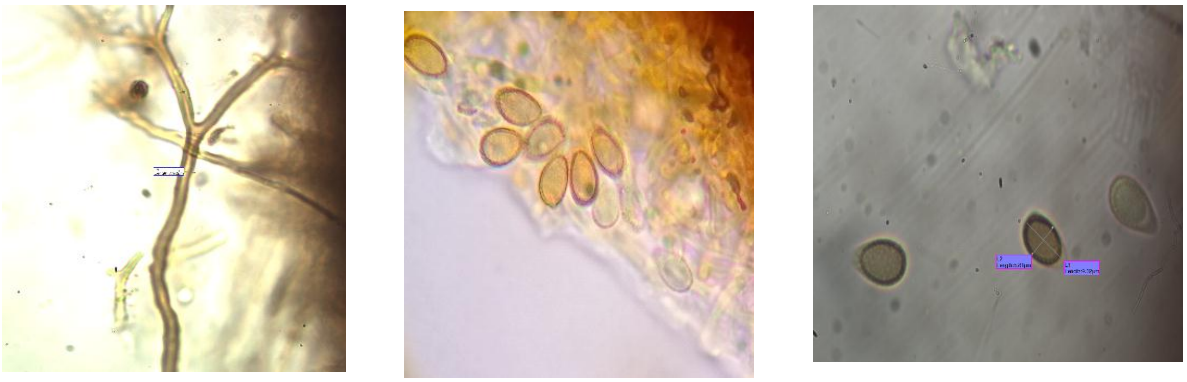

Figure-3: Ganoderma applanatum: A – Basidiocarp, B- Pore Side, C to D- Hyphae[10], E to F - Basidiospore[10].

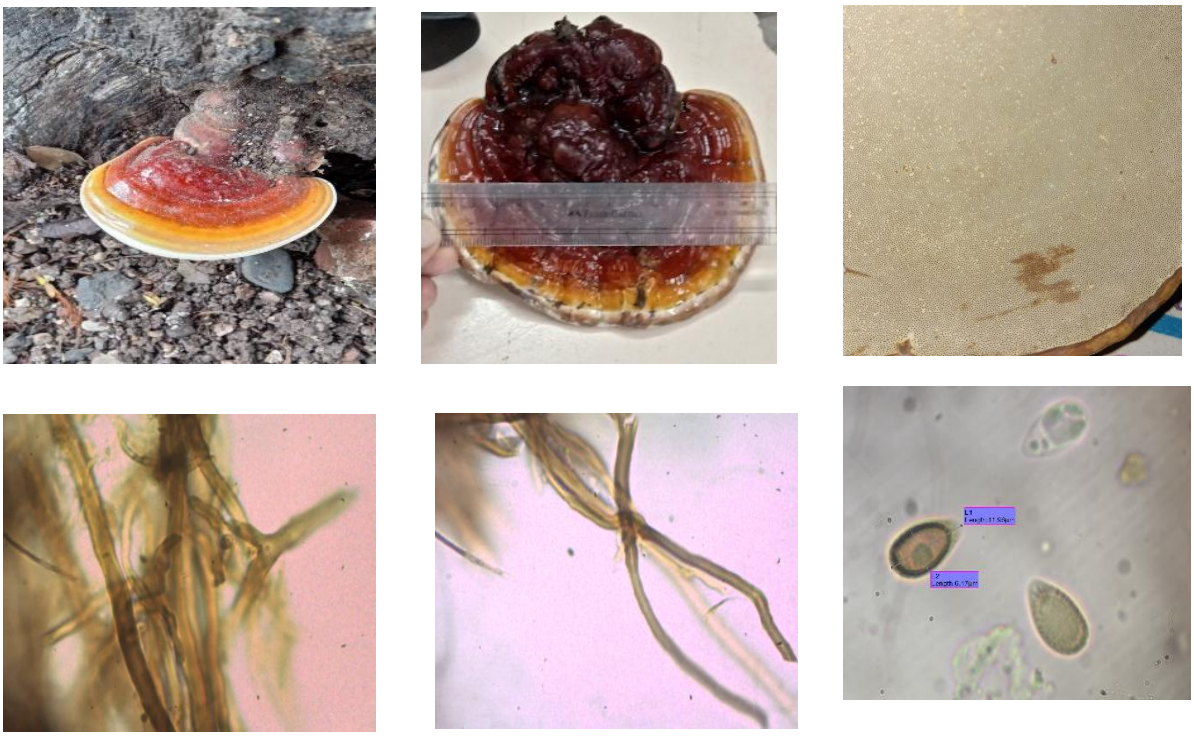

Figure-4: *Ganoderma lucidum:* A to B – Basidiocarp, C- Pore Side D to E – Hyphae[10], F – Basidiospore[10].

Conclusion

In conclusion, the research provides a comprehensive exploration of poroid fungi in the Melghat region, shedding light on their ecological roles, morphological characteristics, and potential medicinal significance. The studied species, including Phellinus and Ganoderma, exhibit diverse adaptations, impacting both living and dead trees.

The findings underscore the importance of ongoing research to understand these fungi's ecological dynamics and their broader implications in forest ecosystems. The study contributes valuable insights to mycologists and ecologists and emphasizes the need for conservation efforts to preserve fungal biodiversity.

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