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Diversity and Characteristics of Indigenous Mushrooms in Barshi Tehsil: A Comprehensive Morphological Study

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Abstract

This research study, conducted between June and October in 2020 and 2022 in Barshi tehsi, focused on cataloguing the variety of indigenous mushrooms and their physical traits. In total, 10 distinct mushroom specimens were gathered for this study. Each specimen was identified at the species level and represented a unique genus from 3 separate families. Notably, Agaricus impudicus was more prevalent in the area than other species. The most common genera identified were Agaricus, Lepiota, and Coprinopsis. Regarding the mushroom families, Psathyrellaceae with Agaricaceae are frequently found. Out of the species collected, 3 were deemed edible, 4 were inedible, and 3 were either edible, inedible, toxic, or of uncertain value. This research sheds light on the mushroom diversity in Barshi tehsil, Maharashtra's Solapur district, emphasising their significant ecological role and potential future benefits for culinary and industrial applications. Statistical diversity analysis revealed moderate macrofungal diversity in the study area, with Shannon–Wiener diversity index (H′) of 0.94 and Simpson's diversity index of 0.58 at the family level. Agaricaceae (50%) and Psathyrellaceae (40%) were the dominant families, while Pielou's evenness index (J = 0.86) indicated a relatively uniform distribution among the recorded families. These findings highlight a moderately structured macrofungal community with notable taxonomic dominance patterns in Barshi Tehsil.

Keywords: Mushroom; Diversity; Barshi; Edibility; Morphology;

Introduction

Mushrooms, known as the fruiting bodies of larger fungi types like macromycetes, are recognised by their unique cap-like structures. These organisms are non-photosynthetic, spore-producing eukaryotes that depend on other organic materials for nourishment. They typically thrive in environments rich in organic matter, including moist fields, soil, animal waste, and various forest elements such as roots, bark, and dead leaves. These mushrooms emerge from a subterranean network called fungal mycelium [1,2]. Optimal temperature and humidity conditions encourage mycelium to form one or several mushroom bodies [3]. Among these, mushrooms with conspicuous spore-producing structures are classified under

gilled fungi [4] and display a wide variety in shapes, especially within the Ascomycetes and Basidiomycetes groups [5]. Species of Basidiomycetes and Ascomycetes thrive in environments with abundant organic matter and humus, such as damp woodlands, areas with animal remains, especially after significant rainfall or rapid temperature shifts. These fungi typically have a short lifespan, often disappearing within hours or a few days, leaving only their mycelium behind. As seasonal organisms, mushrooms play various roles within the forest ecosystems. They can be classified by their growth above or below ground and are easily visible and collectable. These fungi fall into one of three primary ecological categories: forming symbiotic relationships with plants (mycorrhizal), living as parasites, or decomposing organic matter (saprophytic) [4,6].

Mushrooms, found worldwide and requiring specific environmental and nutritional conditions, have been recognised for their significance since historic periods. In various Asian nations, wild mushrooms are commonly consumed as a tasty and nutritious food, and also utilised for medicinal purposes. These wild macrofungi are appreciated not just for their unique taste and texture, but also for their valuable nutritional and chemical properties [7]. Fungi, with their incredible variety and striking beauty, play a vital role in the ecosystem. Numerous nations have embarked on research exploring the wide variety of macrofungi, consistently identifying new species globally. Efforts to estimate the number of fungal species worldwide suggest a tentative count of around 1.5 million. India, recognised as one of the world's top 10 biodiverse countries, is rich in various wild mushroom species, especially during the monsoon. In Maharashtra, systematic research and classification of mushrooms started in the 1970s. The work of Professor A.V. Sathe and his team identified 75 species across 43 genera in Maharashtra, Karnataka, and Kerala between 1978 and 1980. Research on agarics in Maharashtra has been thorough, with studies conducted in different regions over the years. More recent research has delved into the range of edible, non-edible, and medicinal mushrooms in specific regions of Maharashtra, though detailed taxonomic information remains incomplete. The National Fungal Culture Collection of India (NFCCI) was founded at the Agharkar Research Institute for preserving fungi from various environments. This led to further investigations into the diversity of mushrooms in the Western Ghats. Additionally, Senthilarasu conducted a comprehensive revision of gilled mushrooms in Maharashtra in 2014 [8].

Barshi tehsil, located within Solapur district, boasts a wide variety of plant and animal life. Despite this, there's been a noticeable lack of attention towards studying the fleshy mushrooms found in this locality. To date, no significant research has delved into the indigenous mushroom species of this region. As a result, the knowledge about the macrofungi in Barshi remains largely uncharted. The main objective of the current research is to classify these wild macrofungi to the species level and record their variety in their native environments, underscoring the necessity of this study.

This research centres on the detailed examination of wild mushrooms with soft textures observed in the Barshi tehsil of the Solapur district, Maharashtra, India. Local traditional healers, known for their deep understanding of the region's plant life, were consulted during field investigations to obtain detailed knowledge of these mushrooms and

the localities they are associated with. The outcomes of this research may make significant contributions to the fields of pharmacology and food science, potentially improving human welfare in future scenarios.

Material and methods:

(a) Study area and collecting sites:

The Barshi tehsil, in the Solapur district of Maharashtra, India, lies on the Deccan Plateau. It is specifically located at 17° 40' 48" North latitude and 75° 55' 12" East longitude. This region is characterised by a semi-arid climate, marked by distinct wet and dry periods, primarily influenced by the southwest monsoon. This monsoon period, extending from June to September, contributes significantly to the annual precipitation. The area experiences high temperatures and aridity during summers, while winters are comparatively cooler.

Vegetation in Barshi tehsil has adapted to these climatic conditions. The region spans 1483.1 square kilometres and is situated at an elevation of 540 meters above sea level. It features diverse topography, including agricultural plains, hilly terrain, and forests. The climate is predominantly hot and dry, categorizing the area as drought-prone with shallow and nutrient-deficient soil. The average annual rainfall is approximately 677 mm, and temperatures range between 10 °C to 30 °C.

The region's hydrological challenges are underscored by poor soil moisture retention and erratic rainfall, leading to frequent water scarcity. Despite these constraints, Barshi tehsil was selected for a study focusing on fleshy mushrooms due to its rich flora and diverse geographical distribution. Field visits were conducted across various localities from June to October during the years 2020 to 2022, resulting in the collection of numerous mushroom samples from both rural and urban areas within the region.

(b) Mushroom collection, photography and morphological characterization

The optimal period for mushroom collection is immediately following rainfall. During the monsoon seasons of 2020 to 2022, specimens were meticulously gathered from diverse locations, encompassing primary and secondary forests, roadsides, plantations, crop fields, jhum fallows, and agricultural lands. This collection employed a simple random sampling methodology, ensuring an unbiased selection of samples. Each specimen was randomly selected to ensure a representative sample of fungal diversity in these regions.

The specimens, specifically Basidiomycetes fruiting bodies, were harvested from various habitats, including forests, suburban areas, and agricultural fields. The collection process involved using tools such as forceps, knives, steel spatulas, measuring tape, a hand lens, books, labels, paper, and rigid plastic bottles, as well as a camera. Precautions were taken to minimize disturbance to the natural habitats during the collection. Prior to collection, detailed photographs of each specimen were taken to document its morphological characteristics in its natural environment.

Morphological data such as the colour, diameter, shape of the pileus, stipe colour, length, gill colour and attachment, odour, and taste were meticulously recorded as field notes. Additional characteristics, including the size, shape, and colour of the fruiting body, lamellae

positioning, and presence of annulus, spore print, type of volva, and habitat, were documented. Specific locations were documented using GPS-tagged photographs. This comprehensive data collection facilitated the identification and classification of the specimens. The distribution map of collected mushrooms in Barshi Tehsil is presented in Fig.1

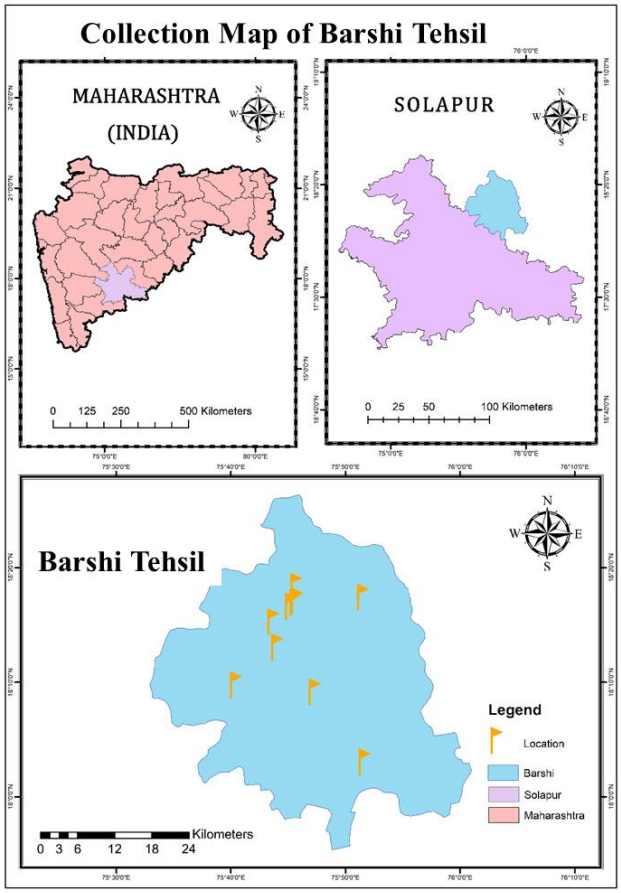

Fig. 1: The distribution map of collected mushrooms in Barshi Tehsil

Each sample was assigned a specific laboratory serial number for tracking and analysis. The morphological characteristics recorded were critical for identifying the mushroom species, encompassing aspects such as the size, scale, colour of the gills, edges, stipe, type of veil, and volva. For the final identification and classification of the specimens, the recorded characteristics were compared with standard references. Additionally, field photographs were taken to record visual characteristics such as colour, size, shape, and habitat, while olfactory and other ecological characteristics were noted in a field notebook.

(c) Microscopic characterization, identification and preservation

Specimens of Basidiomycetes were meticulously identified utilising their microscopic characteristics. For detailed microscopic analysis, rehydrated basidiocarps were cut into thin sections and prepared on semi-permanent glass slides. These sections were stained with cotton blue and glycerine, subsequently mounted on glass slides, and secured with coverslips. The semipermanent slides were then examined using a primary light microscope at magnification of ×100, and then final observation records with the help of 'LYNX' Trinocular Research Microscope (Model No. LM52207), and Photographs were captured

with the help of a Camera (Model No. LM50912/1) and Retina Screen (Model No. LM-52-RS). The phenotypic identification of the gathered mushroom samples was conducted based on their distinct morphological features. Spore morphology was investigated by collecting spores via spore prints and observing them under a microscope. The specimens were preserved in 4% (v/v) formaldehyde and maintained in a herbarium for future reference. Preservation of fresh samples employed a method incorporating 2% and 4% formaldehyde, depending on their physical condition. The drying and processing of mushrooms adhered to the protocol as per scientific procedure. The collected samples were cleaned and sun-dried for 3-4 days. Subsequently, a hot-air electric dryer was utilised for 4 to 8 hours to thoroughly eliminate moisture. The dried mushrooms were then stored in air-tight plastic bottles for subsequent studies, with silica gel added at a 10% dry weight.

Identification of the fungal species employed standard morphological characters, including cap shape, types of gills, stipe characteristics, and colour of the spore print, ecological type, and edibility. The edibility of the mushroom was recorded based on previous research papers. Species within the Basidiomycota phylum were identified through comparison with morphological characteristics documented in existing literature (Augusto Rinaldi, Vassili Tyndalo, 1972, Peter Jordan, The Mushroom Guide and Identifier, Anness Publishing Limited 1995,1996,2000) [38, 39], Additional identification methodologies included the use of keys from the book by David Arora (Mushroom Demystified, 1986) [40].

Result and Discussion:

***Cystoagaricus trisulphuratus* (Berk.) Singer, Mycologia 39(1): 87 (1947) [Fig. 2 (a-c)]**

Basidiocarp solitary, scattered, medium sized, total height 3 - 5 cm, scarlet orange at young then becomes dark irony orange; **Pileus** 1.8 x 2 cm in long and 3.2 x 4 cm across, hemispherical, Surface covered with thin, loose fibrillose, floccose squamules which is caduceus, concolorous with the pileus; margin appendiculate with velar remnants; **Context** milky white to brown, fleshy, 1–2 mm thick at the disc; **Lamelleae** free, fuscous,milky white at young then becoming dark brown, crowded; **Stipe** 2.5 x 4.5 cm long and 0.3 x 0.6 cm broad, centric, equal, cylindric, concolorous, covered by the pulverulent veil. **Annulus** superior, at the upper quarter of the stipe, floccose, fugacious; **Volva** absent; **Spore prints** dark brown. **Basidiospores** 4.98–6.64 × 3.32–4.98 µm, ellipsoid, adaxially applanate, brown colored, thick–walled.

Collection Examined India, Maharashtra, Solapur, Barshi, Babhulgoan, Saprobic, on humus rich soil, coll. Thonge and Tembhurne (Y20S5).

Remark

Cystoagaricus trisulphuratus (Psathyrellaceae Vilgalys, Moncalvo & Redhead), formerly identified as Agaricus trisulphuratus Berk. in Agaricaceae Chevall., can be readily identified in the field by its small basidiomes, which feature a scarlet orange pileus and stipe. Both surfaces are covered by a well-developed, concolourous, detersile universal veil, and the stipe apex bears an indistinct, floccose annulus. This species is distinct from its closest morphological relative, *Agaricus crocopeplus* Berk. & Broome (Agaricaceae), due to the absence of a distinct annulus, its brown spores with a slightly irregular outline, and the

presence of clamp connections. *Cystoagaricus trisulphuratus* has been previously documented in Karnataka, Kerala, Punjab, Tamil Nadu, Uttar Pradesh, and West Bengal. Reports from Maharashtra include sightings in Pune, Mulshi, and Ratnagiri (Senthilarasu and Kumaresan, 2016) [9]. Most recently, Bornak and Patil (2023) [10] reported this species in the Kolhapur district of Maharashtra, adding a new location to its known distribution.

Fig. 2: *Cystoagaricus trisulphuratus* Basidiocarp at natural condition, (a) Surface view, (b) Gill view, (c) Basidiospores with Basidia.

***Leucocoprinus cretaceus* (Bull.) Locq., Bull. mens. Soc. linn. Soc. Bot. Lyon 14: 93 (1945) [Fig. 3(a-d)]**

Basidiocarp solitary to gregarious, grouped, scattered, medium sized, total height 2.7- 13 cm, chalky white; **Pileus** 2.7 to 3.6 cm long , 3.2 – 6.4 cm across, chalky white, bulbous when immature becoming convex, umbonate then applanate as it grows and ages, surface covered by easily removed, granular, fully floccose white squamules, over a smooth ground with a brownish yellow tinge at the centre of the cap, margin distinctly sulcate-striate; **Context** fleshy, white, about 1-3 mm thickness; **Lamellae** free, off white to very pale cream, crowded; **Stipe** 2-12.5cm long and 0.3- 1 cm broad, centric, clavate to sub-bulbous, the base reaching 1-1.7 cm diameter, cylindric, hollow, white to yellowish white, surface entirely floccose to fibrillose, especially from basal half of stipe length, **Annulus** fragile and easily detachable, membranous, delicate, medial to apically positioned, white; **Volva** absent; **Spore print** white; **Basidiospores** 8.3 – 11.62 µm in length and 6.64 – 8.3 µm in width, ellipsoid to ovoid, smooth and thickened with a small pore.

Collection Examined India, Maharashtra, Solapur, Barshi, Pangri, Saprobic, Manure, bagyash, coll. Thonge and Tembhurne (Y21S6).

Remark

For many years, *Leucocoprinus cretaceus* was mistakenly identified and confused with other agaric mushrooms. It was not until Locquin's work in 1950 that it was recognized as a distinct species and named *Lepiota cretata* Locq. This species is characterised by its fleshy white cap (pileus) and stem (stipe) surface, which is covered with easily removable, woolly scales (floccose squamules), and a fusoid stipe that is swollen towards the base. *Leucocoprinus cretaceus* is related to *Leucocoprinus squamulosus* (Mont.) Pegler, found in Guyana and the Lesser Antilles, which has similar basidiospores but lacks an annulus and an

inflated stipe base [11]. In India, this species has been previously reported in Kerala (Manimohan et. al 2013) [12], Punjab (Amandeep K. et al., 2015) [13], Gujarat (Rajput et. al 2017; Kokni et al., 2019) [14,15], Tripura (Debnath et al., 2020) [16], and Odisha (Mishra et al., 2021) [17]. This species has been reported for the first time in Maharashtra.

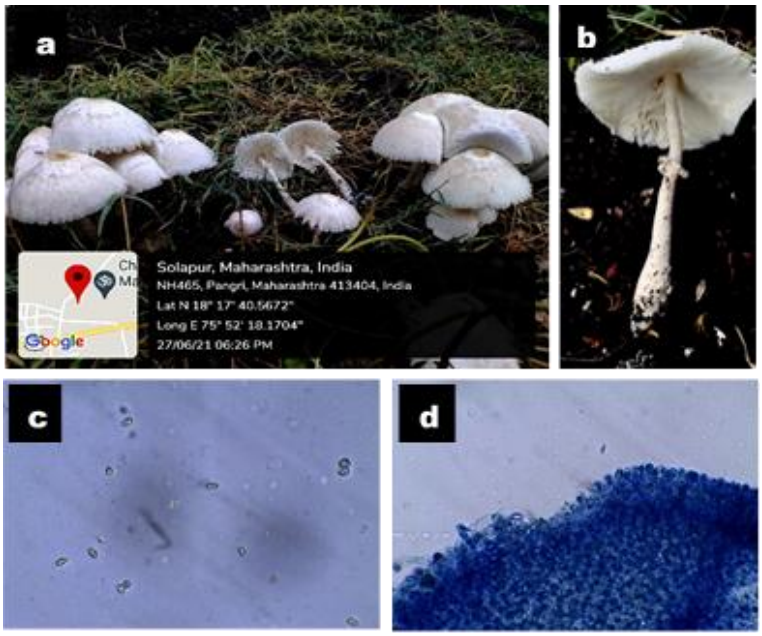

Fig. 3: *Leucocoprinus cretaceus* Basidiocarp at natural condition, (a) Surface view, (b) Lamellae and Stipe view, (c) Basidiospores, (d) Basidia.

***Agaricus impudicus* (Rea) Pilát 1951 [Fig. 4 (a-c)]**

Basidiocarp solitary, scattered, grouped sometimes, medium sized, total height 5.9–11.5 cm, scaly, dark grey brown; **Pileus** 2 – 4.6 cm long, 4.5 – 9 cm across, globose to pulvinate initially often becoming convex, flat-topped as it expands; large scales usually in various shades of dark grey brown on a white to pale brown background; with thin, involute, undulating margin with remnants of the veil; **Context** fleshy, fibrous, whitish, turning slowly greyish brown on exposure unchanging or becoming slightly yellow, about 1-2 mm thick; **Lamellae** free, thin, whitish to greyish pink, turning brown with age, crowded; **Stipe** 4.8 – 10.3 cm long and 0.7-1.4 cm broad with a slightly bulbous base; centric, surface entirely smooth that turns brown with age, hollow; **Annulus** ring white pendulous, fragile, delicate, medial to apically positioned; **Volva** absent; Spore print chocolate brown; **Basidiospores** 4.98-6.64µm in length and 3.32- 4.98µm in width, ovoid, ellipsoid, smooth, pale brown.

Collection Examined India, Maharashtra, Solapur, Barshi, Kavhe, Saprobic, Dead decomposed part of soil, coll. Thonge and Tembhurne (Y21S13).

Remark

Agaricus impudicus, initially described as *Psalliota impudica* by Rea in 1932, is easily identified by its distinctive cap adorned with red-brown, adpressed concentric scales against a white background and a smooth stem. Morphologically, it shares similarities with *Agaricus porphyrizon* but can be differentiated based on cap coloration, ecological preferences, spore size, and rapid color change to a strong red upon cutting or bruising.

Previously, *Agaricus impudicus* has been documented in India from regions such as Gujarat (Kokni et al., 2019) [15], Assam (Paul et al., 2019) [18], and Uttar Pradesh (Vishwakarma and Tripathi, 2019) [7]. Recent findings have also reported its presence in Poona, Maharashtra (Saini et al., 2018) [19]. This study presents a novel report of *Agaricus impudicus* from a new location within the study area.

Fig. 4: *Agaricus impudicus* Basidiocarp at natural condition, (a) Surface view, (b) Unopened Gill view, (c) Basidiospores with basidia.

***Coprinopsis cinerea* (Schaeff.) Redhead, Vilgalys & Moncalvo in Taxon 50(1): 227, 2001 [Fig. 5(a-e)]**

Basidiocarp solitary, scattered, medium sized, total height 6.5–10 cm, scaly, greyish to blackish brown; **Pileus** 2.7 – 3.9 cm long, 1.6 – 3.5 cm across, initially ovoid then becoming conical, thin and humped with increasingly extreme upturned edges, after it begins to dissolve rapidly, campanulate to convex to conical with slightly raised apex; surface moist, scaly, scales whitish, loosely appressed and easily removable, greyish to blackish brown, margin irregular, radially splitting, striated, uplifted; **Context** thin, soft, bluish grey to dark blackish at maturity, about 1 mm thick; **Lamellae** free, thin, narrow, being whitish grey at first, then liquefying and finally become black at maturity, crowded; **Stipe** 5.8 – 9.5 cm long and 0.5–0.9 cm broad, centric, tapering upwards, cylindrical with a thickened base, off white, highly fragile, hollow, surface with a flaky-scaly whitish appearance, **Annulus** absent; **Volva** absent; **Spore print** black; **Basidiospores** 8.3- 11.62µ in length and 4.98- 8.3µ in width; ellipsoidal, with a broad central germ pore, thick–walled, smooth, dark blackish brown.

Collection Examined India, Maharashtra, Solapur, Barshi, Shelgoan, Saprobic, Rotten plant materials, coll. Thonge and Tembhurne (Y21S22).

Remark

Coprinopsis cinerea, formerly known as *Coprinus cinereus* as identified by (Schaeff.) Gray in 1821, is characterized by specific features such as veil structures, basidiospore size and shape, and its habitat. A closely related species, *Coprinopsis macrocephala*, is distinguished by its larger spores, which measure 12.2–16.8 × 8.2–9.8 µm, and it's ellipsoidal to oblong cheilocystidia, as described by Uljé and Noordeloos (1999) (Amandeep et al. (2014) [20] . Previous records of *Coprinopsis cinerea* in India include reports from Punjab by Ginai (1936), Manjula (1983), and Amandeep et al. (2014) [20]. This study presents the first report of *Coprinopsis cinerea* from the current study area.

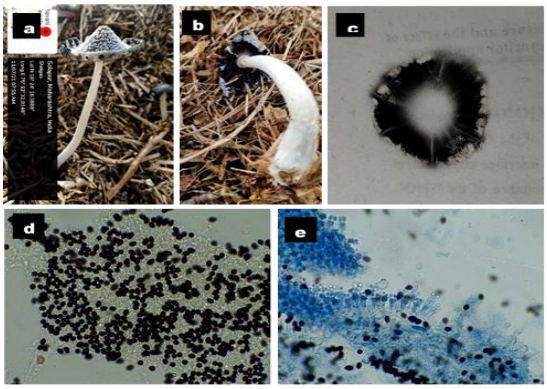

Fig. 5: *Coprinopsis cinerea* Basidiocarp at natural condition, (a) Surface view, (b) Lamellae and Stipe view, (c) Spore print, (d)Basidiospores, (e) Basidia.

***Coprinellus domesticus* (Bolton) Vilgalys, Hopple & Jacq. Johnson in Taxon 50(1): 233, 2001 [Fig. 6(a-d)]**

Basidiocarp gregarious, scattered, sometimes solitary, medium sized, total height 4.8–9.5 cm, scaly, honey yellow to brownish white; **Pileus** 1.7 – 3.7 cm long, 2.6 – 6.8 cm across, initially ovoid then becoming convex to broadly conical, honey yellow to brownish white, surface radially grooved, covered with thick, flaky, loosely appressed and easily removable, whitish to brownish floccules like universal veil fragments, margin irregular, somewhat ribbed and splitted at the end, **Context** thin, fragile, soft, white to pale yellow brown and dark brown at maturity, about 1- 2 mm thick; **Lamellae** free, thin, narrow, being white at first, then pale yellow brown and finally dark brownish black on deliquescent at maturity, highly crowded; **Stipe** 4 – 8.7 cm long and 0.4–1.0 cm broad, centric, tapering upwards, cylindrical with a thickened base, more or less equal, smooth, glossy, hollow, milky white, sometime with **Volva** like rim at the base and remains of orange-reddish mycelium; **Spore print** dark brown to black; **Basidiospores** 6.64- 10.6µ in length and 3.32-4.98µ in width, somewhat cylindrical, with an eccentric germ pore, slightly yellowish brown to blackish brown.

Collection Examined India, Maharashtra, Solapur, Barshi, Kuslamb, Saprobic, on decaying soil, coll. Thonge and Tembhurne (Y21S28).

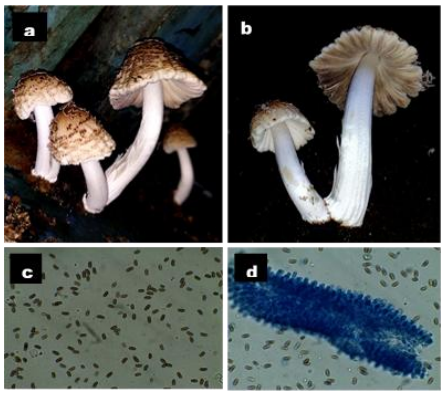

Fig. 6: *Coprinellus domesticus* Basidiocarp at natural condition, (a) Surface view, (b) Lamellae and Stipe view, (c) Basidiospores, (d) Basidia.

Remark

Coprinellus domesticus, initially described as *Agaricus domesticus* by James Bolton in 1788, is distinguished by its fruiting bodies that emerge from an orange mycelium, which may be visible at the base of the stem. Although morphologically similar to *Coprinellus radians* in most characteristics, it differs by having smaller Basidiospores [41]. In India, this species has been previously documented in several states: Jammu and Kashmir (Anand et al., 2014; Koul et al., 2017) [21,22], Tamil Nadu (Thulasinathan et al., 2018) [23], Uttar Pradesh (Singh et al., 2018) [24], Uttarakhand (Sharma & Jaitly, 2021) [25], and Kerala and Tamil Nadu (Akshaya et al., 2023) [26]. This study reports the first occurrence of *Coprinellus domesticus* in Maharashtra.

***Lepiota atrodisca* Zeller, Mycologia 30(4):473 (1938) [Fig. 7(a-d)]**

Basidiocarp grouped, gregarious, solitary sometimes, scattered, medium sized, total height 4.2–6.6 cm, scaly, white; **Pileus** 0.3– 0.6 cm long, 2.4 – 5.3 cm across, oval or convex becoming broadly umbonate or flat, finally uplifted, disc with flattened unbroken dark greyish blue to almost black scales or fibrils on white background, margin incurved at first, becoming slightly crenate and finally becomes eroded, upturned and cracked; **Context** fleshy, white, unchanging, sometimes becoming dingy in age but not staining when touched, about 1-2 mm thick; **Lamellae** free, thin, Narrow, white, sub-distant to close, in two tiers, near stem often with forks; **Stipe** 3.5 – 5.9 cm long and 0.3-0.7 cm broad, somewhat equal, centric, surface entirely smooth, white, unchanged, hollow, with white pendulous **annulus** ring which is fragile, delicate, membranous, superior, persistent, frequently with a blackish lower margin, medial to apically positioned; **Volva** absent; **Spore print** white; **Basidiospores** 6.64-8.30 µm in length and 3.32- 4.98µm in width, ovoid to ellipsoid and tapered, thick walled, without a germ pore, smooth, transparent, pale greenish yellow.

Collection Examined India, Maharashtra, Solapur, Barshi, Wanevadi, Saprobic, on Humus-rich soil, coll. Thonge and Tembhurne (Y21S29).

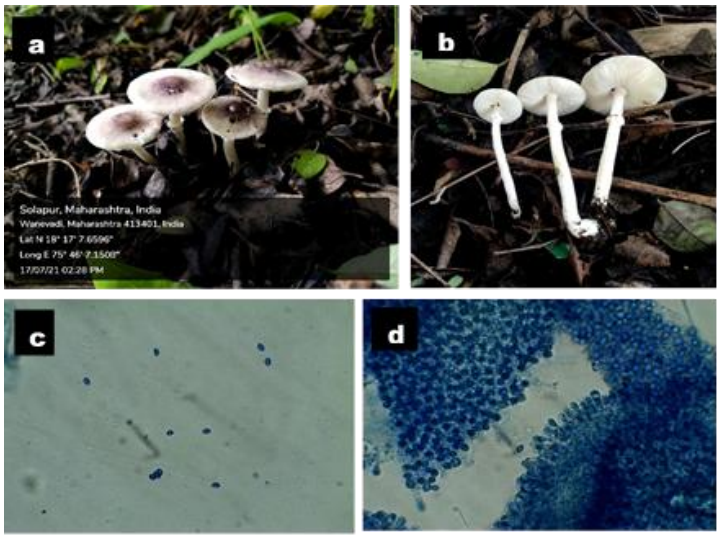

Fig. 7: *Lepiota astrodisca* Basidiocarp at natural condition, (a) Surface view, (b) Lamellae and Stipe view, (c) Basidiospores, (d) Basidia.

Remark

Lepiota atrodisca is characterized by its distinctive grayish-black scales. It also features a white, scaly cap; free, close, white or creamy gills; a white, smooth, dry stipe; and a membranous ring with a white upper surface and a brownish underside, often with a black edge. Additionally, it produces a white spore print. Previously, this species has been documented in various regions of India: Karnataka (Pushpa and Purushothama, 2012) [27] North India (Kumari et al., 2012) [28], West Bengal (Pramanik and Chaudhuri, 2017) [29] and Gujarat (Rajput et al., 2017; Kokni et al., 2019) [14,15], Uttar Pradesh (Vishwakarma and Tripathi, 2019) [7]. This is the first report of *Lepiota atrodisca* from Maharashtra.

***Agaricus sylvicola* (Vittad.) Peck, Annual Report on the New York State Museum of Natural History 23: 97 (1872) [Fig. 8(a-d)]**

Basidiocarp solitary, scattered, medium sized, total height 4.5–10.2 cm, glabrous, creamy white; **Pileus** 0.1 – 1.1 cm long, 4.3-6.5 cm across, initially subglobose, then becomes hemispherical, and finally plano-convex, with smooth and glabrous surface, margin entire, sometimes cracked, creamy white; **Context** fleshy, soft, thin, initially white, then brownish, about 1-3 mm thick; **Lamellae** free, thin, narrow, whitish at first, then pale pinkish and finally chocolate to blackish brown, crowded; **Stipe** 4.1 – 9.5 cm long and less than 0.6-1.1 cm broad, centric, somewhat equal, slightly broad at base, moist, fibrous, brownish white, thick, hollow, surface entirely smooth, cylindrical; **Annulus** is delicate, thin, pale brownish white pendulous, superior, medial to apically positioned; **Volva** absent; **Spore print** dark brown; **Basidiospores** 4.98 - 6.64µm in length and 3.32- 4.98µm in width, globose to oval, ellipsoidal, thick walled, smooth, transparent, dark brown.

Collection Examined India, Maharashtra, Solapur, Barshi, Jamgoan, Saprobic, on fallen leaves, humus rich soil, coll. Thonge and Tembhurne (Y22S34).

Remark

Agaricus sylvicola, previously classified as *Agaricus campestris var. sylvicola* by Vittadini in 1835, is characterized by its free gills, which turn dark brown upon maturation, a white stalk that is slightly broader at the base, and small basidiospores.

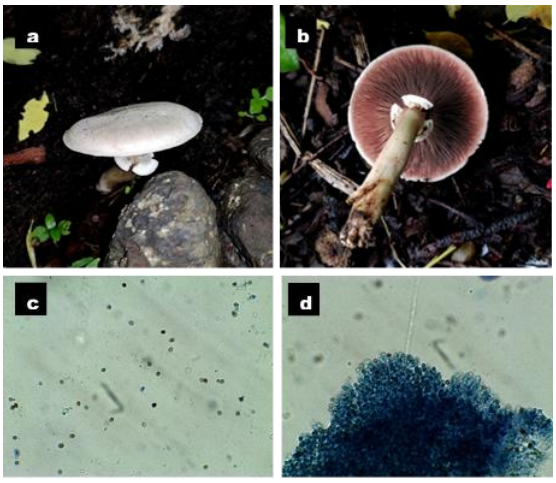

Fig. 8: *Agaricus sylvicola* Basidiocarp at natural condition, (a) Surface view, (b) Lamellae and Stipe view, (c) Basidiospores, (d) Basidia.

This species can be easily confused with *Agaricus arvensis* (Horse Mushroom), which also emits an aniseed smell and typically grows in grasslands, often forming rings. Despite the similarity in appearance and smell, *Agaricus sylvicola* can be distinguished by its relatively longer and slimmer stem with a pronounced bulbous base [42]. In India, *Agaricus sylvicola* has been documented in Punjab (Kang et al., 2014) [30], Gujarat (Rajput et al., 2017) [14], West Bengal (Pramanik and Chaudhuri, 2017) [29], South West India, Himachal Pradesh and Uttar Pradesh, Punjab, Jammu and Kashmir (Saini et.al 2018) [19], Uttar Pradesh (Vishwakarma and Tripathi, 2019) [7] and Maharashtra, with reports from Pune (Senthilarasu, 2014) [31] and Amravati District (Karwa and Rai, 2010) [32]. This paper presents the first report of *A. sylvicola* from the current study area.

***Gymnopus androsaceus* (L.) J.L. Mata & R.H. Petersen, 2004 [Fig. 9(a-e)]**

Basidiocarp solitary, scattered, sometimes grouped, gregarious, small sized, total height 1.0–3.3 cm, dry, very thin, smooth, slightly pinkish to whitish brown; **Pileus** 0.1-0.2 cm long, 0.3-1.2 cm across, convex initially, flattening with a sunken centre at maturity, with dry, smooth, radially grooved and wrinkled surface, margin entire to slightly crenate, sometimes cracked, pinkish to whitish brown, brownish buff in the centre but usually much paler towards the margin; **Context** soft, thin, papery, whitish to pale brownish, unchanging, about 0.1-0.2 mm thick; **Lamellae** adnate, thin, narrow, short, dull whitish, distant; **Stipe** 0.7 – 2.9 cm long and less than 0.1 cm broad, centric, somewhat equal, dry, wiry, brownish white, (white near the apex and brown afterwards), hollow, surface entirely smooth, cylindrical, with abundant black rhizomorphs attached to the base; **Annulus** ring absent; **Volva** absent; **Spore print** white; **Basidiospores** 4.98-8.30 µm in length and 3.32- 4.98µm in width, subellipsoid to elongated, thin walled, hyaline, smooth.

Collection Examined India, Maharashtra, Solapur, Barshi, Kuslamb, Saprobic, Decaying wood, leaves, coll. Thonge and Tembhurne (Y21S35).

Remark

Gymnopus androsaceus, previously documented as *Marasmius androsaceus* (L.) Fr. in 1838 is identifiable by several morphological characteristics. These include a dark, wiry stem, pinkish gills, and a pinkish-brown, widely pleated cap. The gills of *Gymnopus androsaceus* are broadly attached to the stem. A notable feature distinguishing this species is the presence of abundant black rhizomorphs at the base of the stem. While it shares morphological similarities with *Marasmius rotula*, the primary difference lies in the attachment of the gills in *Gymnopus androsaceus*, they are broadly attached to the stem rather than to a collar. In India, *Gymnopus androsaceus* has been reported previously in Kerala (Manimohan et al., 2013) [12], Karnataka (Senthilarasu and Kumaresan, 2016; Karun et al., 2018) [9, 33], and Mahabaleshwar, Maharashtra (Senthilarasu, 2014) [31]. This study marks the first report of this species from the current study area.

Fig. 9: *Gymnopus androsaceus* Basidiocarp at natural condition, (a) Habit, (b)Surface view, (c) Lamellae and Stipe view, (d)Basidiospores, (e) Basidia.

***Cystolepiota seminuda* (Lash) Bon Documents Mycologiques 6(24): 43 (1976) [Fig. 10(a-d)]**

Basidiocarp mostly grouped, gregarious sometimes solitary, tiny, total height 1.4-4.7cm, lepiotoid, white to light cream in color; **Pileus** 0.2- 0.5cm in length and 1.2- 2.3 cm across, conical to bell shaped at young then expanding to plano-convex to flat, often with a broad umbo at the centre; surface white, when young, changing to light pink to creamy with age, covered with small, whitish densely powdery to granulose squamules, which disappear with age, margin appendiculate; **Context** soft, thin-walled, fleshy, whitish, about 0.1-0.2 mm thick; **Lamellae** free, thin, narrow, white to pale creamy pink, changing color to the touch, crowded; **Stipe** 1.1 – 4.2 cm long and less than 0.1-0.2 cm broad, centric, throughout equal, hollow, reddish to purplish brown, surface covered with whitish light cream to light brownish powdery squamules, easily breaking off; **Annulus** whitish, evanescent, attached to the upper third of the stipe, detached on handling; **Volva** absent; **Spore print** white; **Basidiospores** 3.32-4.98 µm in length and 1.66- 3.32 µm in width, ellipsoidal, slightly cylindric, smooth, thin walled, lacking a germ-pore, slightly yellowish white.

Collection Examined India, Maharashtra, Solapur, Barshi, Ratanjan, Saprobic, on Saprobic, Decaying plant parts with humus rich soil, coll. Thonge and Tembhurne (Y21S43).

Remark

Cystolepiota seminuda, previously known as *Lepiota seminuda* (Lasch) Kumm., Ftthr. in 1871, is characterized by a smooth, plano-convex to flat cap that changes to a light pink to creamy color upon touch. The stipe exhibits a reddish to purplish brown hue, covered with whitish to light cream or light brownish powdery squamules. Morphologically similar to *Cystolepiota constricta*, *Cystolepiota seminuda* can be distinguished by its lack of pyramidal scales on the cap (Albuquerque et al., 2017). In India, this species has been previously documented in Karnataka (Swapna et al., 2008) [34] and Uttarakhand (Semwal and Bhatt, 2019) [35]. This report marks the first occurrence of *Cystolepiota seminuda* in Maharashtra.

Fig. 10: *Cystolepiota seminuda* Basidiocarp at natural condition, (a) Surface view, (b) Lamellae and Stipe view, (c) Basidiospores, (d) Basidia

***Parasola plicatilis* (Curtis) Redhead,Vilgalys & Hopple, in Redhead, Vilgalys, Moncalvo, Johnson & Hopple, Taxon 50(1): 235 (2001) [Fig. 11(a-d)]**

Basidiocarp solitary, scattered, sometimes grouped, gregarious, small sized, total height 2.9–7.8 cm, dry, very thin, fragile, smooth, slightly dull orange to greyish brown; **Pileus** 0.1-0.2 cm long and 1.2 –3.7 cm across, ellipsoid or ovoid at the beginning, then campanulate to convex, plane at the maturity, with a small central bump, deeply grooved from the margin to centre, slightly dull orange to greyish brown in color with dark brown spot at the centre of disc, with radially grooved surface, margin plicate to striate up to the disc; **Context** soft, thin, membranous, dull orange at first then become greyish to brownish black, about 0.1-0.2 mm thick; **Lamellae** free, thin, narrow, short, radiate form a collar around the stipe apex on the underside of the cap, dull orange at first then becoming black, non-deliquescent, close to sub distant; **Stipe** 2.4 – 7.2 cm long and less than 0.1-0.3 cm broad, centric, thin, tubular, delicate, surface glabrous, throughout equal, hollow, dull white, surface entirely smooth, cylindrical; **Annulus** ring absent; **Volva** absent; **Spore print** brownish black; **Basidiospores** 8.30 – 11.62 µm in length and 4.98- 8.30 µm in width, ellipsoidal, sub ellipsoid, sub globose, thick walled with eccentric truncate germ pore, smooth, dark blackish brown.

Collection Examined India, Maharashtra, Solapur, Barshi, Pimpalgaon, Saprobic, on Dung, humus-rich soil, coll. Thonge and Tembhurne (Y22S110).

Remark

Parasola plicatilis, previously known as Coprinus plicatilis by Watling and Gregory (1980), can be readily identified in the field by its distinct morphological features. These include a slightly dull orange to greyish-brown, thin cap with a brownish disc and radially plicate striate margin, non-deliquescent gills, and a slender, white, tubular stipe. In India, this species has been documented in several regions: West Bengal (Dutta et al., 2013) [36], Kerala, Jammu & Kashmir, Punjab (Amandeep et al., 2015) [13], Karnataka (Senthilarasu and Kumaresan, 2016) [9], Tamil Nadu (Thulasinathan et.al 2018) [23] as Coprinus plicatilis,

Gujarat (Rajput et al., 2017; Kokni et al., 2019) [14,15], and Uttarakhand (Sharma and Jaitly, 2021) [25]. In Maharashtra, it has previously been reported from Pune (Senthilarasu, 2014) [31] and Washim (Borul et al., 2023)) [37]. This study presents the first report of Parasola plicatilis from the specified study area.

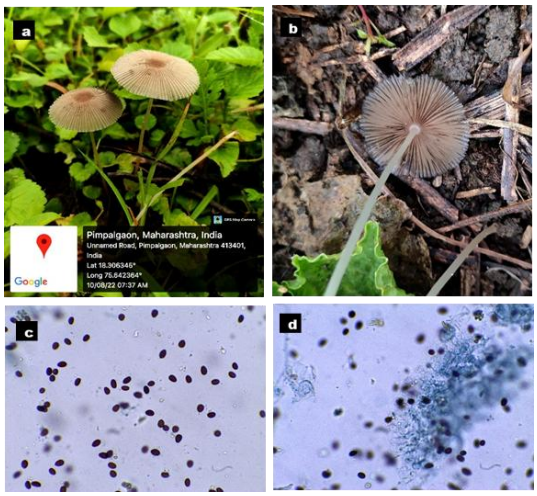

Fig. 11: *Parasola plicatlis* Basidiocarp at natural condition, (a) Surface view, (b) Lamellae and Stipe view, (c) Basidiospores, (d) Basidia

The summarised data on wild mushroom diversity in Barshi Tehsil, including valid scientific name, common name, family, date of collection, locality, coordinates, and edibility, are presented in **Table 1.** The statistical diversity analysis for the given species is shown below.

Statistical Diversity Analysis

1. Species Richness (S)

Total number of species recorded:

S=10S = 10S=10

Thus, Barshi Tehsil shows **10 macrofungal species** during the study period.

2. Family-wise Distribution

From Table 1, species distribution across families:

Family	**Number of Species**	**Proportion (p)**
Agaricaceae	5	0.50
Psathyrellaceae	4	0.40
Omphalotaceae	1	0.10
Total	10	1.00

3. Shannon–Wiener Diversity Index (H')

Calculated at the family level using:

$H' = -\sum P_i \ln P_i$

Where:

$P_i \ln P_i$ = proportion of species in each family

$H' = -[(0.5 \ln 0.5) + (0.4 \ln 0.4) + (0.1 \ln 0.1)]$

$H' = -[(-0.3466) + (-0.3665) + (-0.2303)]$

$H' = 0.9434$

Interpretation:

The Shannon index value of **0.94** indicates **moderate family-level diversity**, with dominance of Agaricaceae and Psathyrellaceae.

4. Simpson's Diversity Index

Simpson's Dominance Index (D):

$D = \sum Pi^2$

$D = [(0.5)^2 + (0.4)^2 + (0.1)^2]$

$D = 0.25 + 0.16 + 0.01 = 0.42$

$D = 0.42$

Simpson's Diversity Index:

$1 - D = 1 - 0.42 = 0.58$

Interpretation:

A value of **0.58** suggests moderate diversity with noticeable dominance by two families.

5. Evenness (Pielou's Evenness Index, J)

$$J = \frac{H'}{\ln S}$$

Where:

- S = number of families = 3
- Ln (3) = 1.0986

$$J = \frac{0.9434}{1.0986}$$

Interpretation:

An evenness value of 0.86 indicates a relatively uniform distribution among families, although Agaricaceae is slightly dominant.

6. Edibility Composition Analysis

Category	Number of Species	Percentage
Edible	3	30%
Inedible	4	40%
Not Known / Uncertain	3	30%

This indicates that **40%** of recorded species are inedible, while **30%** have edible potential, suggesting moderate ethnomycological importance.

Serial No.	Name of the Species	Common name	Family	Date of Collection	Locality	Coordinates	Edibility
	Cystoagaricus trisulphuratus	Inky Mushroom	Psathyrellaceae	09/07/2021	Babhulgoan	18.290974°N 75.770613° E	Not Known
	Leucocoprinus cretaceous	The Chalk White Mushroom	Agaricacee/Psathyrellaceae	27/06/2021	Pangri	18°17'40.5672" N 75°52' 18.1704" E	Inedible [17]
	Agaricus impudicus	Tufted Wood Mushroom	Agaricacee	20/06/2021	Kavhe	18°11'7.6092"N 75°41' 11.9472" E	Edible [18]
	Coprinopsis cinerea	Grey shag	Psathyrellaceae	11/07/2021	Shelgoan	18°24'18.3888" N 75°12' 32.9148" E	Edible [43]
	Coprinellus domesticus	Firerug Inkcap	Psathyrellaceae	27/09/2021	Kuslamb	18°28'41.1892" N 75°77' 98.3912" E	Inedible [24]
	Lepiota astrodisca	Black-disc lepiota	Agaricacee	17/07/2021	Wanevadi	18°17'7.6596"N 75°46' 7.1508" E	Inedible [14]
	Agaricus sylvicola	Woodland Agaricus	Agaricacee	21/07/2022	Jamgoan	18.18217°N 75.885776° E	Edible [14]
	Gymnopus androsaceus	Horse-hair Fungus	Omphalotaceae	03/09/2021	Kuslamb	18.284988°N 75.772026° E	Not Known
	Cystolepiota seminuda	Bearded Dapperling	Agaricacee	24/07/2021	Ratanjan	18°2'40.9308"N 75°52'22.206" E	Not Known
	Parasola plicatlis	Japanese umbrella	Psathyrellaceae	10/08/2022	Pimpalgoan	18.306345°N 75.642364°E	Inedible [14]

Table 1: Summarised data of wild mushroom diversity of Barshi Tehsil with their valid scientific name, common name, family, date of collection, locality, coordinates, and edibility.

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Author contributions

Pragati N. Thonge: Investigation, Methodology, Data curation, Writing - original draft, Writing – review & editing, Formal analysis

Suprimkumar D. Dhas: Conceptualisation, Visualization, Methodology, Supervision, Visualization, Software

Ramesh R. Tembhurne: Resources, Supervision, Project administration, Writing – review & editing.

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Availability of data and material: Data will be made available on request**.**

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