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# First Report of *Podaxis pistillaris* (L.) Fr. from the Eastern Ghats, Odisha, India

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**ABSTRACT: *Podaxis pistillaris* (L.) Fr., a secotioid fungus belonging to the family Agaricaceae, is commonly found in arid and semi-arid regions across India and other parts of the world. This study reports, for the first time, the occurrence of *P. pistillaris* from the Eastern Ghats region of Odisha, India. The specimens were collected during a macrofungal survey conducted in 2024 from open, sandy patches within dry deciduous forest zones of Khordha district. Morphological identification was confirmed through standard taxonomic keys, and diagnostic features matched previous descriptions, including the presence of a cylindrical stipe, ovoid cap, and a dark, powdery gleba. This finding represents a significant eastward extension of the species' known distribution and suggests a broader ecological adaptability than previously recognized. The report contributes to the growing inventory of macro-fungi in the Eastern Ghats and highlights the need for continued mycological exploration in under-documented forest regions.**

**Keywords:** Eastern Ghats, India, Odisha, *Podaxis.*

## INTRODUCTION

The family Agaricaceae forms a monophyletic clade of saprotrophic fungi with a broad geographic distribution. It comprises approximately 85 genera and 1,340 species (Kirk *et al.*, 2008), including both poisonous and edible, as well as therapeutically important mushrooms. Members of this family are morphologically diverse and include gasteroid, secotioid, and agaricoid taxa (Moncalvo *et al.*, 2000; Matheny *et al.*, 2006). The genus *Podaxis* is believed to have originated in India, as first described by Linnaeus in 1771. Historically, *Podaxis* was placed in the family Podaxaceae (Morse, 1933), but modern taxonomic systems now classify it under Agaricaceae (Kirk *et al.*, 2008). In a recent molecular study, Conlon *et al.* (2019) examined 45 specimens identified as *Podaxis pistillaris*, primarily collected from South Africa. By analyzing the ITS and LSU rDNA regions, they identified at least six distinct clades (A–F) within the genus, indicating that multiple species of *Podaxis* exist. The first species of the genus *Podaxis*—as it is recognized today—was originally described as *Lycoperdon pistillare* by Linnaeus. A second species, *L. carcinoma*, was described posthumously by Linnaeus's son in 1781 (Linnaeus, 1767).

The genus *Podaxis* is distributed across tropical and subtropical regions between 40° North and 40° South latitude, encompassing parts of Africa, Asia, Australia, and the Americas (Dring, 1964; Berkeley, 1843; Vellinga, 2004; Sharma *et al.*, 2009). *Podaxis* fungi have been documented in a variety of environments, including dry sandy grasslands, arid deserts, and termite mounds inhabited by *Trinervitermes* and *Nasutitermes* species in Asia, Africa, the Americas, and Australia (Kirk *et al.*, 2013; Muhsin *et al.*, 2012; He *et al.*, 2019; Li *et al.*, 2023). *Podaxis pistillaris* (L. ex Pers.) Fr., a fungus belonging to the order Hymenogastrales, bears a superficial resemblance to the "shaggy mane" mushroom, *Coprinus comatus* (Fr.) S.F. Gray (Miller & Miller 1988). However, phylogenetic analyses based on rDNA gene sequences (Hopple Jr & Vilgalys 1999) have shown that *Podaxis* is genetically more closely related to the genera *Agaricus* and *Leucocoprinus.* Consequently, it was reclassified from the now-obsolete family Podaxaceae to the modern family Agaricaceae. *Podaxis* sp. exhibits a distinctive pre-emergence growth phase, during which the fruiting body develops underground to a depth of up to three inches. This subterranean development is followed by a forceful emergence, capable of displacing significant amounts of soil. The emergence typically occurs at night, and is followed by a rapid post-emergence growth phase, with the fruiting body elongating by one to two inches per day until it reaches full maturity (Morse, 1933).

## MATERIALS AND METHODS

In the field, morphological characteristics of the fleshy fruiting bodies were observed and recorded, including

shape, size, colour, and surface features. The form, dimensions, and colour of key taxonomic characters were documented both in the field and the laboratory. To examine internal structures, both longitudinal and transverse sections of the fruiting bodies were made using a new, sharp blade. Digital photographs were taken at various stages of basidioma development. Glebal tissue samples representing different developmental stages were individually transferred to separate microscope slides. Using dissecting needles, the tissues were carefully prepared and mounted in normal saline for observation. Samples were preserved in formaldehyde for further microscopic examination to infer important taxonomic features. For microscopic analysis, free-hand sections of the specimens were mounted in 5% KOH, Congo red, and Phloxine. The sections were then observed under a microscope. Microscopic examination of hyphae, cells, and spores of taxonomic importance was performed using 40× and 100× objectives of an Olympus BX-51 microscope equipped with a digital camera and computer-based image analysis software. Random measurements of 20 basidiospores (length × width) were taken for morphological analysis.

**Taxonomy**

***Podaxis pistillaris*** (L.) Fr. *Systema Mycologicum* 3: 63 (1829).

The pileus is narrowly cylindrical to ovate, measuring 3–5 cm in width and 10–18 cm in length at maturity. Unlike umbrella-shaped fungi, it does not undergo significant expansion. In immature stages, the margin is adnate to the stipe, but becomes free at maturity. The peridium is three-layered:

- Exoperidium: The outermost layer is a thin, membranous sheath (1–2 mm thick), initially white, later turning cream-grey, and peels off in scales.
- Middle layer: A brittle membrane (~1 mm thick), occasionally shedding in longitudinal strips from base to apex.
- Endoperidium: The innermost layer is fibrous, brittle, and hairless, initially white-cream to grey. Over time, it develops longitudinal fissures from the base to the apex, exposing the gleba. Eventually, wind disperses the gleba, leaving behind the capillitium and residual spore mass.

Gills are absent, replaced by a gleba that transitions in color from white to pallid to yellow and brown/black. Maturation is basipetal (from base to apex). A network of capillitial threads intricately interweaves to form a matrix encapsulating the spores. Pleurocystidia and cheilocystidia were not observed. The hymenophore (spore-bearing tissue) comprises a network of interwoven, translucent, thin-walled hyphae (4–20 µm in diameter), which show both generative and skeletal-like features. These support numerous clusters of brachybasidia. Basidioles are broadly oval to elliptical, measuring 10–18 µm in both dimensions. Clamp connections are absent. Basidiospores measure 8–13 × 12–16 µm, varying from elliptic, oval to spherical shapes. Initially hyaline, they become pale yellow, olivaceous, and finally brown, forming a dark spore mass. Spores are smooth, with a distinct germ pore and occasionally papillate. The cell wall is bilayered. Each basidium is club-shaped (clavate), measuring 13–19 µm in length and 8.0–11.0 µm in width, producing 2 to 4 spores (bisporic to tetrasporic). Sterigmata, the projections supporting spores, measure up to 1.6 µm and are arranged in clusters (fasciculate). Immature basidia were also observed. A slender, permanent columella runs through the gleba, gradually narrowing upward. At maturity, the gleba becomes homogenous, lacking internal differentiation. The stipe is 4–10 cm long and 10–12 mm thick at the base, gradually tapering toward the apex. It is slender, tough, woody, fibrous, and striated with a dry, white surface, sometimes covered in membranous scales. The stipe is hollow, with an internal tunnel 2–2.5 mm in diameter. The stipe mycelium consists of a mixture of thin and thick strands, swollen at intervals, and runs parallel to the stipe axis. Initially blackish near the base and white elsewhere, it turns yellowish after 10–15 hours of air exposure. At full maturity, the dried stipe turns brownish and often twists one to three times. The bulbous base is solid, resilient, and 1–2 cm in diameter. This species lacks both a volva and an annulus (Fig. 1-3).

**Fig. 1**. a-Habitat, b-Bud**, c to f** –stages of development of Young basidiocarp, **g** –final stage.

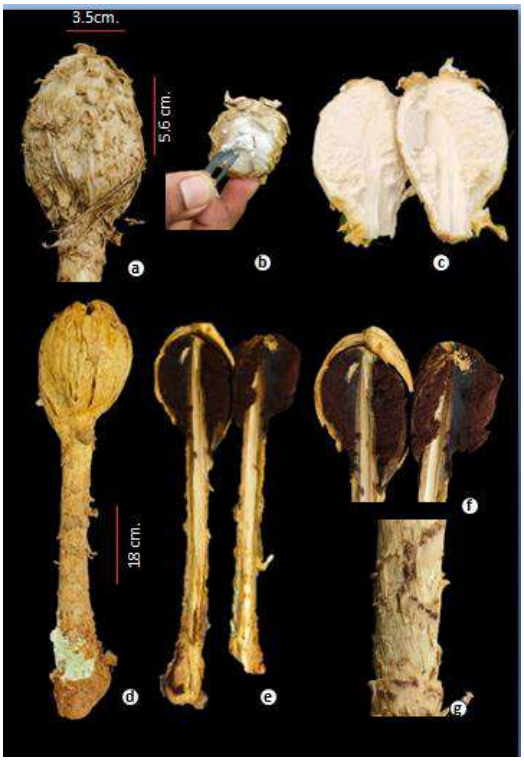


**Fig. 2.** a-Head,b-collection of spore, c-L S of fruiting body, Maturing basidiocarp, e-L.S. of maturing basidiocarp, g stalk.

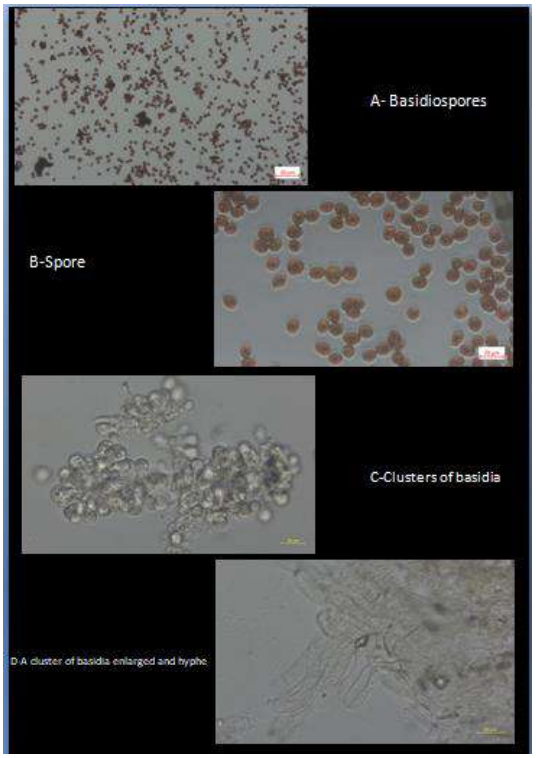


**Fig. 3.**

**Ecology:** *Podaxis pistillaris* typically grows singly or in scattered groups and is most commonly found in sandy soils of riverbanks, road sides, dry pastures, and open scrub lands. It often occurs in large populations under suitable conditions. The associated flora includes *Grona triflora* (L.) H. Ohashi & K. Ohashi, *Evolvulus alsinoides* (L.) L., *Evolvulus nummularius* (L.) L., grasses etc.

**Known Distribution**: India, Odisha [Bhubaneswar], Bihar, Central India, Haryana, Jammu and Kashmir, Madhya Pradesh, Maharashtra and Uttar Pradesh.

**Specimen examined**: India, Odisha, Khordha, Bhubaneswar, Sijua, 20° 14' 2.4" N, 85° 46' 40.8"E near AIIMS, 15.08.2024, *M.P. Sahoo & P.K. Das.* The herbarium specimen bearing Field No. 8765 is housed at the Regional Plant Resource Centre (RPRC), Bhubaneswar.

## RESULT AND DISCUSSION

Fruiting bodies of *Podaxis pistillaris* exhibited notable morphological variability. Specimens collected in July displayed larger dimensions compared to those obtained in October. Variations in size, colour, and shape were significant enough to potentially cause confusion with different species. However, all collected specimens were identified as *Podaxis pistillaris* based on the taxonomic criteria outlined by Morse (1933), who reported considerable intraspecific variability in fruiting body and spore characteristics within this species. Globally, approximately 44 species of the genus *Podaxis* have been reported (Conlon *et al*., 2019). According to Index Fungorum, a total of six species under the name *P. pistillaris* are currently recognized. In India, it has previously been documented from several regions such as, Uttar Pradesh and Bihar (Bilgrami *et al.*, 1979, 1981, 1991), Madhya Pradesh (Patel and Tiwari 2012), Jammu and Kashmir (Sharma & Sharma 2012), Central India (Sharma *et al.*, 2015), Haryana, where it is listed among common wild edible mushrooms (Atri, 2015), Amravati, Maharashtra (Hedawoo, 2020). During our field survey, we documented the presence of *P. pistillaris* from Bhubaneswar, Khordha, Odisha. This represents the first distributional record of the species from the Eastern Ghats region of Odisha.

Despite its reported nutritional and therapeutic properties, *P. pistillaris* has not been widely commercialized due to the hardness of the fruiting body, which limits its edibility (Gupta & Singh 1991). It has been explored for its antibacterial potential (Panwar & Purohit 2002) and traditional use in treating skin disorders (Gupta & Singh, *l.c*). Until now, no confirmed records existed of this species from the Eastern Ghats, specifically the state of Odisha.

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**Conflict of Interest.** None**.**

## REFERENCES

Atri, M. S. (2015). *Podaxis pistillaris*-A common wild edible mushroom from Haryana (India) and its Sociobiology. *Kavaka*, *44*, 34-37.

Berkeley, M. J. (1843). *On two Hymenomycetous fungi, belonging to the Lycoperdaceous group.*

Bilgrami, K. S., Jamaluddin, S. and Rizwi, M. A. (1991). Fungi of India III List and References.Today's and Tomorrow's Printer's & Publisher's, New Delhi.

Bilgrami, K. S., Jamaluddin, S. and Rizwi, M. A. (1981). Fungi of India II Host Index and Addenda.Today's and Tomorrow's Printer's and Publisher's, New Delhi

Bilgrami, K. S., Jamaluddin, S. and Rizwi, M.A. (1979). Fungi of India I List and references. Today's and Tomorrow's Printer's and Publisher's, New Delhi.

Colon, B. H., De Beer, Z. W., Henrik, H., Aanen, D. K. and Poulsen, M. (2016). Phylogenetic analysis of *Podaxis* species from southern Africa reveal hidden diversity and new insights into associations with termites. *Fungal Biology*, *120*(9), 1065-1076.

Conlon, B. H., Aanen, D. K., Beemelmanns, C., De Beer, Z. W., Licht, H. H. D. F., Gunde-Cimerman, N., Schiøtt, M. and Poulsen, M. (2019). Reviewing the taxonomy of Podaxis: Opportunities for understanding extreme fungal lifestyles. *Fungal biology*, *123*(3), 183-187.

Dring, D. M. (1964). Gastromycetes of West Tropical Africa. *Mycological Paper*, *98*, 1-64.

Gupta, S. and Singh, S. P. (1991). Nutritive value of mushroom Podaxis pistillaris. *Indian Journal of Mycology and Plant Pathology*, *21*(3), 273-276.

He, M. Q., Zhao, R. L., Hyde, K. D., Begerow, D., Kemler, M., Yurkov, A. and Kirk, P. M. (2019). Notes, outline, and divergence times of Basidiomycota. *Fungal diversity*, *99*, 105-367.

Hedawoo, G. B. (2020). *Podaxis pistillaris* (L. ex Pers.) Fr (Desert Shaggy Mane): A Potential Gastroid Mushroom from Amravati Region. Pp.193-195.

Hopple Jr, J. S. and Vilgalys, R. (1999). Phylogenetic relationships in the mushroom genus Coprinus and dark-spored allies based on sequence data from the nuclear gene coding for the large ribosomal subunit RNA: divergent domains, outgroups, and monophyly. *Molecular phylogenetics and evolution*, *13*(1), 1-19.

Kirk, P. M., Stalpers, J. A., Braun, U., Crous, P. W., Hansen, K., Hawksworth, D. L. and Stadler, M. (2013). A without-prejudice list of generic names of fungi for protection under the International Code of Nomenclature for algae, fungi, and plants. *IMA fungus*, *4*(2), 381-443.

Li, G. S., Leal-Dutra, C. A., Cuesta-Maté, A., Conlon, B. H., Peereboom, N., Beemelmanns, C. and Poulsen, M. (2023). Resolution of eleven reported and five novel *Podaxis* species based on ITS phylogeny, phylogenomics, morphology, ecology, and geographic distribution. *Persoonia-Molecular Phylogeny and Evolution of Fungi*, *51*(1), 257-279.

Linnaeus, C. (1767). *Mantissa plantarum: Generum editionis VI. et specierum editionis II*. Stockholm: Laurentius Salvius.

Matheny, P. B., Curtis, J. M., Hofstetter, V., Aime, M. C., Moncalvo, J. M., Ge, W. and Hibbett, D. S. (2006). Major Clades of Agaricales: a multilocus phylogenetic overview. *Mycologia*, *98*(6), 982-995.

Miller, O. K., and Miller, H. (1988). Gasteromycetes: morphological and developmental features with keys to the orders, families, and genera. Eureka CA: Mad River Press.

Moncalvo, J. M., Lutzoni, F. M., Rehner, S. A., Johnson, J. and Vilgalys, R. (2000). Phylogenetic relationships of agaric fungi based on nuclear large subunit ribosomal DNA sequences. *Systematic biology*, *49*(2), 278-305.

Morse, E. E. (1933). A study of the genus *Podaxis*. *Mycologia*, *25*(1), 1-33.

Muhsin, T. M., Abass, A. F. and Al-Habeeb, E. K. (2012). *Podaxis pistillaris* (Gasteromycetes) from the desert of southern Iraq, an addition to the known mycota of Iraq. *Journal of Basrah Researches (Sciences)*, *38*(3), 29-35.

Panwar, C. H. and Purohit, D. K. (2002). Antimicrobial activities of *Podaxis pistillaris* and *Phellorinia inquinans* against *Pseudomonas aeruginosa* and *Proteus mirabilis*. *Mushroom Research*, *11*(1), 43-44.

Patel, U. S. and Tiwari A. K. (2012). *Podaxis pistillaris* reported from Madhya Pradesh, India. *Indian Journal of Fundamental and Applied Life Sciences*, *2*(1), 233-239.

Sharma, R. S., Rajak, R. C. and Pandey, A. K. (2009). *Podaxis pistillaris*: a rare Gasteromycetes from Central India. *Mushroom Research, 18*(1), 37-38.

Sharma, A. and Sharma, Y. P. (2012). *Podaxis pistillaris* (L.) Morse-A New Record for Jammu and Kashmir. *Indian Journal of Forestry*, *35*(2), 237-238.

Sharma, R., Rajakand, R. C. and Pandey, A. K. (2015). *Podaxis pistillaris*: a rare Gasteromycetes from Central India. *Mushroom Research, 18*(1).

Vellinga, E. C. (2004). Genera in the family Agaricaceae: evidence from nrITS and nrLSU sequences. *Mycological research*, *108*(4), 354-377.

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