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Taxonomy and Morphological study of Selected taxa of Xylariaceae from Southern Aravalli Region of Rajasthan, India

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ABSTRACT

Xylariaceae (Ascomycota) is a highly diverse and ecologically vital fungal family distributed worldwide. Members of this family exhibit varied ecological roles, functioning primarily as wood-decaying saprobes, endophytes inhabiting internal plant tissues, and occasionally as plant pathogens. Although numerous species of Xylariaceae have been documented from India, comprehensive regional investigations remain limited. The present study was conducted in three districts of Rajasthan namely Rajsamand, Sirohi and Udaipur which form an important part of the southern Aravalli range in the state of Rajasthan. These districts are characterised by diverse topography comprising hills, valleys, plains and forested landscapes, contributing to rich ecological and biological diversity. Field surveys were conducted during the winter seasons, from October 2024 to January 2026. Fungal specimens were collected from decaying wood substrates. In situ photographs were taken prior to collection, and detailed laboratory examinations were carried out using standard morphological and microscopic techniques. Diagnostic features—including stromatal morphology, the structure of asci and paraphyses, and ascospore size, shape, amyloid reaction, and germ slit characteristics—were carefully analysed. These observations were then compared with established taxonomic literature to ensure accurate identification. A total of four species belonging to three genera of Xylariaceae were identified: Rosellinia (one species), Anthostomella (one species), and Hypoxylon (two species). The species recorded include Rosellinia apiculate, Anthostomella spirilla, Hypoxylon cohaerens and Hypoxylon fuscum . This study establishes a foundational reference for future taxonomic, ecological, and molecular investigations of wood-inhabiting fungi within semi-tropical forest ecosystems of the southern Aravalli region of Rajasthan.

Keywords: *Xylariaceae; southern Aravalli region; decaying wood; asci; ascospores.*

1. INTRODUCTION

The family Xylariaceae, belonging to the phylum Ascomycota, represents one of the most extensive and taxonomically diverse groups of fungi with a nearly global distribution. Its occurrence across a wide spectrum of ecological conditions and geographic regions has been well documented in earlier investigations[1]. Members of this family are predominantly associated with woody substrates and exhibit particularly high diversity in tropical and subtropical environments. Ecologically, most species function as saprophytes involved in wood decomposition, although several taxa are known to behave as plant pathogens[2,3] or occur as endophytes within living plant tissues.

Xylariaceous fungi have been recorded from a variety of substrates, including decaying wood, leaf litter, animal dung, and soil. While certain species demonstrate a degree of host specificity, others display broader ecological adaptability, colonising diverse plant hosts across different genera[4]. Some taxa are notably associated with bamboo, palms and teak [5]. In India, numerous researchers have made significant contributions to the taxonomy and diversity of the family Xylariaceae [6–10].

Despite these efforts, the delimitation of genera and the accurate identification of species within Xylariaceae remains complex. This difficulty arises from considerable morphological variation and overlap in diagnostic features[11].

Traditionally, classification within the family has relied on stromatal morphology and pigmentation, along with ascospore size and shape. Among the genera, *Xylaria* is the largest and most widely represented. For example, 19 taxa of Xylariaceae were documented in Gujarat[12], including 14 species of *Xylaria* along with representatives of *Daldinia* and *Hypoxylon*. Similarly, *Rosellinia*, comprising approximately 160 species worldwide, is another major genus within the order Xylariales. Globally, members of Xylariaceae play important ecological roles as decomposers of lignocellulosic material, endophytes, and occasional pathogens. In addition to their ecological significance, members of Xylariaceae are known for producing a wide range of biologically active secondary metabolites, largely attributed to their endophytic lifestyle[13,14,15]. Furthermore, these fungi are important sources of lignocellulolytic enzymes, which have extensive industrial applications in sectors such as pharmaceuticals, paper and pulp processing, and textile manufacturing[16].

The southern Aravalli region of Rajasthan represents an ecologically significant landscape characterized by discontinuous forest patches embedded within a predominantly semi-arid environment. Certain elevated zones within this region exhibit relatively higher moisture levels during the monsoon season, supporting diverse vegetation composed of gymnosperms and angiosperms. These conditions create suitable microhabitats for fungal growth, particularly for wood-inhabiting taxa.

Previous studies have indicated that fungal diversity in such humid pockets of the Aravalli range is relatively rich compared to surrounding dry areas. However, detailed investigations focusing specifically on Xylariaceae from this region remain scarce.

The present study documents the diversity of Xylariaceae in the southern Aravalli region of Rajasthan, with particular emphasis on genera such as *Anthostomella, Rosellinia* and *Hypoxylon.* Both macroscopic and microscopic characteristics have been examined using standard taxonomic approaches. The study aims to contribute to the existing knowledge of xylariaceous fungi by providing detailed descriptions and assessing their diversity in relation to regional and global records.

2. MATERIALS AND METHODS

2.1 Study Site and Sampling

Fungal specimens were collected from the southern Aravalli region of Rajasthan, including forested areas and adjoining habitats, during the winter period (October 2024 to January 2026). The study area is characterized by tropical semi-deciduous vegetation interspersed within a predominantly semi-arid landscape.

Fruiting bodies were collected from a variety of substrates, including decaying wood, soil, leaf litter, and plant debris. Each specimen was carefully placed in sterile paper bags and labelled with relevant field data such as collection site, substrate type, and date. In situ photographs were taken prior to collection using a smartphone camera (Apple iPhone 13 Pro Max) to document natural habit and substrate association. All samples were subsequently transported to the laboratory for further examination.

2.2 Morphological Examination

In the laboratory, stromata were examined for macroscopic features including size, shape, colour, and surface characteristics. For microscopic analysis, thin hand sections of stromata were prepared and mounted on glass slides using 3–5% potassium hydroxide (KOH). Additional staining and mounting media, such as lactophenol cotton blue and Melzer's reagent, were employed to observe structural details and to test for amyloid reactions.

Microscopic observations focused on key taxonomic features. Measurements of asci and ascospores were recorded as well as ascus apical apparatus and germ slit characteristics were carefully examined. Members of Xylariaceae are typically characterised by unitunicate, cylindrical asci bearing eight ascospores and possessing an amyloid apical ring, while ascospores are generally pigmented and exhibit germ slits or pores.

Identification of taxa was carried out by comparing observed characters with standard taxonomic descriptions and identification keys for Xylariales [11]. Voucher specimens were preserved and deposited in the mycological collection of Maulana Azad University, Jodhpur, Rajasthan.

2.3 Imaging and Documentation

Field images were captured using an Apple iPhone 13 Pro Max to document the natural occurrence and morphology of the specimens. Photomicrographs were obtained using a compound microscope equipped with a digital imaging system. For each specimen, measurements of 20–30 asci and ascospores were taken, and mean values were calculated to ensure accuracy.

Macroscopic features of stromata were further documented using a macro lens to capture detailed morphological structures. The collected data were analysed and compared with relevant taxonomic literature [11] to confirm identification at the genus and species levels.

3. RESULT

3.1 Morphological and Taxonomic Description

The Xylariaceae taxa recorded in the present study are described below, with particular emphasis on both stromatal and micromorphological characteristics. Standard taxonomic terminology (e.g., ascoma/stroma, ostiole, peridium) has been consistently applied throughout. All measurements are expressed in micrometers (µm) unless stated otherwise.

A total of four species of Xylariaceae, representing three genera—*Rosellinia* (one species), *Anthostomella* (one species), and *Hypoxylon* (two species)—were identified during the course of this investigation. The detailed morphological features of these taxa are presented below:

3.1.1 ANTHOSTOMELLA Saccardo ; Nuovo Giorno Botanico Italiano 8 : 12 : 1875.

The genus comprises approximately 425 species, of which around 70 have been reported from India. During the present study, one species of this genus was recorded.

3.1.1 *Anthostomella spirilla* Panwar & S.J. Kaur **Fig. 1**

Index Fungorum : 308741

Macroscopic Description - Black Ascomata are discrete, and sub-globose in form. They are initially embedded within the substrate but become erumpent upon maturity, developing a distinct beak. The peridial wall is composed of pseudoparenchymatous tissue and measures approximately 45–80 µm in thickness. Individual ascomata range from 400–605 µm in diameter and 330–572 µm in height, with the beak extending up to 35–45 µm in length.

Microscopic Description - Asci are numerous and exhibit a typical xylarioid morphology, characterized by a distinctly amyloid apical apparatus. They arise from both the basal region and lateral sides of the ascoma and are intermingled with paraphyses. The asci are hyaline, unitunicate, and vary from cylindrical to clavate in shape, with short stalks, each containing eight ascospores. They measure approximately 95–130 × 8.5–12.0 µm. Paraphyses are abundant, hyaline, septate, and branched, forming a supportive network among the asci. They are about 4 µm wide and may extend up to 200 µm in length. Ascospores are arranged in a straight to slightly oblique uniseriate fashion within the asci. They are elliptic with rounded ends, dark brown at maturity, and are distinguished by the presence of hyaline spiral bands. Spore dimensions range from 15–20 × 6.5–8.2 µm.

Habit – Dead twigs of *Syzygium cuminii* L. (Seeks) and unidentified dead twigs

Material examined –Police academy & Delwara area at Mount Abu, Sirohi and Luv kush Vatika, Udaipur during Dec. 2024 and Oct. 2024 respectively; lectotype herbarium number 0103(MAUJ).

Remark - This species is first time reported from Udaipur.

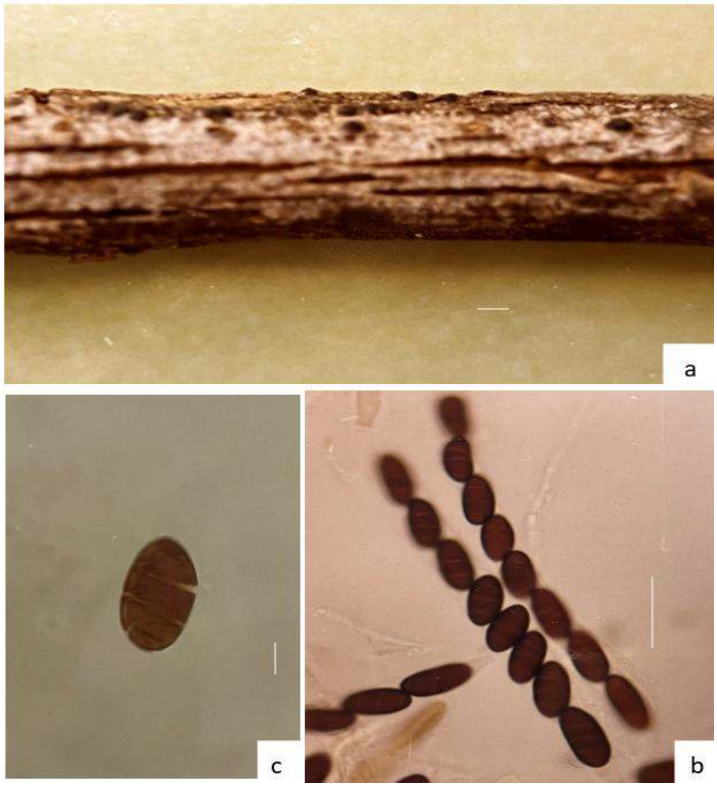

Fig. 1: Anthostomella spirilla Panwar & S.J. Kaur. a. Ascomata on dead wood, b. Asci with 8-ascospores, c. An ascospore showing hyaline spiral bands. Scale bars: a= 80 µm ; b= 5 µm ; c= 30 µ

3.1.2 ROSELLINIA Cesati and de Notaris ; Giorno Botanica Italiano 1 : 334 : 1844.

The genus comprises approximately 531 species, of which 27 have been reported from India, including six from Rajasthan. During the present survey, one species of this genus was collected.

3.1.2.1 *Rosellinia apiculata* Sacc. var. apiculata **Fig. 2**

Index Fungorum : 427341

Macroscopic Description - Stromata are scattered, occasionally occurring in small groups of two to three, and develop superficially on the substrate. They are carbonaceous in consistency and exhibit a pyriform shape, measuring approximately 520–600 µm in length and 570–610 µm in width. The stromata are surrounded by brown, septate hyphae, which are about 4–5 µm thick.

Microscopic Description - Asci are abundant, cylindrical, and stipitate, arising among the paraphyses. They are unitunicate and possess an obtuse apex with a well-defined amyloid apical ring and pore, measuring 100–115 × 15–20 µm.

Paraphyses are hyaline, slender, and filiform, forming a delicate interwoven network between the asci.

Ascospores are eight per ascus and arranged in a uniseriate manner. They are unicellular, dark brown at maturity, and ellipsoidal to slightly curved (flexuous) in shape, often exhibiting a concavo-convex profile. One end of the spore bears a small apiculus. Each ascospore contains one to two oil droplets and is characterized by a distinct germ slit. The spores are surrounded by a thin, uniform sheath and measure 14.0–20.5 × 6.5–7.5 µm.

Habit - Dead twigs of *Artemisia nilgirica* Pemp.

Material examined - Chhipaberi at Mount Abu, Sirohi, Rajasthan during Nov. 2024; lectotype herbarium number 0126(MAUJ).

Remark - The present species comes closer to *R. mammiformis* (Persoon ex Fries) Cesati and de Not., but differs in the presence of mucous sheath around the ascospores and the size of ascomata, asci and ascospores.

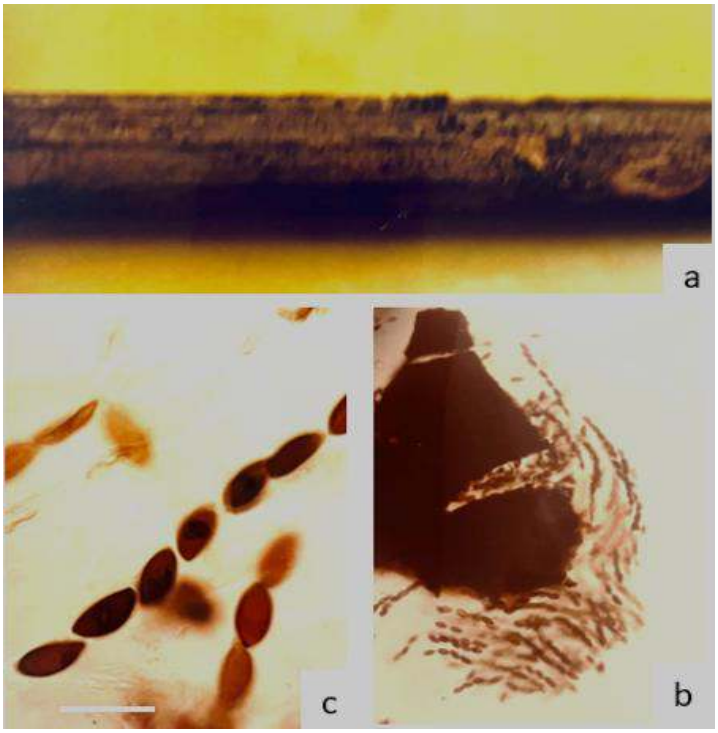

Fig. 2: Rosellinia apiculata Sacc. var. apiculata a. Stromata on wood, c. Asci with Ascospores, d. Ascospores showing oil globules. Scale bar : c = 15 µm

3.1.3 HYPOXYLON Bulliard ; Systema Mycologicum 3 : Index alphabeticus 103 : 1791.

The genus comprises approximately 1,225 species, of which about 730 have been reported from India. During the present study, two species of *Hypoxylon* were recorded.

3.1.3.1 *Hypoxylon cohaerens* (Pers.) Fr. **Fig. 3**

Basionym: Sphaeria cohaerens Pers. 1794

Index Fungorum: 207350

Macroscopic Description - Stromata are erumpent to superficial, measuring approximately 2–4 mm in diameter and 1.0–1.5 mm in height. They occur gregariously, often forming dense clusters that may coalesce and cover relatively large surface areas. Individual stromata are carbonaceous, subglobose, and characteristically flattened at the apex, with sharply demarcated margins. The surface is distinctly mammillate, bearing prominent papillate ostioles that are clearly visible. In immature stages, stromata are reddish-brown to pale brown in colour, gradually darkening to a purplish-black upon maturity.

Microscopic Description - Each stroma contains approximately 6–15 ascomata, which are globose to pyriform and measure 352–500 µm in width and 455–525 µm in height. Asci are numerous, cylindrical, and provided with a well-developed apical apparatus, measuring 140.0–162.5 × 7.5–8.7 µm. Paraphyses are slender, filamentous, and branched, forming an interwoven sterile network among the asci.

Ascospores are arranged obliquely in a uniseriate manner within the asci. They are navicular to elliptic in shape, occasionally inequilateral, and possess a straight germ slit shorter than the spore length. Spores are dark brown at maturity and measure approximately 10–15 × 6–7 µm.

Habit – Dead twigs of *Carrisa congesta* Wt. and unidentified dead twigs.
Material examined – Trevors tank , Nakki lake, Dhobi Ghat at Mount Abu; Biodiversity Park area in Udaipur during Dec. 2025 and Jan. 2026; lectotype herbarium number 0130(MAUJ).
Remark - Earlier, this species was reported from India by Thind and Wariach [6]. The present species differs from the type species in the dimensions of asci and ascospores and is reported here for the first time from Udaipur.

3.1.3.2 *Hypoxylon fuscum* (Pers.) Fr. **Fig. 4**
Basionym: Sphaeria fusca Pers. 1794
Index Fungorum : 163954
Macroscopic Description - Stromata are erumpent to superficial, occurring either singly or in gregarious groups. They are hemispherical to slightly depressed in shape and may appear effused across the substrate. In early developmental stages, the stromata are soft and somewhat fleshy, becoming leathery in texture as they mature. The surface is generally smooth to moderately even, without conspicuous ornamentation. Individual stromata measure approximately 2–3 mm in diameter and 1–3 mm in height, forming small but clearly distinguishable structures on the host substrate
Microscopic Description - Stromata comprise globose to irregularly angular ascomata, each bearing a distinctly sunken (impressed) ostiole. The ascomata measure approximately 330–550 µm in width and 418–660 µm in height.
Asci are numerous, cylindrical, and equipped with a well-developed apical apparatus, measuring 147.5–157.5 × 12.5–15.0 µm.
Ascospores are arranged either uniseriately or obliquely uniseriate within the asci. They are elliptic and inequilateral in outline, with a brown to nearly opaque pigmentation at maturity. A prominent, straight germ slit extending along much of the spore length is present, serving as an important diagnostic feature. Spore dimensions range from 12.5–15.0 × 6.2–7.5 µm.
Habit – Dead twigs of *Lantana camara* L. and Unidentified wood
Material examined – Toll Tax, Nursery & sunset point area at Mount Abu; Biodiversity Park area in Udaipur during Dec. 2025 and Jan. 2026; lectotype herbarium number 0131(MAUJ).
Remark - In the present taxon ascospores are slightly smaller than type species.

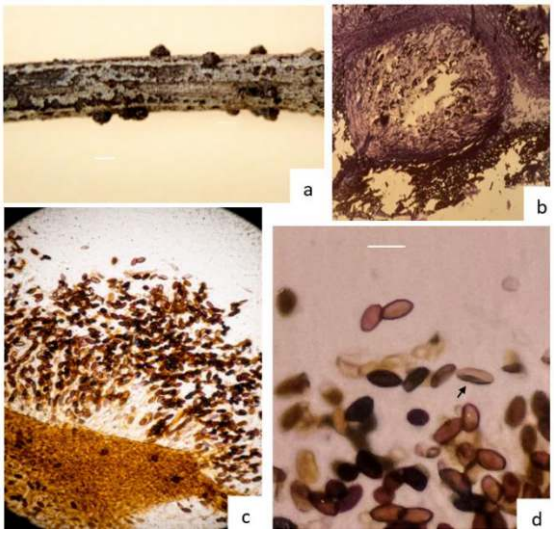

Fig. 3: Hypoxylon cohaerens Pers. a. Stromata on wood, b. Electron microscopic photograph of ascomata showing densely arranged numerous asci in centrum oriented toward the ostiolar region., c. Asci with Ascospores, d. Ascospores (Arrow mark showing germ slit). Scale bars: a= 1mm ; c=10µm

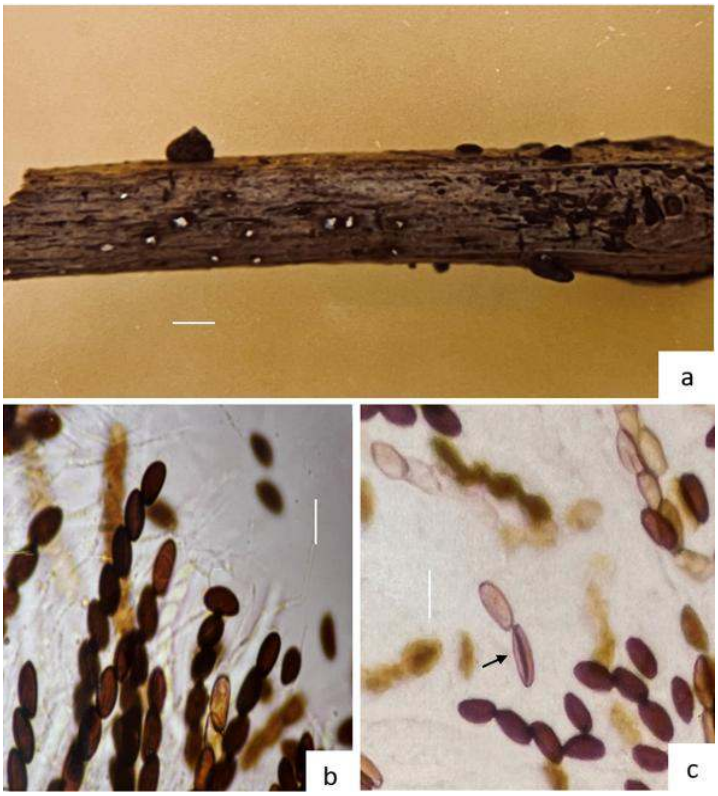

Fig. 4: Hypoxylon fuscum Pers. ex Fr. a. Stromata on wood, b. Asci with dark Ascospores , c. Ascospores (Arrow mark showing germ slit). Scale bars: a= 2mm ; b= 10µm ; c=10µm

Key to the species of three Xylariaceae genera
a. Stromata absent; ascomata discrete, embedded becoming erumpent; ascospores with hyaline spiral bands……***Anthostomella spirilla***
1b. Stromata present, well-developed……2
2a. Stromata pyriform, superficial, surrounded by brown septate hyphae; ascospores with apiculus and mucilaginous sheath……***Rosellinia apiculata* var. *apiculata***
2b. Stromata carbonaceous, subglobose to hemispherical, without surrounding hyphal sheath ……3
3a. Stromata mammillate with papillate ostioles; surface reddish-brown to purplish-black; ascospores navicular to elliptic with short germ slit…… ***Hypoxylon cohaerens***
3b. Stromata smooth to slightly even, lacking mammillate surface; ascospores elliptic with long straight germ slit……***H. fuscum***

4.DISCUSSION AND CONCLUSION

The taxonomic circumscription of Xylariaceae has undergone considerable revision over time, with different authors proposing varying numbers of genera based on morphological and molecular evidence. Earlier comprehensive treatment [17,18] contributed significantly to the understanding of family-level classification. Continued taxonomic refinement has led to the re-establishment of the genus *Dematophora* [19] and the introduction of several new genera, including *Albicollum*, *Nigropunctata* [20], *Oligostoma*, *Spiririma* [21] and *Anthostomella* [22], reflecting ongoing advancements in phylogenetic studies.
The family Xylariaceae represents one of the most species-rich and taxonomically intricate groups within the Ascomycota, particularly in tropical and subtropical regions [7,8,9,11,23,24].

While extensive studies have been conducted in southern and northeastern parts of India, information from northwestern regions remains comparatively limited [12]. The southern Aravalli region of Rajasthan, characterised by localised humid forest patches within an otherwise semi-arid landscape, provides favourable microhabitats for wood-inhabiting and endophytic fungi. Previous investigations from this region have reported the occurrence of dark-spored lignicolous fungi [25], indicating the potential presence of xylariaceous taxa. The present study confirms that the southern Aravalli region supports a noteworthy diversity of Xylariaceae, predominantly associated with decaying wood, fallen twigs, and forest litter.

Micromorphological characters played a crucial role in species identification. Features such as ascospore size, shape, pigmentation, germ slit characteristics, presence of oil droplets, and wall structure proved highly reliable for distinguishing taxa [1,26,27]. In contrast, macroscopic stromatal traits exhibited considerable variability and were influenced by environmental factors including substrate type, moisture availability, and developmental stage [28]. This observation supports earlier findings that reliance solely on external morphology may lead to misidentification, especially within morphologically variable genera such as *Xylaria* [29,30]. Therefore, detailed microscopic examination remains indispensable for accurate species delimitation, particularly in the absence of molecular data.

The taxa documented in this study were predominantly lignicolous saprobes, highlighting the ecological importance of Xylariaceae in the decomposition of woody substrates and nutrient cycling within forest ecosystems [2,3]. Their frequent occurrence on decaying plant material aligns with their role as primary decomposers. Additionally, many members of this family are known to exist as endophytes in living plant tissues, later transitioning to a saprobic phase during host senescence [4]. Such ecological flexibility likely enables these fungi to persist under fluctuating environmental conditions, including the seasonal variations in humidity typical of the southern Aravalli region.

From a biogeographical perspective, Xylariaceae exhibit high diversity in tropical regions, with new species and distribution records continually emerging from Asia, Central America, and India [29,30,31]. The present study expands the known distribution of several taxa into northwestern India and underscores the importance of forested refugia within the Aravalli range for conserving fungal diversity in otherwise dry environments [5]. These findings reinforce the notion that fungal diversity remains insufficiently documented, even in regions that appear climatically marginal[32,33].

Beyond their ecological roles, members of Xylariaceae are of increasing interest due to their ability to produce a wide range of bioactive secondary metabolites with antimicrobial and other pharmaceutical properties [13,15,34]. Since metabolite production can vary significantly among closely related taxa, accurate taxonomic identification is essential for applied and biotechnological research [35]. The morphological framework established in this study therefore provides a valuable foundation for future investigations into the functional and biochemical potential of Xylariaceae from this region.

Although micromorphological analysis proved effective for species identification in this study, contemporary taxonomy increasingly emphasizes the integration of morphological, ecological, and molecular data. DNA-based approaches are particularly useful for resolving cryptic species and clarifying phylogenetic relationships within complex taxa [27,36].

Future research in the southern Aravalli region would benefit from incorporating molecular phylogenetic analyses along with expanded seasonal sampling to achieve a more comprehensive understanding of xylariaceous diversity [10,37].

In conclusion, the present study demonstrates that the southern Aravalli region of Rajasthan harbours a diverse and ecologically significant assemblage of Xylariaceae, despite its location within a predominantly semi-arid zone. Detailed micromorphological analysis, particularly of ascospore and ascus characteristics, proved essential for accurate identification. These findings highlight the importance of localized fungal surveys and provide a baseline for future taxonomic, ecological, and molecular studies in the region.

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COMPETING INTERESTS

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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