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Occurrence and Diversity of Soil and Plant Debris Associated Fungi: Taxonomic Composition and Functional Significance

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Abstract
Soil and plant debris represent important ecological reservoirs supporting diverse fungal communities involved in organic matter transformation, nutrient cycling and interactions with plants. The present study was conducted to investigate the occurrence and diversity of soil and plant debris associated fungi with emphasis on taxonomic composition and functional significance. The investigation revealed a diverse assemblage of fungal taxa associated mainly with soil, leaf litter, plant residues and decomposing organic substrates. The recorded fungi represented ecologically important genera including *Trichoderma*, *Fusarium*, *Bipolaris*, *Chaetomium*, *Curvularia*, *Phoma*, *Nigrospora*, *Pestalotiopsis*, *Epicoccum* and other saprophytic groups. The identified taxa exhibited diverse ecological functions, including organic matter decomposition, nutrient transformation, plant association and antagonistic potential. Soil-associated fungi such as *Trichoderma* spp., *Fusarium* spp. and *Aspergillus* spp. reflected the complex microbial interactions occurring within terrestrial ecosystems, whereas litter-associated fungi contributed to decomposition processes through colonization of plant residues. The study highlights the diversity and functional importance of soil and plant debris associated fungi and provides baseline information regarding fungal communities involved in terrestrial ecosystem processes.

Keywords: Airborne fungi; Microfungi; Taxonomy; Morphology; Anamorphic fungi.

1. Introduction

Soil represents one of the most complex microbial habitats on Earth, supporting a wide range of microorganisms that regulate essential ecosystem processes. Among these microorganisms, fungi play a fundamental role due to their ability to colonize organic substrates, decompose complex plant materials and participate in nutrient cycling. Their extensive hyphal networks enable efficient exploration of soil environments and contribute significantly to organic matter transformation and ecosystem functioning (Dighton, 2016; Frąc et al., 2018).

Plant debris and leaf litter serve as major nutrient reservoirs in terrestrial ecosystems and provide suitable substrates for colonization by diverse fungal communities. Litter-associated fungi participate in the degradation of cellulose, hemicellulose and other plant-derived compounds, facilitating nutrient release and maintaining soil fertility. The fungal community associated with plant residues changes according to substrate quality, environmental conditions and stages of decomposition (Osono, 2007).

Soil fungi represent diverse ecological groups including saprotrophs, plant-associated fungi, pathogenic fungi and beneficial microorganisms. Saprophytic fungi such as species belonging to *Chaetomium*, *Trichoderma*, *Penicillium* and *Aspergillus* contribute to decomposition processes, whereas other groups such as *Fusarium*, *Bipolaris* and *Rhizoctonia* include species associated with plant interactions and disease development (Bridge & Spooner, 2001).

The genus *Trichoderma* represents an ecologically important group of soil fungi known for its rapid colonization ability, antagonistic activity and contribution to biological control of plant pathogens. Several *Trichoderma* species are widely distributed in soil and organic substrates and are recognized for their role in maintaining microbial balance within terrestrial ecosystems (Harman et al., 2004). Plant debris-associated fungi constitute another important ecological group because they contribute to decomposition and nutrient recycling. Fungi belonging to genera such as *Bipolaris*, *Nigrospora*, *Pestalotiopsis*, *Phoma* and *Chaetomium* commonly colonize dead plant materials and participate in the breakdown of organic residues (Bills & Polishook, 1994).

2. Materials and Methods

2.1 Study Material and Substrate Selection

The study was designed to investigate fungal communities associated with soil and plant debris substrates. Samples representing different organic and terrestrial habitats were considered to evaluate the diversity of fungi inhabiting decomposing plant materials and soil environments. Soil and litter substrates were selected due to their importance as reservoirs of saprophytic fungi and their role in supporting fungal communities involved in organic matter transformation. The collected substrates represented natural sources of fungal colonization, where fungi actively participate in decomposition, nutrient recycling and interaction with plant-derived materials.

2.2 Recovery of Fungal Isolates from Environmental Substrates

Fungal isolates were recovered from soil and plant debris samples following standard isolation procedures used in environmental mycology. The samples were processed under sterile laboratory conditions and inoculated on appropriate fungal media to encourage the growth and development of associated fungi.

Developing fungal colonies were examined regularly, and morphologically distinct colonies were selected for purification. Pure cultures were obtained through repeated transfer and maintained for subsequent identification and characterization.

2.3 Characterization and Identification of Fungal Isolates

The isolated fungi were characterized through a combination of cultural and microscopic observations. Colony morphology, pigmentation, growth habit and sporulation features were recorded during cultivation.

Microscopic examination focused on reproductive and vegetative structures, including hyphal characteristics, conidiophore development, spore morphology and arrangement of reproductive structures. Identification was carried out by comparing observed characters with standard descriptions available in fungal taxonomic manuals and published literature.

2.4 Ecological Categorization of Fungal Taxa

Following identification, the recorded fungi were grouped according to their ecological association with soil and plant debris substrates. The taxa were evaluated based on their known functional attributes, including saprophytic activity, organic matter degradation, plant association and beneficial ecological roles.

Particular emphasis was given to fungi representing important functional groups such as decomposer fungi, soil-inhabiting fungi, plant-associated fungi and potentially beneficial taxa involved in biological interactions.

2.5 Compilation and Interpretation of Fungal Diversity Data

The identified fungal taxa were compiled to assess the diversity pattern of soil and plant debris associated mycoflora. The data were interpreted considering taxonomic representation, substrate preference and ecological functions of individual fungal groups.

3. Observations and Results

3.1 Taxonomic Composition of Soil and Plant Debris Associated Fungi

The examination of soil and plant debris substrates revealed a diverse group of fungi associated with terrestrial habitats. A total of 15 fungal taxa were recorded, representing saprophytic, soil-associated and plant-associated fungal groups. The identified fungi belonged to important genera including *Trichoderma*, *Bipolaris*, *Chaetomium*, *Fusarium*, *Curvularia*, *Phoma*, *Nigrospora*, *Pestalotiopsis*, *Epicoccum* and other litter-associated fungi.

The recorded fungal taxa showed distinct associations with soil, leaf litter and plant debris substrates. Soil-associated fungi were mainly represented by taxa belonging to *Trichoderma*, *Fusarium* and *Rhizoctonia*, whereas litter and plant debris supported fungi involved primarily in decomposition processes. The occurrence of these fungi indicates the importance of terrestrial substrates as reservoirs of fungal diversity and functional microbial activity.

The occurrence of different fungal taxa was evaluated to understand the contribution of soil and plant debris habitats towards maintaining fungal diversity and supporting ecological processes in terrestrial environments.

Table 1. Taxonomic Composition and Habitat Association of Selected Soil and Plant Debris Associated Fungi

Sr. No.	Fungal Taxa	Major Habitat/Source
1	*Arthrinium phaeospermum*	Leaf litter
2	*Bipolaris maydis*	Plant debris
3	*Bipolaris sorokiniana*	Soil and grasses
4	*Chaetomium globosum*	Leaf litter
5	*Curvularia lunata*	Soil and litter
6	*Epicoccum nigrum*	Leaf litter
7	*Fusarium oxysporum*	Soil and roots
8	*Humicola grisea*	Soil and litter
9	*Nigrospora oryzae*	Leaf litter
10	*Pestalotiopsis funerea*	Leaf litter
11	*Phoma herbarum*	Leaf litter
12	*Rhizoctonia solani*	Soil
13	*Trichoderma asperellum*	Soil
14	*Trichoderma harzianum*	Soil
15	*Trichoderma viride*	Soil and litter

3.2 Genus-wise Distribution Pattern

The recorded fungal assemblage represented 13 genera, indicating considerable taxonomic diversity within soil and plant debris habitats. Among the identified fungi, the genus *Trichoderma* showed greater representation with three recorded species, followed by *Bipolaris* represented by two taxa.

The occurrence of multiple *Trichoderma* species highlights the importance of soil habitats in supporting beneficial fungal communities. These fungi are commonly associated with soil environments due to their rapid colonization ability and interaction with other microorganisms. Plant debris-associated genera such as *Bipolaris*, *Chaetomium*, *Nigrospora*, *Pestalotiopsis* and *Epicoccum* represented important litter colonizers involved in the utilization of plant-derived substrates.

3.3 Functional Categorization and Ecological Importance of Recorded Fungal Taxa

The recorded fungal taxa associated with soil and plant debris exhibited diverse functional characteristics based on their substrate preference and ecological roles. The fungal assemblage mainly consisted of saprophytic fungi involved in decomposition processes, soil-associated fungi contributing to microbial interactions, and beneficial or plant-associated fungi influencing terrestrial ecosystem functions.

3.3.1 Decomposer and Litter-Associated Fungi

A major proportion of the recorded fungi showed association with plant debris and leaf litter substrates. Fungi such as *Arthrinium phaeospermum*, *Chaetomium globosum*, *Epicoccum nigrum*, *Nigrospora oryzae* and *Pestalotiopsis funerea* were associated with decomposing plant materials.

These fungi represent important saprophytic groups involved in the breakdown of organic residues and transformation of plant-derived compounds. Their occurrence in litter habitats indicates their contribution to decomposition processes and nutrient recycling within terrestrial ecosystems.

3.3.2 Soil-Inhabiting and Functionally Important Fungi

Soil-associated fungal taxa represented an important component of the recorded mycoflora. Species belonging to *Trichoderma*, *Fusarium* and *Rhizoctonia* were mainly associated with soil habitats. The presence of *Trichoderma asperellum*, *T. harzianum* and *T. viride* highlights the ecological importance of beneficial soil fungi. Members of this genus are widely distributed in soil environments and are recognized for their rapid growth, competitive ability and interactions with other microorganisms.

Similarly, the occurrence of *Fusarium oxysporum* and *Rhizoctonia solani* reflects the diversity of soil fungi involved in plant-associated interactions. These fungi represent important components of soil microbial communities due to their close association with plant roots and soil organic matter.

3.3.3 Plant-Associated and Substrate-Specific Fungi

Several recorded taxa exhibited strong association with plant-derived substrates. Fungi belonging to *Bipolaris*, *Curvularia* and *Phoma* are commonly associated with plant residues and soil environments.

The presence of *Bipolaris maydis*, *B. sorokiniana*, *Curvularia lunata* and *Phoma herbarum* indicates the contribution of plant-associated fungal groups to the diversity of soil and litter communities. These fungi are capable of colonizing plant materials and maintaining active fungal populations in terrestrial habitats.

3.3.4 Functional Diversity of Soil and Plant Debris Mycoflora

The overall fungal composition demonstrated that soil and plant debris habitats support a functionally diverse fungal community. The recorded fungi represent multiple ecological strategies, including organic matter decomposition, substrate colonization, soil persistence and interaction with plants.

The occurrence of decomposer fungi along with beneficial soil fungi indicates the ecological complexity of terrestrial fungal communities. Such fungal assemblages contribute to ecosystem stability by maintaining nutrient turnover, organic matter decomposition and microbial interactions within soil environments.

4. Discussion

Soil and plant debris represent important ecological niches that support diverse fungal communities involved in decomposition, nutrient transformation and interactions with plants. The present study recorded 15 fungal taxa associated with soil and plant debris habitats, representing saprophytic, soil-inhabiting and plant-associated fungal groups. The occurrence of diverse fungal taxa indicates the importance of terrestrial substrates as reservoirs of fungal diversity and functional activity.

The dominance of saprophytic fungi associated with plant debris and leaf litter highlights their important role in organic matter decomposition. Fungi belonging to genera such as *Chaetomium*, *Epicoccum*, *Nigrospora* and *Pestalotiopsis* are commonly associated with decomposing plant materials and contribute to the breakdown of complex organic compounds. Litter-associated fungi play a significant role in nutrient cycling by converting plant residues into simpler compounds that become available within terrestrial ecosystems (Osono, 2007).

The occurrence of *Trichoderma asperellum*, *T. harzianum* and *T. viride* in soil substrates reflects the ecological importance of this genus in terrestrial environments. *Trichoderma* species are widely distributed soil fungi known for rapid colonization, competitive interactions and their ability to influence microbial communities. Their frequent occurrence in soil has been reported from different ecosystems, highlighting their importance as functional members of soil fungal communities (Harman et al., 2004).

The presence of *Fusarium oxysporum* and *Rhizoctonia solani* indicates the occurrence of plant-associated soil fungi within the studied fungal assemblage. These fungi represent important components of soil microbial communities due to their close association with plant roots and their interaction with host plants. Their detection demonstrates the complex nature of soil fungal communities, where beneficial, saprophytic and plant-associated fungi coexist within the same environment.

Plant debris-associated fungi such as *Bipolaris maydis*, *B. sorokiniana* and *Curvularia lunata* indicate the contribution of plant-derived substrates towards maintaining fungal diversity. These fungi are commonly associated with grasses, crop residues and decomposing plant materials, where they participate in substrate colonization and organic matter transformation. The fungal composition observed in the present study demonstrates that soil and plant debris habitats support a functionally diverse fungal community. The presence of decomposer fungi along with beneficial and plant-associated taxa reflects the ecological complexity of terrestrial fungal assemblages. Documentation of such fungal diversity provides valuable information regarding fungal distribution, substrate association and their potential contribution to ecosystem functioning.

5. Conclusion

The present study revealed considerable diversity of soil and plant debris associated fungi, documenting 15 fungal taxa representing different ecological groups. The recorded fungi showed distinct substrate preferences, with litter-associated taxa contributing mainly to decomposition processes and soil-associated fungi representing important components of terrestrial microbial communities.

The occurrence of *Trichoderma* species highlights the presence of beneficial soil fungi, while other taxa reflect the diversity of saprophytic and plant-associated fungal groups. The study provides baseline information on soil and plant debris mycoflora and emphasizes the functional importance of fungi in maintaining terrestrial ecosystem processes.

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