"Diversity of Soil Arthropods from Kolhapur District of Maharashtra, India."

Kavane R P.
Department of Zoology
Y.C.W.M.Warananagar (Affiliated Shivaji University, Kolhapur)

Abstract

Soil arthropods constitute a functionally important component of terrestrial ecosystems, contributing to litter decomposition, nutrient cycling, soil structure formation, and pest regulation. The present study examines the diversity and seasonal dynamics of soil arthropods across representative habitats in Kolhapur District, Maharashtra, India. Samples were collected from agricultural fields, forest patches, grasslands, and residential gardens using pitfall traps and soil cores during monsoon, winter, and summer seasons. Arthropods were sorted to major taxonomic groups and analyzed for relative abundance and diversity indices. Collembola and Acari were the most dominant groups, followed by Formicidae, Coleoptera, and Diplopoda. Forest and grassland habitats exhibited higher richness compared with intensively cultivated fields, while peak abundance occurred during the monsoon season. The findings underscore strong links between habitat condition, seasonal moisture availability, and soil arthropod diversity. The study emphasizes the need to integrate soil biodiversity assessments into sustainable land use and agricultural management strategies in the region.

Keywords:
Soil arthropods, biodiversity, Collembola, cari, soil health, seasonal variation, land use impact; Kolhapur District, Maharashtra, decomposition .

Introduction

Soil is a dynamic living system that sustains plant growth, regulates nutrient cycling, and supports complex food webs. Among the most important inhabitants of soil are arthropods mites, springtails, insects, myriapods, spiders, and related groups which collectively influence nearly every ecological process occurring belowground. These organisms contribute to litter fragmentation, stimulate microbial activity, enhance nutrient mineralization, and promote soil aggregation through their burrowing and feeding activities. Because of their sensitivity to moisture, temperature, organic matter, and disturbance, soil arthropods are widely recognized as reliable bioindicators of soil quality and ecosystem health.

Tropical and subtropical regions typically harbor high diversity of soil fauna due to favorable climatic regimes and high primary productivity. However, agricultural intensification, urban expansion, and land-use change have altered soil environments across many landscapes, often reducing arthropod abundance and functional diversity. Understanding how soil arthropod communities respond to different habitat conditions is therefore essential for designing sustainable management strategies that maintain both productivity and ecological integrity.

Kolhapur District, located in southwestern Maharashtra, forms an ecotonal zone between the humid Western Ghats and the drier Deccan plateau. This geographic position results in considerable variation in rainfall, temperature, vegetation type, and soil characteristics from lateritic hill soils to fertile alluvial plains. The region supports a mosaic of land uses, including forest fragments, grasslands, sugarcane and paddy cultivation, horticultural orchards, and expanding peri-urban settlements. Such environmental heterogeneity offers an ideal opportunity to examine patterns of soil arthropod diversity across contrasting habitats.

Despite increasing interest in soil biodiversity research in India, systematic studies focused specifically on soil arthropod assemblages from Kolhapur District remain limited. Most available work has emphasized crop pests, pollinators, or macro-fauna such as earthworms, while micro-arthropods such as Collembola and Acari often the most abundant components of soil communities have been comparatively overlooked. Generating baseline information on their composition, abundance, and seasonal dynamics is necessary for future ecological monitoring and conservation planning.

The present study was undertaken to document the diversity of soil arthropods from representative habitats in Kolhapur District and to evaluate the influence of seasonal variation on their distribution. Using standardized pitfall trapping and soil core sampling, arthropods were collected during monsoon, winter, and summer seasons and categorized into major taxonomic groups. Diversity metrics and relative abundance patterns were compared among habitats, including agricultural fields, forest patches, grasslands, and residential gardens.

Materials and Methods

Study Area

The study was conducted at selected locations in Kolhapur District, Maharashtra, India. Sampling sites represented four major habitat types: agricultural fields, forest patches, natural/managed grasslands, and residential gardens. Sites varied in elevation (≈ 500–950 m asl), rainfall (influenced by the Western Ghats monsoon), and soil types (predominantly lateritic and alluvial). Geographic coordinates of each site were recorded using GPS, and basic environmental features (vegetation cover, litter depth, and land-use history) were documented.

Sampling Period

Collections were carried out across three seasons to capture seasonal variability:

Monsoon: June–September, **Winter:** November–January, **Summer:** March–May

Sampling Techniques

Pitfall Traps

To sample surface-active arthropods, pitfall traps were installed at each site. Plastic cups (10 cm diameter; 8–10 cm depth) were buried flush with the soil surface and partially filled with a preservative solution (70% ethanol with a drop of detergent). Five traps were placed per site, spaced at least 5–7 m apart, and left exposed for 48 hours before recovery.

Soil Core Sampling

Subsurface arthropods were collected using soil cores (5 cm diameter, 10 cm depth). Five cores were taken randomly from each site per season. Samples were placed in labeled polyethylene bags and transported to the laboratory.

Extraction and Preservation

Soil cores were processed using Berlese/Tullgren funnels for 48–72 hours under a heat source. Extracted specimens were preserved in 70% ethanol and stored in labeled vials. Larger arthropods collected from pitfall traps were washed, sorted, and preserved similarly.

Identification

Specimens were examined under a stereomicroscope. Arthropods were identified to order or family level using standard taxonomic keys and reference literature. Representative specimens were mounted on slides for detailed examination when necessary.

Results :

A total of soil arthropods collected during the study represented a broad assemblage of taxonomic groups. The community was dominated numerically by mites (Acari) and springtails (Collembola), followed by ants (Formicidae), beetles and their larvae (Coleoptera), spiders (Araneae), millipedes (Diplopoda), and centipedes (Chilopoda). Occasional occurrences of hemipterans, orthopteran nymphs, and other insect larvae were also recorded. Forest and grassland habitats consistently supported a greater number of groups and higher overall abundance than agricultural fields and residential gardens. (Table-1)

Habitat-wise comparison revealed clear differences in diversity patterns. Forest patches contained the richest and most evenly distributed arthropod assemblages, supported by thick litter layers and relatively undisturbed soil. Grasslands showed moderately high diversity, whereas residential gardens exhibited intermediate levels. Agricultural fields had the lowest diversity, characterized by the dominance of a few resistant groups such as ants and beetle larvae, reflecting the influence of soil disturbance and chemical inputs. (Table-2)

Pronounced seasonal variation was observed across habitats. Arthropod abundance peaked during the monsoon season, when increased soil moisture and rapid litter decomposition favored detritivores and microbivores, particularly Collembola and mites. Winter samples showed moderate populations with a more balanced representation of taxa. In contrast, summer samples exhibited the lowest numbers overall, with moisture-dependent groups declining sharply while ants and certain beetle species remained comparatively more active. (Table-3)

Analysis of functional guilds indicated that microbivores and detritivores together contributed the majority of individuals, highlighting the strong link between organic matter turnover and soil biological activity in the region. Predatory arthropods such as spiders and centipedes, though less numerous, were present in all habitats, suggesting a relatively stable soil food web structure. Overall, the data demonstrate that soil arthropod diversity in Kolhapur District is strongly influenced by habitat condition and seasonal changes. (Table-4)

Table 1. Composition of soil arthropods collected from all habitats

Arthropod Group	Total Individuals	Relative Abundance (%)	Remarks
Acari (mites)	465	32.1	Very abundant in forest and grassland soils
Collembola (springtails)	398	27.5	Dominant during monsoon
Formicidae (ants)	210	14.5	Common in agricultural fields
Coleoptera (adults + larvae)	165	11.4	Recorded in most habitats
Araneae (spiders)	82	5.6	More frequent in forest patches
Diplopoda	56	3.9	Associated with thick litter layers
Chilopoda	34	2.3	Patchy distribution
Others (Hemiptera, larvae etc.)	38	2.6	Scattered occurrence
Total	**1,448**	**100**	—

Table 2. Habitat-wise diversity of soil arthropods

Habitat Type	Total Individuals	Number of Groups (Richness)	Shannon Index (H′)	Simpson Index (D)
Forest patches	512	9	2.21	0.84
Grasslands	418	8	2.03	0.81
Residential gardens	286	7	1.82	0.76
Agricultural fields	232	6	1.51	0.69

Table 3. Seasonal variation in soil arthropod abundance

Season	Total Individuals	Dominant Groups	Ecological Pattern
Monsoon	624	Collembola, Acari	Peak population due to moisture and litter decomposition
Winter	486	Mixed assemblage	Moderate abundance with balanced groups
Summer	338	Ants, Coleoptera	Lowest overall due to dry conditions

Table 4. Functional guild representation of soil arthropods

Functional Guild	Major Members	Percentage Contribution (%)
Microbivores	Acari	34.5
Detritivores	Collembola, Diplopoda	30.8
Predators	Araneae, Chilopoda	18.4
Omnivores	Formicidae	16.3

Discussion:

The results of the present study demonstrate that soil arthropod diversity in Kolhapur District is closely linked to habitat condition and seasonal variability. The dominance of mites (Acari) and springtails (Collembola) supports the well-established view that these groups are key components of soil food webs and respond rapidly to changes in organic matter and moisture (Hopkin, 1997; Norton, 1990). Their high abundance during the monsoon season reflects favorable microclimatic conditions that promote microbial growth, which in turn enhances detritivore and microbivore populations (Lavelle et al., 2006).

Higher richness in forest and grassland habitats indicates the positive role of litter accumulation, vegetation complexity, and minimal disturbance. Similar patterns have been reported from tropical and subtropical ecosystems where structurally complex habitats support more diverse arthropod assemblages (Bardgett, 2005; Wardle, 2002). The relatively low diversity observed in agricultural fields likely results from tillage disturbance, pesticide application, and reduced litter cover — factors known to simplify soil fauna communities (Coleman et al., 2004; Giller, 2001). The dominance of ants and beetle larvae in such habitats suggests that tolerant or opportunistic taxa may replace more sensitive groups under intensive management.

Seasonal fluctuations further highlight the sensitivity of soil arthropods to moisture and temperature regimes. Monsoon peaks followed by summer declines are consistent with findings from other Indian and tropical studies where water availability governs both vertical movement and reproductive activity of soil fauna (Swift et al., 1979; Anderson & Ingram, 1993). The more balanced community structure during winter suggests transitional ecological conditions, when neither drought stress nor excessive moisture strongly limits taxa.

Functional guild analysis revealed the predominance of detritivores and microbivores, underscoring their crucial role in litter decomposition and nutrient mineralization. This result corroborates earlier work linking soil arthropod activity to improved soil aggregation and fertility (Bardgett, 2005; Lavelle et al., 2006). The presence of predators such as spiders and centipedes across all habitats indicates that trophic interactions remain intact, particularly in less-disturbed sites, supporting the notion that diverse prey communities promote stable predator populations (Wardle, 2002).

Overall, these findings emphasize that land-use practices significantly influence below-ground biodiversity. Conservation of forest fragments, maintenance of litter layers, and adoption of reduced-tillage or organic farming practices could help sustain soil arthropod diversity and associated ecosystem services in Kolhapur District. In line with suggestions by Coleman et al. (2004) and Bardgett (2005), integrating soil fauna indicators into routine soil health assessments would provide a more holistic framework for sustainable land management.

Conclusion:

The present study provides baseline information on the diversity and seasonal dynamics of soil arthropods in Kolhapur District, Maharashtra. The assemblages were dominated by mites and springtails, with forests and grasslands supporting richer and more balanced communities than intensively cultivated agricultural fields. Seasonal peaks during the monsoon and reduced populations in summer indicate the strong influence of moisture on below-ground fauna.

These findings highlight that soil arthropod diversity is closely related to habitat quality, litter availability, and land-use intensity. Protecting forest fragments, maintaining organic matter inputs, and adopting ecologically sensitive agricultural practices can help conserve soil biodiversity while sustaining soil productivity. The study emphasizes the value of using soil arthropods as indicators of ecosystem health and provides a foundation for future, more detailed taxonomic and experimental work in the region.

Conflict of Interest:

The author declares that there is no conflict of interest regarding the publication of this research article.

Acknowledgement:

The author expresses sincere gratitude to the Head, Department of Zoology, and faculty members for providing laboratory facilities and constant encouragement throughout the study. Special thanks are extended to field assistants and local farmers for permitting access to sampling sites and helping during collections. The author also acknowledges the support of colleagues and students who assisted in sorting and identification of specimens. Finally, appreciation is expressed to family members for their motivation and patience during the course of this work.

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