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# SEASONAL ABUNDANCE OF SOIL ARTHROPODS IN FOREST AND AGRO ECOSYSTEMS IN WARANGAL DISTRICT, TELANGANA STATE, INDIA

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## ABSTRACT

Soil arthropods play a crucial role in ecosystem functioning and theirpopulations are influenced by seasonal and ecological factors. This study aimed toinvestigate the seasonal variations in the abundance of soil arthropods in forest and agro- ecosystems within Warangal district, Telangana, India. Soil samples were collected from two 10-acre sites—an agricultural field and a forest area—across three seasons: Summer, Monsoon, and Winter. Tullgren funnels were used to extract and identify arthropods, withtheir abundance recorded and analyzed for seasonal trends. Results indicated that Collembola was the most abundant order in the forest ecosystem throughout the year, withsignificant peaks during the Monsoon, while the agro-ecosystem showed higher abundance of Collembola and Orthoptera in the Monsoon. Protura and Thysanura were also more prevalent in the forest during Winter, and seasonal fluctuations were more pronounced in the agro-ecosystem. These findings highlight the differential impacts of seasonal changes on arthropod communities in various ecosystems, emphasizing the stability of forest environments compared to the more dynamic agro-ecosystems.

**Key words:** Arthropods, Warangal, Rajanpalle, Agro-ecosystem, Forest-ecosystem,

## INTRODUCTION

The study of soil arthropods is crucial for understanding the ecological dynamics of both forest and agro-ecosystems. These organisms play a vital role in nutrient cycling, decomposition, and soil structure maintenance, thereby influencing overall soil health and productivity (Brussaard, 1997; Lavelle et al., 2006). Warangal district in Telangana State, India, offers a unique setting with its varied ecosystems, ranging from dense forests to cultivated agricultural lands. This diversity provides an excellent opportunity to study howseasonal changes impact the abundance and distribution of soil arthropods in thesecontrasting environments (Kumar et al., 2017; Rao et al., 2019).

Soil arthropods exhibit significant seasonal variation in their populations due to fluctuations in temperature, moisture, and food availability (Coleman et al., 2004; Kather et al., 2019). In forest ecosystems, the dense canopy and rich organic matter provide a stable environment that supports a diverse and abundant arthropod community (Wardle, 2006; Decaëns, 2010). Conversely, agro-ecosystems, influenced by agricultural practices such as tilling, pesticide application, and crop rotation, show more pronounced seasonal shifts in arthropod populations (Wardle et al., 1999; Veres et al., 2013). These differences highlight the impact of human activities on soil biodiversity and underline the importance of sustainable agricultural practices for maintaining soil health.The Warangal district, with its distinct wet and dry seasons, offers an ideal case study to explore these seasonal dynamics. Previous studies in similar climatic regions have shown that soil arthropod populations peak during the monsoon season due to increased moisture and organic matter availability (Bhattacharyya et al., 2008; Sheoran et al., 2018). However, the extent of this abundance and the specific taxa affected can vary significantly between forested and agricultural lands (Kumar & Venkatesan, 2018; Kumar et al., 2021). By examining these patterns in Warangal, this study aims to contribute to the broader understanding of how land use and seasonal factors influence soil arthropod communities in tropical regions. The specific objective of this study is to compare the seasonal abundance of soil arthropods in forest and agro-ecosystems within Warangal district, thereby identifying the key environmental factors driving these patterns and their implications for ecosystem management and conservation

## MATERIALS AND METHODS

### The Study Area:

The study was carried out in Rajanpalle village, Gudur mandal, within Warangal district of Telangana, India, situated 55 km east of the district headquarters and it is governed by the Rajanpalle Gram Panchayat, the village is part of the Gudur Community Development Block and is surrounded by Khanapur, Chennaraopet, Kesamudram, and Narsampet mandals. It lies within the Gudur forest zone, a part of the Pakhal Wildlife Sanctuary, and is situated at coordinates 17°44'56.0"N 79°54'59.3"E. Rajanpalle lies amidst a network of surrounding mandals and is part of the Gudur forest zone, included in the Pakhal Wildlife Sanctuary. The research focused on two distinct sites: Site-1, an agricultural land spanning 10 acres near Gudur forest, characterized by fertile soils and the cultivation of crops such as cotton, maize, chilies, and turmeric; and Site-2, a 10-acre forest area with diverse soil types including regular and chaluka soils, and a significant weathered zone within granite formations. Site-1 is located 31 meters from Rajanpalle, while Site-2 is 410 meters away.

### Sampling of Soil Arthropods:

Soil samples were gathered on a monthly basis over a span of two years, from February 2015 to January 2017. The sampling period encompassed three distinct seasons: winter (September-January), summer (February-April), and monsoon (May-August). Ten soil samples were procured from agricultural land, while another ten were obtained from forest land. All sample collections occurred between 6:00 am and 10:00 am. At each site, soil organisms were sampled along a 40×5 m transect. Within this transect, ten sampling points were identified and marked, evenly spaced at 5-meter intervals.

Monoliths measuring 25cm×25cm×30cm in depth were extracted by cutting down and digging with a spade. The soil was meticulously hand-sorted in a large tray, and soil arthropods were collected, euthanized, and preserved. The gathered organisms were preserved in a solution comprising 75% alcohol and 4% formalin (Bignell et al., 2008).


**Figure-1. Study Area: Rajanpalle village, Gudur mandal, within Warangal district of Telangana, India**

**Seasonal Abundance of Soil Arthropods:**
Soil arthropod abundance was assessed across different seasons—Summer, Monsoon, and Winter—in both agroecosystems and forest ecosystems. At each site, which included a 10-acre agricultural field and a 10-acre forest area within Rajanpalle village, soil samples were collected quarterly to represent each season. The collected soil samples were air-dried and sifted through a 2 mm mesh to remove larger particles and debris. Soil arthropods were extracted using Tullgren funnels, where heat was applied to drive the arthropods into collection jars. Extracted arthropods were preserved in 70% ethanol for identification. Taxonomic identification was conducted using standard identification guides, and arthropods were counted to determine their abundance per square meter of soil.

## RESULTS

**Seasonal Abundance of Soil Arthropods:**
The analysis of the seasonal abundance of soil arthropods in forest and Agro- ecosystems reveals a diverse array categorized into six distinct orders. The most species- rich order is Collembola,

with 19 identified species types, indicating the abundance and ecological significance of springtails in soil ecosystems. Following Collembola, the orders Araneae and Coleoptera demonstrate considerable diversity, with 17 and 11 identified species types, respectively. Arachnids, including spiders and mites, play crucial roles in pest control and nutrient cycling, while beetles (Coleoptera) contribute to various ecological processes as decomposers, predators, and herbivores. Additionally, Hymenoptera and Orthoptera orders are represented with eight and four identified species types, respectively, showcasing the diversity of bees, ants, grasshoppers, and crickets in soil ecosystems. The Acarina order, comprising four species types, includes mites and ticks, which are integral components of soil communities. In total, the analysis identifies 63 types of species across the six orders, emphasizing the importance of understanding soil arthropod diversity for ecosystem management and conservation.In order to analyses the biological parameters and to determine the seasonal abundance in biological parameters of Warangal District, Telangana two sampling stations viz., Natural Forest Area (Pakhal Wild Life Sanctuary, Warangal), and Agricultural Area (Agro-ecosystem) from Rajanpalle Village in Gudur mandal weresurveyed consecutively for two years (2015-17).

A total of 63 species of soil arthropods were documented during the present study from the forest and agricultural areas which are belongs to the six orders (Collembola, Araneae, Coleoptera, Hymenoptera, Orthoptera, and Acarina). The order of dominance of different orders at all the sampling stations, on an overall qualitative basis, is as follows:

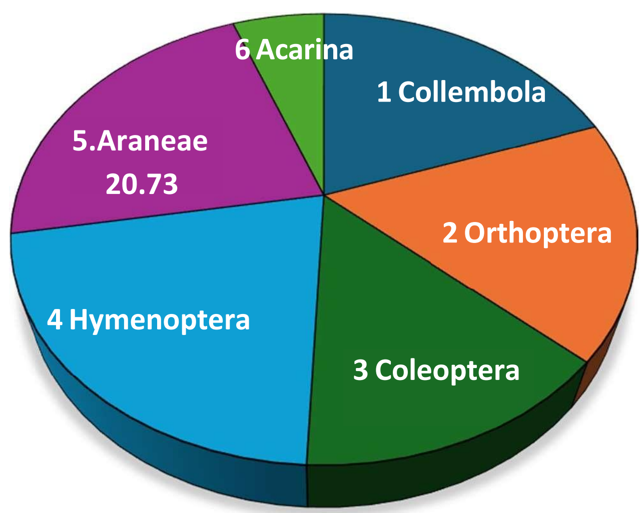


**Figure-1. Percent contribution of total number of soil arthropods observed inthe two sites of Rajanpalle Village in Gudur mandal during year 2015-17.**

Collembola > Araneae > Coleoptera > Hymenoptera > Orthoptera>Acarina.

Out of the six orders— Collembola, Araneae, Coleoptera, Hymenoptera,Orthoptera, and Acarina - order Collembola (24.9%) contributes the most, with 20 genera, followed by Araneae (20.73%)

which has 17 genera, and Order Coleoptera (13.4%) which has 11 genera, order Hymenoptera (9.76%) has 8 genera and order Orthoptera and Acarina contributes the fewest amount of 4 genera (4.8%).

**Table-1. Qualitative analysis (Number and percentage-wise) of soil arthropods in forest and agro-ecosystem during different seasons**

| Name of the Orders | Forest Ecosystem | | | Agro-ecosystem | | |
|---|---|---|---|---|---|---|
| | Winter | Summer | Monsoon | Winter | Summer | Monsoon |
| | (No.) % | (No.) % | (No.) % | (No.) % | (No.) % | (No.) % |
| Protura | (74) 1.28 | (21) 0.496 | (31) 0.529 | (75) 2.177 | (21) 0.904 | (22) 0.642 |
| collembola | (1041) 18.013 | (423) 10.004 | (968) 16.527 | (749) 21.747 | (280) 12.063 | (619) 18.078 |
| Diplura | (43) 0.744 | (25) 0.591 | (47) 0.802 | (22) 0.638 | (19) 0.818 | (20) 0.613 |
| Thysanura | (243) 4.204 | (100) 2.365 | (159) 2.714 | (54) 1.567 | (34) 1.464 | (65) 1.898 |
| Microcoriphia | (11) 0.19 | (5) 0.118 | (9) 0.153 | (6) 0.203 | 0 | (5) 0.146 |
| Orthoptera | (517) 8.946 | (655) 15.491 | (669) 11.422 | (409) 11.875 | (301) 12.968 | (418) 12.207 |
| Isoptera | (140) 2.422 | (126) 2.98 | (246) 4.2001 | 0 | 0 | 0 |
| Embioptera | (12) 0.207 | (7) 0.189 | (8) 0.136 | 0 | 0 | 0 |
| Thysanoptera | 0 | (9) 0.236 | (10) 0.1707 | 0 | (2) 0.086 | (6) 0.146 |
| Hemiptera | (125) 2.163 | (45) 1.064 | (135) 2.304 | (143) 4.152 | (32) 1.378 | (110) 3.212 |
| Homoptera | (132) 2.284 | 0 | (146) 2.492 | (46) 1.335 | 0 | (73) 2.132 |
| Neuroptera | (38) 0.657 | (33) 0.78 | (21) 0.358 | (53) 1.538 | (33) 1.421 | (23) 0.671 |
| Coleoptera | (407) 7.042 | (485) 11.471 | (570) 9.731 | (331) 9.6109 | (297) 12.796 | (268) 7.827 |
| Diptera | (6) 0.103 | 0 | 0 | (11) 0.319 | 0 | (4) 0.116 |
| Hymenoptera | (939) 16.248 | (852) 20.151 | (682) 11.644 | (451) 13.095 | (444) 19.129 | (417) 12.178 |
| Aranea | (975) 16.871 | (640) 15.137 | (704) 12.019 | (528) 15.331 | (528) 22.74 | (506) 14.77 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Acarina | (215) 3.72 | (60) 1.419 | (261) 4.456 | (149) 4.326 | (46) 1.981 | (147) 4.29 |
| Solpugida | (23) 0.397 | (21) 0.473 | (7) 0.136 | 0 | 0 | 0 |
| Scorpionida | (29) 0.501 | (22) 0.496 | (26) 0.443 | (11) 0.319 | (12) 0.56 | (18) 0.525 |
| Pseudo scorpionida | (30) 0.501 | (70) 1.655 | (51) 0.8707 | (5) 0.145 | (6) 0.301 | (8) 0.262 |
| Dermoptera | (262) 4.533 | (264) 6.244 | (276) 4.712 | (69) 2.003 | (63) 2.714 | (72) 2.102 |
| Chilopoda | (60) 1.038 | (52) 1.229 | (66) 1.126 | (25) 0.725 | (34) 1.464 | (34) 0.992 |
| Diplopoda | (115) 1.989 | (59) 1.395 | (253) 4.319 | (43) 1.248 | (18) 0.775 | (90) 2.628 |
| Symphyla | (36) 0.622 | (25) 0.591 | (70) 1.195 | (56) 1.626 | (23) 0.9909 | (97) 2.832 |
| Isopoda | (79) 1.367 | (49) 1.158 | (27) 0.4609 | (16) 0.464 | (9) 0.387 | (7) 0.204 |
| Coleopteran Larvae | (164) 2.837 | (113 )2.672 | (224) 3.824 | (124) 3.6004 | (64) 2.757 | (150) 4.3808 |
| Lepidopteran Larvae | (64) 1.107 | (67) 1.584 | (190) 3.243 | (67) 1.945 | (53) 2.283 | (244) 7.126 |

The analysis of the results reveals a diverse ecosystem with distinct contributions from various orders. Collembola, represented by 24.90%, signify a notable presence, potentially indicating their ecological significance or abundance. Orthoptera, at 4.80%, suggest a lesser prevalence or specific environmental conditions less conducive to this order. Coleoptera, constituting 13.40%, demonstrate a substantial and diverse population, showcasing adaptability. Hymenoptera, at 9.76%, suggest a moderate presence, likely playing roles as pollinators or predators. Araneae, with a substantial 20.73%, highligt their importance in the ecosystem, particularly in regulating insect populations. Acarina,represented by 4.88%, indicate a smaller but discernible presence, possibly in a specialized ecological niche.

**Qualitative Analysis of Soil Arthropods:**

The analysis of the number of soil arthropods found in 27 orders reveals significant variations across different ecosystems and seasons. In the winter season, the forest ecosystem exhibits notable numbers of soil arthropods across various orders, such as Protura with 74 individuals, collembola with 1041 individuals, Diplura with 43 individuals, and Thysanura with 243 individuals. Conversely, the agro-ecosystem during winter shows different counts, with Protura having 75 individuals, collembola with 749 individuals, Diplura with 22 individuals, and Thysanura with 54 individuals. Similarly, in the summer season, the forest ecosystem continues to demonstrate varying arthropod populations, including Protura with 21 individuals, collembola with 423 individuals, Diplura with 25 individuals, and Thysanura with 100 individuals. Meanwhile, the agro- ecosystem during summer presents different numbers, such as Protura with 21 individuals, collembola with

280 individuals, Diplura with 19 individuals, and Thysanura with 34 individuals. Lastly, during the monsoon season, the forest ecosystem displays fluctuations in arthropod counts, with Protura having 31 individuals, collembola with 968 individuals, Diplura with 47 individuals, and Thysanura with 159 individuals.

In contrast, the agro-ecosystem during monsoon exhibits distinct numbers, including Protura with 22 individuals, collembola with 619 individuals, Diplura with 21 individuals, and Thysanura with 65 individuals.

The qualitative analysis of soil arthropods in forest and agro-ecosystems during different seasons reveals distinct patterns of abundance and diversity. In the forest ecosystem, the Collembola order consistently dominated across all seasons, with a significant peak in abundance during the Monsoon (16.527%). Protura and Thysanura also showed notable presence, particularly in the Winter season. In contrast, the agro-ecosystem demonstrated a higher abundance of Collembola and Orthoptera, especially during the Monsoon (21.747% and 11.875%, respectively), indicating a potential influence of seasonal crop dynamics and soil conditions on these populations.

## DISCUSSION

Seasonal variations significantly impacted the abundance of specific arthropod orders in both ecosystems. The forest ecosystem exhibited a relatively stable presence of major orders like Collembola and Hymenoptera across seasons, while the agro-ecosystem showed more pronounced seasonal shifts, with increased numbers of Collembola and Orthoptera during the monsoon. This variation highlights the influence of seasonal changes on arthropod populations, with the forest ecosystem maintaining a more stable community structure compared to the more dynamic agro-ecosystem (Kumar et al., 2017; Sheoran et al., 2018).

Comparing these findings with other scientific studies, similar patterns of seasonal abundance and species composition have been observed in various ecosystems worldwide. For example, research by Oliver and Beattie (1996) in temperate forest ecosystems reported comparable trends in Collembola abundance across seasons, highlighting the influence of habitat characteristics and climatic factors on soil arthropod communities. Additionally, studies by Perner and Malt (2003) in agricultural landscapes have documented the importance of temperature and moisture levels in shaping the seasonal dynamics of soil arthropod populations, corroborating our observations in agro-ecosystems.

Among the species examined, Gryllus assimilis and Nemobius sylvestris demonstrate relatively consistent percentages across winter, summer, and monsoon seasons, with Gryllus assimilis ranging from approximately 30.3% to 24.6% and Nemobius sylvestris ranging from approximately 24.9% to 20.3%. This stability suggests potential resilience to seasonal fluctuations or environmental changes (Badenhausser et al., 2007). Conversely, Gryllus pennsylvanicus and Acheta domesticus exhibit fluctuations in abundance. Gryllus pennsylvanicus shows slightly lower percentages in agro-ecosystems compared to forest ecosystems, particularly during winter and monsoon seasons. This observation may indicate habitat preferences or responses to different environmental conditions between ecosystems (Gardiner et al., 2006). On the other hand, Acheta domesticus displays slightly higher percentages in agro-ecosystems, especially during summer and monsoon seasons, suggesting potential adaptations or responses to agricultural conditions, such as increased vegetation or temperature fluctuations (Andersen, 2001).

## CONCLUSION

The qualitative analysis of soil arthropods in forest and agro-ecosystems reveals significant seasonal and ecological variations. In the forest ecosystem, Collembola consistently showed high abundance, peaking during the Monsoon, while Protura and Thysanura also featured prominently in Winter. Conversely, the agro-ecosystem displayed greater seasonal fluctuation, with Collembola and Orthoptera notably more abundant in the Monsoon. These patterns highlight how seasonal changes impact arthropod populations differently across ecosystems, with the forest showing stability and the agro-ecosystem demonstrating more pronounced seasonal shifts. This underscores the importance of seasonal and habitat-specific factors in understanding and managing soil arthropod communities.

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