International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 06-01-2024, Accepted: 29-01-2024, Published: 21-02-2024
Volume 9, Issue 2, 2024, Page No. 94-97

Diversity of soil Microarthropods in Semievergreen Forest of Southern western ghats during different seasons

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Abstract
The Vadasserikkara range's west coast semi-evergreen forests in the Ranni Forest Division of Pathanamthitta served as the study's site. This range encompasses around 268 square kilometers, or 103 square miles, within the Ranni Forest.Samples of soil were collected throughout the year. Although they are a part of the intricate food webs in soils, microarthropods are rarely given due credit. Microarthropods affect organic waste, microbial decomposers, nematodes, roots, and pathogenic fungus, according to findings from both laboratories and field studies. They only have an indirect effect on primary production, though. The majority of the organisms were often found in the uppermost layer of the soil. In summer, when soil humidity was low and circumstances were unfavorable, a vertical movement to deeper layers was noted.

Keywords: Microarthropods, complex food webs, microbial decomposers, vertical migration

Introduction
Soil organisms comprise a significant portion of the terrestrial biodiversity found worldwide. They provide a variety of functions crucial to the fertility and health of the soil in both agricultural and natural settings. Species that live their entire lives or part of their lives in the soil are called members of the soil food web. A complex food web is formed by the interactions of soil creatures, some of which feed on live plants and animals (herbivores and predators), others which feed on plant waste after it has died (detritivores), still others which feed on fungi or bacteria, and still more which live off of their hosts but do not consume them (parasites). The development in agriculture over the past few decades has resulted in significant changes in land usage, which have drastically reduced biodiversity (Tscharntke T., Klein A.M., Kruess A). More natural ecosystems are created on agricultural land in an effort to counterbalance the loss of biodiversity. These ecosystems are created to increase the diversity and richness of beneficial arthropods. At local scales, soil biodiversity is far higher than above-ground diversity (De Deyn G.B [5]., Van der Putten W.H. Linking 2005] [5]. In a 1959 study on microarthropod population density, Wallwork found that there were 7250 acarina, 6250 oribatids, and 1350 collembola per square meter. A mixed pine stand in East Tennessee yielded 59 oribated species, according to Crossley and Bohnsak's 1960 assessment. In their 1966 study, Loots and Ryke examined the population of quantitative microarthropods in several pasture soil types, finding that it peaked in late summer and decreased in the winter. During the rainy season, Singh and Singh (1975) [14] investigated the population density of various groups of microarthropods on the tropical deciduous forest floor in Varanasi, India. They found that a higher percentage of cryptostigmata's population was found in both soil and litter. In a comparative analysis of the quantity and vertical distribution of arthropods in Brazil's secondary dryland forest's yellow latosol (0–14 cm depth) during the wet and dry seasons, Adis *et al*. (1987) [1] also noted that the higher layer of the arthropod population was larger. In Tripua, Northeast India, Sarkar (1991) [12] conducted research on the community structure of soil microarthropods in an undisturbed habitat. He discovered that the most prevalent group was Acari, followed by Collembola and other microarthropods. In their study of soil acarina and collembola in pine woods and cultivated land in Khasi Hill, Meghalaya, Hattar *et al*. (1992) [7] discovered that pine forests had a greater diversity of species than cultivated land. Tropical forest soil has a significantly lower population density of soil microarthropods than temperate forest soil, yet tropical forests likely have a higher species variety than temperate forests (Wallwork, 1976) [20]. Although there are many different species found in soil ecosystems, the reasons behind this diversity are not as well understood as they are for many aboveground living organisms (Wardle, 2006) [21]. In the current study, the quantity, distribution, density, and species diversity of soil and litter microarthropods were investigated in a natural (undisturbed) forest ecosystem in the Ranni forest, Pathanamthitta district of Kerala.

Resources and techniques
Study Locations: The forest ecosystem of Chittar served as the study location for this one. This forest is a component of the Ranni Forest division and is situated in the Pathanamthitta district of the Vadasserikkara forest range. The coordinates of Chittar are 76° 55′ 58″ E and 9° 19′ 58″ N. The Ranni Forest Division, covering an area of roughly 268 square kilometers (103 sq mi), is covered by this range. The climate is tropical summer, with summer temperatures typically reaching 35 °C (95 °F) and winter temperatures typically reaching 18 °C (64 °F). The tributaries of the Pamba River, Kallar and Kakkattar, go through this range. Small-scale farming is carried out in the inhabited regions of the Vadasserikkara range, especially on the gentle slopes. There are four types of natural forests found in this range: grasslands, southern moist mixed deciduous woods, west coast semi-evergreen forests, and west coast tropical evergreen forests. The township of Chittar is primarily a plantation. Apart from rubber, other crops grown include pineapple, tapioca, ginger, almonds, and pepper. It is situated in the eastern region of the Pathanamthitta district,

with the Perunad panchayath to the north, Thannithodu to the south, Vadasserikkara to the west, and Seethathodu to the east as its borders.

Although the natural forest site is rich in vegetation, these forest areas are home to many unusual plants and herbs. Deeper in the forest are medicinal plants such Dysoxylum malabaricum (Vella akil), Pseudarthria viscida, Cissus quadrangularis, Solanum anguivi, Desmodium gangeticum, and Shatavari (Asparagus racemosus). These plants can flourish here in the forests because of the favorable eco-system.

Climate: The study area, located near ranni, is marked by an abundant rainfall from June to october, and dry conditions from February to May. Temperature ranges from 34º Cin summer to 23 ºC in winter with an average rainfall of about

Sampling and extraction: Three elevations are used for the sampling collection sites: lower (site 1), middle (site 2), and upper (site 3). Every site is then subdivided into three distinct plots, each measuring 10 m × 10 m and spaced roughly 25 to 30 m apart. Samples of soil were taken for microarthropod analysis from every region. The sampling process began in December 2021 and ran for one month, ending in November 2022. Every sample was taken in the middle of each month, from 9:00 am to 11:00 am. Three copies, one for each location, were gathered from sites at higher, intermediate, and lower elevations in each Ecosystems. As a result, during the course of the 12-month study period, 324 samples—three duplicates, one from each area—were gathered from each ecosystem—from upper, middle, and lower elevation. The O-layer and a 5 cm in diameter by 5 cm deep soil core made up the samples. Following collection, every sample was transferred right away into a separate polythene bag, labeled, and packaged to prevent moisture loss and any form of disruption to the organisms during transit. The gathered soil samples were put onto a tray of 15 by 25 centimeters, manually sorted to extract large micro-arthropods, and then fixed in 10% formalin. Small microarthropods were collected from locations at higher, intermediate, and lower elevations in all ecosystems using a modified Tullgren funnel. Using a binocular microscope, soil microarthropods were counted and categorized into different orders after being extracted into a collecting vial containing 70% ethanol and placed into a petridish. Sutton's (1972) standard keys were used to identify the animals that had been collected.

Statistical analysis: Soil microarthropod community structure was described in terms of species diversity (Shannon-weiner index), Dominance bergerparker, abundance by hills, richness by margeby was also calculated Species Diversity and Richness calculated with help of Biodiversity Professional Software.

Results

Table 1: K dominance of microarthropods in various seasons

	Pre-monsoon	Monsoon	Post Monsoon	winter
Site 1	Coleoptera	Collembola	Collembola	Acari
Site 2	Acari	Diplopoda	Collembola	Acari
Site 3	Acari	Diplopoda	Acari	Hymenoptera

Table 2: Diversity Indices of Microarthropods in soil during various Seasons

	Pre-monsoon			Monsoon			Post-monsoon			Winter		
	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
Shannon-Wiener Index	0.099	0.092	0.095	0.129	0.116	0.107	0.081	0.077	0.085	0.1	0.091	0.092
Berger-Parker Dominance(d)	0.099	0.092	0.095	0.129	0.116	0.107	0.081	0.077	0.085	0.1	0.091	0.092
Simpson’s Index	0.057	0.056	0.056	0.064	0.064	0.063	0.052	0.052	0.053	0.054	0.053	0.054
Hill Index-- Hill's Number H1	9.4	9.37	9.46	8.24	8.34	8.40	10.26	10.20	10.15	9.72	9.82	9.77
Margalef Index -	7.177	7.177	7.188	7.841	7.83	7.794	8.125	8.111	8.091	7.97	7.958	7.912
Mackintosh Eveness Index	1.28	1.287	1.286	1.287	1.286	1.286	1.287	1.287	1.287	1.287	1.286	1.286

Discussion

Species Richness: A community's overall species count is expressed as a species richness metric. Nevertheless, comprehensive inventories of all species found at a given place are practically impossible to achieve in real-world applications. Simpson's Index Simpson provided the likelihood that any two people chosen at random from an endlessly large society will belong to distinct species. As a result, 1-D or 1/D are used to express the Simpson index. Simpson's score is less responsive to species richness and is highly weighted in favor of the sample's most abundant species. It has been demonstrated that the underlying species abundance distribution plays a significant role in deciding whether the index has a high or low value after the number of species surpasses ten. Diversity declines as D rises. Margalef Index ability to discriminate is excellent. However, the sample size has an impact on it. It is a measurement of the number of species that exist for a specific population size. It is considered in relation to species richness, though. This index has an advantage over the Simpson index in that values can be more than 1, as opposed to the other index's range of values from 0 to 1. In this manner, it is simple to compare the species richness of samples taken from distinct ecosystems. The Berger-Parker Index The proportional significance of the most prevalent species is expressed by this simple intrinsic index. Similar to the Simpson index, the Berger-Parker index's reciprocal version is typically used, meaning that a rise in the index's value corresponds to a decrease in dominance and an increase in variety.

Species Diversity Indices

The Shannon index of diversity is a function that was independently derived by Wiener and Shannon. In fact, this presupposes that a random sample of people is drawn from a sizable independent population. The index additionally presumes that every species is included in the sample. Shannon variety is often measured in the range of 1.5 to 3.5, and it seldom exceeds 4.5. As an alternative to H', expected Shannon diversity (Exp H') is also employed. The number of equally common species needed to generate the value of H' provided by the sample is equal to Exp H'. Every time, the observed diversity (H') is compared to the maximum Shannon diversity (Hmax), which can arise in a scenario in which the abundance of each species is equal. The most popular metric for assessing diversity across different ecosystems is Shannon-Shannon diversity (Clarke and Warwick, 2001).

Species Evenness Indices

This illustrates how equally individuals are dispersed across the various species. Hill's Numbers, Hill (1973b) suggested combining multiple diversity metrics into a single statistic. The benefit is that it may be used to calculate all of these metrics rather than requiring the computation of separate indices for variety, richness, and evenness. When compared to species (k) rank or log species (k) rank, the k-dominance displays the cumulative percentage, which is the percentage of the k-th most dominant species plus all other more dominating species. In this case, the sample that corresponds to the lower line has a greater diversity.

K dominance (Table I) shows that Acari is the most prevalent species before the monsoon, Diplopoda during the monsoon, Collembolan after the monsoon, and Acari during the winter. Hemiptera are the least common species throughout the pre- and post-monsoon seasons. In the monsoon, hymenoptera predominate, while Blattodea are less common in the winter. species (k) rank or log species (k) rank in respect to the hill number of dominance. In this case, the sample that corresponds to the lower line has a greater diversity.

A moderately diverse environment is represented by the Shannon-Wiener Index (Table II). The usual dominance of species in the research area across all locations is represented by the Simpsons diversity index (Table II). Table II, Hills Number of Dominance, shows that during the post-monsoon season, 10 species are plentiful, approximately 8 species during the monsoon, and 9 species are abundant during the remaining seasons. Peak species abundance occurs in the post-monsoon season. A higher Margalef Index (> 8) suggests a richer forest environment following the monsoon season. The Mackintosh Eveness Index (Table II) shows that species distribution is even throughout the entire research region.

Conclusion

In a 1963 study, Davis investigated the microarthropod fauna in the mineral soil close to Corby, Northants. He observed that the microarthropod population peaked during the monsoon season, when moisture levels were at their highest, and decreased during the summer, when moisture content was at its lowest. In the current study, the microarthropod population peaks during the monsoon season when moisture levels are at their highest and troughs during the summer, when moisture content is at its lowest. Price (1973) observed that acarina predominated, followed by collembola, in his study of the quantity and vertical distribution of microarthropods in the surface layers of California pine forest soil. Collembola population density was shown to be substantially higher in forest areas compared to shifting agriculture areas by Takeda (1981). Singh and Mahajan (1983) worked on community structure and bioecology of soil microarthropods in deciduous forest in Varanasi and found highest percent composition of acari in forest soil while collembola was dominant in the litter.

Acarina and Collembola are the most prevalent and prominent soil microarthropod groups in the soil-litter subsystem. Because they break down and mineralize leaf litter, they are essential to the preservation of the edaphic elements and the health of the forest ecosystem. The four orders that make up the tiny class of free-living soil and litter-dwelling creatures known as Acarina are Cryptostigmata, Mesostigmata, Prostigmata, and Astigmata. The Cryptostigmata (oribatidae) are commonly referred to as beetle mites due to their striking similarity to little beetles. Adults have a sclerotized exoskeleton and reside in leaf litter, beneath stones and bark. Gamasida, another name for mesostigmata, are flattened, tick-like mites that can act as parasites, predators, or scavengers. They are primarily free-living mites that predominate in soil, humus, and leaf litter. The Prostigmata, also known as Actinedida, are fragile, colorless to white, and prone to drying out. Astigmata are free-living, non-tracheal mites that are sometimes referred to as cheese mites. They are often connected to very organic, decaying materials like manure. There are three sub-groups of wingless Collembola, sometimes known as springtails: Entomobryomorpha, Poduromorpha, and Symphypleona. They have a special feature called a furculum that allows them to leap when startled. The majority of them consume pollen, bacteria, fungi, algae, and other decomposing organic matter. They are found all throughout the world and, although only being 0.2–9 mm in size, are abundant enough to be considered essential soil organisms that aid in the decomposition process (Christiansen and Bellinger, 1980). Collembola have well-developed mouthparts that can break up plant material; they primarily feed on detritus or fungi (Seastedt, 1984). The other major groups of microarthropods that contribute significantly to the belowground food web in the majority of forest ecosystems are the little insects from several orders, the hymenoptera, isopoda, coleoptera, diplopoda, and chloropoda. In nutrient-poor environments, the role of microarthropods (Acari and Collembola) in the breakdown of organic matter and nutrient cycling has demonstrated that they may support primary productivity. According to the study, the near-neutral pH and higher organic content of forest soil samples contribute to the richness of the soil micro-arthropod fauna. The soil of the woodland contained collembolan species, including Onychiuridae, Sminthuridae, Entomobryidae, and Isotomidae. The soil of forests was found to be abundant in the aforementioned three micro-arthropods. The amount of leaf litter in a soil has a big impact on its fertility. Other organic molecules are produced as they decompose. Decomposition is a biological process that breaks down complex organic molecules of dead material into smaller organic and inorganic compounds by physical disintegration and biochemical conversion (Mader *et al*., 2002). Trombetti and William (1999) assert that soil microarthropods are essential to the food chain's decomposers. Nature is unable to recycle organic material on its own without them.

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