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A COMPARATIVE STUDY ON LITTER ARTHROPOD DIVERSITY IN MIXED AND MONOCROP AGROECOSYSTEMS IN MUVATTUPUZHA, CENTRAL KERALA

*** Seetha Lakshmi R**
**** K.V. Vinod**
***** Mani Shankar Babu**

Abstract

The present study aimed to analyse the diversity of litter arthropods associated with mixed crop and monocrop agroecosystems present in Muvattupuzha region of central Kerala. Litter arthropod samples were collected during December 2019 to January 2020 using pitfall trapping and Berlese funnel extraction. In the present study, 15 different litter arthropod groups were collected from both the agroecosystems. When both the agroecosystems are taken into account, ants dominated the litter arthropods with 34.65% of abundance followed by termites (16.15%), and isopods (12.63%). Others accounted for less than 10% of abundance. Millipedes, mites, dermapterans, hemipterans and diplurans were the least abundant groups. All the 15 arthropod groups were recorded from mixed crop agroecosystem. Ants dominated with a relative abundance of 26.02 % followed by isopods (19.88 %) and termites (17.84 %). Beetles, collembolans, hemipterans and mites accounted 1.75 % of total abundance. Millipedes, dermapterans and diplurans were the lowest. In monocrop agroecosystem also, all the 15 litter arthropod groups were present. Two groups dominated here, namely ants (43.36%) and termites (14.45%). All other arthropod groups were accounted less than 10 % of abundance. Diplurans, mites and hemipterans were the lowest. Both the ecosystems were equal in terms of abundance

Keywords : *Litter, Arthropods, Diversity, Agroecosystems,Centre Kerala.*

** Nirmala College, Muvattupuzha, Ernakulam, Kerala-686661*

and richness. But Shannon diversity index value of mixed agroecosystem is high (3.12) when compared to monocrop. Comparative assessment of the rank abundance plots clearly indicated that litter arthropod groups in mixed plantation is more even than mono. Ants dominated both the agroecosystems, but their relative abundance is high in rubber plantation. Data showed that mixed agroecosystem is the favourable agroecosystem for isopods, which is the second dominant group there. Mites, diplurans, hemipterans and dermapterans were the lowest in both the agroecosystems. The present study highlights the importance of agroecosystems in sustaining biodiversity especially of litter arthropods.

Introduction

Arthropods inhabiting the litter and in the upper strata of the soil are considered as a vital component of the ecosystem, because of their role in ecosystem services, such as organic matter decomposition and mineralization (Whitfordand and Parker, 1989) nutrient cycling (Irmler,1982) and soil formation (Persson,1989). They also help stabilizer the soil, prevent soil crusting and increase soil fertility. The activity of litter Arthropod help in the formation of soil aggregates. Its feces help in the formation of humus. Arthropod grazing helps to prevent microbial blooming (Thomas.W.Culliney,2013).

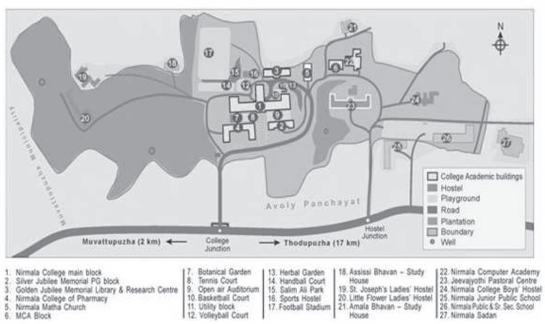
Today cropping pattern of agriculture undergoes tremendous change. The negative consequences of modern intensive agriculture on a biodiversity can be at various spatial scales from local to regional. The farming techniques affect agricultural fields on a regular basis, landscape structure can influence community structure in the fields by providing refugial zones or alternative trophic resources. This may have an impact on the persistence and dispersal strategies of organisms, mainly soil arthropod. We have to maintain a proper habitat for increase in the diversity of arthropods (Previati Enrico ,et al.2007). Management strategies in production systems have an impact on the abundance and variety of soil and foliar arthropods, and the consequences of these systems are dynamic throughout the cropping season. Weed management practises as a source of disturbance and diminished arthropod diversity. Greater arthropod variety is fostered in agricultural systems with lower management intensity, whether due to organic methods or lower levels of disturbance (Paul R Adam,et al.2017).

Land use changes, particularly agricultural intensification, have an impact on managed landscape biodiversity. Indeed, due to commercialization and fragmentation of land holdings, a considerable part of Kerala family gardens have been turned in to small-scale coconut and rubber plantations or cropping systems with fewer crop (Kumar and Nair, 2004). In this scenario, there is an urgent need to conduct more studies on the influence of cropping pattern on litter arthropod diversity. Hence the present study is aimed to analyse the impact of change in cropping patterns in Kerala on the diversity of litter Arthropods.

Materials and Methods

Study Area

Present study was conducted in selected agroecosystems in Muvattupuzha. Muvattupuzha (Figure 1) is a prominent old town in the midlands directly to the east of Kochi. It is situated at around 35 km from downtown to Kochi. The specific location of the selected habitats were in the campus of Nirmala College, Muvattupuzha.



Agroecosystems selected for the study

The study was conducted in mixed crop & monocrop agroecosystems. The mixed crop agroecosystem covers an area 50 cents. It is adjacent to the herbal garden in the College campus. The monocropping agroecosystem selected for the study was the rubber plantation in the campus with an extend of 3 acres.

Sampling Methodology

Sampling of litter fauna was carried out in three months from December 2019 to January 2020. Altogether 16 samples were collected during the study period. Pitfall trapping and Berelese funnel extraction were used for sampling.

Pitfall Trapping: Pit fall traps of 15 cm diameter were buried to soil with their rim in level with soil surface. Water-soap-salt solution was used as preservative. Collection was made in every 24 hrs. Specimens were retrieved with help of a plastic sieve. 4 samples were collected from each habitat.

Berlese funnel extraction: Berlese funnel was used for the extraction of litter arthropods from samples collected from the field. The litter was put into two-third of the funnel having a diameter of 15 cm. A tungsten filament light bulb (60 W) was set above the funnel. A collecting jar with 70 % alcohol was placed below the funnel There should be no space for the organisms to escape. The whole set up was illuminated for 24 hours. Organisms living within the sample tend to move downwards & eventually fall into alcohol. Sample bottles were labelled, having information on the sample number, date of collection, habitat etc.

Identification: The preserved sample was emptied into a Petri dish & the dish was observed under a stereo zoom binocular microscope. Invertebrates were identified with the help of keys, their number counted & classified into different faunal groups. Then the organisms were removed with the help of small hair brush & placed in small vials containing preservative. Each vial contains a clearly displayed label.

Data Analysis: To understand the diversity patterns, alpha diversity indices were used. Alpha diversity indices for estimating diversity were used to estimate the diversity of each habitat. Rank abundance plot was also prepared.

Shannon Diversity Index: It measures the diversity of faunal groups within the community of an ecosystem. It will be zero if the sample in consideration has only one order & would be maximal when all the orders of the sample in consideration have even abundances. Typical values are generally between 1.5 and 3.5 in most ecological studies, & the index is rarely greater than 4. The Shannon index increases as both the richness & evenness of the community increase.

$$H= \sum (pi \times \ln pi)$$

where *pi*= proportional frequency of the i^{th} species

Rank abundance plot: Patterns in composition of various orders were analyzed by constructing rank abundance plot. Rank abundance plot was plotted with relative abundance of each order against various invertebrate orders.

Results and Discussions

In the present study, 15 different litter arthropods were collected from both the agroecosystems (Table1). The arthropod groups include ants, beetles, centipedes, collembolans, dermapterans, diplurans, dipterans, hemipterans, isopods, millipedes, mites, psuedoscorpions, spiders, termites and insect larvae.

Diversity of litter arthropods

Present study revealed the presence of 15 litter arthropods from both the habitat. When both the agroecosystems are taken into account, ants dominated the litter arthropods (Figure 2) with 34.65% of abundance followed by termites (16.15%), and isopods (12.63%). Rest of the arthropod groups accounted for less than 10% of abundance. Millipedes, mites, dermapterans, hemipterans and diplurans were the least abundant groups.

Diversity of litter arthropods in mixedcrop agroecosystem

The study of litter arthropods in mixed crop agroecosystem showed that all the 15 groups were observed in this ecosystem (Table 2). Ants dominated the arthropod groups with a relative abundance of 26.02 % followed by isopods (19.88 %) and termites (17.84 %) (Figure 3). Beetles, collembolans, hemipterans and mites accounted 1.75 % of total abundance. Millipedes, dermapterans and diplurans were the lowest. Altogether 342 specimens were collected from the agroecosystem. Shannon diversity index value of the agroecosystem is 3.12, which is moderately diverse.

Diversity of litter arthropods in monocrop agroecosystem

In the rubber plantation also, all the 15 litter arthropod groups were present (Table 3). Only two groups were dominant here, namely ants (43.36%) and termites (14.45%) (Figure 4). All other arthropod groups were accounted less than 10 % of relative abundance. Diplurans, mites and hemipterans were the lowest. A total of 339 specimens were collected. Shannon diversity index value of the ecosystems is 2.85.

Comparative assessment of litter arthropod diversity in mixed and monocropping agroecosystems

A total of 15 orders of litter arthropod groups were reported from both habitats (Table 4). That means both the agroecosystems supported equal number of litter arthropod groups in terms of richness (Figure 5 and 6). Similarly, both the ecosystems were equal in terms of abundance also, with mixed agroecosystem has 50.22% arthropods. But Shannon diversity index value of mixed agroecosystem is high (3.12) when compared to rubber plantation.

Comparative assessment of the rank abundance plots clearly indicated that litter arthropod groups in mixed plantation is more even than rubber. Ants dominated both the agroecosystems, but their relative abundance is high in rubber plantation. Data showed that mixed agroecosystem is the favourable agroecosystem for isopods, which is the second dominant group there. Mites, diplurans, hemipterans and dermapterans were the lowest in both the agroecosystems.

Table 1: Abundance of litter arthropods associated with two agroe

ARTHROPOD GROUP	Rubber plantation Total	Rubber plantation Mean	Mixed plantation Total	Mixed plantation Mean
Ants	147	18.375	89	11.125
Beetles	18	2.25	6	0.75
Centipedes	6	0.75	11	1.375
Collembolans	11	1.375	6	0.75
Dermapterans	4	0.5	4	0.5
Diplurans	3	0.375	3	0.375
Dipterans	31	3.875	23	2.875
Hemipterans	2	0.25	6	0.75
Insect Larvae	10	1.25	20	2.5
Isopods	18	2.25	68	8.5
Millipedes	5	0.625	5	0.625
Mites	3	0.375	6	0.75
Psuedoscorpions	15	1.875	11	1.375
Spiders	17	2.125	23	2.875
Termites	49	6.125	61	7.625
TOTAL	**339**	**42.375**	**342**	**42.75**

Table 2: Abundance of litter fauna in mixed crop agroecosystem

ARTHROPOD GROUP	Samples								Total	Relative abundance (%)
	1	2	3	4	5	6	7	8		
Ants	20	21	15	14	1	2	6	10	89	26.02
Isopods	0	2	2	0	5	30	21	8	68	19.88
Termites	0	3	0	0	49	5	4	0	61	17.84
Dipterans	6	1	1	4	10	0	0	1	23	6.73
Spiders	3	0	2	2	0	14	1	1	23	6.73
Insect Larvae	1	2	2	1	1	8	1	4	20	5.85
Centipedes	1	1	0	0	1	0	0	8	11	3.22
Psuedoscorpions	2	0	0	3	0	1	0	5	11	3.22
Beetles	0	0	0	1	2	2	0	1	6	1.75
Collembolans	4	0	0	1	0	1	0	0	6	1.75
Hemipterans	2	0	0	1	0	2	0	1	6	1.75
Mites	2	1	0	0	0	0	3	0	6	1.75
Millipedes	1	0	0	0	3	0	1	0	5	1.46
Dermapterans	2	1	0	0	0	1	0	0	4	1.17
Diplurans	2	0	0	0	1	0	0	0	3	0.88

Table 3: Abundance of litter fauna in monocrop agroecosystem

ARTHROPOD GROUP	Samples								Total	Relative abundance (%)
	1	2	3	4	5	6	7	8		
Ants	49	36	40	9	1	5	3	4	147	43.36
Termites	0	0	3	1	0	34	11	0	49	14.45
Dipterans	5	0	0	7	16	3	0	0	31	9.14
Beetles	10	3	0	2	2	0	0	1	18	5.31
Isopods	0	1	4	2	0	2	5	4	18	5.31
Spiders	2	4	2	4	0	2	1	2	17	5.01
Psuedoscorpions	1	2	0	4	0	0	0	8	15	4.42
Collembolans	8	0	0	1	0	0	1	1	11	3.24
Insect Larvae	2	1	1	3	2	0	1	0	10	2.95
Centipedes	1	1	0	0	0	2	2	0	6	1.77
Millipedes	1	0	0	0	0	2	2	0	5	1.47
Dermapterans	1	0	2	0	0	1	0	0	4	1.18
Diplurans	1	0	0	1	0	0	0	1	3	0.88
Mites	0	1	0	0	0	1	1	0	3	0.88
Hemipterans	0	1	0	0	1	0	0	0	2	0.59

Table 4: Litter arthropod diversity and abundance recorded from two agroecosystems

	Agroecosystems	
	Monocrop	**Mixedcrop**
No. of arthropod groups	15	15
Abundance	339	342
Shannon diversity Index	2.85	3.12

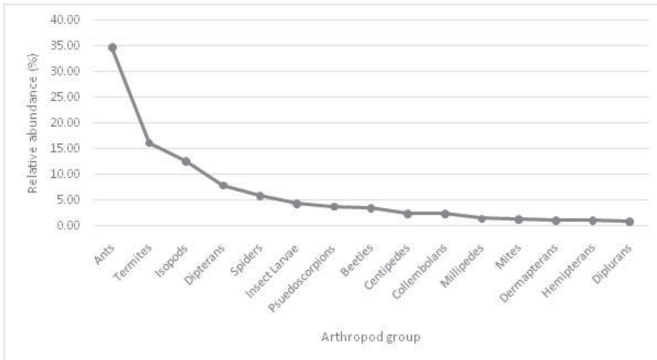


Figure 2: Rank abundance plot showing the relative abundance of faunal groups based on overall abundance from both agroecosystems.

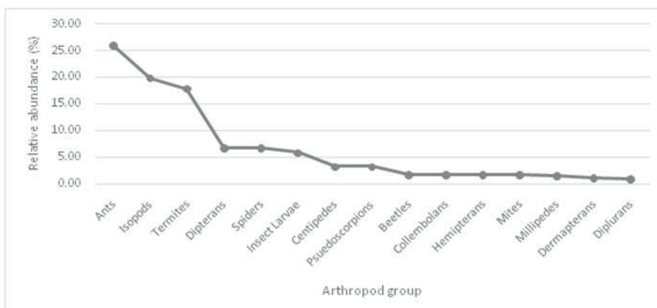


Figure 3: Rank abundance plot showing the relative abundance of faunal groups in mixedcrop agroecosystem

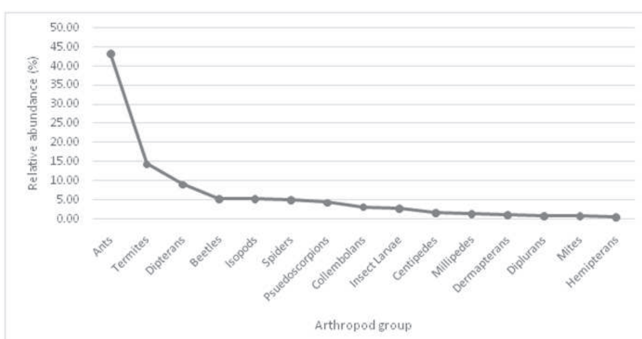


Figure 4: Rank abundance plot showing the relative abundance of faunal groups in mono crop agroecosystem

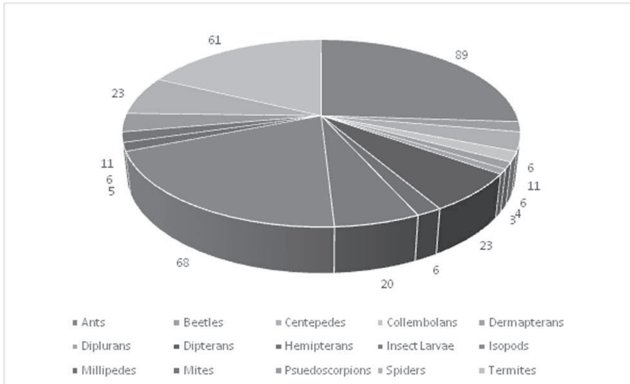


Figure 5: Pi chart showing the relative abundance of faunal groups in mixedcrop agroecosystem

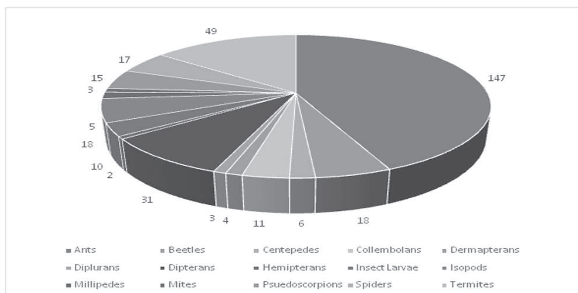


Figure 6: Pi chart showing the relative abundance of faunal groups in monocrop agroecosystem

Conclusion

Results of the present study clearly indicates the role of ecosystems in sustaining our biodiversity. Biodiversity of litter arthropods is an important determinant of agroecosystem function, influencing production and other ecosystem processes, and also in satisfying the needs of the farmer and society. Recent reviews of the role of biodiversity in ecosystem function have emphasised the influence of species richness and the role of different functional, including trophic, groups and keystone species in ecosystem functions and properties such as production, decomposition, nutrient cycling and population dynamics, including such aspects as stability and resilience (Solbrig, 1991). Mixed cropping, including intercropping, is the oldest form of systemized agricultural production and involves the growing of two or more species or cultivars of the same species simultaneously in the same field. Mixed crop system conserve plant diversities that can help to maximize the action of natural enemies to control the vast majority of pests (Perrin and Phillips, 1978). The study also highlights the significance of maintaining mixedcrop agroecosystems.

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