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Abundance and diversity of soil arthropods in a tropical deciduous forest and mangrove forest of Kerala, India

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ABSTRACT: The abundance and diversity of soil arthropods in the Marottichal tropical deciduous forest and Kodungallur mangrove habitat of Thrissur District were studied. A total of 98 species belonging to 15 orders and 5 classes were obtained from the study area. Of these, 59 species belonging to 13 orders and 3 classes were recorded from forest habitat and 47 species belonging to 8 orders and 4 classes from mangroves. Order Coleoptera was the most abundant in both forest (30.69%) and mangrove (36.5%) habitats. Sorenson's similarity index showed only 15.09% similarity among species indicating that both the habitats harboured significantly different types of species. It was noted that, as the humidity and moisture decreased, the abundance of species also decreased in both habitats. Temperature was negatively correlated with abundance of species. The diversity in forest habitat (4.03) was higher than mangrove habitat (3.77). Maximum abundance was recorded during monsoon season (June- August) and least during winter season (December- February). The species accumulation curve plotted for the study area indicated that there are more species likely to be discovered in both the habitats.

KEYWORDS: Soil arthropods, ecologically different habitats, abiotic factors

INTRODUCTION

Arthropods have long been recognized as important in the functioning of soil ecosystems, and a vast literature accordingly has accumulated, and principal roles played by arthropods in the processes that maintain soil fertility have been reviewed exhaustively (Culliney, 2013). Soils may harbor an enormous number of arthropod species. Arthropods represent as much as 85 % of the soil fauna in species richness. They comprise a large proportion of the meso and macrofauna of the soil. Arthropods function on two of the three broad levels of organization of the soil food web: they are plant litter transformers and ecosystem engineers. The activity and diversity of soil organisms are regulated by a hierarchy of abiotic and biotic factors. The main abiotic factors are climate, including temperature and moisture, soil texture and soil structure, and salinity and pH (Bagyaraj *et al.*, 2016).

In India, only a few studies have been done on soil arthropod diversity in comparison to other groups (Prabhoo, 1971, 1976, 1986). In Kerala more recently Mujeeb *et al.* (2011) studied diversity of soil invertebrates in annual crops, agroforestry and forest ecosystems in the Nilgiri biosphere reserve of Western Ghats and concluded that abundance and diversity of soil invertebrates increased from

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annual crops to forest ecosystem. Bini *et al.* (2016) studied the seasonal variations of soil arthropods in rubber plantations of Central Travancore area and reported that seasonality exerted a strong effect on the abundance and diversity. Lakshmi and Joseph (2016) studied soil micro arthropods in the home gardens in Kerala and found that the occurrence of microarthropods was positively correlated to soil moisture and organic carbon and had negative correlation to soil temperature and soil pH.

The soil arthropods of specific habitats like mangrove forest of Kerala are also poorly understood. The present study on soil arthropods of Marottichal, a tropical deciduous forest and Pullut, a mangrove habitat in Thrissur District will provide baseline data on soil arthropods and their diversity. The study will also help to understand how their diversity varies in different environments and changing abiotic conditions.

MATERIALS AND METHODS

Study area: The study was carried out in two selected habitats of Thrissur District, Kerala. Marottichal forest habitat and Pullut mangrove habitat (Fig. 1). Marottichal forest is part of Western Ghats and is located nearly 22 km from Thrissur Town. The forest is tropical moist deciduous type. The soil is mainly detritus and blackish in nature. The predominant flora includes *Hydnocarpus pentandra, Dalbergia latifolia, Mallotus philippensis, Terminalia paniculata, Embelia ribes, Olea dioica.* The mangrove habitat of Pullut, Kodungalur was encountered in isolated patches. It is located in 10.487 and 76.21ast longitude in Kodungallur taluk, Thrissur. The soil is saline and muddy type. The major flora present include *Avicennia officinalis, Acanthus ilicifolius, Acrostichum aureum*, *Bruguiera cylindrica, Derris uliginosa, Thespesia populnea.*

Soil samples of volume 10×10×10 cm were collected using trowel from 6 different plots randomly for 9 months (June 2017 to February 2018).Time of collection was between 9 AM to 11AM. Separate samples were taken for the estimation of pH, moisture and organic carbon. The collected samples were immediately transferred into polythene bags in order to prevent the loss of moisture. The labelled samples were bought to the laboratory for extraction within 24 hours of their collection. Temperature and humidity were measured using hygro thermometer (HTC-1). Soil pH was recorded using pH meter. The soil moisture was recorded using oven drying method. Organic carbon value of the soil was calculated using Walkley and Black titration method.

Extraction of soil samples was carried out by 'Tullgren Funnel Apparatus' modified by Mac fadyen (1953) with a 40 Watt bulb for providing heat and light and kept for 24 hours. Collected soil samples were preserved in 70% ethanol. The arthropods were first separated into Recognizable taxonomic units (RTU) based on the morphological differences and were later identified up to order level. Each such RTU was given a serial number within that order and the representatives of each RTU were preserved. The specimens were later identified up to order level using standard literature.

Species richness (S) and abundance (N) were calculated and the results were graphically represented. Alpha diversity measures (Dominance index, Shannon index, Evenness, Margalef's richness index) were calculated using PAST. Paired T test (two tailed) was calculated in XLSTAT to determine if the diversity indices along months of tropical deciduous forest and mangroves were significantly different at 5% significance. Sorenson's similarity index was calculated to compare the similarity of species composition in the two study areas.

Different soil parameters like soil pH, relative humidity (%), moisture content (%), temperature (^{o}C) and organic carbon content (%) of each habitat were calculated. Pearson correlation of species abundance with soil parameters was calculated to determine if these factors affected the soil arthropod abundance in the study area.

RESULTS AND DISCUSSION

A total of 402 individuals belonging to 98 species, 15 orders and 5 classes were recorded during the study. Arachnida (3 orders), Diplopoda (1 order),

Fig. 1 Two selected habitats of Thrissur, Kerala - Marottichal forest habitat and Pullut mangrove habitat

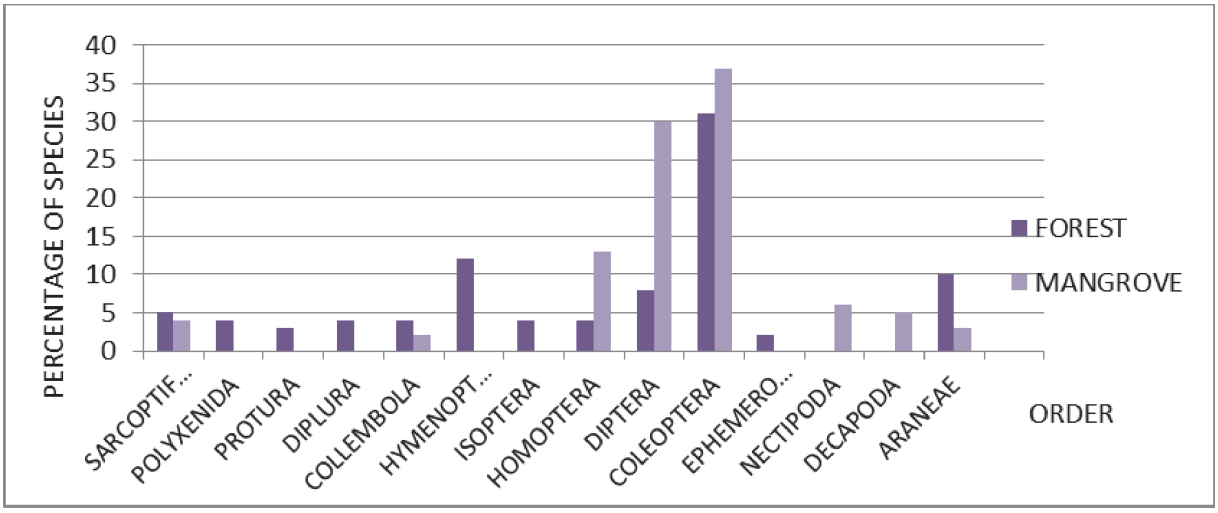

Fig. 2 Distribution of soil arthropods in the habitat

Insecta (9 orders), Remipedia (1 order) and Malacostraca (1order) were the five classes recorded. The 15 orders were Araneae, Pseudoscorpiones, Sarcoptiformes (Class Arachnida), Polyxenida (Class Diplopoda), Protura, Diplura, Collembola, Hymenoptera, Ephemeroptera, Isoptera, Homoptera, Diptera and Coleoptera (Class Insecta), Nectipoda (Class Remipedia) and Decapoda (Class Malacostraca). Of this, 59 species belonging to 13 orders and 3 classes were recorded from forest habitat and 47 species belonging to 8 orders and 4 classes from the mangroves.

In the forest habitat Insecta was the predominant class (71%) followed by class Arachnida (25%) and Diplopoda (4%). Coleoptera was the most abundant insect order (31%) and Ephemeroptera was the least abundant (2%). In the mangrove habitat also class Insecta was most abundant (81%) followed by Arachnida (8%), Remipedia (6%) and

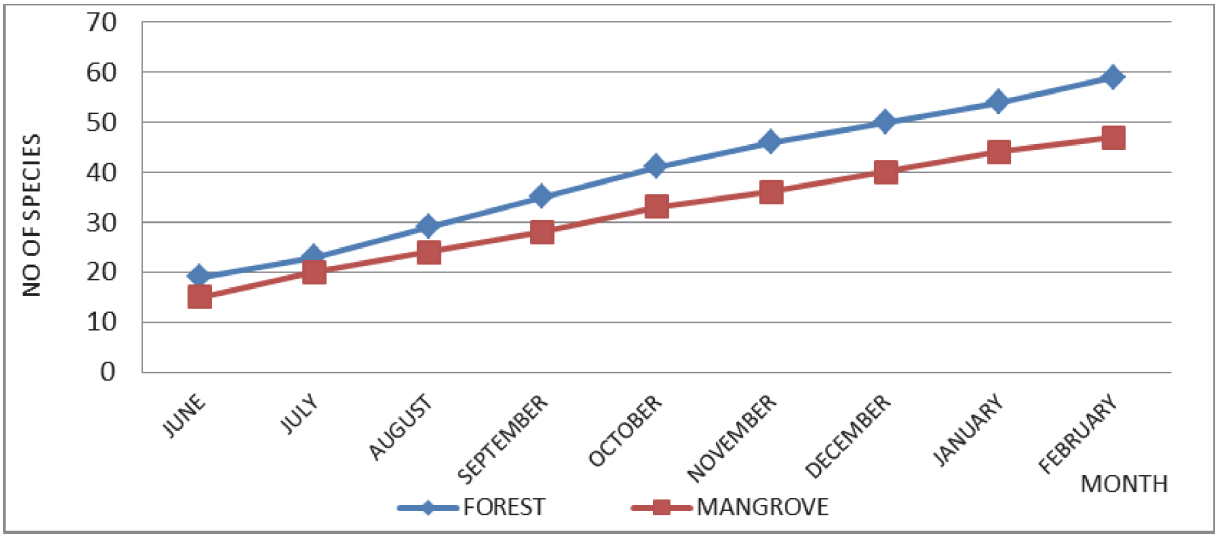

Fig. 3 Species accumulation curve of soil arthropods in different habitats.

Malacostraca (5%). Coleoptera was the dominant order (37%) while Diptera occupied the second position (30%). Order Collembola was least abundant (2%) (Fig. 2). The species accumulation curve did not reached the asymptote indicating that there are more number of species to be discovered in both the habitats (Fig. 3).

Diversity indices of soil arthropods like Shannon index (4.03), Simpson's dominance index (0.98), Margalef's richness (10.93) and evenness (0.95) were higher in the forest habitat (Table 1). Seasonal pattern of diversity indices were calculated. Simpson's index was almost similar during each season in the forest habitat. Maximum diversity was recorded in post monsoon season (3.49) followed by monsoon season (3.47). Evenness (0.94) and Margalef's index (8.17) were higher during post monsoon. However in the mangrove habitat, maximum diversity, dominance and evenness was observed during monsoon season (Table 3). Overall maximum dominance (0.97), Shannon diversity (4.12), evenness (0.92) and Margalef's richness(10.68) was maximum during monsoon season (Table 2). Shannon index and Simpson's index showed significant difference between seasons, the P value being 0.033 and 0.027 respectively (significant at 5% level). Evenness and richness didn't show any significant difference.

Table 1. Diversity parameters of soil arthropods in the study area

	Forest	Mangrove
Taxa_S	59	47
Individuals	202	200
Simpson_1-D	0.98	0.97
Shannon_H	4.03	3.77
Evenness_e^H/S	0.953	0.92
Margalef	10.93	8.68

Sorenson's similarity index between two sites showed 15.09% similarity among species composition indicating that both the habitats harboured significantly different types of species. This might be due to the differences in habitats with respect to environment and micro climatic conditions. Therefore, even though same orders were obtained from both habitats, species were different. Higher species diversity was observed in forest habitat than in mangrove habitat but the abundance was almost similar in both the habitats.

Among the abiotic factors, temperature was negatively correlated with abundance, while humidity and moisture content were positively correlated with abundance. This indicated that soil

Table 2. Seasonal pattern of diversity in the habitat

	Monsoon			Post Monsoon			Winter		
	Forest	Mangrove	Total	Forest	Mangrove	Total	Forest	Mangrove	Total
Taxa_S	35	27	56	34	26	54	30	25	50
Individuals	88	90	178	64	60	124	50	49	99
Simpson_1-D	0.96	0.95	0.97	0.96	0.95	0.96	0.96	0.94	0.96
Shannon_H	3.47	3.18	4.12	3.49	3.09	3.89	3.32	2.87	3.64
Evenness_e^H/S	0.92	0.89	0.92	0.94	0.88	0.90	0.92	0.83	0.87
Margalef	7.59	5.77	10.68	8.17	6.10	10.2	5.66	6.16	8.90

arthropods can flourish only in optimum range of humidity and moisture conditions. Increase in temperature might have caused loss in water content from soil and this might have adversely affected their abundance in both the habitats. Organic carbon content was more in mangrove habitat and showed significant positive correlation with arthropod population (Table 3). pH was positively correlated with arthropod abundance in mangrove habitat, while in forest habitat no significant relation was seen. Lakshmi and Joseph (2016) reported that micro arthropods were positively correlated to soil moisture and organic carbon and negatively correlated to soil temperature and soil pH. Jawaheer (2015) reported significant differences between study sites and months when considering humidity, temperature, soil carbon content and soil moisture. However, no significant difference was recorded between months when considering soil pH and soil calcium.

Table 3. Correlation between soil parameters and arthropod diversity in the study area

Parameters	Forest	Mangrove
Temperature	-0.93	-0.98
Moisture	0.98	0.97
Humidity	0.94	0.97
OC	0.01	0.90
pH	0.38	0.93

The results in the present study can be regarded as a baseline data on the soil arthropod diversity of two ecologically different habitats of Kerala. More intensive studies of longer duration can only substantiate the results obtained in the present study. However, it may be concluded that changes in abiotic conditions can affect the soil arthropod abundance and diversity.

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REFERENCES

Bagyaraj D. Nethravathi C. and Nitin K.S.(2016) Soil Biodiversity and Arthropods: Role in Soil Fertility. Economic and Ecological Significance of Arthropods in Diversified Ecosystems: sustaining regulatory mechanisms 10:17-51.

Bini B., Sanal Kumar M.G. and Vinod P. (2016) Studies on seasonal variations in the diversity pattern of soil arthropods in rubber plantations- Central Travancore area. International Journal of Scientific and Research Publications 6(1): 256-264.

Culliney TW (2013) Role of arthropods in maintaining soil fertility. Agriculture 3: 629–659

Jawaheer Z., Singh HR and Ganeshan S. (2015) Effect of Soil Parameters on the Distribution of Soil Fauna from Roadside Trees at Three Elevations in

Mauritius. Entomology Ornithology Herpetology 4(4): 1-7.

Lakshmi G. and Ammini Joseph (2016) Soil microarthropods as indicators of soil quality of tropical home gardens in a village in Kerala, India. Agroforestry systems 90(2): 1-9.

Macfadyen A. (1953) Notes on Methods for the Extraction of Small Soil Arthropods. Journal of Animal Ecology 22(1): 65–77.

Mujeeb Rahman P., Varma R.V. and Sileshi G.W. (2011) Abundance and diversity of soil invertebrates in annual crops, agroforestry and forest ecosystems in the Nilgiri biosphere reserve of Western Ghats, India. Agroforestry Systems 85: 165-177.

Pai C.G.A. and Prabhoo N.R. (1981). Preliminary observations on the microarthropod fauna of paddy fields and adjoining uncultivated soils in South Kerala. Progress in Soil Biology and Ecology in India, UAS 37: 27–32.

Prabhoo N. R. (1971) Soil and litter Collembola of South India. Arthropleona. Oriental Insects 5(1): 1–46.

Prabhoo N. R. (1976) Soil microarthropods of a virgin forest and adjoining tea fields in the Western Ghats in Kerala - a brief ecological study. Oriental Insects 10(3): 435–442.

Prabhoo N. R. and Pai C. G. A. (1986) Collembola of fire affected and control sites in the Ponmudi-Kallar region of the Western Ghats in Kerala. In 2nd International Seminar on Apterygota. pp. 157–162.

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