Comparison of spatial variation of ecologically important soil arthropods

Sibani Chaudhuri, Priyanka Sarangi, Suchetana Karmakar and Partha Pratim Chakravorty*

*PG Department of Zoology, Raja Narendra Lal Khan Women's College (Autonomous), Gope Palace, Medinipur, West Bengal -721102, India, *Email: parthapratimchakravorty@yahoo.com*

ARTICLE INFO

Received: 02.05.2022

Revised: 04.11.2022

Accepted: 06.11.2022

Key Words: *Soil, Micro arthropods, Bio indicator, Soil inhabitants, Soil fauna, Edaphic factors.*

ABSTRACT

Various kinds of organisms are inhabitants of soil. The present study was done in the area lying near the vicinity of Vidyasagar University campus, Midnapore district of West Bengal. Soil inhabiting micro-arthropods were collected for one year (March – February) from grassland, paddy field and forest field and the community structure, physicochemical parameters of the selected study sites have been done. Monthly fluctuation of faunal population in relation to some selected edaphic factors and the usefulness of selected soil arthropod species as a bio indicator of soil has also been investigated.

Introduction

Soil occurring in the upper most layer of the earth can be defined as a decomposition product of both minerals and organic matter inhabited by a wide range of organisms (Kuhnelt, 1976). According to Smith (1990) soil acts as a pathway between the organic and mineral world and interaction between abiotic and biotic components make it a living system. This organ mineral complex provide a suitable habitat for many organisms and the activity of these organisms contribute to soil formation processes like profile differentiation, decomposition of mineral and organic materials and mixing of organic matter and nutrients among different strata.

The soil ecosystem is not an independent ecosystem but is only a part of the total terrestrial ecosystem and Parkinson (1982) described it as a part of complex bio-physico-chemical system supporting a wide variety of organisms.

Soil organisms can be defined as organisms which spend at least a part of their life cycle in or on the soil (Hendrix et al, 1990). Morphologically soil organisms range from less than 1 micrometer in diameter to several centimeters in diameter (Lee, 1985). In general soil fauna acts as a catalyst of microbial activity including hundreds and thousands of species of invertebrates starting from protozoa, arthropods, and mollusks (Burges and Raw, 1967).

Ecological importance of soil micro arthropods includes mechanical breakdown and partial digestion of litter during feeding, enhancement of humus formation and mixing up of soil, trophic relationship with other soil organisms etc. (Kuhnelt, 1976; Crossley, 1977). The indirect effects of these animals in the soil are more important than their direct role. They promote growth and distribution of microbes in different horizons of soil litter (Luxton, 1972).

Materials method:

Site Location

Experimental sites are located in the vicinity of Vidyasagar University campus of Paschim Medinipur (86.6° - 88.2° East latitude and 21.6°-22°29' North latitude and about 23 meters above sea level) in the West Bengal, India.

Soil and Climate Description- The climate follows a hot tropical weather pattern. Summers last from april to mid-june with diurnal highs ranging from the upper 30°C to the mid 39°C and lows in the low 30°C. However, extensive daily heat if often followed by evening rains known as Kalboisakhhis or dust-stroms (loo). Monsoon rains can last from mid-june to late august or even September with rains from the southeast monsoon typically contributing the lions-share of the annual rain fall of around 1403.4mm. Winters last for two to three months and are mild; typical lows are from 9°C to 14°C.

The soil towards North is partially laterite type and sandy clay to sandy loam type.

Site description

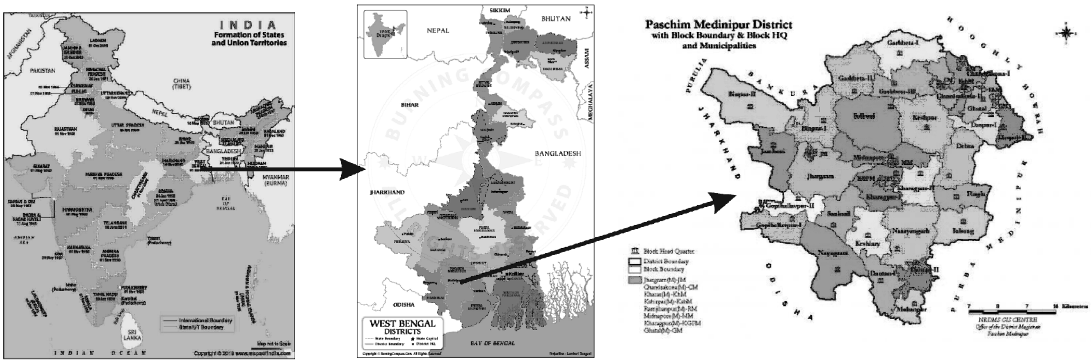
1. Grassland- The site was an uncultivated land densely covered mainly by grasses particularly during rainy season. Out of20 plant species collected from the site *Imperata cylindrical* (L.), Raeus was the most common species of grass. No watering or any agricultural activities were done during the entire period of investigation.
2. Paddy field- Paddy was collected twice in a year from july-nov and Feb-April. The site remained inundated about ¾ times in a year. Low doses of farmyard manure and high doses of chemical fertilizers and pesticides are used from time to time.
3. Forest- It is a managed forest consisting of highly degraded lateritic land of Midnapore forest division. The tree layer had 21 species though only *Acacia auriculiformis* was planted with few *Tectona grandis* during 1989. The total no of species accommodated in the plantation area were 160.

Methods:

Collection and extraction of soil micro-arthropod

In order of quantify micro-arthropod population in soil (0-10cm) soil samples are collected random from the selected sites at an interval of 15 days. Samples are taken at an equivalent distance from among the rows of plants without disturbing the plants. The time of sampling was fixed to morning between 8.00 to 9.00 hours. Samples are collected by using a specially designed steel corer measuring 5×5 cm along the inner cutting edges. The corer was forced into the soil up to a mark of 10cm after withdrawal the intact soil cannel inside the corer are packed in labeled polythene pockets

Location of study site (Paschim Midnapore, West Bengal, India)



Study Site - Grass Land

Study Site - Paddy Field

Study Site - Forest Field

and transformed into the laboratory for extraction of micro- arthropods.

In the present study all the actively moving micro-arthropods were extracted from the soil samples using a modified 'high gradient extraction chamber' having 60 funnels. Each funnel is provided with a sample container to carry a soil sample of size 5×5×10 cms, a 40 W electric bulb is used as light and speed source above the samples. This arrangement maintained a temperature around 40°C on the surface of soil samples. The micro-arthropods during their downward migrations were collected and preserved in 70% ethyl alcohol in labeled specimen tubes, placed under each funnel. The extraction continued for 24h and this much time found sufficient enough to drive out majority of specimens. Micro-arthropods separated from the collecting vials by means of a fine camel hair brush. After shorting, counting of micro arthropods groups were done by examining them under a stereoscopic dissecting binocular microscope (40x) in square cavity blocks and identified into three major taxonomic groups. Soil samples after extraction are processed and preserved for physicochemical analysis.

Physicochemical properties of soil:-

Soil color, temp., moisture, p^H, organic carbon, available N, available P and available K, soil samples are determined by physicochemical analysis of soil.

a) **Determination of soil texture-** The texture of the soil was determined by following the international pipette method (Piper, 1942).
b) **Determination of soil color-** Soil color was determined by comparing a small amount of soil with the 'Munsell color chart' which has different standard color chips arranged systematically on cards. Color determination was done using air-dry soil samples. Nearest matching color chip was selected for each soil sample and color of each soil was designated accordingly.
c) **Determination of soil temperature and moisture-** Temperature of the soil was recorded by inserting a soil thermometer. The prevailing moisture content of the soil was measured using an "infra-red torsion balance moisture meter" at about 105°C-110°C.
d) **Determination of soil p^H-** pH of the soil sample was determined with the help of z glass electrode pH meter (Systronics model 512SE).
e) **Determination of soil nitrogen-** Total nitrogen analysis of the soil was done by Macro- Kjeldahl process following Bear, 1964.
f) **Determination of soil organic carbon-** The organic carbon of the soil sample was determined following Walkley and Black's rapid titration method.
g) **Determination of available P-** Available P was determined by Olsen's method (Jackson, 1973).
h) **Determination of available K-** Available K was determined by ammonium acetate extraction method (Jackson, 1973) using flame photometer (Sytronics-MK-1).

Statistical Analysis-

The following statistical analyses were done in the tabulated data obtained from the field.

a) Abundance(A)= ni/X

Where X= Total number of sampling unit ni =of i^{th} species

N= Total number of individuals of all the species

b) Relative abundance(RA)= The relative abundance of major micro-arthropod groups are calculated in terms of percentage occurrence as given below:

% Relative abundance = ni /N×100n/N×100 n = Total no of individuals of species 'i' N= Total no of individual of all species X= Total number of sampling units

c) Dominance species was ascertained on the basis of (RA) using

Engelmann scale (Engelmann, 1973)

Eudominant species=RA 31.7%-100%

Dominant species=RA

10.1% - 31.6% Subdominant species= RA

3.2%-10% Racedent species= RA 1.1%-10%

Subracedent species=RA

below 1.0%

d) Spatial micro distribution was estimated by 'mean crowding' (Lioyd, 1967) using the following expression

$$\dot{X} = \bar{X} + \left(\frac{S^2}{\bar{X}}\right) - 1$$

Where $\dot{X}$ = mean crowding

x= number of individuals present in a sample

$\bar{X}$= mean of x n=number of sample

s^2=variance = $\Sigma(\bar{X} - X^2) / (n-1)$

Dominance index:

The concentration of influence on the two most abundant species was calculated following Mc Naughton and Wolf's dominance index

DI=(Y1+Y2/Y×100

Where DI= Dominance index, Y1 & Y2 = abundance of two most common species and Y= total abundance

Result:

Physico-chemical properties of soil:

The ratio of sand, silt and clay varied at different sites. In grassland and forest the soil was sandy clay where as in paddy field it was clayey loam. In forest, soil was olive colored (5Y 5/3), in grassland it was light olive grey (5Y 6/2) and in paddy field it was pale olive (5Y 6/3) in color (Table no 1).The mean moisture content was lowest in grassland (8.54%), while it is highest in paddy field (14.04%) (Table no 1).The mean value of pH of soil was 5.82 in forest, 5.95 in paddy field and 6.14 in grass land (Table no 1).Available nitrogen in soil was 234.47 ppm in grass land, 223.80 ppm in paddy field and

260.16 in forest. Mean available phosphate content in soil was found to be min in grassland (34.29 ppm), and max in 41.13 ppm in forest and 39.49 ppm in paddy field, the amount of phosphate is medium (Table no 1).In general potassium content was very high (>199) in all the study sites. The mean value varied from 408.33ppm in paddy field to 2541.66 ppm in forest. The potassium content in soil is highest in forest also higher in grass land and lowest in paddy field (Table no 1).The mean organic carbon content in soil ranged from 58% in paddy field to 1.3% in forest (Table 1).The temperature of the three sites were compared, it is observed that mean average temp in forest is lowest (20.72) as compared to grass land

(28.40) and (27.74) in paddy field (Table no 1).

Community structure of the soil inhabiting mesofauna in three contrasting sites:-

In all the three sites grassland, paddy field and forest, the Acari fauna dominated over all other arthropods. Among the insects the collembolan dominated over the insect groups like Hymenoptera, Hemiptera, Diplura, Isoptera, Diptera, Coleoptera, Pseudoscorpionida, and Isopoda. Quite a good number of developmental stages and juveniles are obtained in all the sites which are not classified and are placed under unclassified juveniles. On the whole the max, no of faunal groups is observed in forest then grassland and least in paddy field.

Table-1

Comparison of the physicochemical parameters of three sites:

Edaphic parameters	Grassland	Paddy field	Forest
Texture (%)	Clay-40, Slit-20, Sand- 40, Sandy-clay	Clay-35, Slit-35, Sand- 30, Clayey loam	Clay-35, Slit-20, Sand- 45, Sandy-clay
Colo r	Light olive gray 5Y 6/2	Pale Olive 5Y 5/3	Olive 5Y 6/3
Temperature	Mean: 28.4±1.9 Max: 38.4 Min: 18	Mean: 27.74±1.5 Max: 34.2 Min: 19	Mean: 20.72±1.2 Max: 25.2 Min: 14.2
Moisture content (%)	Mean: 8.54±0.92 Max: 16.53 Min:4.38	Mean: 14.04±0.91 Max: 17.91 Min:8.5	Mean: 9.81±0.98 Max: 5.93 Min:15.4 2
pH	Mean: 6.14±0.09 Max: 6.66 Min:5.55	Mean: 5.9±0.1 Max: 6.4 Min:5.01	Mean: 5.82±0.03 Max: 5.6 Min:6.02
Organic carbon (%)	Mean: 0.89±11 Max: 1.73 Min:0.25	Mean: 0.90±0.06 Max: 1.3 Min:0.58	Mean: 1.3±0.14 Max: 1.9 Min:0.75
Available phosphate (ppm)	Mean: 34.29±6.4 Max: 98.20 Min:9.0	Mean: 39.49±6.49 Max: 86 Min:10. 7	Mean: 41.13±4.5 Max: 63.66 Min:12.33
Available nitrogen (ppm)	Mean: 234.47±18.6 Max: 400.66 Min:155	Mean: 223.80±13.4 Max: 324.66 Min:162.33	Mean: 260.16±9.16 Max: 321.33 Min:221.33
Available potassium (ppm)	Mean: 980.9±183.28 Max: 2356.66 Min:199	Mean: 596.7±63.16 Max: 1165 Min:306.66	Mean: 1426.3±210.6 Max: 2541.66 Min:408.33

Table -2

Comparative mean of mesofaunal population in 3 fields:

Mesofaunal population	Grassland	Paddy field	Forest
Acarina	Mean: 16.33±3.02 Max: 33.2 Min: 18	Mean: 6.4±1.06 Max: 12.6 Min: 1.8	Mean: 16.9±2.23 Max: 29.6 Min: 3.2
Collembola	Mean: 6.1±1.5 Max: 16.2 Min: 0.6	Mean: 2.6±0.81 Max: 8.4 Min: 0.2	Mean: 5.37±1.1 Max: 12.60 Min: 1.4
Hymenoptera	Mean: 4.05±0.46 Max: 2.2 Min: 7	Mean: 1.6±0.51 Max: 6.0 Min: 0.00	Mean: 5.26±1.0 Max: 11.6 Min: 2.2
Hemiptera	Mean: 1.13±0.56 Max: 5.6 Min: 0.00	Mean: 0.38±0.08 Max: 0.8 Min: 0.00	Mean: 3.9±0.91 Max: 13.4 Min: 1.6
Diplura	Mean: 2.5±0.54 Max: 6.4 Min: 0.60	Mean: 0.33±0.12 Max: 1.4 Min: 0.00	Mean: 0.76±0.15 Max: 2 Min: 1.5
Isoptera	Absent	Absent	Mean: 0.46±0.15 Max: 1.6 Min: 0.00
Diptera	Absent	Absent	Mean: 2.2±0.48 Max: 5.8 Min: 0.00
Coleptera	Mean: 1.2±0.54 Max: 0.8 Min: 0.00	Absent	Mean: 3.08±0.58 Max: 6.8 Min: 0.6
Pseudoscorpionida	Mean: 0.133±0.07 Max: 0.8 Min: 0.00	Absent	Mean: 0.15±0.43 Max: 0.4 Min: 0.00
Araneida	Absent	Absent	Mean: 1.4 Max: 3.66 Min: 0.00
Isopoda	Absent	Absent	Mean: 1.2±0.45 Max: 4.6 Min: 0.00
Unclassified juveniles	Mean: 2.3±0.56 Max: 6.8 Min: 0.60	Mean: 2.18±0.45 Max: 5 Min: 0.4	Mean: 1.7±0.38 Max: 4.2 Min: 0.2

A simple correlation was performed (tables 3, 4, 5) to compare the dominant faunal population with the various edaphic parameters of the three different fields. It was found that a negative correlation was observed between both Acari and Collembola and soil temperature. A significant negative correlation was observed between both Acari and Collembola and soil temperature in both forest and grassland (table 3, 5).

When compared with the moisture content a negative correlation was observed between both Acari and Collembola in grassland (table 3) but positive correlation was observed between both Acari and Collembola in forest and paddy field (table 4, 5).

In all three fields the pH shows a positive correlation with both Acari and Collembola in forest . A negative correlation with Collembola is seen in the paddy field. A positive correlation was observed between Acari population and pH in grassland.

When organic carbon is taken into account both Acari and Collembola in grassland and forest showed a positive correlation with organic carbon but in paddy field a negative correlation was observed between both Acari and Collembola. Again a significant positive correlation was observed between organic carbon and Acari in forest.

Available nitrogen source a positive correlation with both Acari and Collembola in paddy field and forest but a negative correlation was observed between Acari and Collembola in grassland.

Available phosphorus showed a positive correlation with both Acari and Collembola in three fields. A significant positive correlation was observed in collembolan population and a available P in forest and paddy field.

Also available k shows a positive correlation with Acari and Collembola population in three fields, but a significant correlation was observed between Collembola and Acari in forest.

Table -3

Correlations Grass land market Correlations are significant at p<0.5000 N=12

	Soil temp (°C)	pH	Moist cont. (%)	OC (%)	Available N (ppm)	Available phos (ppm)	Available potas (ppm)
Collembola	-0.557	0.365	-0.203	0.540	0.002	0.547	0.733*
	P=0.06	P=0.24	P=0.52	P=0.07	P=0.99	P=0.06	P=0.01*
Acarina	-0.627*	0.292	-0.464	0.445	-0.155	0.370	0.618*
	P=0.03*	P=0.36	P=0.12	P=0.14	P=0.63	P=0.24	P=0.03*
Diplura	-0.307	0.284	0.164	0.643*	0.038	0.725*	0.722*
	P=0.33	P=0.37	P=0.61	P=0.02*	P=0.90	P=0.01*	P=0.01*
Hemiptera	-0.147	0.364	0.116	0.528	0.008	0.778*	0.758*
	P=0.64	P=0.24	P=0.71	P=0.07	P=0.97	p=0.003*	P=0.004*
Hymenoptera	-0.049	0.077	0.403	-0.116	0.071	0.025	0.143
	P=0.87	P=0.81	P=0.19	P=0.72	P=0.83	P=0.94	P=0.66
Coleoptera	0.015	-0.058	0.490	-0.107	-0.391	-0.049	0.042
	P=0.96	P=0.86	P=0.10	P=0.74	P=0.22	P=0.88	P=0.90
Pseudoscorpionida	-0.549*	0.034	-0.373	-0.099	-0.067	-0.191	0.153
	P=0.04*	p=0.91	P=0.23	P=0.76	P=0.83	P=0.55	P=0.63
Unclas juva	-0.674*	0.255	-0.355	0.583*	-0.105	0.36	0.623
	P=0.02*	P=0.42	P=0.25	P=0.05*	P=0.74	P=0.24	P=0.03

Table-4

Correlations Paddy Field Marked Correlations are significant at p<0.05000 N=12

	Soil Temp(°c)	pH	Moist content	OC (%)	Avail N(ppm)	Avail Phosp (ppm)	Avail Potas (ppm)
Collembola	-0.518	-0.126	0.175	-0.426	0.417	0.631*	0.209
	P=0.084	P=0.695	P=0.585	P=0.167	P=0.177	P=0.028*	P=0.514
Acari	-0.363	0.106	0.123	-0.287	0.282	0.545	0.103
	P=0.245	P=0.743	P=0.702	P=0.365	P=0.374	P=0.066	P=0.749
Diplura	-0.2437	-0.0552	0.1978	-0.1977	0.4349	0.2524	0.7630*
	P=0.445	P=0.865	P=0.538	P=0.538	P=0.158	P=0.429	P=0.004*
Hemiptera	0.387	-0.537	-0.054	0.037	0.309	0.132	0.032
	P=0.213	P=0.071	P=0.867	P=0.908	P=0.327	P=0.683	P=0.921
Hymenoptera	-0.307	0.201	0.327	-0.349	0.313	0.360	0.855*
	P=0.331	P=0.529	P=0.299	P=0.265	P=0.321	P=0.250	P=0.000*
Unclas Juve	-0.828*	0.146	-0.250	-0.275	-0.192	0.314	0.013
	P=0.001*	P=0.650	P=0.433	P=0.386	P=0.549	P=0.319	P=0.968

Table 5
Correlations Forest Field Marked Correlations are significant at p<0.05000 N=12

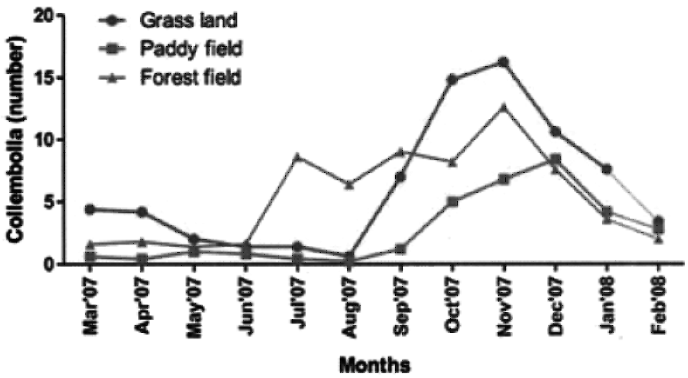
	Soil temp (°C)	pH	Moist content (%)	OC (%)	Available N (ppm)	Available phos (ppm)	Available potas (ppm)
Collembola	-0.411	0.4735	0.781	0.2995	0.393	0.622	0.448
	P=0.184	P=0.120	P=0.003	P=0.344	P=0.206	P=0.031	P=0.143
Acari	-0.780	0.868	0.091	0.664	0.095	0.375	0.529
	P=0.003	P=0.000	P=0.778	P=0.019	P=0.767	P=0.229	P=0.077
Diptera	-0.152	0.304	0.734	0.185	0.065	0.267	0.321
	P=0.635	P=0.336	P=0.006	P=0.564	P=0.840	P=0.400	P=0.309
Diplura	-0.228	0.044	0.155	0.207	0.239	0.222	0.325
	P=0.475	P=0.891	P=0.630	P=0.517	P=0.454	P=0.487	P=0.302
Hemiptera	0.0792	0.0040	0.4654	0.1121	0.6008	0.0949	-0.0496
	P=0.807	P=0.990	P=0.127	P=0.729	P=0.039	P=0.769	P=0.878
Hymenoptera	0.503	-0.368	0.389	-0.224	0.119	-0.059	-0.247
	P=0.095	P=0.238	P=0.211	P=0.484	P=0.712	P=0.855	P=0.438
Coleoptera	-0.669	0.111	-0.404	-0.014	-0.141	0.302	0.225
	P=0.017	P=0.729	P=0.192	P=0.964	P=0.662	P=0.339	P=0.480
Pseudoscorpionida	-0.080	-0.055	0.002	0.024	-0.381	0.181	0.493
	p=0.803	p=0.864	p=0.996	p=0.939	P=0.222	P=0.547	P=0.104
Aranedia	-0.3761	0.2224	0.0865	-0.1063	-0.3166	-0.2049	0.2213
	P=0.228	P=0.487	P=0.789	P=0.742	P=0.316	P=0.523	P=0.489
Isoptera	0.452	-0.155	0.840	0.222	0.460	-0.046	-0.286
	P=0.140	P=0.631	P=0.001	P=0.488	P=0.132	P=0.887	P=0.367
Isopoda	-0.182	0.292	0.679	0.001	0.306	0.036	0.008
	P=0.571	P=0.357	P=0.015	P=0.997	P=0.333	P=0.910	P=0.980
Unclas juve	-0.808	0.675	-0.125	0.449	-0.244	0.460	0.679
	P=0.001	P=0.016	P=0.699	P=0.144	P=0.444	P=0.132	P=0.015

Mean crowding (Lloyd, 1967) was calculated in order to estimate the spatial micro distribution of the micro arthropods in various fields. It is observed that most of the groups are contagious in micro distribution, a few showed regular distributions. Comparing the distribution in three fields, it was found that most of the species are contagiously distributed in the forest and grassland as compared to paddy field (table 6).

Table 6

Mean crowding pattern of soil mesofauna in three different fields:

	Grassland	Paddy field	Forest
Collembola	9.67	4.63	7.10
Acari	22.31	7.55	19.46
Diptera	2.94	--	2.46
Diplura	--	-0.11	0.13
Hemiptera	3.55	-0.40	5.50
Hymenoptera	3.70	2.55	6.75
Coleoptera	3.17	--	3.43
Pseudoscorpionida	-0.41	--	-0.70
Aranedia	--	--	1.65
Isoptera	--	--	0.06
Isopoda	--	--	2.23
Unclassified Juveniles	2.99	2.34	1.73



I

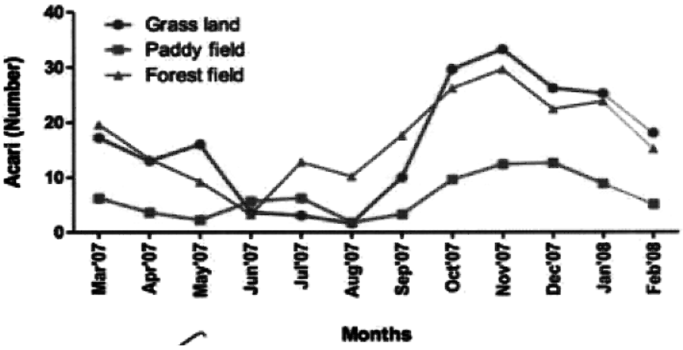


Fig. elds

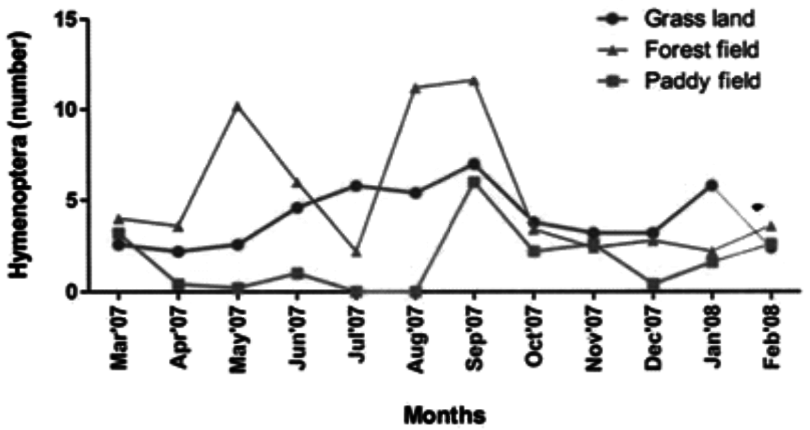


Fig.1(c) Monthly Variation of Hymenoptera Population in three fields

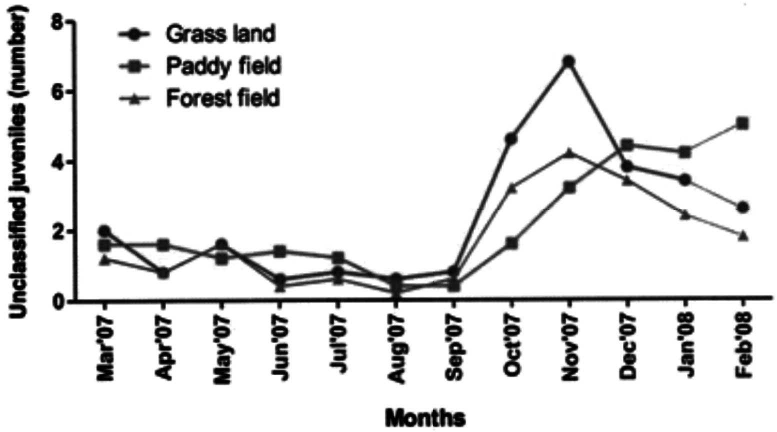


Fig.1(d) Monthly Variation of Diplura Population in three fields

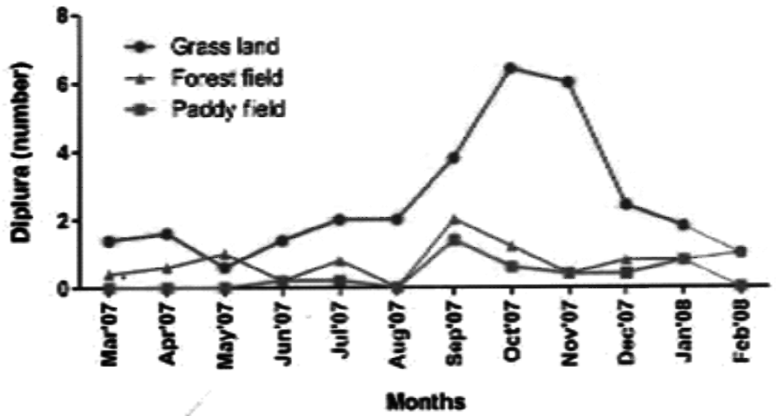


Fig.1(e) Monthly Variation of unclassified juvenile Population in three fields

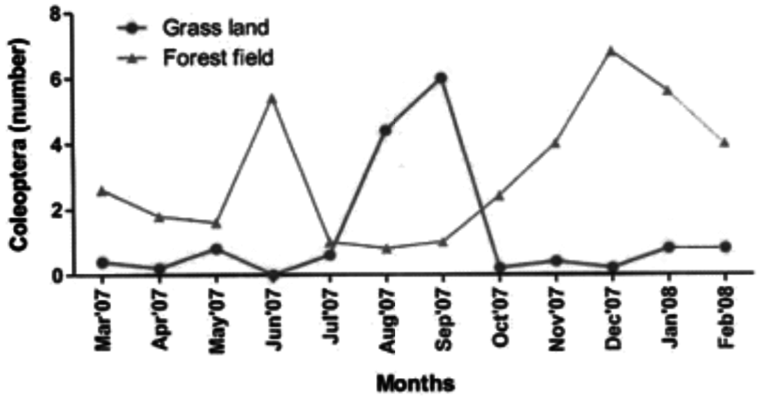


Fig.1(f) Monthly Variation of Coleoptera Population in two fields

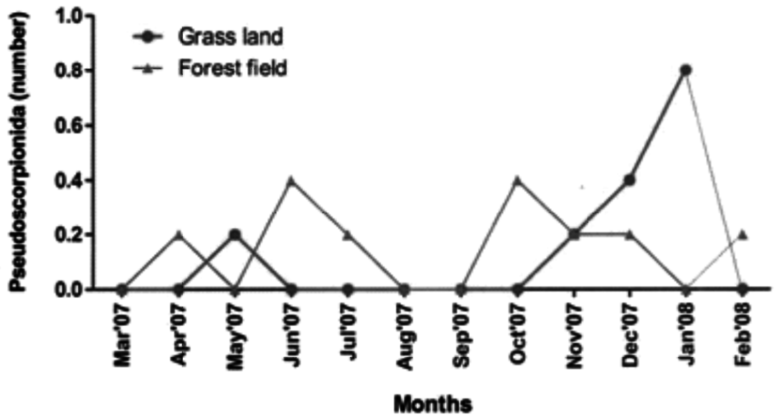


Fig.1(g) Monthly Variation of Pseudoscorpionida Population in two fields

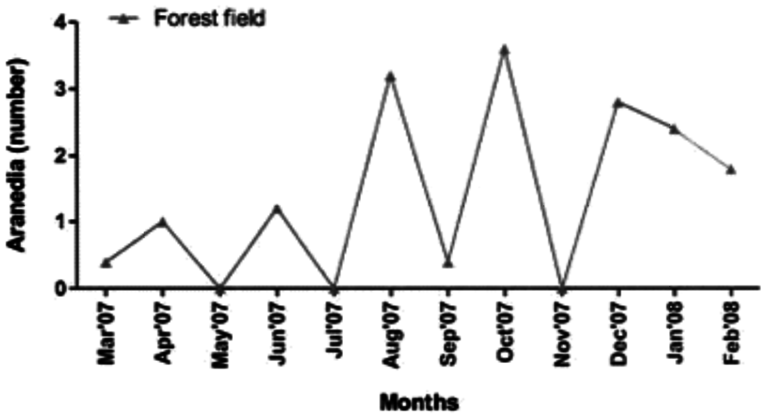


Fig.1(h) Monthly Variation of Aranedia Population in Forest

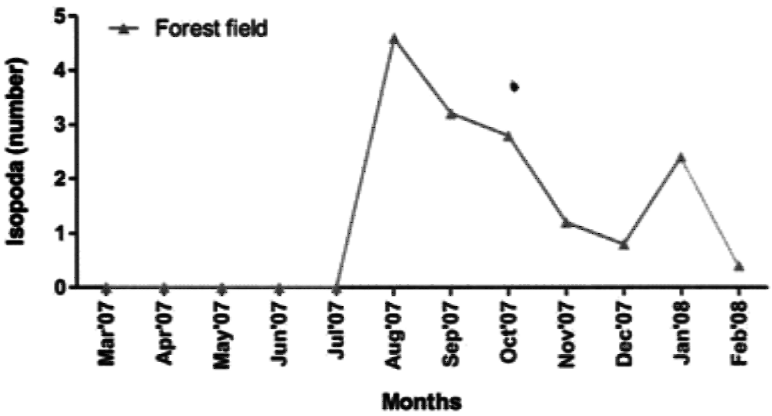


Fig.1(i) Monthly Variation of Isopoda Population in Forest

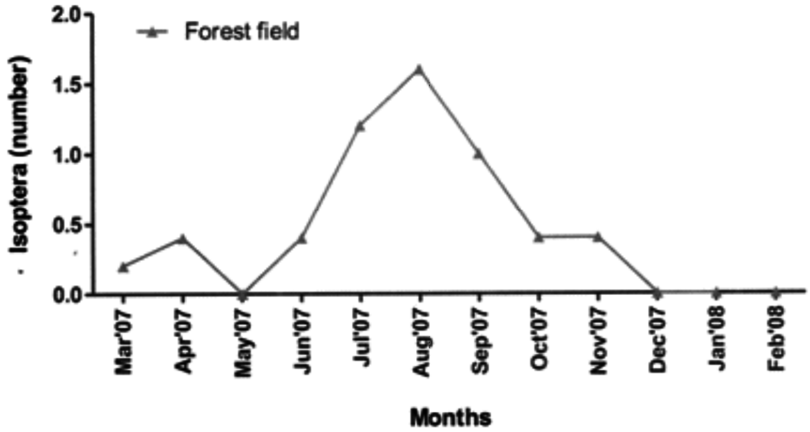


Fig.1(j) Monthly Variation of Isoptera Population in Forest

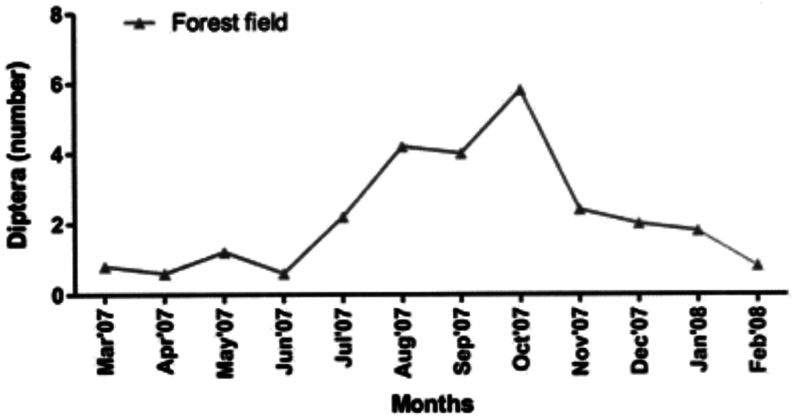


Fig.1(k) Monthly Variation of Diptera Population in Forest

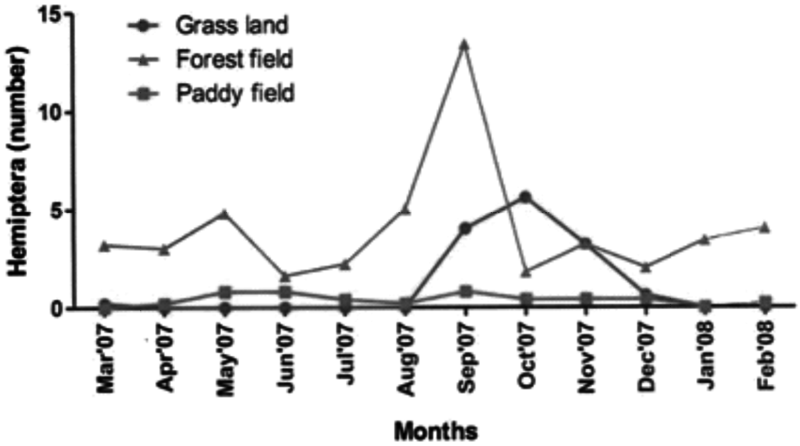


Fig. 1(l) Monthly Variation of Hemiptera Population in three fields

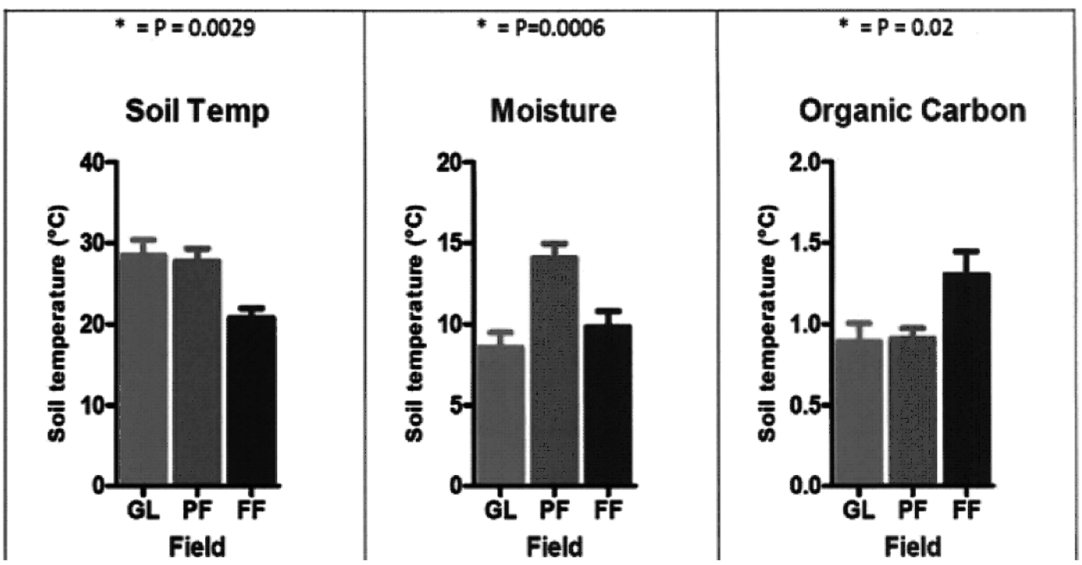


Fig.2. (a) one way anova graph of soil temp in three fields

Fig.2. (b) one way anova graph of soil Moisture in three fields

Fig.2. (c) one way anova graph of organic carbon in three fields

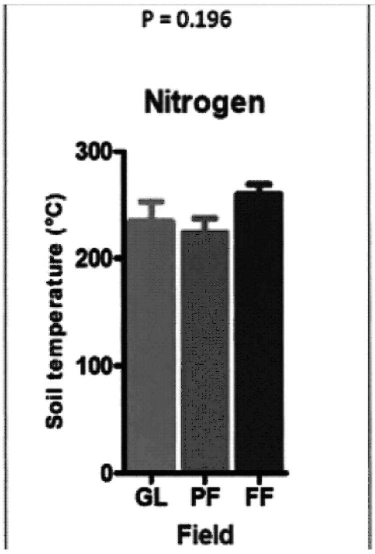


Fig.2. (d) one way anova graph of soil Nitrogen in three fields

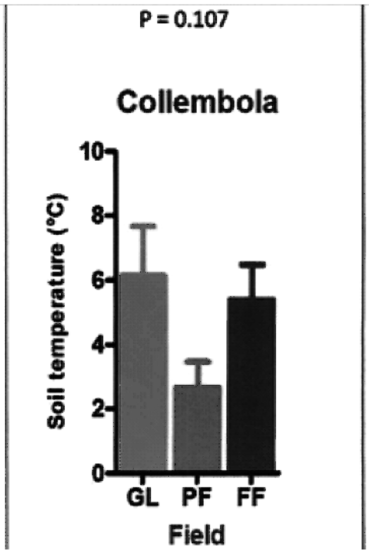


Fig.2. (e) one way anova graph of soil Collembola in three fields

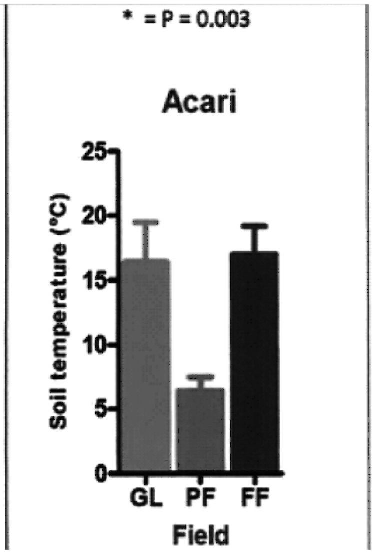


Fig.2. (f) one way anova graph of soil Acari in three fields

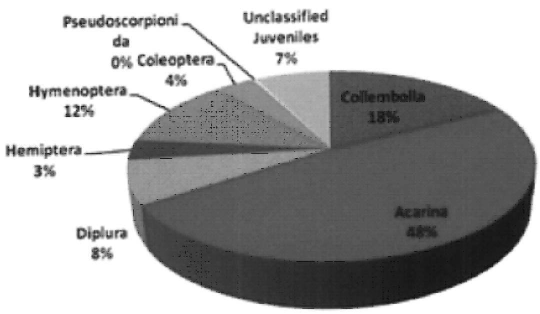


Fig.3. (a) Pie-diagram of faunal population in grassland

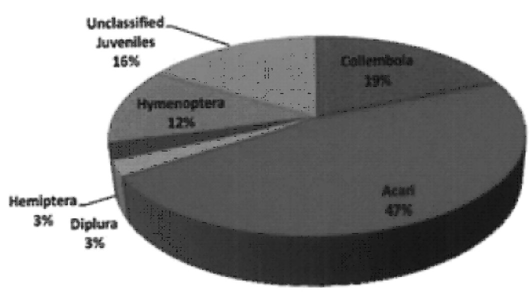


Fig.3. (b) Pie-diagram of faunal population in Paddy field

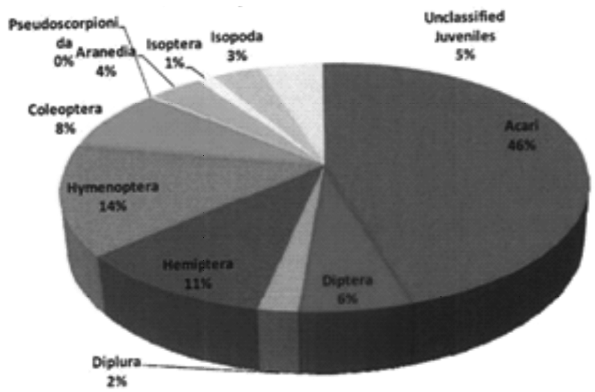


Fig.3. (c) Pie-diagram of faunal population in Forest field

Discussion:

Acari predominated over Collembola in all the sites; Grassland, paddy field and forest field. Predominance of Acari in all the sites in the present study is in agreement with the findings of Bhattacharya and Joy (1978), Singh (1977) in the floor of soil forest, Varanasi, Singh and Pillai (1981) and Mitra et al. (1981). However, Mukherjee and Singh (1970), Prabhoo (1976) and Reddy and Ao (1995) found the Collembola as the predominating group in the rose garden in UP and in maize field in Nagaland respectively. Again abundance of Acrofauna over the micro arthropods corroborates the findings of Singh and Singh (1975).

The post monsoon peak of Acari in grassland and forest agree with the finding of Sanyal et al. and Chattopadhyay and Hazra (2000) showed post monsoon peak in uncultivated fields of West Bengal. The lower population of Acari in three contrasting sites during monsoon agrees with the observation of Sarkar (1990) in some sampling plots of Tripura. A recent study conducted by Hazra, 2022 suggested the abundance of acarina near litter zones.

However, peak population buildup of Collembola during winters in this study differs from majority of the other reports of many workers who have reported higher population buildup of soil micro arthropods during rainy season only few studies have shown post-monsoon increase winters peak reported by Sinha et al. 1991 which agrees with the results obtained in this study. A sharp decline of Collembola population during summer months agrees with the findings of Hazra and Sanyal, 1996; Jam et al. 1986; Reddy and Venkataiah 1990; Reddy et al. 1992.

The higher abundance of Hymenoptera (mainly represented by ants) in the forest followed by grassland accounts the geophilic nature of ants who finds the forest and grassland a very suitable habitat.

The population buildup of soil micro arthropod is influenced by a variety of factors viz., vegetation, soil, climate etc. and their interaction (Narula et al.1998). Population fluctuation of soil arthropod is controlled by cumulative action of several edaphic factors which varies in different fields due to which the edaphic factors are compared.

The capacity to withstand the condition of drought and desiccation as well as higher moisture may vary from species to species which might be considered as the probable reason for population fluctuation. Thus comparing the temperature and moisture regimes in the grassland, paddy field and forest is seen that while soil temperature was higher, soil moisture was lower in grassland compared to other two fields. Higher soil moisture content in forest at the time of sampling was favorable for soil organisms. Similar trends of lower temperature and higher moisture regimes in forest compared to open grassland mainly on account of shade have been reported by (Reddy and Venkataiah, 1990) in semiarid region and (Badejo et al. 1990). Such fluctuation in temperature and moisture regimes are more pronounced in surface layers and are partially responsible for the migration of microarthropods by indirectly affecting the growth of micro flora, especially fungi, besides enhancing palatability of litter to macro phagophytes. Thus it is evident that forest provides better habitat compared to grassland in tropical regions.

In grassland highly significant negative correlation was found between soil temperature and faunal population. Similar trend in correlation between soil micro arthropods and temperature was reported in North-East India (Sarkar, 1991).

In forest a highly significant positive correlation was found between soil moisture and population which are in agreements with the earlier works done by (Hazra and Sanyal, 1996) in alluvial soils and (Narula et al. 1998) in deciduous forest. The negative correlation found between Acari and moisture in grassland agree with the findings of (Gibson, 1962; Choudhury and Pande, 1982; Sarkar, 1991 and Sanyal and Sarkar, 1993) observed negative correlation between moisture and Acari population. Hazra 1978, found a maximum population of collembola during monsoon when the moisture content is relatively higher.

In present investigation the pH of soil sample did not exhibit a very wide range of variation, it was as low as 5.8 in forest to 6.14 in grassland, the range of pH was believed to be well within tolerance range of most of the species as reported by Choudhury and Banerjee, 1977 and Sanyal, 1994., Mahajan et al. 2015.

In grassland and forest statistical analysis revealed a significant positive correlation between soil pH and Acari populations. In paddy field a negative correlation found between pH and collembolan which are in agreement with the review report of Sanyal, 1994, Behara and Shukla, 2015. According to which pH may have inhibitory role in population increase.

In all the three sampling sites organic carbon content shows relatively wide range of variation and exhibited a very strong positive correlation with population. A study conducted by Ghosh et al. 2006, corroborates this fact. Ghosh et al. 2006, found a higher number of samples during post winter or pre monsoon period due to a high concentration of organic matter in soil during that period.

Nitrate though acts as an attractant for the arthropods shows no significant correlations with mite population in the three fields. For collembola, Choudhuri and Roy, 1972, concluded that there is a positive correlation between the nitrate concentration and collembola population.

Available phosphate shows positive correlation with population with grassland and forest but a significant correlation with Collembola population was observed in paddy field and forest.

Available potassium also showed positive correlation in three fields but a significant positive correlation was observed with collembolan in grassland and forest. In grassland a significant positive correlation was observed in case of Acari also.

On comparing the spatial micro distribution of micro arthropods in various field, it is found most of the faunal groups are contagious in distribution and a very few group shows regular distribution which varies from field to field. Generally, most of the collembolan and mites tend to aggregate in soil. The differences in behavior towards randomness or aggregation of soil mites and collembolan in present study may be attributed to their nature and feeding habits besides favorable micro climatic condition and availability of foods. Bhunia et al. 2018 showed assessment of spatial variability of soil properties using geostatistical approach of laterite soil (West Bengal, India). On comparison of the faunal diversity in three sites, it was found that maximum diversity is seen in the forest, then in grassland and least in paddy field.

Finally it can be concluded from the above study that acrofauna dominated over collembola in all the three sites and among soil arthropods fauna, soil mites and collembola are known to dominate most of the Indian soil and indicate the status health of soil and fertility. From the view point of diversity they can be considered as bio indicators of deterioration in biodiversity.

References:

1. Badejo MA, Seasonal abundance of soil mites (Acarina) in two contrasting environments, Biotropica, 1990, 25, 382-390.
2. Behara SK, Shukla AK, Spatial distribution of surface soil acidity electric conductivity soil organic carbon content and exchangeable potassium calcium and magnesium in some cropped acid soils of

India, Land Degard Dev, 2015, 26(1), 71-79.

3. Bhattacharya T, Joy VC, A study of the micro-arthropod community of four contrasting sites in Srinikatan, West Bengal, Visva Bharati, J. Res. Sci., 1978, 2, 17-28.
4. Bhunia GS, Pravat KS, Chattopadhyay R, Assessment of spatial variability of soil properties using geostatistical approach of laterite soil (West Bengal India), Ann of Agrar Sci, 2018, 16(4), 436-443.
5. Burges A, & Raw F, Soil Biology, Academic Press, London, 1967.
6. Choudhuri DK, and Roy S, An ecological study on collembola of West Bengal (India), Rec. Zool. Surv. India, 1972, 66 (1-4):81-101.
7. Choudhuri DK, and Banerjee S, Soil factors of soil oribatid mites under conditions of West Bengal, The University of Burdwan Publication, 1975, 1-88.
8. Choudhuri DK, and Pande T, An ecological study of Acarines from soil of Himalayan ecosystem, Geobios new Reports, 1982, 1, 24-26.
9. Crossley DA Jr, The roles of terrestrial saprophagus arthropods in forest soil. In: Mattson, W.J.(eds.). The roles of arthropods in forest ecosystem (ed. Mattson, W.J.), Springer, Verlag, Berlin, 1978, 49-56 pp.
10. Ghosh TC, Saha GK, Roy S, Studies on the impact of four edaphic factors on the density, seasonal abundance and diversity of acarine fauna in the soils of a tea estate in Darjeeling, Rec. zool. Surv. India, 2006, l06 (Part-2):25-34.
11. Hazra AK, Ecology of collembola in a deciduous forest floor of Birbhum District, West Bengal in relation to soil moisture, Oriental Insects, 1978, 12:2, 265-274.
12. Hazra AK, & Sanyal AK, Ecology of collembolan in periodically inundated newly emerged alluvial island in the river Hooghly, West Bengal, Proceeding Zoological Society Calcutta, 1996, 49, 157-169.
13. Hazra KK, Diversity of Soil arthropods in Contai Municipality,Purba Medinipur,WB,India, IJCRT, 2022.
14. Hendrix PF, Crossley Jr DA, Blair JM, Coleman DC, Soil Biota as components of sustainable agro-ecosystems, In: Sustainable Agricultural Systems, Soil and Water Conservation Society, Ankeny, Lowa, 1990, pp.637-654.
15. Jam BST, Yadav PS, Elangbam JS, Population density of soil arthropods in the subtropical forest ecosystems at Shiroy hill, Manipur, 1986, pp. 272-288. In: Proceeding of National Symposium on Pesticides Residues and environmental pollution, Muzaffarnagar.
16. Kuhnelt W, Soil Biology with Special Reference to the Animal Kingdom, Faber, London, 1961.
17. Lee KE, Earthworm, their ecology and

relationship to soil and land use, Academic press, Australia, 1985.
18. Luxton M, Studies on the oribatid mites of a Danish beech wood soil. Nutritional Biology, Pedobiologia, 1972, 12, 434-463.
19. Mahajan GR, Manjunath BL, Latare AM, D'Souza R, Vishwakarma S, Singh NP, Fertility status of the unique coastal acid saline soils of Goa, J Indian Soc Soil Sci, 2015, 63(2), 232-237.
20. Mukharji SP, Singh J, Seasonal variations in the densities of soil arthropod population in a rose garden in Varanasi, (India). Pedobiologia, 1970, 10, 442-446.
21. Narula A, Vats LK, & Hansda S, Collembola and mites of deciduous forest stand. Indian Journal of Forestry, 1998, 147-149.
22. Parkinson D, Functional relationship between soil organisms, New Trend in Soil Biology (eds Lebrum PH, Andre HM, Medts AD, Wibo GC.and Wauthy G.), Proc VIII Int. soil zool. Colloq. Belgium, 1982, 153-165 pp.
23. Piper CS, Soil and plant analysis, 368 pp, Hans Publ., Bombay,1942.
24. Prabhoo NR, Soil micro-arthropods of a virgin forest and adjoining tea fields in the Western Ghats in Kerala-a brief ecological study, Oriental Insects, 1976, 10, 435-442.
25. Reddy MV & Venkataiah B, Effects of tree-plantation on seasonal community structure of soil micro-arthropods in a tropical semi-arid savanna, Tropical Ecology, 1990, 31, 96-105.
26. Reddy M V , Reddy V R , Kumar V P K, Yule D F , Cogle A L , Soil Management and Seasonal Community Structure of Soil Micro arthropods in Semi- Arid Tropical Alfisols, 1992, pp. 204-218. In: M. Herman (ed.) Proceeding of International Conference on Problems in Modern Soil Management, Research Institute of Agro ecology and Soil Management, Hrusovany (near Brno) Czechoslovakia.
27. Reddy MV and Ao MA, Species composition and seasonably in soil surface arthropod population in two upland agro-ecosystems of Nagaland, Advances in Ecology and Environment (Ed by P.C. Mishra, N. Behera, B.K. Senapati & B. C. Guru), pp.561-597, Ashish Publishing House, New Delhi, 1995.
28. Sanyal AK and Sarkar BJ, Ecology of soil oribatid mites in three contrasting sites at Botanical Garden, Howrah, West Bengal, Environment & Ecology, 1993,11 (2), 427-434 .
29. Sanyal AK, Ecological studies on soil mites (Acari) in India: A Review, Advances in Ecology and Environmental Sciences, 1994, Chapter 6, 79-96.
30. Sarkar S, Studies on micro-arthropod community in one undisturbed habitat of Tripura. (India) with special reference to oribatid mites, Revue D'Ecologie et de Biologie du So/, 1990, 27, 307-329.
31. Sarkar S, Taxonomy of oribatid mites from

the soils of Tripura. I. Two new species of Allonothrus and Eremulus, Advances in Management & Conservation of Soil Fauna (Ed by G. K. Veeresh, D. Rajagopal &C. A. Viraktamath), pp. 727-731, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1991.

32. Singh J & Singh UR, An ecological study of soil micro-arthropod from soil and litter of tropical deciduous forest of Varanasi (India), Tropical ecology, 1975, 16, 81-85.

33. Singh UR, Relationship between population density of soil micro-arthropods and mycoflora associated with litter and total litter respiration on floor of Sal forest Varanasi, India. Ecological bulletin (Stockholm), 1977, 25, 463-470.

34. Walkey A, Black I, An examination of Degtijareff method for determining organic carbon in soils: effect of variations in digestion conditions and organic soil constituents, Soil Sci, 1934, 63, 251-263.