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A Study on Variation of Relative Abundances and Group Diversities of Major Soil Microarthropod Taxa at Four Different Sites in Uttar Dinajpur, West Bengal, India

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Abstract:

Soil samples were periodically and regularly collected from four different sites i.e., an agricultural field, a river basin, a brick field and a forest floor from the district of Uttar Dinajpur, West Bengal. Relative abundance and group diversity of soil micro arthropod population varied considerably among all of the sites. Fluctuation in relative abundance was statistically significant ($p<0.05$). In all the sites in general, maximum abundance was noted following post-monsoon season while the minimum was during the onset of monsoons or at the end of summer. Variations in relative abundance of major groups of microarthropods were significant. Oribatids were the single largest order followed by collembolans as observed in almost all the collection efforts. Significant negative correlation ($p<0.05$) was observed between collembolans and other microarthropod groups excluding oribatids and mesostigmatid populations. No spatial or temporal effect was statistically significant on fluctuation of microarthropod populations except oribtids which exhibited site-associated variation of relative abundance.

Keywords: **Soil Microarthropods, Relative Abundance, Group Diversity.**

1.0 Introduction:

Soil microarthropods are known for their significant role in decomposition and nutrient cycling in soil (Mattson, 1977, Colman et al., 2004; Devi and Singh, 2006). Studies of litter-soil organisms generally permit easy and direct approaches to biological processes integral to life in virtually any natural situation. Soil microarthropods including Acarines play an important role in the physico-chemical dynamics of soil that have drawn attention of a number of workers in and outside of India (Sanyal, 1982; Bhattacharya and Chakrobarty, 1994; Norton, 1994; Crossley and Coleman, 1999; Chitrapati and Singh, 2006).

Studies on different microarthropod groups were taken up by a number of workers. Moitra *et al*. (2012) studied altitudinal pattern of distribution of oribatid mites in the Darjeeling Himalayas and found greater diversity in the middle altitudinal regions there. Impact of experimental fire upon dynamics of fungivorous microarthropods was investigated by Rutigliano *et al.* (2013). Indicator species analysis using oribatid species was attempted by Moitra *et al.* (2013). Cameron *et al.* (2013) studied effect of earthworm on the movement of soil microarthropods. Akoijam *et al.* (2014) investigated the efficiency of tullgren funnel for the extraction of microarthropods. Impact of mosses and shrubs on the soil dwellers in a boreal forest were studied by Bokhorst *et al.* (2014). The current study was attempted to collect basic data on variation of relative abundances of soil microarthropods as well as to compare the selected places of different paedological features at Kaliyaganj, Uttar Dinajpur West Bengal where no such work has been carried out earlier.

2.0 Material and Methods:

2.1. Collection Sites:

Four sampling sites each having different paedological characteristics were selected for the study. All the sites are located in the division of Kaliyaganj, within the administrative boundary of the District Uttar Dinajpur, West Bengal. An account the sites have been given in earlier publication (Sarkar et al., 2014) The sites are as follows: S1. Agricultural field near Dalimgaon Rail

Station (25° 38’07”N, 88° 22’10”E); S2. Brick field at Madanpur (25° 38’7”N, 88° 16’10”E); S3. River basin region at Tungail bill para (25°40’11”N, 88°19’10”E); S4. Forest area at Anaun (25°36’3” N, 88 °19’10”E) ***(Fig. a).***

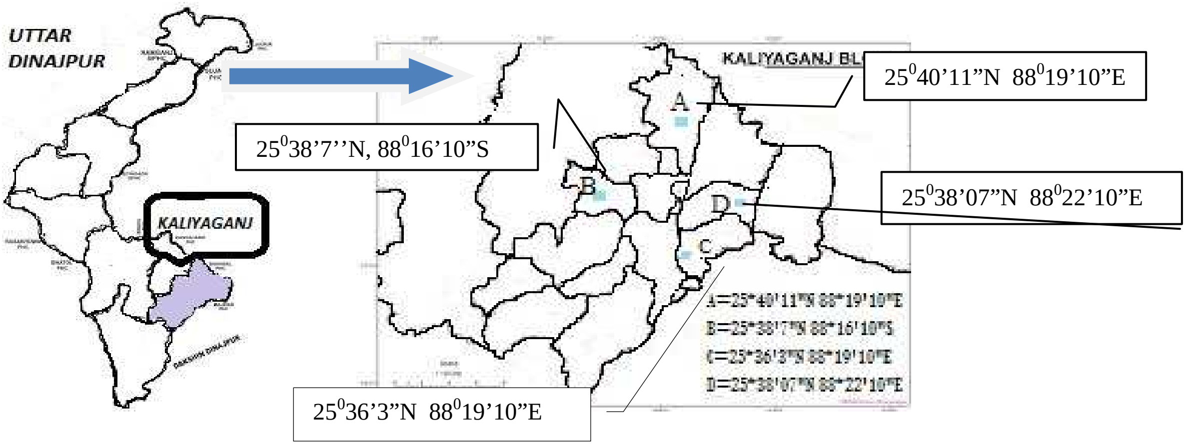

Figure a: Shows location of the sampling sites (A=S1, B=S2, C=S3, D=S4).

The climate of this zone is sub-tropical humid in nature. The average annual rain fall varies from 2100 to 3000 mm, the maximum rainfall occurs during the rainy months of June to September amounting to more than 80% of the total rain fall. The annual average day night temperature ranges between 19.7and 29.9°C with the mercury soaring even as high as 33°C in April and cascading to a low of 3°C in January.

2.2. Sampling and Extraction:

Soil samples were collected from four different sites during four seasons, in 2014 with an interval of 30 days. Five sub-plots of 1 m^2 area were selected at each site and three cores (5 cm diameter) of samples were collected from each of the sub-plots. Soil samples were brought to laboratory in plastic packets for subsequent analysis. Extraction was run from three to five days depending upon the moisture content of the soil using tullgren funnel apparatus as modified by Macfadyen (1953). Micro arthropod groups were sorted from the extract using needles and fine camel hair brush. They were preserved in 85% alcohol.

2.3. Analysis:

Abundance data for each site was obtained by adding the collection from five sub-plots of that site. Relative abundance was calculated in percentage. Group diversity was calculated using Shannon’s Index following Cancela da Fonseca and Sarkar (1998). Logarithmic transformations of data were made as per requirement of statistical analyses.

3.0 Results and Discussion:

A total of 240 cores of soil samples were collected from four sampling sites each having five sub-plots during four seasons in 2014. Based upon abundances entire collection was divided into four groups for analyses as: 1.Order Oribtida, 2. Order Mesostigmata, 3. Order Collembola, 4. Other microarthropods that included astigmata and prostigmata mites, arenae and other insect orders like diptera, coleoptera, hymenoptera, protura, diplura etc excluding collembola.

Table 1: Monthly fluctuatuation of relative abundances (%) major soil microarthropod groups at different sites.

	Seasons	Oribatida	Mesostigmata	Collembola	Others
	Summer	42.31	16.67	22.44	18.59
	Monsoon	40.07	15.9	25.93	17.85
	Post-monsoon	33.33	14.51	17.9	33.64
S1	Pre-winter	32.58	22.85	28.46	16.1
	Summer	26	38.5	14	22
	Monsoon	28.26	10.87	32.61	27.17
	Post-monsoon	34.17	28.33	19.17	17.5
S2	Pre-winter	26.36	14.55	20	39.09
	Summer	26.04	25	31.25	17.71
	Monsoon	30.47	15.63	18.75	34.38
	Post-monsoon	28.8	22.51	32.98	15.71
S3	Pre-winter	29.31	16.38	17.4	37.07
	Summer	37.44	17.44	28.21	16.48
	Monsoon	42.92	9.17	25.42	22.08
	Post-monsoon	35.25	15.59	20.86	27.83
S4	Pre-winter	36.19	17.51	29.57	16.73

Oribatid mites constituted the most abundant group of microarthropods followed by collembolans in overall collection. Mesostigmatids were also numerous and their relative abundance crossed oribatids and collembolans at a few instances.

Relative abundance of oribatid mites ranged from 42.92% to 26% (Table 1). Mesostigmata exhibited highest relative abundance at S2 during the post-monsoon and lowest at S4 (during summer). Their relative abundance ranged from 9.17% to 38.5%. Relative abundance of collembolans varied from 32.98% to 14%. They were most abundant at S3. Other microarthropods including diptera, coleoptera, hymenoptera, protura, diplura, arenae etc showed occasional high relative abundance, particularly at S1 and at S2 during the pre-winter season. Abundance of microarthropods was relatively higher during the post monsoon and lower during the summer (Figs. b-e). It matches with the observations made by Bhattacharya and Ray choudhury (1979), Bhattacharya *et al*., (1980). Lowest abundance during summer might have resulted due to high temperature and low moisture in the soil. Soil Oribatid mites was the largest fraction of microarthropod groups followed by collembolans in most of the collection efforts. This observation is in conformity with the observations made by Sanyal (1981a, 1981b, 1982), Bhattacharya and Chakraborti (1994), Cancela da Fonseca and Sarkar (1998), Ghosh and Roy (2004), Joy (2006) and Moitra *et al*., (2007, 2013). Greater abundance of mesostigmatids however, has also been recorded by a few workers (Singh and Pillai, 1981; Sengupta and Sanyal, 1991; Bedano *et al*., 2005).

Abundance of collembola however exceeded the abundance of oribatids at S2 and S3 during monsoon and post-monsoon respectively. Temporary disturbance might be responsible for such variations. Among soil acarines, Mesostigmata was the second most abundant group while two other acarine orders – Prostigmata and Astigmata were found to be few in number at the sites. Higher abundance of collembolans than acarines however, was recorded by Chattopadhyay and Hazra (2000) at one of their study sites in Kolkata. Greater abundance of oribatids in the current study might have resulted for their longer life span in comparison to other microarthropod groups, many of the oribatid species are found to be k- selected (Norton 1994; Crossley and Coleman., 1999).

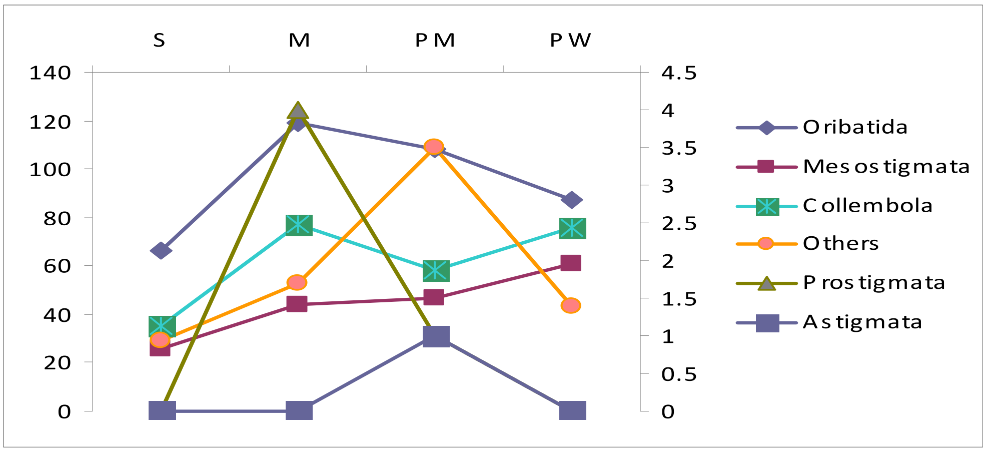

Figure b: Variation in numerical abundances of different groups of soil microarthropods at S1(S= Summer, M= Monsoon, PM= Post-monsoon, PW= Pre-winter).

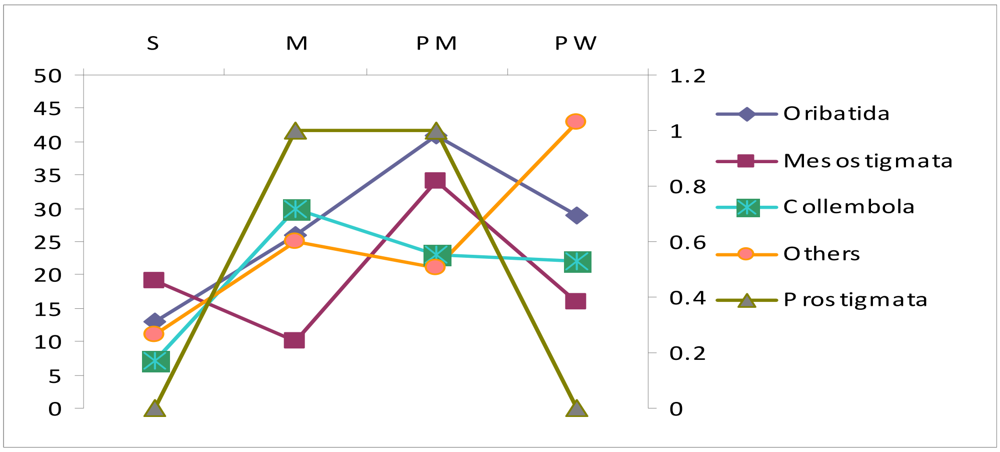

Figure c: variation in numerical abundances of different groups of soil microarthropods at S2 (S= Summer, M= Monsoon, PM= Post-monsoon, PW= Pre-winter).

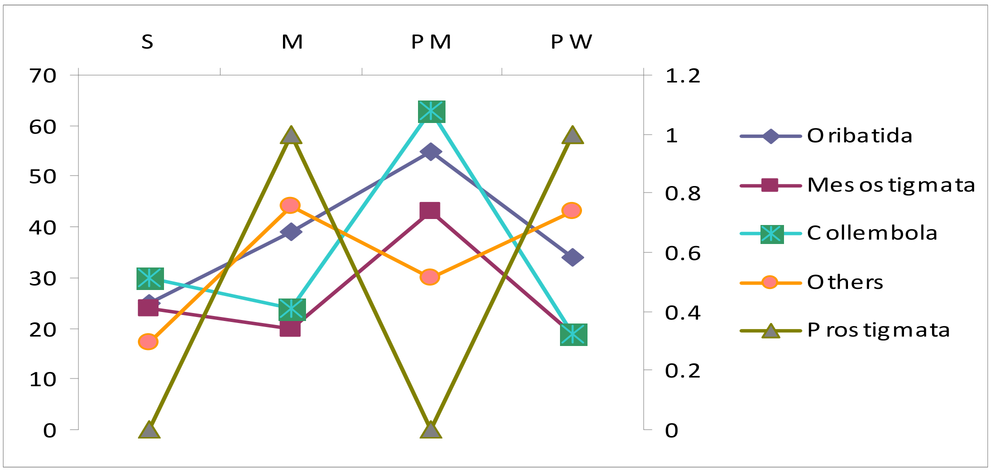

Figure d: variation in numerical abundances of different groups of soil microarthropods at S3 (S= Summer, M= Monsoon, PM= Post-monsoon, PW= Pre-winter).

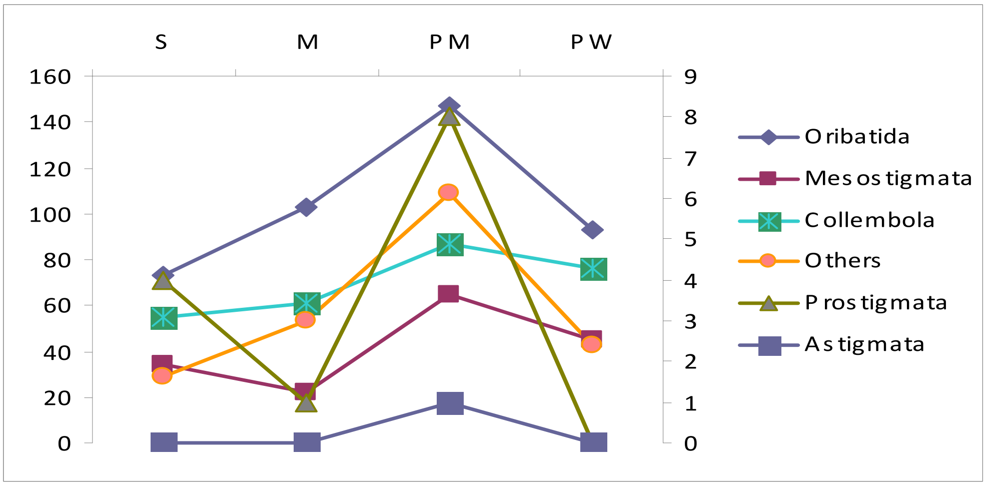

Figure e: variation in numerical abundances of different groups of soil microarthropods at S4 (S=Summer, M= Monsoon, PM= Post-monsoon, PW= Pre-winter).

Over-all group diversity was highest at S3 which supported less numerous arthropod populations that was higher only than S1. Lowest value was observed at S1 (Fig. f). Lower abundance coupled with comparatively higher group diversity has been reported in the Darjeeling Himalayas (Moitra, 2007). Greater group diversity in comparison to a wasteland, a roadside and a forest was recorded by Moitra *et al*., (2013) at the sides of a sewage canal at the outskirt of Kolkata. Favorable moisture level and vegetation growth by the sides of water body might have impact on diversity of microarthropods dwelling there.

Table 2: Correlation analysis between microarthropod communities.

	Or	Ms	Coll
Ms	-0.428		
	0.098		
Coll	0.150	-0.252	
	0.578	0.346	
OMcr	-0.363	-0.401	-0.575
	0.168	0.124	0.020

Cell Contents: Pearson correlation
P-Value

(Or= Oribtida, Ms= Mesostigmata, Coll= Collembola and OMcr= Other microarthropods)

Correlation analysis indicated significant negative correlation ($p<0.05$) between the populations of collembolans and other microarthropod groups. Correlation coefficients were positive between oribatid and collembolans and between collembolans and mesostigmatids but they were not statistically significant (Table 2). Variations in fluctuations of relative abundances of major groups differed significantly when sites-wise differentiation was not considered as one-way ANOVA suggested ($p<0.05$) (Table 3).

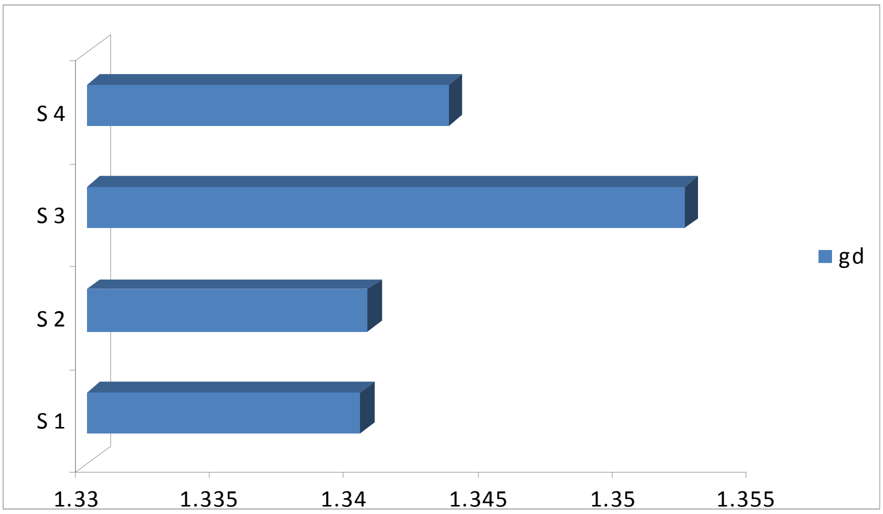

Figure f: Variation of group diversity of soil microarthropods at the sampling sites. (gd = group diversity)

Two-way ANOVA revealed that only spatial effect was significant for variation in oribatid mite population; for other groups no spatial or temporal impact appeared significant regarding the fluctuation (Table 4). Comparing data in this aspect for the sampling area is lacking. Observations on abundance of microarthropods may vary a lot depending upon the extraction method and the efficiency in extraction process is also highly variable (Huhta, 1972; Wallwork, 1976; Edwards, 1991; Rohita, 1992; Akoijam, 2014). Other than edaphic conditions, several other factors may have influence on the density and distribution of microarthropod groups at variable extent. Earthworms have been found to have influence on the movement and the density of microarthropods (Maraun *et al.*, 1999, Cameron *et al.*, 2013). Further long term studies therefore seem required to get an insight of the edapho-biological condition of the selected sampling sites.

Table 3: Result of one-way ANOVA on group-wise variation of abundances of microarthropods.

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Analysis of Variance
Source      DF        SS        MS        F        P
Factor       3    3.0935    1.0312    12.49    0.000
Error       60    4.9522    0.0825
Total       63    8.0457
                                   Individual 95% CIs For Mean
                                   Based on Pooled StDev
Level        N      Mean     StDev  -+---------+---------+---------+-----
Or          16    3.4860    0.1680                           (----*-----)
Ms          16    2.8700    0.3529  (-----*-----)
Coll        16    3.1513    0.2577            (-----*-----)
OMcr        16    3.1046    0.3331          (-----*-----)
                                    -+---------+---------+---------+-----
Pooled StDev =    0.2873           2.75      3.00      3.25      3.50
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(DF = Degree of Freedom, SS = Sum of square, MS = Mean square, F = F statistics, StDev = Standard deviation, CIs = Confidence Intervals, Or= Oribtida, Ms= Mesostigmata, Coll= Collembola and OMcr= Other microarthropods. Individual confidence intervals given in dotted line indicate (with 95% confidence) the probable range of occurrence of the mean. The asterix in the middle of the line marks the current mean. The ranges of mean within parentheses not overlapping implies that those means are different)

Table 4: Two-way ANOVA on spatial and temporal effects on fluctuation of soil microarthropod populations at the sampling sites.

Analysis of Variance for Or					
Source	DF	SS	MS	F	P
Seasons	3	0.0307	0.0102	0.88	0.488
Site	3	0.2881	0.0960	8.26	0.006
Error	9	0.1047	0.0116		
Total	15	0.4235			
Analysis of Variance for Ms					
Source	DF	SS	MS	F	P
Seasons	3	0.7855	0.2618	2.95	0.091
Site	3	0.2834	0.0945	1.06	0.412
Error	9	0.7995	0.0888		
Total	15	1.8684			
Analysis of Variance for Co					
Source	DF	SS	MS	F	P
Seasons	3	0.0377	0.0126	0.13	0.939
Site	3	0.1134	0.0378	0.40	0.759
Error	9	0.8576	0.0953		
Total	15	1.0088			
Analysis of Variance for Oth					
Source	DF	SS	MS	F	P
Seasons	3	0.223	0.074	0.54	0.666
Site	3	0.155	0.052	0.38	0.772
Error	9	1.236	0.137		
Total	15	1.614			

(DF = Degree of Freedom, SS = Sum of square, MS = Mean square, F = F statistics, StDev = Standard deviation, Or= Oribtida, Ms= Mesostigmata, Coll= Collembola and OMcr= Other microarthropods)

4.0 Conclusion:

Temporal effect on relative abundances of major microarthropod groups appeared negligible in the study area while site-wise variation appeared significant only for oribatid mites. Group-wise variations, when considered irrespective of the sites, were significant. Though abundance varied noticeably between the sites with forest floor supporting higher abundance and the brick field the least, but relative abundance did not differ significantly. Continuation of current study appears important for gathering year-wise data, analyzing and better understanding of the conditions in the study region.

5.0 Acknowledgement:

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