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A study on abundance and group diversity of soil microarthropods at four different soil habitats in North Dinajpur, West Bengal, India

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Abstract

Sampling was conducted at 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, India. Though abundance was higher at the forest site, the group diversities during summer, monsoon and post-monsoon seasons were highest at the river basin. Site-specific and temporal variation of abundance was significant among the sites ($p<0.05$).

Keywords: Abundance, agricultural field, forest, group diversity, soil micro-arthropods.

Introduction

Soil micro-arthropods play significant role in ecological dynamics in soil and therefore have drawn attention of workers around the globe including India. (Crossley and Coleman, 1999; Colman et al., 2004; Devi and Singh, 2006; Chitrapati and Singh, 2006). Rutigliano et al., (2013) conducted works on the impact of fire on microarthropods. Impact of earthworm movements on microarthropods was investigated by Cameron et al., (2013). Bokhorst et al., (2014) studied the impact of mosses and shrubs on the soil dwellers in a boreal forest. Callejas et al., (2015) investigated the relationship between the soil microarthropods and the higher trophic level. The bio-indicator value of micro-arthropods in a forest ecosystem was assessed by Calugar and Ivan (2016) while, Lakshmi and Joseph (2016) worked on the utility of microarthropods as indicators of soil quality in a tropical garden.

The present study was taken up to examine the seasonal variation of microarthropod groups which are abundant in the alluvial plains of a part of northern parts of Bengal and also to assess the variability in group diversity in the region. The work is expected to provide a data base for the assessment of soil quality in the selected region.

Material and Methods

Soil samples were collected from four different sites during March, 2015 to February, 2016, with an interval of 30 days. Fifteen cores (5cm diameter) samples were collected from each of the five sub-plots of 1 m^2 area were selected at each site. Extraction was run using tullgren funnel apparatus as modified by Macfadyen (1953). Microarthropod groups were sorted from the extract and preserved in 80% alcohol. Mean values of four collection effort

per season (per 15 cores) were taken for comparison.

Shannon's Index following Cancela da Fonseca and Sarkar (1998) was used to work out group diversity. Logarithmic transformations of data, as per need of parametric statistics were made accordingly.

Collection sites

A description of the sites has been given in an earlier publication (Sarkar et al., 2014). The sites are: S1. an agricultural field; S2. a brick field S3. a river basin region; S4. a forest area. All the sites are situated in the District Uttar Dinajpur, West Bengal, India.

Results and Discussion

The observation is based upon a total collection of 720 cores (5cm diameterX5cm depth) from four sites during one year period. Seasonal abundance for each site was estimated taking a mean of total collection of three month for each season (individuals in 15 cores/season at a site). For analyses, major groups were divided as: 1.Oribtida, 2. Other mites, 3. Collembola, and 4. Other microarthropods (Cancela da Fonseca and Sarkar, 1998). Other mites included orders like mesostigmata, prostigmata and astigmata. Aranae and other insect orders like hymenoptera (mostly ants), diptera, coleoptera, (larval forms + nymphs mostly), protura, diplura etc excluding collembolan were grouped into other microarthropods.

One way ANOVA showed no statistically significant difference among the sites in variance of abundance while the mean abundances also did not differ significantly as the Tukey test indicated (Tables 1, 2). The variation however appeared significant ($p<0.05$) when sites and seasons were considered together in two-way ANOVA (Table 3). The numerical abundances of microarthropods were relatively higher during the post monsoon and lower during the summer at all the sampling sites (Figure 1). Bhattacharya and Ray choudhury (1979), Bhattacharya et al., (1980) reported similar findings in their studies.

Oribatida was the most abundant order of microarthropods followed by collembolans in overall collection and in most of the collection efforts. Relative abundances of oribatid mites varied from 38.1% (S4) to 28.52% (S3). Relative abundance of other mites ranged from 14.47% to 22.63% while, the same of collembolans varied from 22.18% to 26.27% (Figure 2). Though the abundance of meso-stigmatid was high, the other two groups were very few in numbers and found to be absent in most collections efforts. This observation matches with the observations made by Sanyal (1982), Bhattacharya and Chakraborti (1994), Ghosh and Roy (2004), Joy (2006) and Moitra et al., (2007, 2013).

Group diversity was estimated upon seasonal collection. In summer, monsoon and post-monsoon, it was highest at S3 which is located at a river basin. More or less consistent availability of moisture might have rendered favourable effects on all the groups of microarthropods taken into account here in comparison to other sites. Higher group diversity at the sides of a sewage canal when compared to a wasteland, a roadside and a forest was reported by Moitra et al., (2013). Though the highest abundance of microarthrpods was recorded as is expected for a forest site, group diversity was comparatively lower here. It may be due to the current procedure of calculation diversity where variety is fixed and it is rather evenness that would contribute more in the value. The observation therefore, probably indicates the greater dominance of oribatids as a major community of soil mesofauna in comparison to other sites sampled.

Conclusion

In the current study, overall site-wise variation appeared minimal, but, seasons exhibited a significant variable effects on the abundances of

Table 1. One-way ANOVA on total abundance of soil micro-arthropods of the sampling sites.

```
Analysis of Variance for AB
Source     DF        SS        MS        F        P
SITE        3    0.7261    0.2420     2.96    0.075
Error      12    0.9804    0.0817
Total      15    1.7065

                                  Individual 95% CIs For Mean
                                  Based on Pooled StDev
Level       N      Mean     StDev  -----+---------+---------+---------+-
S1          4    5.0948    0.2140              (--------*-------)
S2          4    4.6889    0.2299  (--------*--------)
S3          4    4.7497    0.3490    (--------*--------)
S4          4    5.1825    0.3261                (--------*--------)
                                  -----+---------+---------+---------+-
Pooled StDev =   0.2858             4.55      4.90      5.25      5.60
```

DF = Degree of Freedom, SS = Sum of square, MS = Mean square, F = F statistics, StDev = Standard deviation, CIs = Confidence Intervals

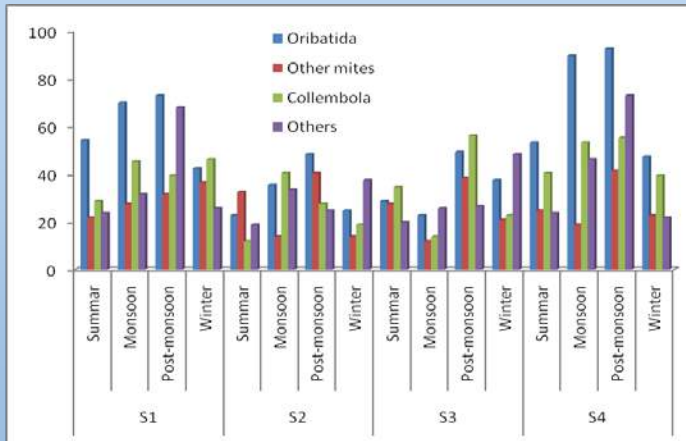
[Individual confidence intervals given in dotted line indicate (with 95% confidence) the probable range of occurrence of the mean. The asterix in the middle of the line marks the present mean. The ranges of mean within parentheses not overlapping implies that those means are different]

Table 2. Tukey test of mean abundance.

```
Family error rate = 0.0500
Individual error rate = 0.0117
Critical value = 4.20
                S1          S2          S3
      S2     -0.1944
              1.0061
      S3     -0.2552     -0.6610
              0.9453      0.5394
      S4     -0.6879     -1.0938     -1.0330
              0.5125      0.1067      0.1675
```

Table 3. Two-way ANOVA on abundance of micro-arthropods in relation to seasons and sites.

```
Two-way ANOVA: Abundance versus Season, Site
Analysis of Variance for AB
Source        DF        SS        MS        F        P
SEASON         3    0.6068    0.2023     4.87    0.028
SITE           3    0.7261    0.2420     5.83    0.017
Error          9    0.3736    0.0415
Total         15    1.7065
```



(DF = Degree of Freedom, SS = Sum of square, MS = Mean square, F = F statistics).

Figure 1. Fluctuation of numerical abundance of soil micro-arthropods at the sampling sites.

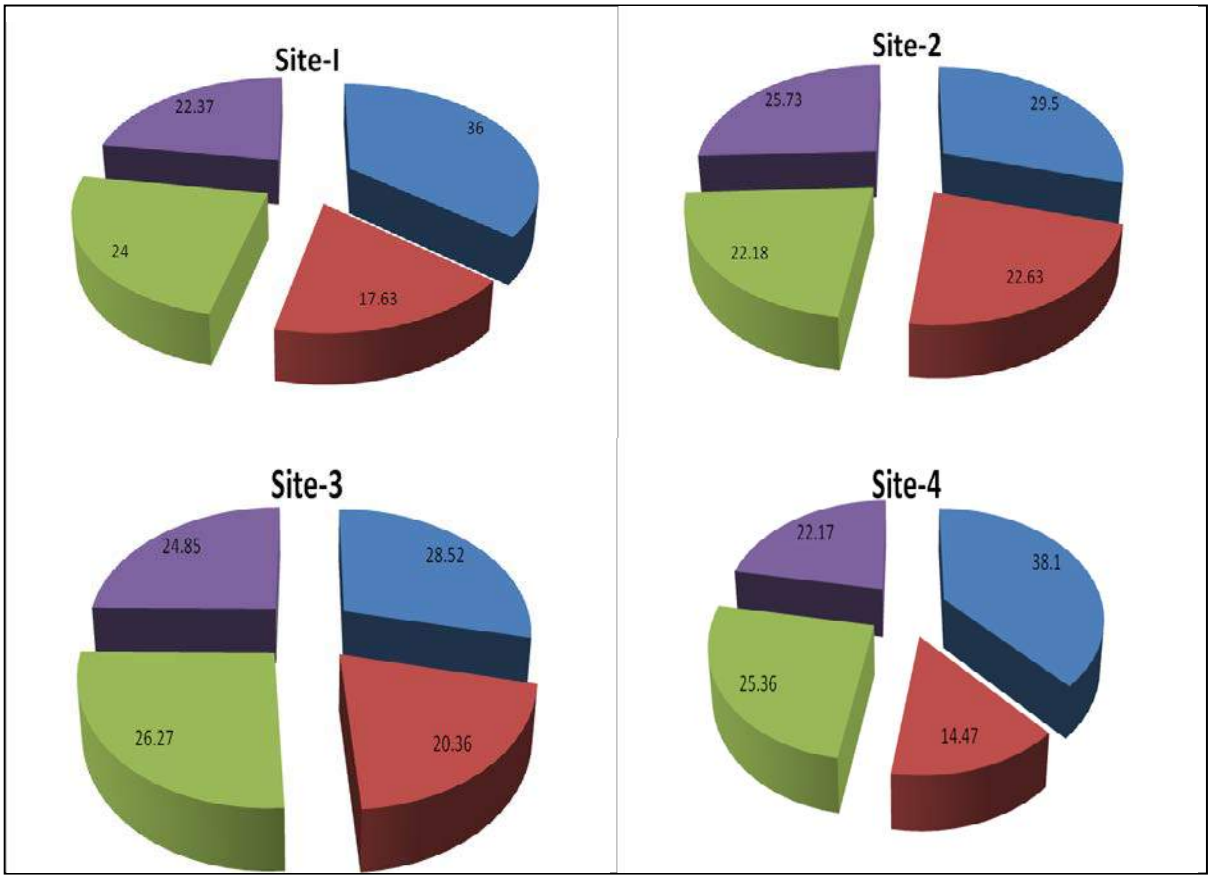


Figure 2. Relative abundance (%) of major microarthrpod groups at the sampling sites.

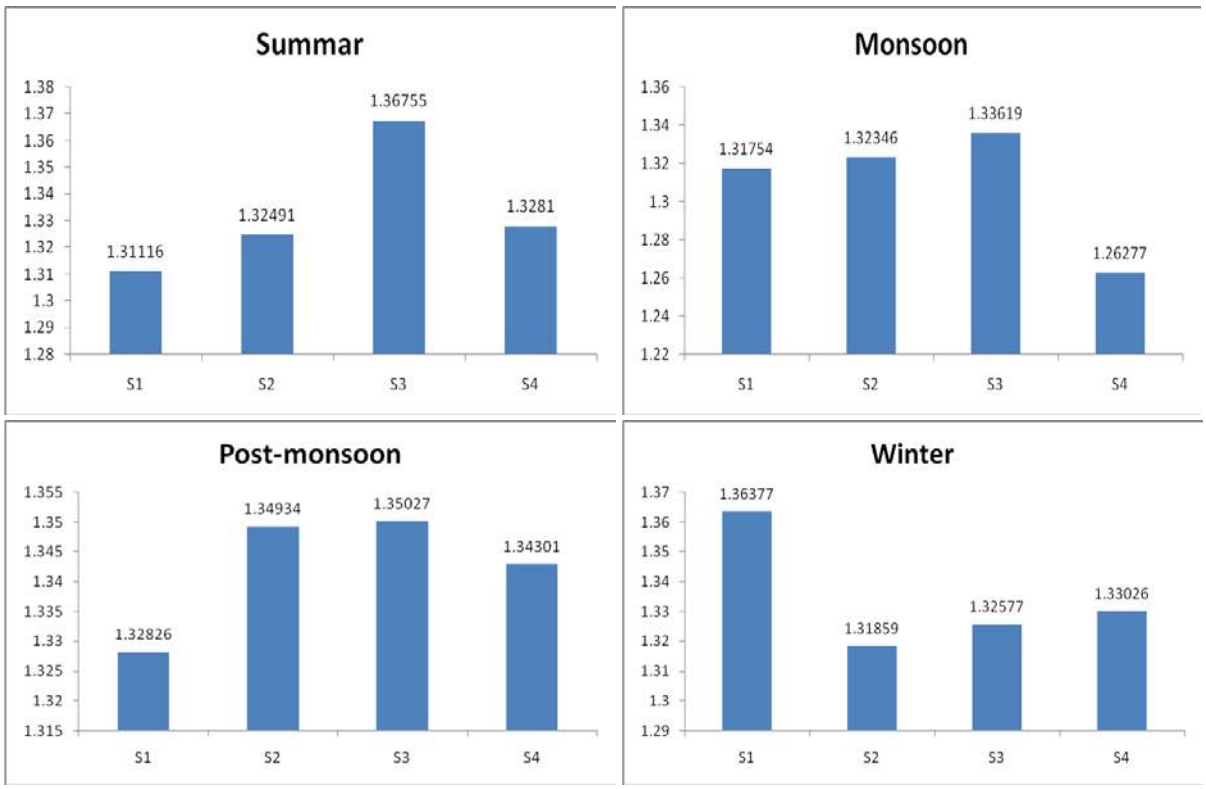


Figure 3. Seasonal variation of group diversity at the sampling sites.

micro-arthropod communities when combined with plots. The efficiencies of various microarthropod extraction procedures are highly variable (Wallwork, 1976; Edwards, 1991; Akoijam, 2014) and several factors may have complex inter-related impacts on abundance, diversity and distribution of microarthropods (Cameron et al., 2013; Bokhorst et al., 2014). Further study therefore appears necessary to have a better understanding of the edapho-ecological characteristics of the area selected.

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