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A Study on Microarthropods Populations under Stressed Environments in Different Edaphic Habitats

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Abstract

Sampling was conducted for three consecutive years in three different sites with disturbed, polluted and modified edaphic environment and a relatively less disturbed forest site in and around a metropolitan township. Sampling sites exhibited statistically significant differences in population abundances of soil microarthropods ($p<0.05$). The waste disposal site supported the least abundant community while the forest site exhibited the highest numerical abundance

Tukey test indicated significant difference between the mean abundance only existed between the control and the disturbed sites; the difference was not significant between the three polluted sites. Group diversity was recorded highest around the sewage canal though the abundance here was significantly lower than the forest site.

Keywords: soil microarthropod, pollution, waste disposal site, abundance, group diversity

1. INTRODUCTION

Soil microarthropods are among the most abundant constituents of soil mesofauna and, are known to assume a very significant role in degradation of organic debris in soil thereby modulating the edaphic dynamicity [1, 2, 3, 4]. A number of studies have been conducted around the globe on the dwelling of microarthropods populations in polluted or degraded habitats [5, 6, 7, 8]. Though a few works were attempted in India [9, 10, 11, 12, 13], the dearth of data however, particularly including waste disposal sites or sewage canals is noticeable in India.

The current work aimed at recording the group-wise composition and over-all abundance of soil microarthropods and fluctuation of the same at the disturbed habitats around a township and comparing them with a control site (*i.e.*, an undisturbed forest); further, to examine the differences (if any) between the sites. The data collected is expected to be a base for future environmental assessments, biomonitoring and necessary remedial measures for the sites selected.

2. MATERIALS AND METHODS

A cylindrical steel holder (5.3 cm diameter and 30 cm long), an iron rod and a stainless steel core with 5 cm internal diameter and 5 cm depth were used for sampling [14].

a total of 2160 samples were collected from the four sites at an interval of 30 days, over a period of three years from January, 2007 to December, 2009.

Tullgren funnel apparatus modified by Macfadyen [15] was used for the extraction of soil fauna from the samples in the present work.

The numbers of microarthropods collected from five subplots per month were pooled together and the monthly density was calculated in individuals/m^2. Relative abundance of each group of microarthropods was estimated in percentage on total population.

Shannon index of diversity [16] was used for the estimation of group diversity [17].

Sampling sites:

Kolkata (22^0 $33'$ latitude and 88^0 20' longitude, elevation ranging from 1.5 m to 9 m) is located on the east bank of Hoogly river in the deltaic part of West Bengal

Four collection sites were selected in and around the metropolitan city of Kolkata. Five sub-plots of 1 sq m area were selected for the collection and three soil samples up to a depth of 15 cm of soil profile were collected from each of the sub-plots.

1. **Dhapa (Site-I):** It is waste disposal ground. Irregular agricultural practices were noticed in the vicinity of the sampling area. Vegetation was this in the plot.
2. **Sides of VIP-Barasat road (Site-II):** It is a connecting road between Ultadanga and Barasat with heavy vehicular activities throughout the day. Biotic system of this site is under high anthropogenic stress and ecological dynamics of such a site thus differs from that of a natural ecosystem.
3. **Tollygunj Nalah (Site-III):** This nulah receives a large amount of sewage daily from the adjoining areas.
4. **Chintamani Abhyaranya, Narendrapur (Site-IV):** This abhayaranya is located near Narendrapur Ramkrishna Mission in south Kolkata (South 24 Pgs.).

Statistical analysis:

A natural log transformation of the data was made to meet the requirements of normality data sets whenever necessary in the application of parametric statistical methods like linear correlation analysis, multiple regression analysis and analysis of variance (ANOVA) [18].

Statistical software Minitab, version 5.1.2600 service pack 2 was used for the test.

3. RESULTS

Population abundance was highest at Site-IV while the lowest was recorded at Site-I (Table 1). Yearly population maxima were observed during post monsoon season while the minima were noticed during summer in all the sites (Figs. 1, 2).

Table 1: Summary of observations on abundance data (mean number of individual per core) of soil microarthropod populations at the sampling sites.

Sites	Mean	Median	StDev	SE Mean	Minimum	Maximum
I	13.36	12.43	4.95	0.82	6.20	25.07
II	15.66	14.63	7.71	1.29	4.87	32.00
III	16.74	15.40	8.72	1.45	5.00	34.80
IV	36.42	32.10	15.11	2.52	13.53	62.80

(StDev= Standard diviation, SE Mean= Standard error of mean)

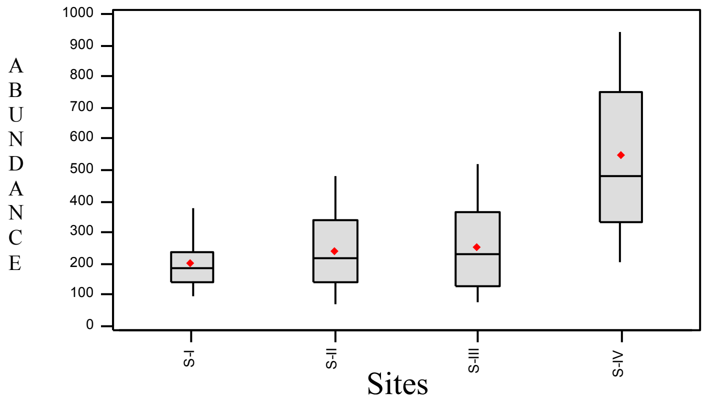

Fig. 1: Box plot on the summary of monthly data of numerical abundance (individuals in 15 samples) of soil microarthropod population of each site. (Boxes depicts the ranges of middle 50% data of total observations, while lines shows rests of the upper (25%) and lower (25%) part. Mean and median are indicated by solid circle and midline of each box.

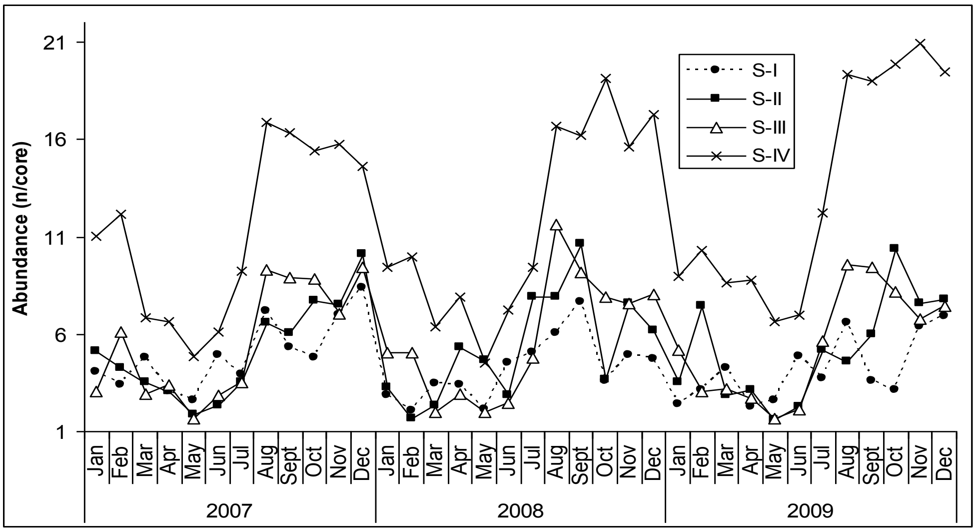

Fig. 2: Fluctuation of monthly abundance (individuals / core) of total microarthropods at the sampling sites.

Sampling sites exhibited statistically significant differences in population abundance of soil microarthropods as one way ANOVA revealed (Table 2). Tukey test however showed significant difference of mean population existed only between Sites-I and IV; Sites-II and IV and Sites-III and IV (Table 3). There were no statistically significant differences of mean populations among the other sites.

Table 2: ANOVA for abundance (mean number of individual per core in a month) of soil microarthropods at different sites.

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Analysis of Variance
Source     DF        SS        MS        F        P
Site        3    22.398     7.466    30.70    0.000
Error     140    34.049     0.243
Total     143    56.446
                                   Individual 95% CIs For Mean
                                   Based on Pooled StDev
Level       N      Mean     StDev  ---------+---------+---------+-------
Site-I     36    1.4193    0.3809  (---*----)
Site-II    36    1.5228    0.5346     (---*---)
Site-III   36    1.5658    0.5864      (---*---)
Site-IV    36    2.4050    0.4450                           (---*---)
                                   ---------+---------+---------+-------
Pooled StDev =   0.4932                 1.60      2.00      2.40
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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 indicates (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 menas are different]

Table 3 : Tukey test showing the difference of mean abundance of microarthropods between the collection sites.

Tukey's pairwise comparisons

	Site-I	Site-II	Site-III
Site-II	-0.4060 0.1990		
Site-III	-0.4490 0.1560	-0.3455 0.2595	
Site-IV	-1.2883 -0.6833	-1.1848 -0.5798	-1.1418 -0.5368

Acari was the highest numerically abundant group among soil microarthropods in the study area followed by collembolans. The relative abundance of soil acarines (on the total microarthropods of the respective site) ranged from 72.15% (Site-II) to 56.24% (Site-III), while the same of collembolans ranged from 37.33% (Site-I) to 23.74% (Site-II). The percentage (on total microarthropods) of other microarthropods varied from 14.13% (Site-III), and from 3.99% (Site-I) (Figs. 3-6). Group diversity was highest at site-III. Availability of moisture and moderate disturbance at this site might have contributed in the current observation (Fig. 7).

Site-wise observations:

Site-I: This site supported the least abundant microarthropod population. Soil acari constituted 56.68% of microarthropod population. Collembolans were next in abundance sharing 37.33% of total population. The relative abundance of collembolans was highest in here among the sampling sites. Other microarthropods including Hymenoptera, Diptera, Coleoptera and Arenae were fewer in abundance constituting nearly 4% of total population (Fig. 3).

Site-II: The second lowest abundance of microarthropod population was recorded here. Proportion of soil acari was highest in this site that constituted more than 72% of total microarthropod population. Collembolans were the second numerically abundant group having 23.74% of total population though it was the least relative abundance recorded from the sites. Other microarthropods included Hymenoptera, Diptera, Coleoptera, Diplura and Arenae constituted nearly 4% of microarthropod population (Fig. 4).

Site-III: Microarthropod population was higher in abundance here in comparison to above two sites. Soil acari constituted more than 56% of microarthropod population. Collembolans were next abundant group sharing 29.64% of total population. Other microarthropods constituted nearly 14% of total population. Diptera (6.19%) was third highest in abundance after collembolans and Hymenoptera (3.31%) was the next. Rest of the proportion was constituted by Coleoptera, Hemiptera, Diplura, Thysanoptera and Arenae (Fig. 5).

Site-IV: This site had the highest microarthropod population. Soil acari was the most abundant group that constituted 62.3% of total microarthropod population. Collembolans were next in abundance having a relative abundance of 26.16%. Other microarthropod groups including Hymenoptera, Diptera, Hemiptera, Coleoptera, Diplura, Thysanoptera, Protura, Pauropoda, Arenae and Pseudoscorpionida together constituted more than 11% of total population. Hymenoptera (4.96%) was the most abundant among them followed by Diptera (3.1%) (Fig. 6).

4. DISCUSSION

Soil acarines constituted the largest group of soil microarthropods in the study area followed by collembolans. This observation matches with those of earlier workers studied in West Bengal in different ecosystems [19, 20, 21, 22, 23, 24, 13]Bhattacharya and Joy, 1980; Joy *et al*., 1986; Sanyal, 1988; Chattopadhyay and Hazra, 2000; Ghosh and Roy, 2004; Moitra *et al*., 2006; Sarkar et al., 2015). Chattopadhyay and Hazra [22] however, recorded higher abundance of collembolans at one of their study site in Kolkata, but in the same study they observed acarines to be the most abundant group at rest of the sites. Cancela da Fonseca and Sarkar [17] reported higher abundance of acarines in comparison to collembolans at a wasteland in Tripura, India. Lamoncha and Crossley [25] in a study at North Carolina, US, recorded a high relative abundance (74.5% of total microarthropods) and density (65,000 individuals /m^2) of soil acarines whereas the same for collembolans were 18.2% and 15,900 individuals /m^2. Joy [26] observed considerably greater density and relative abundance of soil Acari (990 individuals /m^2, 66.89% of total microarthropods) than Collembola (225 individuals /m^2, 15.2% of total microarthropods) in the wasteland ecosystems of adjacent areas of Shantiniketan at the southern part of West Bengal. Chitrapati and Singh [27] also recorded far higher abundance of soil acarines than that of collembolans both in a protected forest and in a degraded site in Manipur, India. Iloba and Ekrakene [6] however, in a study conducted at sites polluted with petroleum byproducts and carbide in Nigeria, found collembolans to be more numerous than acarines. Sarkar et al. [13] observed acarines to be the most abundant group in a disturbed habitat (Brick field). The same authors [28] reported greater group diversity at the river-basins. The current study is in conformity to the observations that the magnitude of the group diversity is not always consistent with the population abundance of microarthropods.

CONCLUSION

Soil microarthropod communities at the sites with polluted environments appeared more or less similarly affected in view of abundance and they supported significantly low population in comparison to the forest site. Diversity at site-III was higher which was located at the side of a sewage canal. Moisture, nutrient availability and moderate disturbance might be important factors related to this observation.

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REFERENCES

[1] Crossley, D.A. (Jr). 1977. “The roles of terrestrial saprophagous arthropods in forest soils: current status of concepts.” In: *Proceedings in Life Sciences The Role of Arthropods in Forest Ecosystems.* WJ Mattson (ed). Springer-Verlag, New York, pp. 49-56.

[2] Sanyal, A. K. 1982. “Soil oribatid mites and their relation with soil factors in West Bengal.” *J. Soil Biol, Ecol.,* **2(1)**: 8-17.

[3] Heneghan, L., Coleman, D. C., Zoub, X., Crossley, D. A. (Jr), Hainesc, B. L. 1998. “Soil microarthropod community structure and litter decomposition dynamics: A study of tropical and temperate sites.” *Applied Soil Ecology*, **9**: 33-38.

[4] Rutigliano, F.A., Migliorini, M., Maggi, O., Ascoli, D., Fanciulli, P. P. and Persiani, A.M. (2013). “Dynamics of fungi and fungivorous microarthropods in aMediterranean maquis soil affected by experimental fire.” European Journal of Soil Biology. 56: 33-43.

[5] Zaitsev, A. S., van Straalen, N. M. 2001. “Species diversity and metal accumulation in oribatid mites (Acari, Oribatida) of forests affected by a metallurgical plant.” *Pedobiologia*, **45(5)**: 467-479.

[6] Iloba, B. N., Ekrakene, T. 2008. “Soil Microarthropods Associated with Mechanic Workshop Soil in Benin City, Edo State, Nigeria.” *Research Journal of Agriculture and Biological Sciences*, **4(1)**: 40-45.

[7] Bokhorst, S., Wardle, D. A., Nilsson, M. C. and Gundale, M. J. 2014. “Impact of understory mosses and dwarf shrubs on soil microarthropods in a boreal forest Chronosequence.” Plant and Soil. 379(1-2): 121-133.

[8] Manu, M., Onete, M., Florescu, L., Bodescu, F., Iordache, V. 2017. "Influence of heavy metal pollution on soil mite communities (Acari) in Romanian grasslands." North-Western Journal of Zoology, 2017; e161104

[9] Hazra, A. K., Mukhopadhya, P., Guha, D. K. Sanyal, A. K. 1982. "Effects of industrial effluents on population structure of soil microarthropods at Durgapur Steel Plant area: A preliminary report." *Proc. Symp. Ecol. Anim. Popul.,* Zoological Survey of India, Kolkata, **3**: 93-98.

[10] Hazra, A. K., Choudhuri, D. K. 1990. "Ecology of subterranean macro and microarthropod fauna in different degraded and polluted soil environment in West Bengal, India." *Rec. zool. Surv. India. Occasional Paper No.* **120**: 1-195.

[11] Bhattacharya, T., Chakraborti, P. 1994. "Community structure of soil Oribatida of a young Rubber plantation and an adjacent waste land in Tripura (India)." In : *Advances in Ecology and Environmental Science*. PC Mishra, N Behera, BK Senapati, BC Guru (eds). pp. 65-77.

[12] Ghosh, S. N., Chattopadhyay, A., Bhattacharya, D. K. 2007. "Studies on road side soil inhabiting ants (Hymenoptera:Formicidae) of Kolkata with special reference to the effects of lead emitted through automobile exhaust." Occassional Paper No. 257. *Records of The Zoological Survey of India*, Occassional Paper No. **257**: 149.

[13] Sarkar, S. K., Moitra, M.N., Chakraborty, K. 2015. "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." World Journal of Environmental Biosciences, 4(1): 7-15.

[14] Dhillon, B. S., Gibson, N. H. E. 1962. "A study of the Acarina and Collembola of Agriculture soils 1. Numbers and distribution in grassland." *Pedobiologia*, **1**: 189-209.

[15] MacFadyen, A. 1953. "Notes on methods for the extraction of small soil arthropods." *J. Animal Ecol*., **22**: 65- 77.

[16] Shannon, C. E., Weaver, W. 1963. In: *The mathematical theory for communication*. University of Illinois Press, Urbana. pp. 117.

[17] Cancela da Fonseca, J. P., Sarkar, S. 1998. "Soil microarthropods in two differently managed ecological systems (Tripura, India)." *Applied Soil Ecology*, **9**: 105-107.

[18] Gerard, G., Berthet, P. 1966. "A statistical study of microdistribution of Oribatei (Acari). II. The transformation of the data." *Oikos,* **17**: 142-149.

[19] Bhattacharya, T., Joy, S., Joy, V. C. 1980. "Community structure of soil cryptostigmata under different vegetations conditions at Shantiniketan." *J. Soil. Biol. Ecol*. **1**: 27-42.

[20] Joy, V. C., Ray, N., Bhattacharya, J. 1986. "Phytogenetic composition of litter and soil inhabiting microarthropods in an artificial forest at Santiniketan." *Proceedings of the III Oriental Entomology Symposium,* Trivandram, India. Vol-I. pp. 193-203.

[21] Sanyal, A. K.1988. "Relationship between soil factors and oribatei (Acari) in deltaic soil in West Bengal, India." In: *Progress in Acarology*, I. GP Channa Basavanna, CA Virakthmath (eds). pp. 491-498.

[22] Chattopadhyay, A., Hazra, A. K. 2000. "Effect of heavy metal contaminated sewage effluents on the soil arthropods in and around Calcutta." *Rec. zool. Serv. India*, Occasional paper No. **186**: 1-107.

[23] Ghosh, T. C., Roy, S. 2004. "Distribution and diversity of acarina community three tea gardens at different altitudes of Darjeeling Himalayas." *Proc. Zool. Soc. Calcutta*, **57**: 87-93.

[24] Moitra, M. N , Sanyal, A. K., Chakrabarti, S. 2006. "Impact of four edaphic factors on the abundance of soil Acari in relation to altitudes in the Darjeeling Himalayas, West Bengal, India." *Environment and Ecology*, **24(2)**: 366 – 372.

[25] Lamoncha, K. L., Crossley, D. A.(Jr). 1998. "Oribatid mite diversity along an elevation gradient in a southeastern appalachian forest." *Pedobiologia,* **42**: 43-55.

[26] Joy, V. C. 2006. "Biodiversity and the biomarker potential of soil fauna". In: *Biodiversity and Biotechnology*. S. Ray, A. K. Ray (eds). New Central book agency, Kolkata, pp. 114-124.

[27] Chitrapati, C., Singh, T. B. 2006. "The role of abiotic factors in the distributional patterns of acarina and collembola in the sub-tropical forest ecosystem of Manipur." Indian. *J. Environ. & Ecoplan*, **12(1)**: 39-45.

[28] Sarkar, S. K., Chakraborty, K., Moitra, M. N. 2016. "A study on abundance and group diversity of soil microarthropods at four different soil habitats in North Dinajpur, West Bengal, India." International Journal of Experimental Research. 7: 32-37.