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Some Features of Soil Microarthropod Population with Special Reference to Oribatid Mites (Acari, Oribatei) in Two Different Types of Roadsides

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Abstract

A study of the population density of the soil microarthropods was conducted from January to December 2007 along the divider of Eastern Metropolitan Bypass with heavy traffic load and a residential roadside of Barrackpore area with relatively less vehicular disturbance. The study reveals that population density of soil microarthropods was found to be higher in the residential roadside as compared to that of the road with heavy traffic load. The probable casue might perhaps be due to the impact of vehicular traffic disturbance on the soil microarthropod population which forces these microarthropods to burrow deeper into the soil or to migrate to the undisturbed adjoining areas. The number of species and Shannon diversity index was higher at the residential roadside. Temperature and moisture exhibited similar mode of correlation at either sites. In both the instances, temperature and moisture had strong negative and positive correlations respectively with the abundance of oribatid mites.
Key words : Soil microarthropods, Oribatid mites, Population density, Edaphic factors, Roadside population.

Microarthropods are important components of different types of soil ecosystems as they often constitute the largest share of soil mesofauna and play a significant role in the physico-chemical dynamics of soil (1, 2). The abundance and composition of microarthropod populations are known to vary according to the nature of soil, vegetation and different climatic factors (3—5). Though several ecological studies have been conducted on these aspects, information is inadequate on the comparative ecology of roadside microarthropod population. Biotic systems of roadsides are under high anthropogenic stress and therefore ecological dynamics differ from that of natural ecosystems. Vehicular emissions containing heavy metals get deposited on the roadside soil and interfere with the biological processes resulting in enormous changes in the bionomics of soil arthropod population (6, 7). Distribution of airborne pollutants in the form of acid deposition, containing SO_4^{2-}, NO_X, H^+, heavy metals and some organic compounds in soil in an area depends upon topography and plant cover of that region and affect soil fauna both directly and indirectly (8). In terms of registered vehicles Kolkata is one of the largest metropolitan cities in India (9). The present work was undertaken to study

Table 1. Monthly values of three edaphic factors in EMB and RRB sites (January—December, 2007).

	Road side			Road side control		
Months	Temperature	Moisture	pH	Temperature	Moisture	pH
Jan	21.7	18.23	6.94	20.3	25.67	6.97
Feb	23.8	15.39	6.83	22.3	24.54	6.95
Mar	27.4	13.62	6.98	27.2	15.2	6.98
Apr	30.5	16.72	7.11	28.8	18.33	6.99
May	32.3	14.43	7.08	30.6	13.53	7.02
Jun	28.4	20.7	6.92	29.9	16.88	6.96
Jul	29.6	28.4	6.9	18.0	23.21	6.96
Aug	26.4	21.6	7.1	27.6	26.4	6.95
Sep	27.2	24.1	6.93	25.6	29.8	6.98
Oct	25.1	15.3	6.97	25.5	12.34	6.88
Nov	23.5	22.5	7.1	22.0	27.6	6.92
Dec	22.4	27.4	6.99	21.0	24.45	6.9

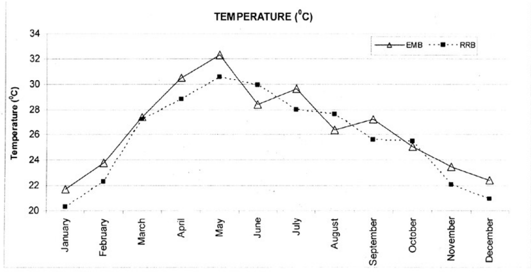

Figure 1. Fluctuation of temperature (C) at two sites during collection period (January to December, 2007).

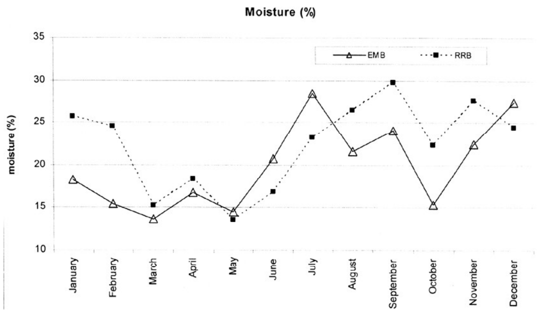

Figure 2. Fluctuation of moisture (%) at two sites during collection period (January to December, 2007).

the nature and extent of impact of vehicular pollution on soil ecology and biodiversity by studying the microarthropod population with special reference to oribatid mites which is often found to be dominant constituent of soil mesofauna.

Collection Sites

To study the impact of vehicular exhaust on soil ecosystem the divider of Eastern Metropolitan Bypass (EMB) was selected for collection of soil samples and a residential roadside at Barrackpore (RRB), North 24 Parganas was selected as control site. A brief account of the collection sites is given below.

Eastern Metropoliton Bypass (EMB). The has been built recently and is the main arterial road with heavy vehicular traffic in Eastern Kolkata. Soil was grey in color and sandy loam in texture. The collection site was shosen near Salt Lake Stadium. The site was characterized by the presence of *Acacia auriculiformis, Michelia champaka, Parthenium hysterophorus, Euphorbia* sp., *Jatropha* sp., *Saccharum spontaneum* and *Calotropis* sp.

Residential Roadiside at Barrackpore (RRB). The site selected as control was a part of a connecting road with relatively less vehicular activity between Kalyani Expressway and Barasat-Barrackpore Road. Soil was blackish brown in color and loamy in texture. Common vegetation included *Tamarindus indica, Bauhinia accuminata, Euphorbia hirta, Colocasia esculenta, Datura matoc, Amaranthus* sp., and *Arerrhoa* sp.

Methods

Soil samples were collected with stainless steel corers (5 cm diameter ×5 cm deep) as employed by Dhillon and Gibson (10) up to a depth of 10 cm of soil profile; 5 sub-plots of 1 sq m area were selected for collection of soil samples at each site. Soil fauna were extracted by Tullgren funnel apparatus modified by Macfadyne (11). Altogether 120 soil samples were collected at an interval of 30 days from January to December 2007. The extracted soil fauna were collected and preserved in 90% alcohol. Oribatid mites were macerated in 1 : 1 lactic acid and 90% alcohol and temporary slides for identification were prepared with lactic acid. Camera lucida drawings were made when necessary. Soil temperature was recorded by a

Table 2. Monthly abundance of microarthropods at EMB (January—December, 2007).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Oribatid	22	18	11	16	8	11	18	30	36	31	44	53
Mesostigmata	15	16	14	10	5	8	11	27	18	42	22	38
Prostigmata	9	15	6	9	5	6	10	24	13	10	17	27
Astigmata	2	1				1		1			1	
Total mites	48	50	31	35	18	26	39	82	67	92	89	107
Other microarthropods	31	18	11	12	6	9	14	29	23	32	31	37
Total microarthropods	79	68	42	47	24	35	53	111	90	124	120	144

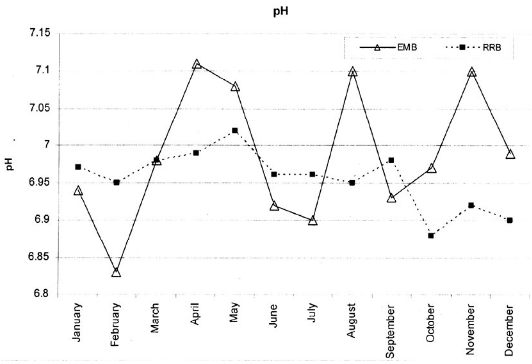

Figure 3. Fluctuation of pH at two sites during collection period (January to December, 2007).

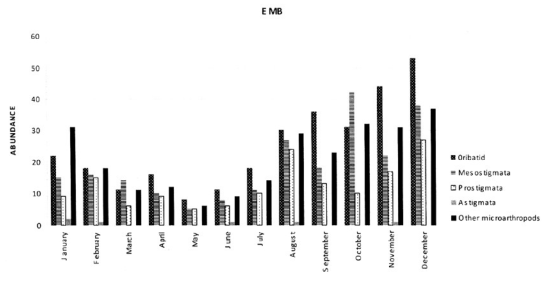

Figure 4. Monthly abundance of microarthropods in EMB during January to December, 2007.

soil thermometer and soil moisture was determined by an infra-red moisture balance (model A). The pH was estimated by an electric pH meter.

Results and Discussion

The soil temperature ranged from 21.7 C (January) to 32.3 C (May) at EMB and from 20.3 C (January) to 30.6 C (May) at RRB. The average temperature was lower at RRB (25.7 C) than that at EMB (26.5 C). Soil moisture content varied from 14.43% (May) to 28.4% (July) and from 13.58% (May) to 29.8% (September) at EMB and RRB respectively. Average moisture content was higher at RRB (22.33%). The pH varied within a narrow range. This was higher at EMB (average pH 6.9) where it ranged from 6.83 to 7.11. At RRB, pH varied from 6.9 to 7.02 (Table 1 and Figs. 1 to 3).

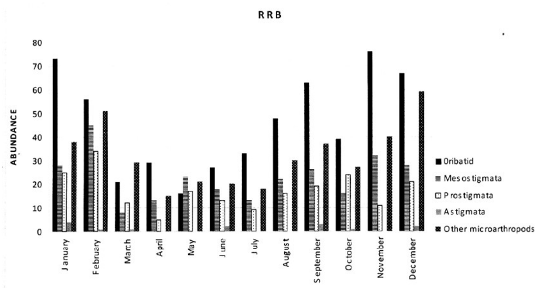

Figure 5. Monthly abundance of microarthropods at RRB during January to December, 2007.

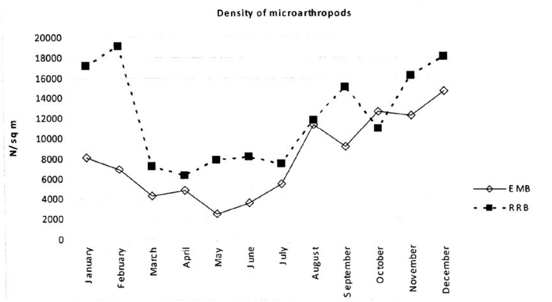

Figure 6. Monthly fluctuation of densities of soil microarthropods at two sites during collection period (January to December, 2007.

Table 3. Monthly abundance of microarthropods at RRB (January—December, 2007).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Oribatid	73	56	21	29	16	27	33	48	63	39	76	67
Mesostigmata	28	45	8	13	23	18	13	22	26	16	32	28
Prostigmata	25	34	12	5	17	13	9	16	19	24	11	21
Astigmata	4	1				2			3	1		2
Total mites	142	136	42	47	56	60	55	91	111	80	119	118
Other microarthropods	38	51	29	15	21	20	18	30	37	27	40	59
Total microarthropods	168	187	71	62	77	80	73	116	148	107	159	177

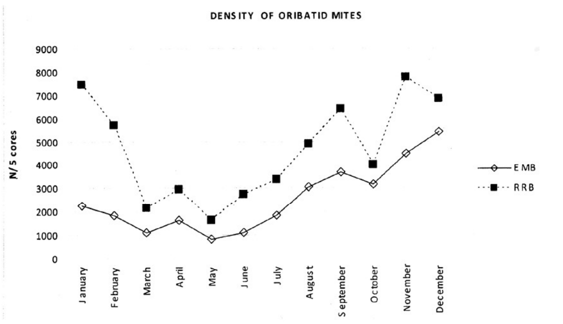

Figure 7. Fluctuation of densities of soil oribatid mites at two sites during collection period (January to December, 2007).

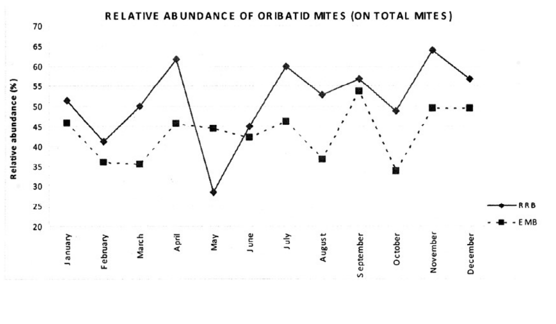

Figure 9. Monthly variation of relative abundance (%) of soil oribatid mites on soil acari at two sites during collection period (January to December, 2007).

About 2,379 microarthropods were obtained from a total of 120 soil samples. Oribatid mites constituted the highest numerically abundant group at either site. This is in conformity with the earlier observations made by several workers in different parts of West Bengal (4, 5, 12—14). Mesostimata was the second largest group of mites recorded. Highest abundance of mesostigmatid mites was recorded during October at EMB while, at RRB it was recorded during February. Other groups of mites (prosigmata and astigmata) were few in number. Populations of other microarthropods (Collembola, Protura, Diplura, Diptera, Coleoptera, Hymenoptera, Hemiptera, Chilopoda and Diplopoda) were at maxima during the end of the year (Figs, 4, 5) at both the sites.

Total microarthropod population at EMB was highest during winter. A second peak appeared during the post monsoon season. On the other hand, the population of microarthropods at RRB was at peak during February. Abundance at either site declined during summer possibly for the lowering of soil moisture due to high temperature. This is corroborated by the observation of positive correlation between soil moisture and the oribatid population in the sites as discussed later. Population minimum were observed in May at EMB and during April at RRB (Tables 2, 3 and Figs. 6, 7). This matches with the observations on soil microarthropods made by earlier workers (15—19).

Abundance of oribatid mites also followed almost the same pattern of temporal fluctuation like that of total microarthropods at either site. However, at RRB the highest peak appeared during November and the lowest was recorded in May.

Overall abundance of microarthropods and oribatid mites was higher at RRB which had experienced

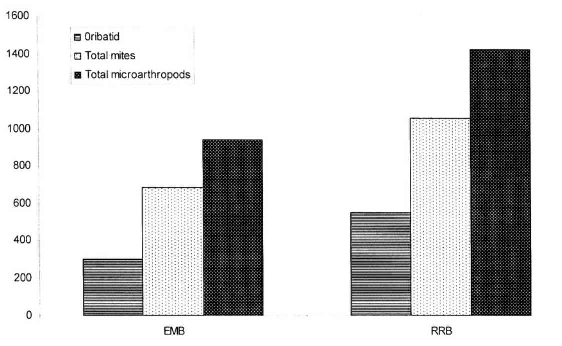

Figure 8. Comparison of over all abundance of orivatid mites, total mites and total microarthropods between two sites from January to December, 2007.

Table 4. Values of correlation coefficients between oribatid population and edaphic factors and the regression equations taking the abundance of orivatid mites as response (Y) and edaphic factors as predictors (X). * = Significant at 5% level of significance; ** = Significant at 0.1% level of significance; NS = Not significant.

Edaphic factors	Sites	Correlation coefficients (r value)	Level significance	Regression equations (Y=response; X=predictors)
Temperature	EMB	-0.6468	*	Y=6.94 - 0.126X
	RRB	-0.8911	**	Y=6.31 - 0.123X
Moisture	EMB	0.588	*	Y=1.65 + 0.0923X
	RRB	0.8787	**	Y=1.71 - 0.0676X
pH	EMB	0.0316	NS	Y=53.5 - 7.16X
	RRB	-0.4681	NS	Y= - 0.7 + 0.54X

Table 5. Values of Shannon index of diversity and percentage of different species at two collection sites. (H′) = Shannon index of diversity.

EMB Genus/species	EMB Percent of abundance	EMB H′	RRB Genus/species	RRB Percent of abundance	RRB H′
1. *Scheloribates albialatus*	49.66		1. *Scheloribates parvus*	32.48	
2. *Scheloribates parvus*	24.5		2. *Lamellobates palustris*	19.89	
3. *Lamellobates palustris*	19.8		3. *Tectocepheus velatus*	15.69	
4. *Oppia kuehnelti*	4.36	1.2181	4. *Haplochthonius intermedius*	12.23	1.7847
5. *Galumna* sp.	1.68		5. *Galumna* sp.	10.04	
			6. *Allonithrus russeolus*	5.11	
			7. *Xylobates seminudus*	3.28	
			8. *Setoxylobates* sp.	1.28	

lower anthropogenic stress (Fig. 8). Pollution at EMB was comparatively higher due to increased vehicular activities. Direct toxic effect of airborne pollutants (SO_4^{2-}, NO_X, H′, heavy metals and some organic compounds) involve uptake of free acidic water and consumption of contaminated food materials by soil microathropods, while indirect effect is primarily associated with the reduction of food resources (microflora and microfauna) and modification of microclimate (8). All these are associated with the decline of abundance of the soil fauna and the same might explain the reason for the lower abundance of microarthropods at EMB.

Relative abundance of oribatid mites both on total acari and microarthtopods was higher at RRB (Figs. 9, 10). The reason could be ascribed on lower range of pH at RRB as oribatid mites are relatively successful dweller as compared to other microarthropods in lower pH (20, 21).

Abundance of oribatid mites was negatively correlated with temperature (P<0.05) at either site. This matches with the earlier observations made by several workers (12, 16). Correlation with soil moisture was significantly positive (P<0.05) at both the sites. This conforms to the results obtained from various studies conducted in different parts of West Bengal (13, 16). The pH did not exhibit any significant correlation with the abundance. Various authors have earlier recorded either significant or weak positive or negative correlations between the said factors (12, 13). Notably, no conspicuous difference was observed in the influence of three major edaphic factors considered in the study on the abundance of oribatid mites between the sites. More or less similar environmental conditions prevailing in the entire study region might have resulted in the above observation (Table 4).

A total of 10 species of oribatid mites were col-

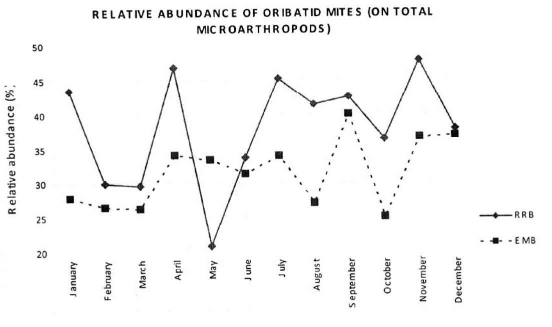

Figure 10. Monthly variation of relative abundance (%) of soil oribatid mites on total soil microarthropods at two sites during collection period (January to December, 2007).

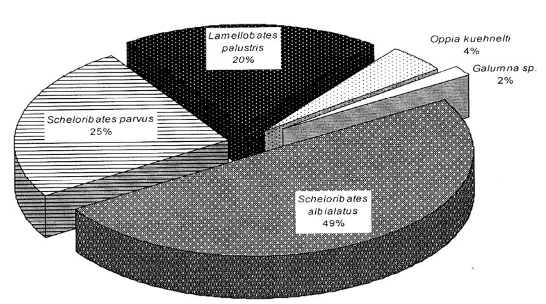

Figure 11. Relative abundance of different species recorded at EMB

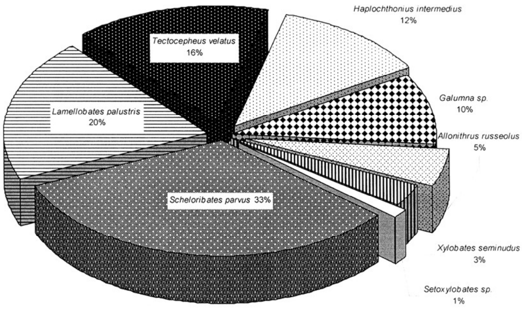

Figure 12. Relative abundance of different species recorded at RRB.

lected from two sites. Five species of oribatid mites were collected from EMB while from RRB, 8 species were collected. Three species (*Scheloribates parvus, Lamellobates palustris* and *Galumna* sp.) were common to both sites. *Scheloribates albialatus* was the dominant species at EMB while at RRB the highest numerically abundant species was *Scheloribates parvus* followed by *Lamellobates palustris* (Figs. 11, 12). Sanyal and Bhaduri (22) cited 10 species of oribatid mites which are considered as dominant oribatid species in soil conditions of West Bengal. *S. albialatus, S. parvus, L. palustris* and *Galumna* sp. which have been encountered in higher number in the present study were also mentioned as dominant taxa in the above said citation. Sanyal et al. (23) also reported high abundance of oribatid genera like *Scheloribates, Tectocepheus, Oppia* and *Galumna* in Gangetic delta of West Bengal, which corroborates with the present observation. Shannon index of diversity (24) was higher at RRB as higher number of species was encountered at this site (Table 5).

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