Environment and Ecology 40 (3) : 1061—1068, July- September 2022
ISSN 0970-0420

Observations on Distribution and Group Diversities of Soil Acarines at Different Pedo-Ecosystems in Urban Soils

Manabendra Nath Moitra, Soumya Banerjee, Asok Kanti Sanyal

Received 10 November 2021, Accepted 8 March 2022, Published on 15 July 2022

ABSTRACT

Soil acarines from three differently modified edaphic habitats and a forest floor were collected. Soil acarines were the largest fraction of the soil microarthropods and oribatids and mesostigmatids were the numerically dominant groups. Relative abundance of oribatid mites was highest the wasteland soil, the lowest of the same was recorded at the roadside plot. Above 77% of acarines were collected from upper 0-5 cm layer, lowest abundance was found in the depth of 10-15 cm range, the assemblage at uppermost layer was highest at the forest site. Group diversity varied significantly ($p<0.05$) as one-way ANOVA indicated, the same was highest at the forest floor.

Keywords Mites, Wasteland, Roadside, Sewage canal, Forest floor.

INTRODUCTION

Of the soil mesofauna, Acari is one of the most numerically abundant microarthropod groups which often appears as the largest constituent of the pedal microarthropod populations and studied as the important bioindicators for soil health (Sanyal 1994, Coleman 2001, Manu 2019). Their multi-faceted ecological importance has been documented by a number of workers from different the ecosystems with varying edaphic conditions (Bhattacharya and Bhattacharya 1985, Lakshmi and Joseph 2016, Rieff *et al.* 2016, Moitra *et al.* 2018). Acarines, as the major constituent of the edaphic mesofauna, are observed to render significant influence in the response of the total microarthropod populations to different spatial, temporal, climatic and edaphic variations (Cameron *et al.* 2013, Bokhorst *et al.* 2014, Manu *et al.* 2017, Moitra *et al.* 2020).

Though the acarines well-qualify the criteria to be addressed more seriously, the information on their vertical distribution in variously modified urban soil is limited, besides, the paucity of assessments of group diversity of acarines is also noticeable. Current study was taken up to adding up to the knowledge base for

Manabendra Nath Moitra*
Department of Zoology, P. D. Women's College, Club Road, Jalpaiguri 735101, India

Soumya Banerjee
International Delhi Public School, Proddatur 516360, India

Asok Kanti Sanyal
West Bengal Biodiversity Board, Prani Sampad Bhawan, Sector III, Salt Lake City, Kolkata 700106, WB, India

Email : manab.moitra@gmail.com
*Corresponding author

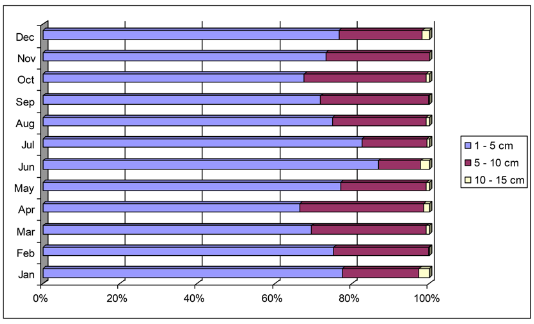

Fig. 1. Vertical distribution of soil mites at Site-I. [Values, based on means of three years, are in percentage of the monthly number of mites collected from each sub-layer (1–5 cm, 5–10 cm and 10–15 cm) of soil on the total number of mites collected in a month].

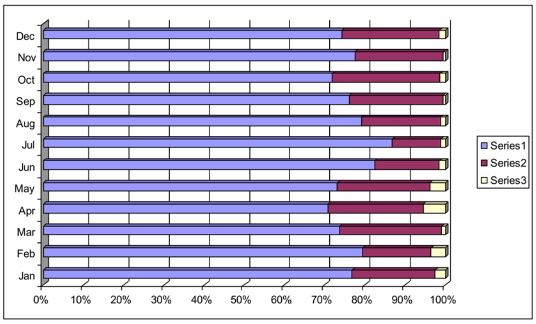

Fig. 2. Vertical distribution of soil mites at Site-II. [Values, based on means of three years, are in percentage of the monthly number of mites collected from each sub-layer (1–5 cm, 5–10 cm and 10–15 cm) of soil on the total number of mites collected in a month].

Table 1. Monthly variation of group diversity (on four groups of mites, *Oribatida, Mesostigmata, Prostigmata and Astigmata*) of mite population at different sites.

	Month	Site-I	Site-II	Site-III	Site-IV
2007	Jan	0.8197	1.1326	1.072	0.8005
	Feb	0.5899	1.1244	1.0006	1.1865
	Mar	0.7604	1.0492	0.7866	0.9692
	Apr	0.6145	1.0788	1.0243	1.0082
	May	0.3145	1.0726	0.9288	0.8771
	Jun	0.6787	1.186	0.8032	0.906
	Jul	0.8215	1.0691	1.1785	0.9358
	Aug	0.5486	1.0466	1.063	0.9542
	Sept	0.8102	1.0018	1.016	0.9501
	Oct	0.7093	0.9675	0.8527	0.8938
	Nov	0.7519	1.0488	1.0266	1.0061
	Dec	0.8325	1.0436	0.9874	1.092
2008	Jan	0.7478	1.0684	1.0488	0.87
	Feb	0.462	1.0754	0.9161	1.0585
	Mar	0.8939	1.066	1.0523	0.8723
	Apr	0.8425	1.0405	0.7685	1.0086
	May	0.9135	1.1513	0.6432	0.8727
	Jun	0.6914	1.0391	0.8036	0.8843
	Jul	0.8628	0.9654	0.8292	0.9056
	Aug	0.8565	1.066	0.9745	0.9415
	Sept	0.9472	1.063	0.8784	0.8262
	Oct	0.7925	1.0661	0.9408	1.0009
	Nov	0.8165	1.0947	0.9007	0.9514
	Dec	0.8939	1.0087	0.8868	1.1581
2009	Jan	0.7712	1.0668	0.8916	0.8643
	Feb	0.4346	1.1469	0.8188	1.0438
	Mar	0.6903	1.039	0.7315	0.942
	Apr	0.8917	1.0692	0.8846	0.9321
	May	0.9011	1.0754	0.8192	1.0454
	Jun	0.7821	1.0691	0.6103	0.8757
	Jul	0.6155	1.0404	0.7444	0.8874
	Aug	0.645	1.1721	0.9283	0.8785
	Sept	0.7419	1.0116	0.9692	0.9411
	Oct	0.8326	1.0646	0.877	0.9088
	Nov	0.9414	1.0185	0.7948	0.9712
	Dec	0.8118	0.9615	0.972	0.7332

for better understanding of the pedal ecology and facilitating environmental assessments with addressing and incorporating the above-said facets.

MATERIALS AND METHODS

Soil samples, up to a depth of 15 cm, were drawn for a period of three years (2007-2009) with samplers and cores with 5cm diameter. Extraction was run using modified Tullgren funnel apparatus (Macfadyen 1952). Acarines separated were preserved in 70% alcohol. Vertical distribution and relative abundances were calculated with percentage of total collection available in three vertical segments of soil profile 0-5 cm, 5 cm< to 10 cm, 10 cm< to 15 cm. Shannon-Wiener index of diversity was used to calculate group diversity (Cancela da fonseca and Sarkar 1998) and subjected to ANOVA as they conformed to normal

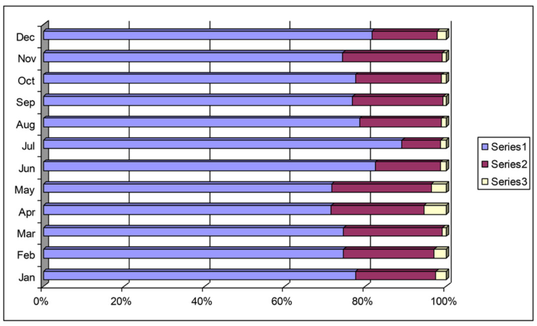

Fig. 3. Vertical distribution of soil mites at Site-III. [Values, based on means of three years, are in percentage of the monthly number of mites collected from each sub-layer (1–5 cm, 5–10 cm and 10–15 cm) of soil on the total number of mites collected in a month].

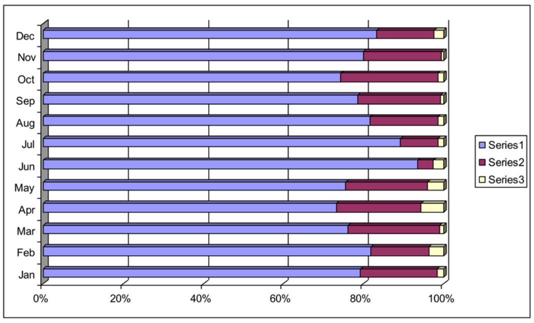

Fig. 4. Vertical distribution of soil mites at Site-IV. [Values, based on means of three years, are in percentage of the monthly number of mites collected from each sub-layer (1–5 cm, 5–10 cm and 10–15 cm) of soil on the total number of mites collected in a month].

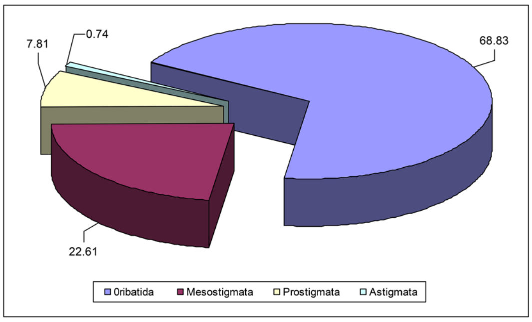

Fig. 5. Relative abundance of mite groups (% on total mite population) at Site-I.

distribution (Gerard and Berthed 1966, Taylor 1978, Sokal and Rohlf 1981).

Soil samples were collected from four sites- one wasteland (Site-I), one roadside (Site-II), one at the side of a sewage canal (Site-III) and one forest floor (Site-IV), all of which were located in and around the metropolitan township of Kolkata (22.5726°N, 88.3639° E). Details of the sampling sites have been discussed in a previous publication (Moitra 2017).

RESULTS

More than 77 % of all mites were encountered within 1-5 cm layer of soil profile. Only 20.7% and 1.82% of total mites were collected from 5-10 cm and 10-15 cm layers respectively. Percentage of the abundance recorded at upper 1–5 cm layer lowered during the summer or dry period in all the sites while the same went up as the moist period prevailed.

Site-wise observations

Site-I : Nearly 75% of total mites were obtained from 0-5 cm layer of soil profile. 24.02% were found to occur within the layer 5-10cm. Only a very small fraction (1.03%) was collected from the layer 10-15 cm. Mean monthly variation of occurrence in different layers is given in Fig. 1.

Site-II : 76.83% of total mites were obtained from

Table 2. One-way ANOVA on group diversity in acarine populations as recorded in the sampling sites. One-way ANOVA: Site-I, Site-II, Site-III, Site-IV.

Analysis of variance

Source	DF	SS	MS	F	P
Factor	3	1.7920	0.5973	49.10	0.000
Error	140	1.7033	0.0122		
Total	143	3.4953			

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev	
				-+---------+---------+---------+-----
Site-I	36	0.7509	0.1471	(--*--)
Site-II	36	1.0628	0.0523	(--*--)
Site-III	36	0.9007	0.1248	(--*--)
Site-IV	36	0.9431	0.0933	(--*--)
				-+---------+---------+---------+-----
Pooled StDev =		0.1103		0.72 0.84 0.96 1.08

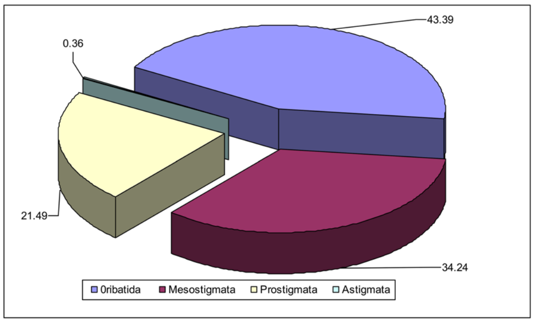

Fig. 6. Relative abundance of mite groups (% on total mite population) at Site-II.

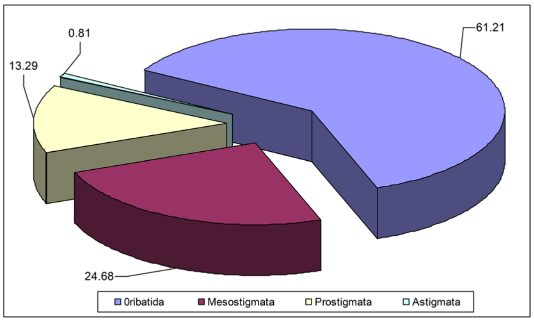

Fig. 7. Relative abundance of mite groups (% on total mite population) at Site-III.

the 0-5 cm layer of soil profile. 21.15% were obtained from the layer 5-10 cm, while 2.02% were collected from 10–15 cm layer. Monthly variation of occurrence in different layers is given in Fig. 2.

Site-III : More than 77% of total collection was encountered from the 0-5 cm layer of soil profile, 20.44 % were collected from the layer 5-10 cm and 2.06% of total collection was obtained below 10 cm layer. Monthly variation of occurrence in different layers is given in Fig. 3.

Site-IV : A considerable part (80.56%) of total mites were encountered in the 0–5 cm layer of soil profile, while 17.22% of total collection was obtained from layer 5–10 cm layer. 2.22% was collected from the layer 10–15 cm. Monthly variations of abundance in different layers are given in Fig. 4.

Relative abundance and group diversity in mite population

Four orders of soil mites- *Oribatida*, *Mesostigmata, Prostigmata* and *Astigmata* were encountered in the sampling sites. The last two groups however were fewer in abundance and particularly *Astigmata* group were not found in most occasions of the sampling events. In study area, order *Oribatida* was the largest

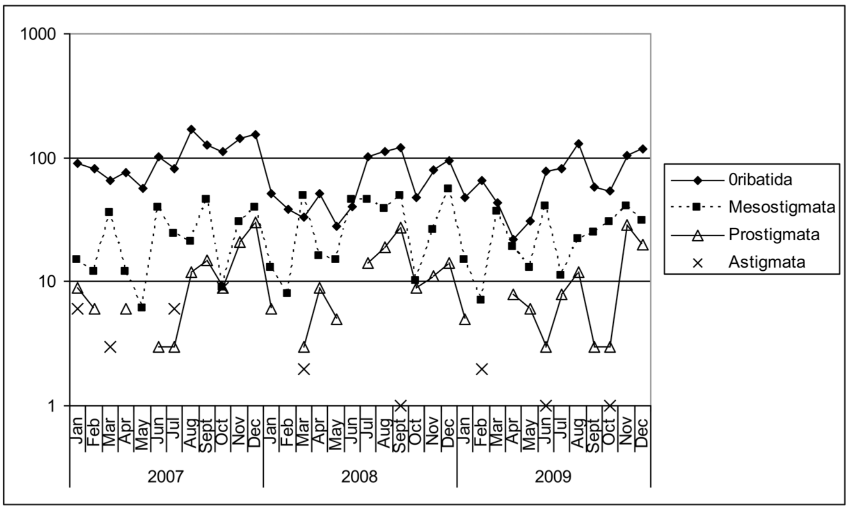

Fig. 8. Monthly variations of the abundance (15 samples/ month) of four groups of soil mites (*Oribatida*, *Mesostigmata*, *Prostigmata* and *Astigmata*) at Site-I. (X axis is taken in logarithmic form to accommodate wide range values).

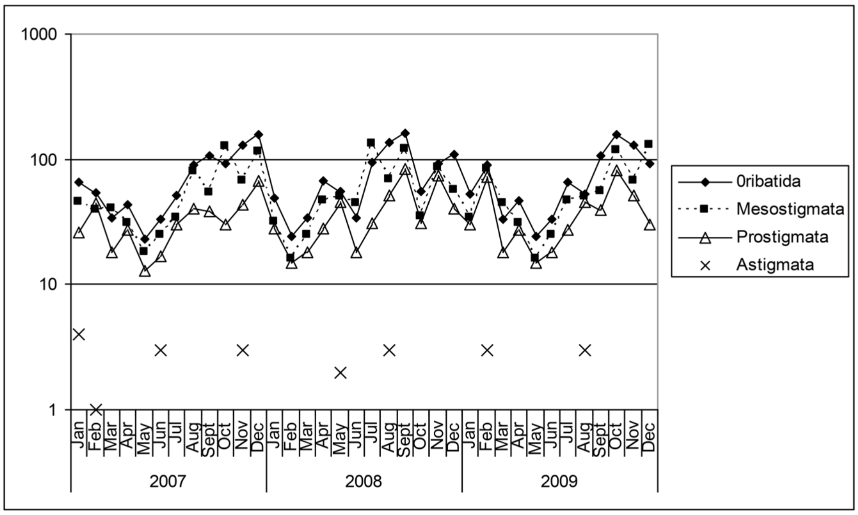

Fig. 9. Monthly variations of the abundance (15 samples/ month) of four groups of soil mites (*Oribatida, Mesostigmata, Prostigmata and Astigmata*) at Site-II. (X axis is taken in logarithmic form to accommodate wide range values).

numerically abundant group of soil microarthropod and soil mites as well, while the second highest group of mites was mesostigmatids (Figs. 5–7). Monthly abundances of oribatids, mesostigmatid and prostigmatid groups tended to be higher during the post-monsoon period as observed at all the sites, while the pattern was inconspicuous for *Astigmata* due their occurrence was low (Figs. 8–11).

Monthly fluctuation of abundance of oribatid and other mites (*Mesostigmata*, *Prostigmata* and *Astigmata*) are depicted in the figures from 28 to 31. There were a few instances in almost every site where the abundance of *Mesostigmata* exceeded that of the oribatid mites. Monthly variation of abundance oribatid mites largely matches with that of total mite as they were the single largest abundant group of the sites.

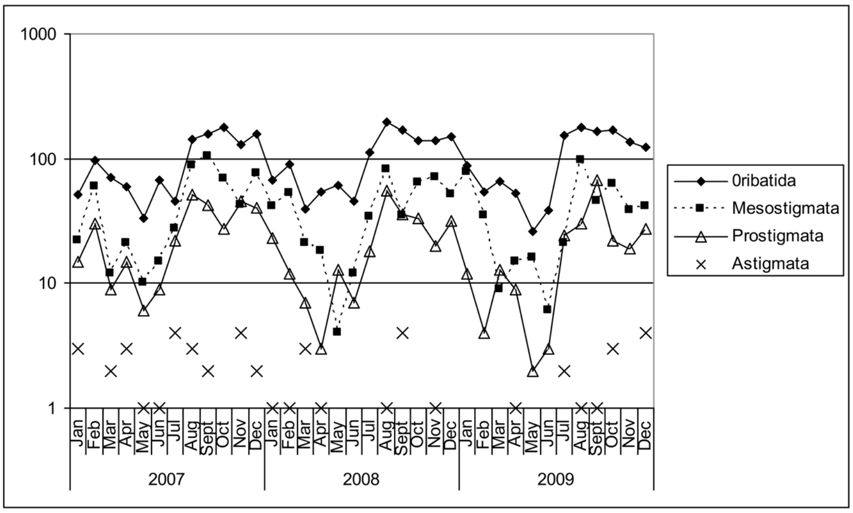

Fig. 10. Monthly variations of the abundance (15 samples/ month) of four groups of soil mites (*Oribatida*, *Mesostigmata*, *Prostigmata* and *Astigmata*) at Site-III. (X axis is taken in logarithmic form to accommodate wide range values).

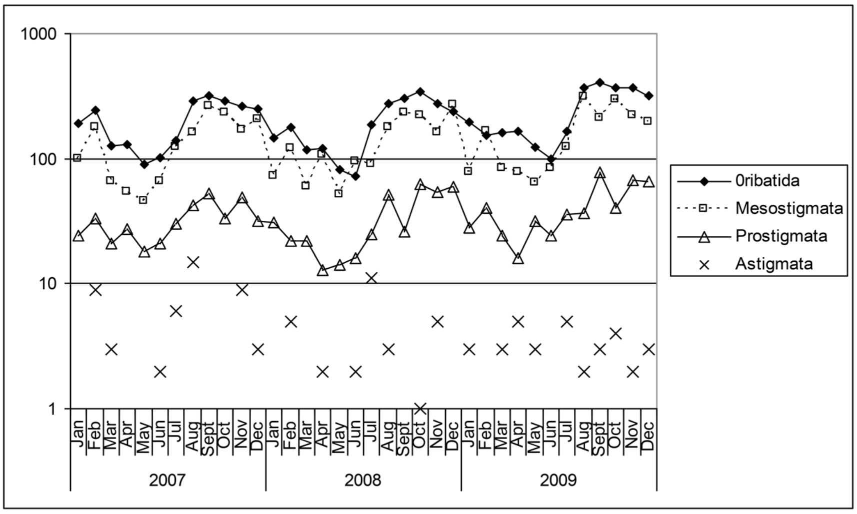

Fig. 11. Monthly variations of the abundance (15 samples/ month) of four groups of soil mites (*Oribatida, Mesostigmata*, *Prostigmata* and *Astigmata*) at Site-IV. (X axis is taken in logarithmic form to accommodate wide range values).

Group diversity index ranged from 1.1865 (Site-IV) to 0.3145 (Site-I) in the study area, the variation among the sites was statistically significant as the one-way ANOVA revealed (Tables 1, 2).

Site-wise observation

Site-I : Major constituents were oribatid (68.83% on total mite) and mesostigmatid mites (22.61%). Other two groups had very low relative abundance and particularly *Astigmata* was very inconsistently encountered (Fig. 5). Group diversity index ranged from 0.3145 to 0.9472 with a mean value of 0.7508. It was lowest in this site (Table 1).

Site-II : Oribatids constituted 43.39% while *Mesostigmata* shared 34.24%. The relative abundance of mesostigmatid mites was highest here among the sites. *Prostigmata* (21.49%) also constituted a considerable part of mite population (Fig. 6). Group diversity was relatively high in this site. It varied from 0.9615 to 1.186 with a mean of 1.0627 which was highest among the sites (Table 1).

Site-III : The largest group *Oribatida* constituted 61.21% of total mite population while *Mesostigmata* made up about 25%. *Prostigmata* was a little above 13% and *Astigmata* was below 1% of total population (Fig. 7). Group diversity had a maximum value of 1.1785 and the minimum was 0.6103 (Table 1).

Site-IV : Oribatids constituted more than 50% of mite populations, followed my mesostigmatids, details have been mentioned in a previous paper in the same journal (Moitra *et al.* 2020). Group diversity in this site that varied from 0.7332 to 1.1865 with a mean value of 0.9431 which was next to Site-II (Table 1).

DISCUSSION

Vertical distribution pattern conformed to various earlier studies conducted in West Bengal, in other parts of India and also outside India. More than 77 % of all mites were collected from 1–5 cm layer of soil profile while, 20.7% and 1.82% of total mites were collected from 5–10 cm and 10–15 cm layers respectively. At different sampling sites, collection from the upper most layers varied from 75% to nearly 81%. During summer season, there was a decline in the availability of mites at upper most layers which may be due to high temperature and dryness of soil (Usher 1971, 1975, Perdue and Crossley 1990, Al-Assiuty *et al.* 1993). During the monsoon, the trend was reverse at the sites. Over moisture chokes soil pores resulting in a reduction in soil aeration, low decomposition rate of liter and a poor fungal growth (Warcup 1957, Kamal and Bhargava 1973). Normal respiration of soil organisms including mites may also be perturbed. Soil moisture facilitates the decomposition of soil organic matter within only an optimum range. The accelerated rate of decomposition in an optimum range of moisture (14 to 25%) and a low rate of decomposition beyond that due to poor oxygen availability were observed by Wang *et al.* (2000).

Choudhuri and Pande (1981) found more than 87% and 76% of mites within the 0–8 cm layer at two different altitudes in Darjeeling. Higher assemblages on upper most layers were also reported by a number of workers in different parts of the world (Curry and Momen 1988, Seastedt and Crossley 1981, Urhan *et al.* 2008). In India, several workers have observed the occurrence of maximum number of mites in the upper layers of soil profile (Singh and Singh 1975, Joy and Bhattacharya 1977, Sanyal 1981, Hazra and Choudhuri 1990, Singh and Yadava 1998, Chitrapati and Singh 2006, Devi and Singh 2006).

Values of group diversity (within Acari) at the sampling sites, calculated using Shannon-Weaver index (Shannon and Weaver 1963, Cancela da Fonseca and Sarkar 1998) were found in the following order - Site-II> Site-IV> Site-III> Site-I. Shannon-Weaver index emphasizes on the number of species and their equitability or the evenness (Magurran 1988, Ray 2006). In the present study, the number of categories, i.e., orders of mites (*Oribatida, Mesostigmata, Prostigmata* and *Astigmata*) were fixed for the sites (i.e., 4), hence the value of the index rather depended on the relative abundance of the groups or the evenness resulting in the above observation. There is no comparing literature for this region on this aspect. Cansela da Fonseca and Sarkar (1998) observed greater group diversity in acarines at a paddy–field than that of a wasteland in Tripura, India. Moitra *et al.* (2007) observed greater group diversity in soil acarines at Tiger Hill (2573 m altitude) than that of Darjeeling (2123 m altitude). Banerjee *et al.* (2009) observed higher group diversity in soil acarines during the monsoon in the forest site. In the same study the lowest value was recorded when the population abundance of total mites was maximum.

REFERENCES

Al-Assiuty AIM, Bayoumi BM, Khalil MA, Van Straalen NM (1993) The influence of vegetational type on seasonal abundance and species composition of soil fauna at different localities in Egypt. *Pedobiologia* 37 : 210—222.

Banerjee S, Sanyal AK, Moitra MN (2009) Abundance and group diversity of soil mite population in relation to four edaphic factors at Chintamani Abhayaranya, Narendrapur, South 24-Parganas, West Bengal. *Proc Zool Soc* 62 (1) : 57—65.

Bhattacharya T, Bhattacharya J (1985) Impact sensitiveness of soil oribatid species to the waste water from a coal distillation plant. *Entemon* 10 (4) : 267—270.

Bhattacharya T, Joy VC (1977) Impact of Bldex-6 (Amine-2, 4-D) upon the density of soil microarthropods of a wheat field. Proceedings of All India Symposium on Environmental Biology Trivandrum, pp 56.

Bokhorst S, Wardle DA, Nilsson MC, Gundale MJ (2014) Impact of understory mosses and dwarf shrubs on soil microarthropods in a boreal forest Chronosequence. *Pl Soil* 379 (1-2) : 121—133.

Cameron EK, Proctor HC, Bayne EM (2013) Effects of an ecosystem engineer on belowground movement of microarthopods. *PLoS ONE* 8 (4) : e62796.doi : 10.1371/journal.pone.0062796

Cancela da Fonseca JP, Sarkar S (1998) Soil microarthropods in two differently managed ecological systems (Tripura, India). *Appl Soil Ecol* 9 : 105—107.

Chitrapati C, Singh TB (2006) The role of abiotic factors in the distributional patterns of acarina and collembola in the subtropical forest ecosystem of Manipur. Indian. *J Environ Ecoplan* 12 (1) : 39—45.

Choudhuri DK, Pande T (1981) Studies on the population and distribution of high altitude soil acarines in relation to different soil factors. In : Channa Basavanna GP (ed). Contributions to acarology in India. Acarological soc. India, Univ. of Agric Sci Bangalore, India, pp 147—154.

Coleman DC (2001) Soil biota, soil systems and processes. In : Levin SA (ed). Encyclopedia of Biodiversity Elsevier, pp 305—314.

Curry JP, Momen F (1988) The arthropod fauna of grassland on reclaimed cutaway peat in Central Ireland. *Pedobiologia* 32 : 99—109.

Devi KL, Singh TB (2006) Population fluctuation of soil mites in relation to some important abiotic factors in the pine forest ecosystem in Manipur, NE India. *J Curr Sci* 9 (2) : 673—678.

Gerard G, Berthed P (1966) A statistical study of microdistribution of Oribatei (Acari). II. The transformation of the data. *Oikos* 17 : 142—149.

Hazra AK, Sanyal AK (1989) Population fluctuation of some predominant species of acarina and collembola on the embankment of the drainage system at Edengardens, Calcutta. *Environ Ecol* 7 (2) : 366—368.

Kamal and Bhargava KS (1973) Studies on soil fungi from teak forests of Gorakhpur x. Edaphic factors and soil microfungi oil microfungi in teak stands of different ages. *Proc Nat Acad Sci India* 43 (B) I and II : 9—16.

Lakshmi G, Joseph A (2016) Soil microarthropods as indicators of soil quality of tropical home gardens in a village in Keral, India. *Agrofor Syst* pp 1—12. DOI 10.1007/s10457-016-9941-z.

Macfadyen A (1952) The small arthropods of a Moliniafen cotbill. *J Anim Ecol* 21: 87—117.

Magurran AE (1988) In : Ecological Diversity and Its Measurement. Princeton University Press, Princeton NJ, pp 179.

Manu M, Honciuc V, Neagoe A, Băncilă RI, Iordache V, Onete M (2019) Soil mite communities (Acari : *Mesostigmata*, *Oribatida*) as bioindicators for environmental conditions from polluted soils. *Sci Rep* 9 : 20250 (2019). https://doi.org doi.org/10.1038/s41598-019-56700-8.

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. *J Zool* el61104.

Moitra MN (2017) Impact of heavy metals and other factors on soil acarines in four different edaphic habitats in and around a metropolitan township. *Int J Curr Res Rev* 9 (12) : 1—10.

Moitra MN, Banerjee S, Sanyal AK (2020) Impact of Heavy Metals and other Edaphic Factors on Oribatid Population at a Forest Floor in an Urban Area. *Environ Ecol* 38 (1) : 46—55.

Moitra MN, Sanyal AK, Chakrabarti S (2007) Variation of group diversity in soil microarthropod community at different altitudes in the Darjeeling Himalayas, West Bengal, India. *J Environ Sociobiol* 4 (2) : 163—168.

Moitra MN, Sarkar SK, Chakraborty K (2018) Impact of edaphic factors on soil microarthropods at an agricultural land of Alluvial Plains in North Dinajpur, West Bengal, India. *Environ Ecol* 36 (2A) : 675—679.

Perdue JC, Crossley DA (Jr) (1990) Vertical distribution of soil mites (Acari) in conventional and no-tillage agricultural systems. *Biol Fertil Soils* 9 : 135—138.

Ray S (2006) Biodiversity in ecology and its measurement, In : Ray S, Ray AK (eds). Biodiversity and Biotechnology. New Central book agency, Kolkata, pp 40—47.

Rieff GG, Natal-da-Luz T, Sousa JP, Wallau MO, Hahn L, Saccol de Sá EL (2016) Collembolans and mites communities as a tool for assessing soil quality: Effect of eucalyptus plantations on soil mesofauna biodiversity. *Curr Sci* 110 (4) : 713—719.

Sanyal AK (1981) Ecology of soil oribatid mites in an uncultivated field of gangetic delta of West Bengal in relation to soil pH and salinity. In : Veeresh GK (ed). Progress in soil Biology and Ecology in India. *UAS Tech Series* 37 : 107—112.

Sanyal AK (1994) Ecological studies on soil mites (Acari) in India : A review. In : Mishra PC, Behera N, Senapati BK, Guru BC (eds). Advances in Ecology and Environmental Science. pp. 79—96.

Seastedt TR, Crossley DA (Jr) (1981) Microarthropod response following cable logging and clear cutting in the southern Appalachians. *Ecol* 62 : 126—135.

Shannon CE, Weaver W (1963) In: The mathematical theory for communication. University of Illinois Press, Urbana, pp 117.

Singh J, Singh UR (1975) An ecological study of soil microarthropods from soil and litter of tropical deciduous forest of Varanasi (India). *Trop Ecol* 16 (2) : 81—85.

Singh TB, Yadava PS (1998) Seasonal fluctuation of oribatid mites in a subtropical forest ecosystem of Manipur, North Eastern India. *Intl J Ecol Env Sci* 24 : 123 — 129.

Sokal RR, Rohlf FJ (1981) In : Biometry. 2nd ed. Freeman : San Francisco, pp 859a.

Taylor LR (1978) Bates, Williams, Hutchinson- a variety of diversities. In : LA Mound Warloff (eds). Diversity of insect faunas : 9th Symposium of posium of the Royal Entomological Society. Blackwell. Oxford, pp 1—18.

Urhan R, Katılmış Y, Kahveci AÖ (2008) Vertical distribution of soil mites (Acari) in Dalaman (Muğla prov. Turkey). *Munis Entomol Zool* 3 (1) : 333—341.

Usher MB (1971) Seasonal and vertical distribution of soil arthropods : Mesostigmata. *Pedobiologia* 11 : 27—39.

Usher MB (1975) Seasonal and vertical distribution of soil arthropods : Cryptostigmata. *Pedobiologia* 15 : 364—374.

Wang Y, Amundson R, Niu X (2000) Seasonal and altitudinal variation in decomposition of soil organic matter inferred from radiocarbon measurements of soil CO_2 flux. *Global Biogeochemi Cycles* 14 (1) : 199—212.

Warcup JH (1957) Studies on the occurrence and activity of fungi in a wheat field soil. *Trans Brit Mycol Soc* 40 : 237—262.