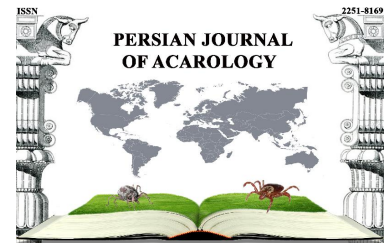




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## Article

### Distribution and seasonal abundance of acarine community (Arachnida: Acari) in a Zoological Park of Darjeeling Himalayas, West Bengal, India

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#### ABSTRACT

In this investigation an attempt has been made to study the species composition, distribution and seasonal fluctuation of acarine community (Arachnida: Acari) in two undisturbed and well-vegetated plots located within Padmaja Naidu Himalayan Zoological Park, Darjeeling, India. The study continued for three consecutive years (January to December 1999–2001) revealed the presence of 10 acarine genera of which six belonged to Oribatida and four to Mesostigmata. However no Prostigmata or Astigmata were recorded. In most of the samples Oribatida outnumbered the Mesostigmata. The total population of Acari during the period of study exhibited an irregular trend of fluctuation showing post winter or pre-monsoon maxima and monsoon minima. The Oribatida which dominated the population were the main contributor of the population abundance curve as observed in this study. Of the 4 edaphic factors (viz. pH, temperature, moisture and organic matter) studied, only the content of organic matter showed a significant and positive correlation with the population while the remaining three (viz. pH, temperature, moisture) had a negative correlation with the population. Both the plots were more or less identical in climatological, edaphological factors as well as vegetation cover with little variation in altitude and did not exhibit any significant variation in diversity index value.

**KEY WORDS:** Abundance; Darjeeling Himalayas; distribution; edaphic factors; soil mites.

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#### INTRODUCTION

This communication results of an ecological study involving the impacts of different edaphic factors on the distribution and seasonal abundance of acarine community in the sampling site of Darjeeling in the Himalayan West Bengal, India. An attempt has been made by present authors to establish a correlation between some of the very important edaphological factors and soil mites occurring in Darjeeling in this study. According to Mani (1962) the high altitude environment affords a complex situation mainly governed by three factors, viz. atmospheric cold, atmospheric aridity and local microclimatic conditions. The taxonomic and ecological studies on acarine community in Himalayan and sub-Himalayan West Bengal have been fragmentally provided from 1979 to 2006 (Choudhuri and Pande 1979, 1981, 1982; Chakraborti and Mondal 1981; Mondal and Kundu 1985, 1986, 1988; Ghosh and Roy 2004; Ghosh *et al.* 2006). Their studies in most cases were restricted to uncultivated and undisturbed plots, tea garden soils in an around Darjeeling. But those attempts in many instances were not comprehensive enough to come to any definite

conclusion with regard to the seasonal abundance, diversity and species composition of acarine community in different areas. The indirect effect of these animals in the soil is more important than their direct role. They promote growth and distribution of microbes in different horizons of soil and litter (Luxton 1972) and perform many other important soil processes (Walter 2009). In view of this, an attempt has been made to analyze the seasonal abundance, population structure and diversity in relation to some edaphic factors in two undisturbed, well-vegetated sampling plots within the campus of Padmaja Naidu Himalayan Zoological Park, Darjeeling, India.

Soil samples for this study were collected from two sampling plots ('A' and 'B') located in the Zoological Park. The plot-'A' was situated at an approximate altitude of 2100m a.s.l. While the plot-'B' was at an altitude of 2040m a.s.l. Both the plots were uncultivated, undisturbed and free from any human interference, fairly sloppy and thickly vegetated with varieties of trees like *Michelia excels* (Magnoliaceae), *Eurya japonica* (Rosaceae), *Rhododendron arboretum* (Ericaceae), *Ficus nemoralis* (Mora-ceae) and *Garciniacowa* (Clusiaceae), etc. Besides the aforesaid trees the plots also contained few herbs, shrubs and climbers like *Carex finitima* (Cyperaceae), *Eranthemum indicum* (Acanthaceae) and *Mucuna macrocarpa* (Fabaceae), etc.

### MATERIALS AND METHODS

The location, altitudinal variation, soil conditions and other characteristics of both the plots have been presented in Table 1. In the present study in each plot an area of 16m<sup>2</sup> (4m x 4m) was selected from where field data as well as soil samples were collected at monthly interval for three consecutive years (January to December 1999–2001). Samples were collected randomly from the surface up to a depth of 10cm with the help of a steel borer (5cm<sup>2</sup> × 10cm = 250cm<sup>3</sup>) as employed by Dhillon and Gibson (1962). Each time three cores were drawn randomly from each plot and those were homogeneously mixed and treated as a sample of soil. Altogether 24 samples (12 samples from each plot) were collected in each year and the samples were extracted by Berlese Tullgren funnel as modified by Macfadyen (1953). The collection, extraction and analyses of edaphic factors were continued for three consecutive years, i.e 1999, 2000 and 2001. Data collected for three consecutive years were pooled month wise.

**Table 1.** Characteristics of the sampling sites in Zoological Park, Darjeeling, India.

Plot	Altitude (approx.)	Soil Characteristics				
		Color	Sand (%)	Silt (%)	Clay (%)	Texture
A	2100m	Fairly blackish grey	59.5	22.7	17.8	Sandy loam
B	2040m	Moderately blackish grey	60.1	21.6	18.3	Sandy loam

Soil temperature was measured by a soil thermometer and pH was determined by an electric digital pH meter. Soil moisture was evaluated by an Infra-Red Moisture Balance (Model-'A') and organic matter was estimated by rapid titration method of Walkley and Black (1934). Temporary slides were prepared and identifications were made with the help of the expert acarologists of Zoological Survey of India, Calcutta following the key of Balogh and Balogh (1992). Only adult specimens were counted and identified because in most cases the extracted juveniles were very poor in number. The data involving various soil factors and the number of acarine fauna extracted from sample units were subjected to statistical analysis separately for each plot, in order to find out the correlation and regression coefficients, etc.

The community analysis was done at sample unit level with reference to mean abundance and relative abundance. For the quantification of species diversity, species temporal diversity (popularly called Shannon-Weiner Diversity Index), species richness and Simpson's Index of Dominance [see Krebs (1989)] were used. To compare the species diversities of two plots, quotient of similarity

(Sørensen 1948) was applied. STATISTICA as well as SPSS software package were used to perform all the required statistical calculations.

## RESULTS AND DISCUSSION

Throughout the period of study the climate in Darjeeling was observed to be relatively cold, fairly humid and foggy with torrential rain in the monsoon month. The sampling site witnessed the cycling of three different seasons in a year such as winter, spring and monsoon.

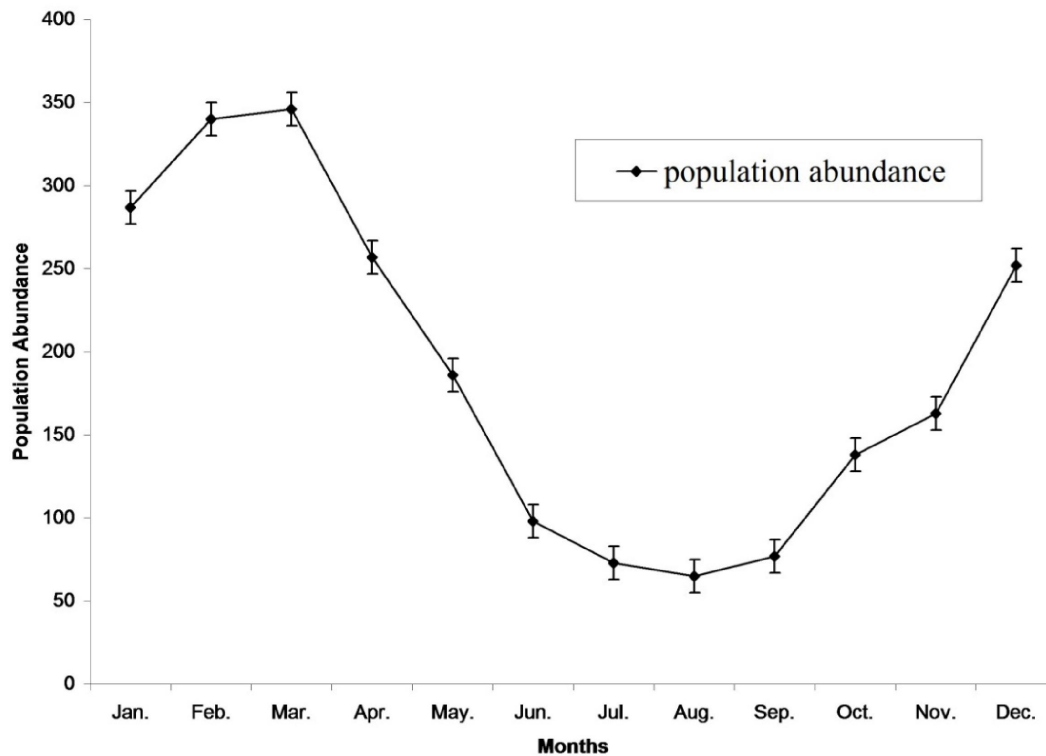
The mean values of soil factors taken together from both the plots and presented in Table 2 revealed that the soil factors exhibited variation with change of season. Soil temperature ranged between 9.23°C (January) to 18.45°C (August). Soil moisture also exhibited appreciable variation and the value was found to vary from 8.93% (April) to 39% (August). The pH of all the samples were found to be acidic showing little variation and ranged between 4.68 (March, November) to 4.75 (July, August). The concentration of organic matter was found to be fairly high and it varied between 8.82% (August) to 10.74% (March).

**Table 2.** Monthly variation of mean value of edaphic factors with standard error of two plots of Zoological Park during 1999–2001 (pooled data).

Edaphic Factors	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
<b>Temp. (°C)</b>	9.23 ± 0.72	10.03 ± 0.61	11.87 ± 0.48	13.41 ± 0.37	16.53 ± 0.31	16.93 ± 0.30	17.47 ± 0.46	18.45 ± 0.40	16.57 ± 0.35	14.10 ± 0.17	12.02 ± 0.57	10.47 ± 0.41
<b>Moisture (%)</b>	18.56 ± 1.20	16.74 ± 1.38	11.13 ± 1.89	8.93 ± 1.35	34.45 ± 0.68	33.13 ± 2.08	37.75 ± 1.00	39.00 ± 0.76	28.71 ± 1.45	26.21 ± 1.03	23.89 ± 0.55	18.91 ± 1.42
<b>pH</b>	4.67 ± 0.25	4.69 ± 0.26	4.68 ± 0.26	4.70 ± 0.25	4.71 ± 0.23	4.69 ± 0.25	4.75 ± 0.30	4.75 ± 0.28	4.71 ± 0.27	4.70 ± 0.24	4.68 ± 0.26	4.72 ± 0.25
<b>Organic matter (%)</b>	10.22 ± 0.59	9.85 ± 0.67	10.74 ± 0.43	9.89 ± 0.37	9.76 ± 0.68	9.13 ± 0.80	9.71 ± 0.49	8.82 ± 1.13	9.85 ± 0.71	9.19 ± 0.89	9.18 ± 0.45	9.58 ± 0.86

The population abundance curve (Fig. 1) showing post winter (spring) maximum and monsoon minimum as observed in this study has also been reported in earlier cases by Choudhuri and Pande (1979, 1981, 1982), Ghosh and Roy (2004) and Ghosh *et al.* (2006) from Darjeeling Himalayas. They have also reported the important contribution of Oribatida in determining the nature of population fluctuation. The relatively insignificant role of Mesostigmata has also been reported in their studies.

The acarine fauna extracted from both the plots were represented mainly by Oribatida and to a less extent by Mesostigmata. Altogether 10 generic forms were obtained of which six belonged to Oribatida and four to Mesostigmata (Table 3, Fig. 2). Of these forms, seven genera were common in both the plots. Among the Oribatida the genera *Scheloribates*, *Brachioppia*, *Galumna* and *Allonothrus* occupied the first, second, third and fourth position respectively in order of dominance (Table 3). Of the Oribatida the genus *Scheloribates* occupied the top most position in numerical abundance among all the acarines and was represented by three species viz. *S. luminosus* Hammer, 1961, *S. rectus* Hammer, 1958 and *S. sachsahumanensis* Hammer, 1961. These three species were previously recorded from the different parts of West Bengal by Banerjee (1978), Ghatak (1978) and Pande (1980).



**Figure 1.** Seasonal fluctuation [pooled data of three consecutive years (1999, 2000 and 2001) of study] in population abundance (individual m<sup>-2</sup>) of acarine community in Padmaja Naidu Himalayan Zoological Park, Darjeeling.

The regular occurrence as well as the numerical dominance of this genus suggested its cosmopolitan nature of distribution as was mentioned by earlier researchers like Oliver and Ryke (1969), Mukherjee and Singh (1971), Hammer (1973), Choudhuri and Banerjee (1977), Sarkar (1990) and Subías (2004). The members of other two forms like *Malaconthrus* sp. and *Acrotritia* sp. was fairly low. The Mesostigmata on the other hand had a low population being represented mainly by *Gymnolaelaps* sp. and *Hypoaspis takiensis* Bhattacharyya, 1966 and to a less extent by *Macrocheles glaber* Miiller, 1860 and *Veigaia uncata* Farrier, 1957 (Table 3, Figs. 3, 4).

Besides the adult individuals the acarine fauna included some juveniles which were extracted from the two sampling plots but their number in most cases were not significant. The monthly variation of population as shown in Table 4 revealed that the total population exhibited a rather irregular trend of fluctuation reaching its peak in March followed by a gradual decline and came down to minimum level in August. From September onwards the population abundance curve showed a tendency of increase and ultimately reached the maximum level in March (Figs. 1–4). Thus the population picture revealed that it had a monsoon minimum and post winter (spring) maximum. The numerical changes as observed in this study (Table 4) was mainly contributed by the important oribatid genera like *Scheloribates*, *Brachioppia*, *Galumna* and *Acrotritia* since their numbers were found to be fairly high (Fig. 2). The other forms of Oribatida as well as the forms of Mesostigmata had a little contribution in population fluctuation. The trend of fluctuation of population as observed in this study was identical to the trend reported by Pande (1980), Choudhuri and Pande (1981), Ghosh (1995), Sanyal *et al.* (1999), Ghosh and Roy (2004) and Ghosh *et al.* (2006) in some sampling sites of Himalayan as well as Gangetic West Bengal.

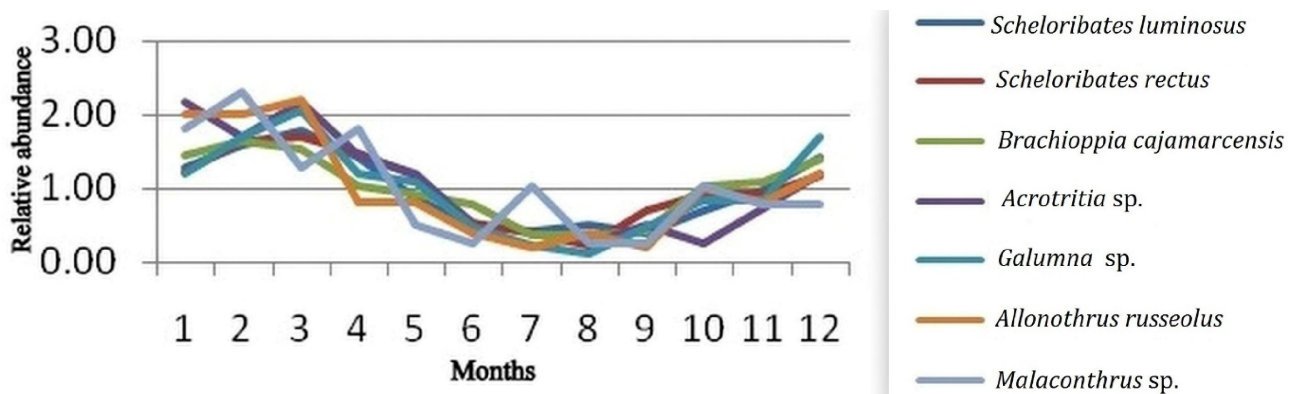
The sampling sites located in the Zoological Park and selected for this study were more or less closer to each other and there was only 60m a.s.l. of altitudinal variation. Both the plots experienced

similar climatological as well as edaphological characteristics. As a result the species composition of the acarine fauna was more or less identical and that too showed the same trend of fluctuation.

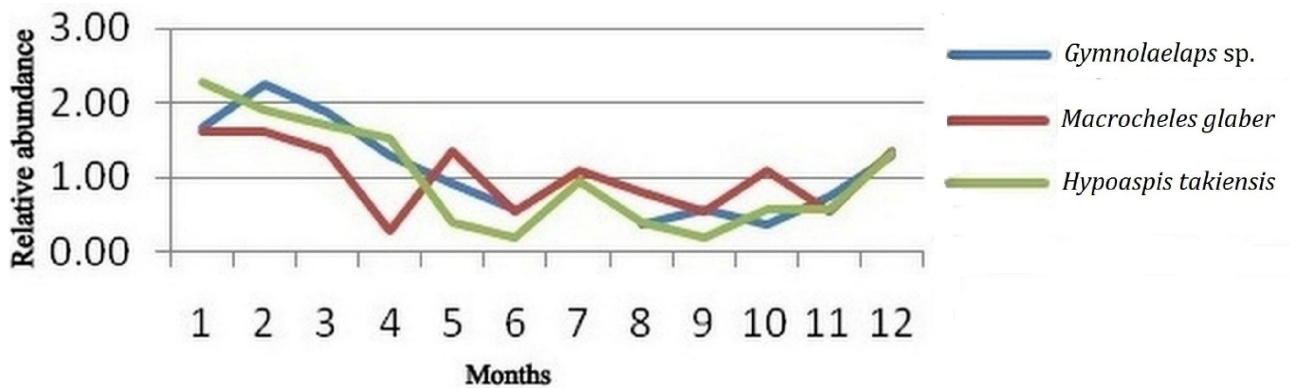
**Table 3.** Acarine diversity and relative abundance (R.A.) of two plots of Zoological Park during 1999–2001 (pooled data).

Plot	Taxa / Specimens	$n_i$	Shannon Wiener's Index ( $H'$ )	R.A. (%) = $(n_i/N) \times 100$
A	<i>Scheloribates luminosus</i> Hammer, 1961	388	1.99	31.29
	<i>Scheloribates rectus</i> Hammer, 1958	226		18.22
	<i>Brachioppia cajamarcensis</i> Hammer, 1961	198		15.96
	<i>Acrotritia</i> sp.	50		4.03
	<i>Galumna</i> sp.	99		7.98
	<i>Allonothrus russeolus</i> Wallwork, 1960	60		4.83
	<i>Malaconthrus</i> sp.	47		3.79
	<i>Gymnolaelaps</i> sp.	64		5.16
	<i>Macrocheles glaber</i> Müller, 1860	45		3.62
	<i>Hypoaspis takiensis</i> Bhattacharyya, 1966	63		5.08
				<b>N = 1240</b>
B	<i>Scheloribates sacsahuamanensis</i> Hammer, 1961	317	2.03	30.42
	<i>Scheloribates rectus</i> Hammer, 1958	162		15.54
	<i>Scheloribates luminosus</i> Hammer, 1961	134		12.85
	<i>Brachioppia cajamarcensis</i> Hammer, 1961	115		11.03
	<i>Galumna</i> sp.	98		9.40
	<i>Allonothrus russeolus</i> Wallwork, 1960	40		3.83
	<i>Acrotritia</i> sp.	33		3.16
	<i>Hypoaspis takiensis</i> Bhattacharyya, 1966	42		4.03
	<i>Gymnolaelaps</i> sp.	69		6.62
	<i>Veigaia uncata</i> Farrier, 1957	32		3.07
				<b>N = 1042</b>

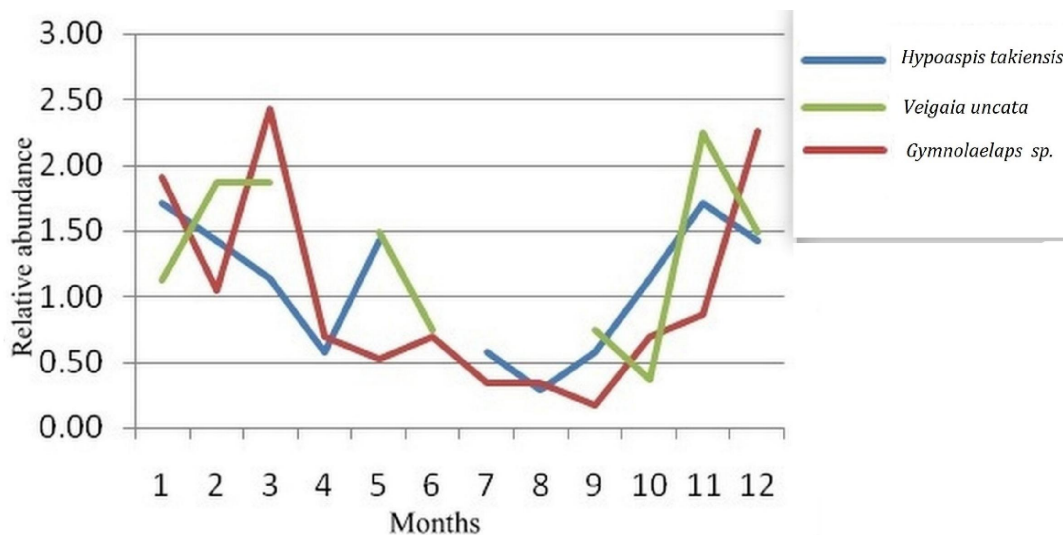
The Oribatida throughout the period of sampling outnumbered the Mesostigmata not only in numerical abundance but also in species composition (Table 3). Similar results have been reported in different years (Choudhuri and Pande 1979, 1981, 1982; Ghosh and Roy 2004; Ghosh *et al.* 2006) in Himalayan West Bengal. The numerical abundance of *Scheloribates*, *Brachioppia* and *Galumna* indicate their probability of high tolerance range which is evident from their constant presence in all ecosystems of West Bengal (Choudhuri and Pande 1979, 1981, 1982; Sanyal 1994; Sanyal *et al.* 1999; Ghosh and Roy 2004; Ghosh *et al.* 2006).



**Figure 2.** Relative seasonal abundance of oribatid mites in Zoological Park during the study period (1999, 2000 and 2001, pooled data).



**Figure 3.** Relative seasonal abundance of mesostigmatic mites in Zoological Park during the period of investigation (1999, 2000 and 2001, pooled data).



**Figure 4.** Irregular trend of fluctuation in relative abundance of mesostigmatic mites in Zoological Park during the period of investigation (1999, 2000 and 2001, pooled data).

It was interesting to note that among the four edaphic factors analyzed only the content of organic matter showed a positive and significant correlation with population (Table 5). The remaining three variables - moisture, temperature and pH had significant but negative correlation with population (Table 5). The post winter (spring) maxima as recorded in this study may be attributed to the presence of high level of organic matter and moderate or optimum level of temperature and moisture. The monsoon minima on the other hand might be due to low organic matter, fairly high soil moisture and temperature. The impact of pH in this study rather appears to be relatively insignificant since, all the samples had acidic pH which exhibited a very little variation and were well within the tolerance range of acarine fauna (Ghosh and Roy 2004; Ghosh *et al.* 2006). The climatological and edaphological conditions as well as vegetation cover in Himalayan and sub-Himalayan West Bengal differ widely from that of Gangetic plain. As a result, the population picture of acarines as well as the impact of edaphic factors on acarine fauna as reported by Sanyal (1994) and Sanyal *et al.* (1999) in Gangetic West Bengal differs widely from that of Himalayan West Bengal.

**Table 4.** Monthly population fluctuation of acarine community in two plots of Zoological Park during 1999–2001 (pooled data).

Plot	Taxon	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
A	<i>Scheloribates luminosus</i>	42	52	58	46	28	17	14	17	13	23	32	46	388
	<i>Scheloribates rectus</i>	23	31	32	28	22	10	7	4	13	17	17	22	226
	<i>Brachioppia cajamarcensis</i>	24	27	25	17	15	13	6	6	7	17	18	23	198
	<i>Acrotritia</i> sp.	9	7	9	6	5	2	-	1	2	1	3	5	50
	<i>Galumna</i> sp.	10	14	17	10	9	4	2	1	4	7	7	14	99
	<i>Allonothrus russeolus</i>	10	10	11	4	4	2	1	2	1	5	4	6	60
	<i>Malaconthrus</i> sp.	7	9	5	7	2	1	4	1	1	4	3	3	47
	<i>Gymnolaelaps</i> sp.	9	12	10	7	5	3	-	2	3	2	4	7	64
	<i>Macrocheles glaber</i>	6	6	5	1	5	2	4	3	2	4	2	5	45
	<i>Hypoaspis takiensis</i>	12	10	9	8	2	1	5	2	1	3	3	7	63
	B	<i>Scheloribates sacsahuamanensis</i>	39	46	48	35	29	16	14	11	7	18	19	35
<i>Scheloribates rectus</i>		19	26	31	19	13	8	3	3	6	4	10	20	162
<i>Scheloribates luminosus</i>		18	20	19	22	18	4	3	4	3	6	3	14	134
<i>Brachioppia cajamarcensis</i>		17	23	14	20	7	5	2	1	4	5	5	12	115
<i>Galumna</i> sp.		13	16	23	12	4	3	1	3	2	8	9	4	98
<i>Allonothrus russeolus</i>		5	8	4	7	3	1	1	-	2	4	4	1	40
<i>Acrotritia</i> sp.		4	7	3	2	3	-	2	1	1	1	3	6	33
<i>Hypoaspis takiensis</i>		6	5	4	2	5	-	2	1	2	4	6	5	42
<i>Gymnolaelaps</i> sp.		11	6	14	4	3	4	2	2	1	4	5	13	69
<i>Veigaia uncata</i>		3	5	5	-	4	2	-	-	2	1	6	4	32
<b>Total collection =</b>		<b>287</b>	<b>340</b>	<b>346</b>	<b>257</b>	<b>186</b>	<b>98</b>	<b>73</b>	<b>65</b>	<b>77</b>	<b>138</b>	<b>163</b>	<b>252</b>	<b>2282</b>

In order to study the biodiversity of acarine community in two sampling plots, the species diversity index was calculated by following the standard and accepted statistical methods [Shannon-Wiener's diversity index (Shannon and Wiener 1963)] (Table 3). It was observed that species diversity value in the sampling plots under study ranged 1.99–2.03. This is also substantiated by the presence of same number of species (10 species in each Plot) in both the plots. Since the sampling plots were located in the same area with relatively little altitudinal variation and having similar soil and microclimatic condition, the plots perhaps did not exhibit any appreciable difference in values of diversity index. The value of Quotient of Similarity between the plot 'A' and 'B' was 0.7.

**Table 5.** Relationship between the acarine community with four edaphic factors at Zoological Park during 1999–2001 (analysis done on pooled data).

Parameters	'r'-value of Acari	Remarks	Regression Equation "y = (a + bx)"
Temperature (°C)	- 0.855	a	y = 18.94 - 0.16 x <sub>1</sub>
Moisture (%)	- 0.861	a	y = 40.75 - 0.51 x <sub>2</sub>
pH	- 0.593	c	y = 4.73 - 7.89 x <sub>3</sub>
Organic matter (%)	0.705	b	y = 8.98 + 0.02 x <sub>4</sub>

<sup>a</sup> Significant at 0.1 % level; <sup>b</sup> Significant at 1 % level; <sup>c</sup> Significant at 5 % level; y = Acari; x<sub>1</sub> = Temperature; x<sub>2</sub> = Moisture; x<sub>3</sub> = pH; x<sub>4</sub> = Organic matter

Thus the role of different soil factors limiting and controlling the distribution and population size of soil acarines revealed that the edaphic factors might have exerted positive or negative impact

on population either individually or in a cumulative way when the conditions with respect to the concentration of soil factors appeared to be favourable. Workers like Choudhuri and Roy (1972) reported an indirect influence of vegetation on soil fauna through its effects on pore space, humus formation and soil moisture. But how the species composition, numerical abundance and seasonal fluctuation of a population depended upon the plant community was difficult to ascertain. However, it could be assumed that the vegetation being an integral part of ecological complex might have exerted certain influence on acarine population.

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### REFERENCES

- Balogh, J. & Balogh, P. (1992) *The oribatid mites genera of the world*. Vol. II. Hungarian National History Museum, Budapest, 375 pp.
- Banerjee, S. (1978) *Interaction between soil factors and soil dwelling oribatid population of West Bengal*. Ph. D. thesis. University of Burdwan, Burdwan, 232 pp.
- Chakraborti, D.K. & Mondal, B.K. (1981) Taxonomic investigation on the oribatid fauna (Acari) of forest and tea soil of Darjeeling, West Bengal, India. *Science & Culture*, 47: 181–184.
- Choudhuri, D.K. & Banerjee, S. (1977) *Soil factors and oribatid mites under conditions of West Bengal*. University of Burdwan Publication, Burdwan, 88 pp.
- Choudhuri, D. K. & Pande, T. (1979) High altitude soil animals and their relation with soil factors with special reference to mites. *Revue d'Ecologie et de Biologie du Sol*, 16: 219–226.
- Choudhuri, D.K. & Pande, T. (1981) Studies on the population and distribution of high altitude soil acarines in relation to different soil factor. In: ChannaBasavanna G.P. (Ed.), *Contribution to Acarology in India*. Acarological Society of India: University of Agricultural Science Publisher, pp. 147–154.
- Choudhuri, D.K. & Pande, T. (1982) An ecological study of acarines from soil of Himalayan ecosystem. *Geobios New Reports*, 1: 24–26.
- Choudhuri, D.K. & Roy, S. (1972) An ecological study on Collembola of West Bengal, India. *Records of the Zoological Survey of India*, 66(1–4): 81–101.
- Dhillon, B.S. & Gibson, N.H.E. (1962) A study of the Acarine and Collembola of agricultural soils. *Pedobiologia* 1: 189–209.
- Ghatak, T.K. (1978) *Ecological investigations of soil arthropods in cultivated and uncultivated fields of Hooghly district*. Ph. D. thesis, University of Burdwan, Burdwan, 282 pp.
- Ghosh, T.C. (1995) *Acarine fauna of three tea garden soils of Darjeeling district, West Bengal – A preliminary study*. M. Phil. thesis, University of Burdwan, Burdwan, 37 pp.
- Ghosh, T.C. & Roy, S. (2004) Distribution and diversity of acarine community in three tea garden soils at different altitudes of Darjeeling Himalayas. *Proceedings of the Zoological Society, Calcutta*, 57(2): 87–93.
- Ghosh, T.C., Saha, G.K. & Roy, S. (2006) Studies on the impact of four edaphic factors on the density, seasonal abundance and diversity of acarine fauna in the soils of a tea estate in Darjeeling. *Records of the Zoological Survey of India*, 106(2): 25–34.

- Hammer, M. (1973) Oribatids from Tongatapu and Eua, The Tonga Islands, and from Upalu, Western Samoa. *Biologiske Skrifter Kongelige Danske Videnskabernes Selskab*, 20: 1–99.
- Krebs, J.C. (1989) *Ecological methodology*. Harper and Row Publishers, New York, 654 pp.
- Luxton, M. (1972) Studies on the oribatid mites of a Danish Beech wood Soil. I. Nutritional Biology. *Pedobiologia*, 12: 434–463.
- Macfadyen, A. (1953) Notes on methods for the extraction of small soil arthropods. *Journal of Animal Ecology*, 22: 65–77.
- Mani, M.S. (1962) *Introduction to high altitude entomology insect life above the timber line in the north-west Himalaya*. Methuen, London, 302 pp.
- Mondal, B.K. & Kundu, B.G. (1985) A new species of *Oppia* (Acari: Oribatei: Oppiidae) from Darjeeling, India. *Bulletin of the Zoological Survey of India*, 7: 305–309.
- Mondal, B.K. & Kundu, B.G. (1986) A new species of Octocephidae (Acari: Oribatei) from Darjeeling, India. *Bulletin of the Zoological Survey of India*, 83: 91–96.
- Mondal, B.K. & Kundu, B.G. (1988) Two new species of oribatid mites (Acari) of the genus *Hoplophthiracarus* Jacor, from Darjeeling, India. *Bulletin of the Zoological Survey of India*, 85: 111–118.
- Mukherjee, S.P. & Singh, J. (1971) Qualitative composition of soil arthropods in some fields of Varanasi, India. *Oriental Insects*, 5(4): 487–494.
- Oliver, P.G. & Ryke, P.A.J. (1969) The influence of citri cultural practices on the composition of soil Acari and Collembola population. *Pedobiologia*, 9: 277–281.
- Pande, T. (1980) *Studies on the relation between soil and its mesofauna with emphasis on mites (Acari) in the Himalayan and Sub-Himalayan ecosystems of Bengal*. Ph. D. thesis, University of Burdwan, Burdwan, 268 pp.
- Sanyal, A.K. (1994) Ecological studies on soil mites (Acari) in India: A Review. In: Mishra P.C., Behera, N., Senapati, B.K. & Guru, B.C. (Eds.), *Advance in ecology and environmental Science*. Ashish Publication House, New Delhi, pp. 79–96.
- Sanyal, A.K., Kundu, B.G. & Roy, S. (1999) Ecology of soil oribatid mites (Acari) in relation to some edaphic factors in Gangetic delta of West Bengal. *Records of the Zoological Survey of India*, 177: 1–55.
- Sarkar, S. (1990) Studies on microarthropod community in one undisturbed habitat of Tripura (India) with special reference to oribatid mites. *Revue d'Ecologie et de Biologie du Sol*, 27(3): 307–329.
- Shannon, C.E. & Wiener, W. (1963) *The mathematical theory of communication*. University of Illinois Press, Urbana Publisher, 117 pp.
- Sørensen, T. (1948) A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. *Royal Danish Academy of Sciences and Letters*, 5(4): 1–34.
- Subías, L.S. (2004) Listado Sistemático, Sinonímico y Biogeográfico de los Acaros Oribatidos (Acariformes, Oribatida) del Mundo. *Graellsia*, 60 (número extra-ordinario): 3–305. (Electronic update 2016: <http://www.ucm.es/info/zoo/Artropodos/Catalogo.pdf>).
- Walkley, A. & Black, I.A. (1934) An extraction of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science*, 37: 29–38.
- Walter, D.E. (2009) Habits and habitats. In: Krantz, G.W. & Walter, D.E. (Eds.), *A manual of acarology*. Texas Tech University Press, 807 pp.

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## پراکندگی و فراوانی فصلی اجتماع کنه‌ها (Arachnida: Acari) در پارک جانورشناسی دارجیلینگ هیمالیا، بنگال غربی، هند

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### چکیده

در این بررسی تلاشی برای مطالعه ترکیب گونه‌ها، پراکندگی و نوسانات فصلی اجتماع کنه‌ها (Arachnida: Acari) در دو کرت دست نخورده و کاملاً کشت شده در پارک جانورشناسی پادماجا نایدو هیمالیا در دارجیلینگ هند صورت گرفت. این مطالعه در سه سال پیاپی (ژانویه تا دسامبر ۱۹۹۹-۲۰۰۱) وجود ۱۰ جنس از کنه‌ها را نشان داد که شش گونه به اریباتیدها و چهار گونه به میان‌استیگمایان تعلق داشتند. اما هیچ کنه پیش‌استیگما یا بی‌استگمایی یافت نشد. در بیشتر نمونه‌ها تعداد اریباتیدها از میان‌استیگمایان بیشتر بود. کل جمعیت کنه‌ها در طول دوره مورد مطالعه نوسانات نامنظمی با بیشینه جمعیت پس از زمستان یا پیش از بادهای موسمی و کمینه در هنگام بادهای موسمی نشان دادند. اریباتیدها با جمعیت غالب عامل اصلی در منحنی فراوانی جمعیت در این مطالعه بودند. از چهار عامل خاکی (یعنی اسیدیت، دما، رطوبت و مواد آلی) مورد مطالعه، تنها حجم مواد آلی رابطه معنی‌دار و مثبتی با جمعیت داشت درحالی‌که سه عامل دیگر (اسیدیت، دما، رطوبت) رابطه منفی با جمعیت داشتند. هر دو کرت از نظر آب و هوایی، عوامل خاک‌شناسی و پوشش گیاهی کم‌وبیش یکسان بودند همراه با اندکی تفاوت در ارتفاع و در مقدار شاخص تنوع اختلاف معنی‌داری ایجاد نکردند.

**واژگان کلیدی:** فراوانی؛ دارجیلینگ هیمالیا؛ پراکندگی؛ عوامل خاکی؛ کنه‌های خاکزی.

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