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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

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INTRODUCTION

Investigation on the taxonomy and ecology of acarine community in the tea garden soils, undisturbed forest floors of Darjeeling district were made from time to time by workers like Choudhuri and Pande (1979, 1981 and 1982), Chakraborti and Mandal (1981), Mandal and Kundu (1985, 1986 and 1988), Ghosh and Roy (2004). But the ecological studies so far made with respect to acarine community in tea garden soils were not comprehensive enough to come to any definite conclusion. To bridge the gap in existing knowledge an attempt has been made in this study to analyse the density, seasonal abundance and diversity of acarine fauna in two sampling plots of Happy Valley Tea Estate at Darjeeling in relation to four important soil factors.

SAMPLING SITES

Soil samples for this investigation were collected from two sampling plots ('A' and 'B') in Happy Valley Tea Estate, situated very close to Lebong cart Road and was within the jurisdiction of Darjeeling town in West Bengal, India. The plot-'A' was at an approximate altitude of 2010m, while the plot-'B' was at an altitude of 1970m and 500m away from the plot-'A' Each of the plot has an area of 16 sq.m (4 m × 4 m). Both the plots contained chiefly tea plants, *Camellia sinensis* (Ternstroemiaceae) approximately 90 cm high and 1m apart from the corresponding plant in either direction. In addition, few mosses, grasses, ferns, herbs and shrubs like *Panicum palmifolium*

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(Gramineae), *Berberis insignis* (Berberidaceae), *Polygonum runcinatum* (Polygonaceae), *Geranium nepalense*, (Geraniaceae), *Anaphalis contorta* (Compositae) *etc.* were also present either in plot-'A' or in plot-'B' The plot-'B' also contained few shade trees like *Cryptomeria japonica* (Taxodiaceae) which was absent in plot-'A' A thin litter layer formed of dead and decaying fallen leaves, twigs etc. was found to prevail on the surface soil of both the plots which were occasionally removed during clearing operation.

Soils of the sampling plots were moderately dark grey (plot-'A') or lightly dark grey in colour (plot-'B'), sandy loam in texture and acidic in reaction. The characteristics of the sampling plots have been presented in Table-1. Both the plots experienced anthropogenic effects during leaf plucking, trimming, cleaning and manuring *etc.* from time to time.

Table 1 : Characteristics of the Sampling sites.

Sampling Site	Location	Plot	Altitude (approx.)	Soil Characteristics				
				Colour	Sand	Silt	Clay	Texture
Happy Valley Tea Estate	Darjeeling	A	2010 m	Moderately dark grey	60.2	21.2	18.6	Sandy loam
		B	1970 m	Lightly dark grey	62.1	20.7	17.2	Sandy loam

MATERIALS AND METHODS

In each plot soil samples were collected at monthly interval over a period of 3-years (Jan.1999 to Dec. 2001). Samples were collected from the surface upto a depth of 10 cm by a steel borer as employed by Dhillon and Gibson (1962) and the cores were extracted by Tullgren funnel as modified by Macfadyen (1953). The collected samples were brought to the laboratory in polythene bags in such a way that the faunal components remain undamaged. Each sample had a volume of 250 cubic centimeter (5 sq. cm × 10 cm). Altogether 72 samples were collected from 2 sampling plots of the tea garden. Soil temperature was recorded by a soil thermometer and soil moisture was determined by an Infra Red Moisture Balance (Model-A). The pH of the soil sample was determined by an electric digital pH meter and the organic matter content was estimated by rapid titration method of Walkley and Black (1934).

RESULTS

The acarine fauna extracted from soil samples of the sampling plots included 11 genera of which 7 belonged to cryptostigmatids and 4 to mesostigmatids. No specimens of either prostigmatids or astigmatids were obtained. In both the plots cryptotigmatids outnumbered the mesostigmatids in

Table 2 : Monthly variation of Mean values of Edaphic factors with S.E. of 2 plots of Happy Valley Tea Estate, Darjeeling during 1999–2001.

Soil Factors	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp (°C)	9.29 ±0.48	10.49 ±0.52	11.65 ±0.47	14.09 ±0.99	17.48 ±0.89	18.96 ±0.71	19.67 ±0.87	20.27 ±0.53	16.99 ±0.76	15.57 ±0.89	12.19 ±0.69	10.11 ±0.69
Moisture (%)	20.43 ±1.45	16.00 ±0.95	12.66 ±1.73	10.55 ±1.26	28.40 ±2.34	34.52 ±0.90	36.98 ±1.17	37.29 ±1.54	28.20 ±2.14	24.50 ±1.84	22.37 ±1.52	18.96 ±1.40
pH	4.91 ±0.07	4.97 ±0.05	4.96 ±0.05	4.93 ±0.05	4.95 ±0.08	4.95 ±0.10	5.00 ±0.08	4.98 ±0.09	4.92 ±0.06	4.94 ±0.05	4.91 ±0.03	4.95 ±0.04
Org. Matter (%)	8.81 ±0.22	8.90 ±0.39	8.30 ±0.67	7.75 ±0.30	7.70 ±0.90	6.80 ±0.71	6.50 ±0.53	6.30 ±0.64	7.03 ±0.51	7.54 ±0.51	7.92 ±0.16	8.21 ±0.21

Table 3 : Showing the species Diversity and Relative Abundance of two plots of Happy Valley Tea Estate, Darjeeling.

Site	Plot	Taxa/Specimens	Ni	Shannon-Wienner's Index (H^-)	R.A. (%)
HAPPY VALLEY TEA ESTATE	A	1. *Scheloribates rectus* Hammer, 1958	308		35.44
		2. *Scheloribates luminosus* Hammer,1961	146		16.80
		3. *Brachioppia cajamarcensis* Hammer, 1961	115		13.23
		4. *Galumna* Heyden, 1826	75		8.63
		5. *Nothrus* Koch, 1836	38	**1.94**	4.37
		6. *Tectocepheus* Berlese, 1913	33		3.79
		7 *Rostrozetes* Sellnick, 1925	28		3.22
		8. *Gymnolaelaps* Berlese, 1916	67		7.71
		9. *Macrocheles glaber* Muller1860	30		3.45
		10. *Trichouropoda* Koch, 1839 Berlese, 1916	29		3.33
			N = 869		
	B	1. *Scheloribates luminosus* Hammer, 1961	404		41.06
		2. *Brachioppia cajamarcensis* Hammer, 1961	188		20.47
		3. *Galumna* Heyden, 1826	94		10.23
		4. *Nothrus* Koch, 1836	34		3.70
		5. *Tectocepheus* Berlese, 1913	30	**1.78**	3.26
		6. *Xylobates* Jacot, 1929	47		5.12
		7. *Gymnolaelaps* Berlese, 1916	69		7.51
		8. *Macrocheles glaber* Muller,1860	21		2.28
		9. *Trichouropoda* Koch, 1839 Berlese, 1916	26		2.83
		10. *Parasitus assamensis* Bhattacharyya, 1972	32		3.48
			N = 945		
Total Collection = 1814					

Table 4 : Showing the relationship between the acarine fauna with different edaphic factors at Happy Valley Tea Estate, Darjeeling during 1999–2001.

Site	Parameters	'r'-value of acarina	Remarks	Regression Equation Y = a + bx
Happy Valley Tea Estate	Temperature (°C)	–0.933	****	$Y = 21.65 - 0.27x_1$
	Moisture (%)	–0.875	****	$Y = 39.17 - 0.59\ x_2$
	pH	–0.250	NS	$Y = 4.96 - 5.17\ x_3$
	Organic Matter (%)	0.949	****	$Y = 6.12 + 0.06\ x_4$

**** Significant at 0.1% level. N. S. Not significant. Y = Acarina
x_1 = Temperature (°C) x_2 = Moisture (%) x_3 = pH
x_4 = Organic Matter (%)

numerical abundance (Table-5). Of the 11 genera encountered, the genera like *Scheloribates*, *Brachioppia*, *Galumna*, *Nothrus*, *Tectocepheus*, *Macrochles*, *Gymnolaelaps* and *Trichouropoda* were common in both the plots while the remaining three genera like *Xylobates*, *Rostrozetes* and *Parasitus* were present either in plot-'A' or Plot-'B' (Table-5). The genus *Scheloribates* occupied the top most position in degree of dominance being followed by *Brachioppia*, *Galumna*, *Gymnolaelaps* and *Nothrus* and constituted 47.30%, 16.70%, 9.32% and 7.50% respectively of the total population. The other forms were numerically low and represented a minor fraction of total population. The acarine fauna in plot B appeared to be relatively higher in number (Table-5). The total population exhibited an irregular trend of fluctuation being maximum in February and minimum in July. The population curve exhibited a trend of increase from September reaching its peak in February followed by a steady decline and reached the minimum level in July (Fig.-1). This trend of fluctuation seems to be chiefly influenced by the fluctuation in abundance of population of *Scheloribates*, *Brachioppia* and *Galumna* (Table-5).

The edaphological factors exhibited some variations during the period of study (Table-2). The lowest soil temperature (9.29°C) was recorded in January and the highest (20.27°C) in August. Soil moisture showed a fairly wide range of variation, the concentration being lowest in April (10.55%) and the highest in August (37.29%). The pH of all the samples were acidic and did not exhibit wide range of variation and varied between 4.91 to 5.00. The concentration of organic matter reached its highest level (8.90%) in February while the lowest value (6.30%) was recorded in August. Mean values of soil factors of different months have been shown in Table-2.

DISCUSSION

The trend of fluctuation as observed in this study was more or less similar to that reported by Choudhuri and Pande (1981 and 1982) Ghosh and Roy (2004) in the undisturbed forest floors and

Table 5 : Monthly population of acarine fauna in two plots of Happy Valley Tea Estimate, Darjeeling during the year 1999–2001.

Site	Plot	Species/Taxa	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
HAPPY VALLEY TEA ESTATE	A	1. *Scheloribates rectus*	38	49	43	31	17	13	12	10	15	19	26	35
		2. *Scheloribates luminosus*	23	26	21	21	7	4	2	1	5	9	14	13
		3. *Brachioppia cajamarcensis*	14	21	24	16	5	4	–	4	4	3	9	11
		4. *Galumna* sp.	11	12	14	7	4	–	3	4	4	7	4	5
		5. *Nothrus* sp.	6	1	5	2	–	5	2	1	2	4	3	7
		6. *Tectocepheus* sp.	4	7	–	4	3	–	1	3	2	3	3	3
		7. *Rostrozetes* sp.	1	5	1	3	5	–	–	2	2	1	4	4
		8. *Gymnolaelaps* sp.	12	7	9	3	6	1	3	2	5	6	3	10
		9. *Macrocheles glaber*	4	3	1	3	–	2	2	2	2	4	3	4
		10. *Trichouropoda* sp.	6	3	2	2	1	1	–	3	–	4	4	3
	B	1. *Scheloribates luminosus*	56	64	51	42	25	13	14	13	17	24	39	46
		2. *Brachioppia cajamarcensis*	25	28	30	20	15	8	4	5	5	11	16	21
		3. *Galumna* sp.	12	15	17	7	8	2	2	3	3	8	2	15
		4. *Nothrus* sp.	3	5	2	7	1	3	1	1	2	2	4	3
		5. *Tectocepheus* sp.	2	4	5	–	3	–	2	1	1	3	2	7
		6. *Xylobates* sp.	7	8	4	7	1	3	2	1	4	3	5	2
		7. *Gymnolaelaps* sp.	14	7	10	7	5	1	2	2	3	7	4	7
		8. *Macrocheles* glaber	3	3	4	–	1	–	1	3	1	2	1	2
		9. *Trichouropoda* sp.	4	4	4	2	1	–	1	2	2	2	2	2
		10. *Parasitus* assamensis	3	8	1	2	1	3	1	1	3	2	4	3
			248	**280**	**248**	**186**	**109**	**63**	**55**	**64**	**82**	**124**	**152**	**203**

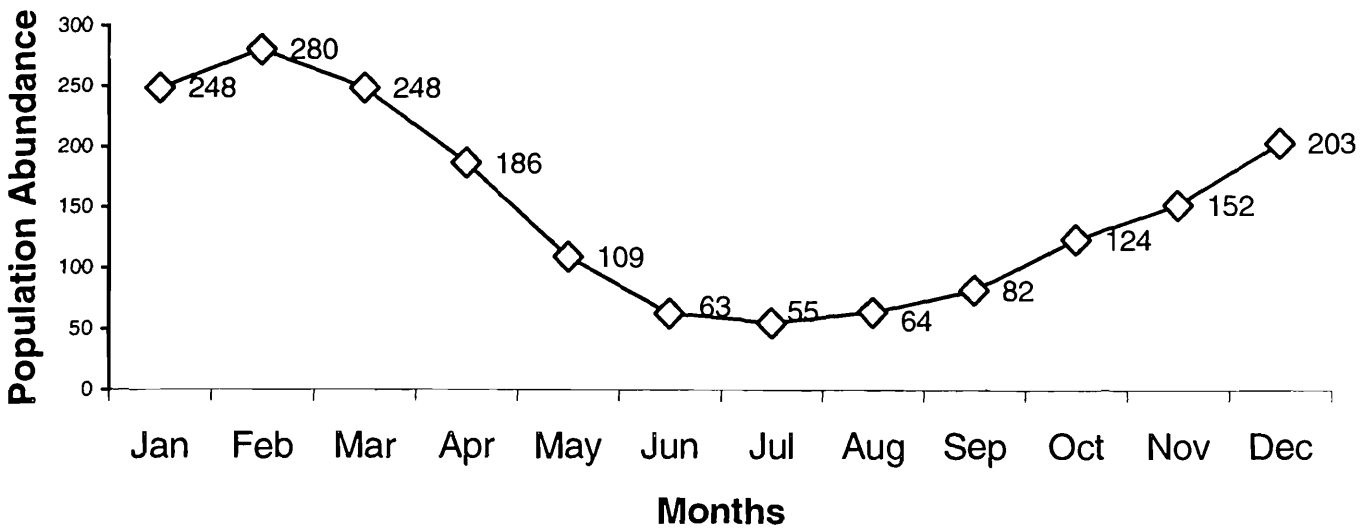

Fig. 1.: Seasonal fluctuation of acarine fauna in Happy Valley Tea Estate, Darjeeling during the year 1999-2001.

tea garden soils of Darjeeling. The numerical dominance of *Scheloribates*, *Brachioppia* and *Galumna* clearly indicate their adaptability and wide tolerance ranges. It is also evident from the data presented in Table-5 that cryptostigmatids in both the plots outnumbered mesostigmatids in numerical abundance as well as in species diversity and this is in conformity with the observation of Choudhuri and Pande (1982), Ghosh and Roy (2004). From December to April moisture content of soil was relatively low, temperature moderate and concentration of organic matter was fairly high and these in turn supported a relatively higher population. In the monsoon months high level of soil moisture, relatively higher surface temperature and low concentration of organic matter led to a decline in population. The pH on the other hand exhibited a narrow variation and possibly did not have a significant impact on population fluctuation. The pH values recorded were well within the tolerance range of most of the species as have been reported by Choudhuri and Banerjee (1977), Sanyal (1994), Sanyal *et al.* (1999), Ghosh and Roy (2004) in different ecosystems of West Bengal. The relatively lean population during monsoon months might be due to heavy down pour during the period which might have led to a surface erosion to some extent in sloppy areas leading thereby to a decline in surface dwelling acarines (Ghosh and Roy, 2004).

It was interesting to note that among the four soil factors studied only organic matter showed positive correlation with population, while the remaining three showed negative correlation (Table-4). Therefore, samples extracted during post winter or pre monsoon months supported a population which was numerically high since concentration of organic matter during that period was fairly high and the other factors were at the optimum level. The quantitative increase of acarine population with increased concentration of organic matter has also been reported by Choudhuri and Banerjee (1977), Choudhuri and Pande (1982), Banerjee and Sanyal (1991),

Sanyal *et al.* (1999), Ghosh and Roy (2004) in different areas of study in West Bengal. Negative correlation of temperature, moisture and pH with population is further substantiated by a lean population in monsoon months when all those factors were relatively high. Similar results with respect to temperature and moisture have also been reported by Choudhuri and Pande (1982), Sarkar (1991), Sanyal and Sarkar (1993), Ghosh (1995), Ghosh and Roy (2004).

The divesity indices as determined by Shannon-Wiener method showed a little variation between the values of plot-'A and plot-'B' of Happy Valley Tea Estate (Table-3). This is substantiated by the occurrence of same number of species (10 in each plot) in both the plots. The plots being located in the same tea garden with little altitudinal variation and having similar soil and climatic condition perhaps did not exhibit any appreciable difference in diversity index value.

SUMMARY

In this investigation an attempt has been made to analyse the density, seasonal abundance and diversity of acarine community in two sampling plots (A and B) of a tea garden in Darjeeling town of Himalayan West Bengal, India in relation to four edaphic factors. The study continued for three consecutive years (Jan, 1999 to Dec, 2001) revealed the presence of 11 genera of which seven belonged to cryptostigmatids and four to mesostigmatids. Among them eight genera were extracted from both the plots. Genera like *Scheloribates*, *Brachioppia*, and *Galumna* common to both the sites occupied the first, second and third position in numerical abundance representing 47.30%, 16.70% and 9.32% of total population respectively. The rest of the genera were extracted either from plot A or plot B or from both the plots. The cryptostigmatids in both the sites outnumbered mesostigmatids in numerical abundance. The population encountered from the sites under study exhibited an irregular trend of fluctuation being maximum in February and minimum in July. Of the four soil factors analysed, only the organic matter showed significant positive correlation with acarine population, while the other factors like temperature, moisture and pH were negatively correlated. The plots being located in the same tea garden with little altitudinal variation and having more or less similar soil and climatic condition did not exhibit any appreciable difference in diversity index value.

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