Acarina 12 (2): 151–157

NOTES ON THE ECOLOGY OF SOIL MITES (ACARI) IN TWO CONTRASTING SITES OF SCHIRMACHER OASIS, EAST ANTARCTICA

К ЭКОЛОГИИ ПОЧВООБИТАЮЩИХ КЛЕЩЕЙ (ACARI) В ДВУХ МЕСТООБИТАНИЯХ ОАЗИСА ШИРМАХЕРА В ВОСТОЧНОЙ АНТАРКТИДЕ

A.K. Sanyal

Zoological Survey of India, M- Block, New Alipore, Kolkata 700 053, India; e-mail: coordinator@enviszsi.org

Key words: soil mites, ecology, Schirmacher Oasis, East Antarctica
Ключевые слова: почвообитающие клещи, экология, оазис Ширмахера, восточная Антарктида

ABSTRACT

Soil mite communities of two contrasting sites in the Schirmacher Oasis, Dronning Moud Land, East Antarctica, were compared. Five taxa of mites, *Nanorchestes sp., Tyrophagus longior,* Acaridae gen. sp., *Suidasia nesbitti* and *Hypoaspis* sp., were recorded. In most cases a positive correlation was found between soil mite communities and soil factors such as the temperature, relative humidity, organic carbon, nitrate, potassium and pH.

РЕЗЮМЕ

Сообщества почвообитающих клещей были изучены в двух отличающихся по своим характеристикам местообитаниях оазиса Ширмахера, участка побережья Земли Королевы Мод в Восточной Антарктиде. Всего зарегистрировано 5 таксонов клещей: *Nanorchestes* sp., *Tyrophagus longior,* Acaridae gen. sp., *Suidasia nesbitti*, and *Hypoaspis* sp. В большинстве случаев обнаружена положительная корреляция между характеристиками населения клещей и почвенными факторами, такими как температура, относительная влажность, содержание углерода, нитратов, калия и pH.

INTRODUCTION

The ecological studies of terrestrial mite fauna in Antarctica are very scanty and mostly restricted to maritime and sub-antarctic zones [Janetschek, 1967; Gressitt, 1970; Fitzsimons, 1971; Young, 1979]. Although the Schirmacher Oasis was discovered in 1938–1939 no consolidated record on ecology of land fauna is available. Ingole and Parulekar [1987] and Ingole et al. [1987] studied moss-inhabiting mites in the Schirmacher Oasis. The present research was carried out during the austral summer of 1999–2000 in two terrestrial sites to reveal the species list and relative abundance of mites as well as their dependence on some physical and chemical parameters of soil in the Schirmacher Oasis.

MATERIAL AND METHODS

The Schirmacher Oasis forms a part of the Dronning Maud Land and is located about 70 km south of the Princess Astrid coast of Antarctica. It covers an area of about 72 km^2 of which about 2% is always free from snow cover. The Indian Station “Maitri” is situated in the Oasis at the latitude 70° 45′53″ S and the longitude 11° 44′ 03″ E. There are over 100 freshwater lakes of different shape and size in the Oasis.

The soil samples for the present study were collected from two sites, which had different characteristics.

Sampling Site I: The site measuring 5 × 5 m was located on the eastern side of the lake Priyadarshini, or Zub-lake. The site was covered with moss-turf (Fig.1).

Sampling site II: The site was a kitchen liquid waste collection area in the form of small flat bottom ponds on the eastern side adjacent to “Maitri”. During the austral summer, when the study took place, the ponds were lacking water but the soil was wet and muddy (Fig.1).

In total of 64 soil samples were taken at random from two sites at the rate of 4 samples from each at weekly intervals over a period of eight weeks (27.12.1999 to 12.02.2000). A stainless steel corer with cross-sectional area of 8.55 cm from a depth of 5 cm was used to take the samples. The mites were extracted using the Tullgren funnel system modified by Macfadyen [1953]. The soil temperature was measured with soil thermometer, the relative humidity was determined by using a dial hygrometer, pH level was estimated by pH meter (WTW make/pH 320), the organic carbon was determined by the rapid titration method by Walkley and Black [1934], nitrate was estimated calorimetrically by the Sprengell method, and potassium was evaluated by the Flame photometry method. The mechanical analysis of soil samples was performed by hydrometer method.

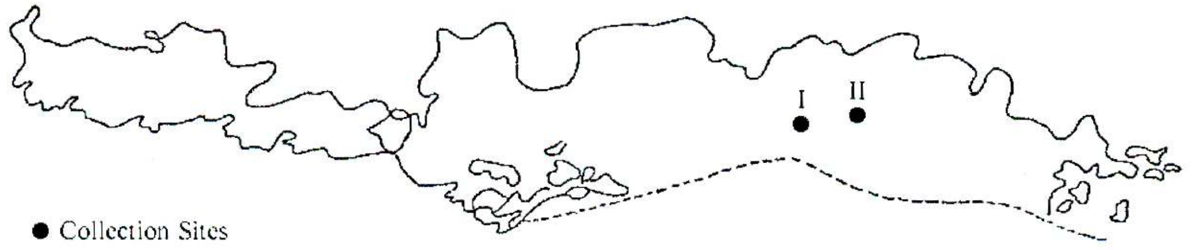

Fig. 1. Schirmacher Oasis, map.

RESULTS

The soil mechanical composition demonstrated a high percentage of coarse sand and a low percentage of clay in the site I, and higher percentage of clay in the site II (Table 1). The color of soil was grayish-black in the site I and blackish-brown in the site II. The mean values of all the physical and chemical parameters of soil were comparatively low in the site I (Table 2, Fig.2).

The soil mites found are reported in Table 3. In total 5 taxa were found. The species *Tyrophagus longior* was most dominant being found in both sites and comprising 31.47% of all mites found. *Nanorchestes* sp. was recorded from the site I only. The changes in the total number of mites in each site are shown in Table 3. *Nanorchestes* sp. showed very irregular trend of population fluctuations (Fig. 3).

In order to find out the regression and correlation, the edaphic factors and mite populations at each site were statistically analyzed. The dependence of soil mite abundance (Y) from each of six edaphic factors (variables) considered here was studied. It was checked whether relationship between the total number of mites and different variables remained constant throughout the period of study (Table 4, Figs. 4, 5).

The test failed to reveal identical relationships for sites I and II. Regression equations were obtained by pulling together data collected during the whole period of research. In the site I the soil temperature and the nitrate content showed insignificant positive correlation (third column of Table 4). All other parameters like the relative humidity, organic carbon, potassium and pH demonstrated negative correlations. Of these, the relative humidity and the organic carbon showed significant correlations with the mite abundance values. Unlike the site I all factors except the nitrate content showed insignificant positive correlations with the mite populations in the site II. The populations of mites indicated insignificant negative correlation with the nitrate content in soil.

DISCUSSION

The abundance of mite differed from one site to another (Fig. 3). According to Ghilarov [1973], the abundance of soil-inhabiting animals can decrease resulting from changes of some soil factors. Hazra [1994] reported lower densities of soil nematodes in non-polluted sites in the Schirmacher Oasis, which contained the low content of organic carbon, nitrate, R/H and significantly low soil temperature. In the present study, though the site II showed higher concentration of all six soil factors, the mite densities obtained were low in comparison to the site I. The site II soil contained higher concentrations of organic carbon, nitrate and potassium. However the toxic effects of pollutants present in the waste-water pond have resulted in low mite numbers. Similar results were obtained in India by Chattopadhyay and Hazra [1983] and Hazra and Choudhuri [1990]. Ingole and Parulekar [1987] and Ingole, Verlencar and Parulekar [1987] reported maximum number of mites in the moss—turf in the peripheral areas of the Priyadarshini lake located at the Schirmacher Oasis. Gressitt [1965] while studying ecology of *Stereotydeus mollis and Nanorchestes antarcticus* at Mc Murdo Sound area recorded 20–2000 specimens per square meter.

Table 1.
Mechanical analysis of soil samples, Schirmacher Oasis

Sites	Coarse sand (%)	Silt (%)	Clay (%)
I	85.70	12.80	1.50
II	70.50	15.40	14.10

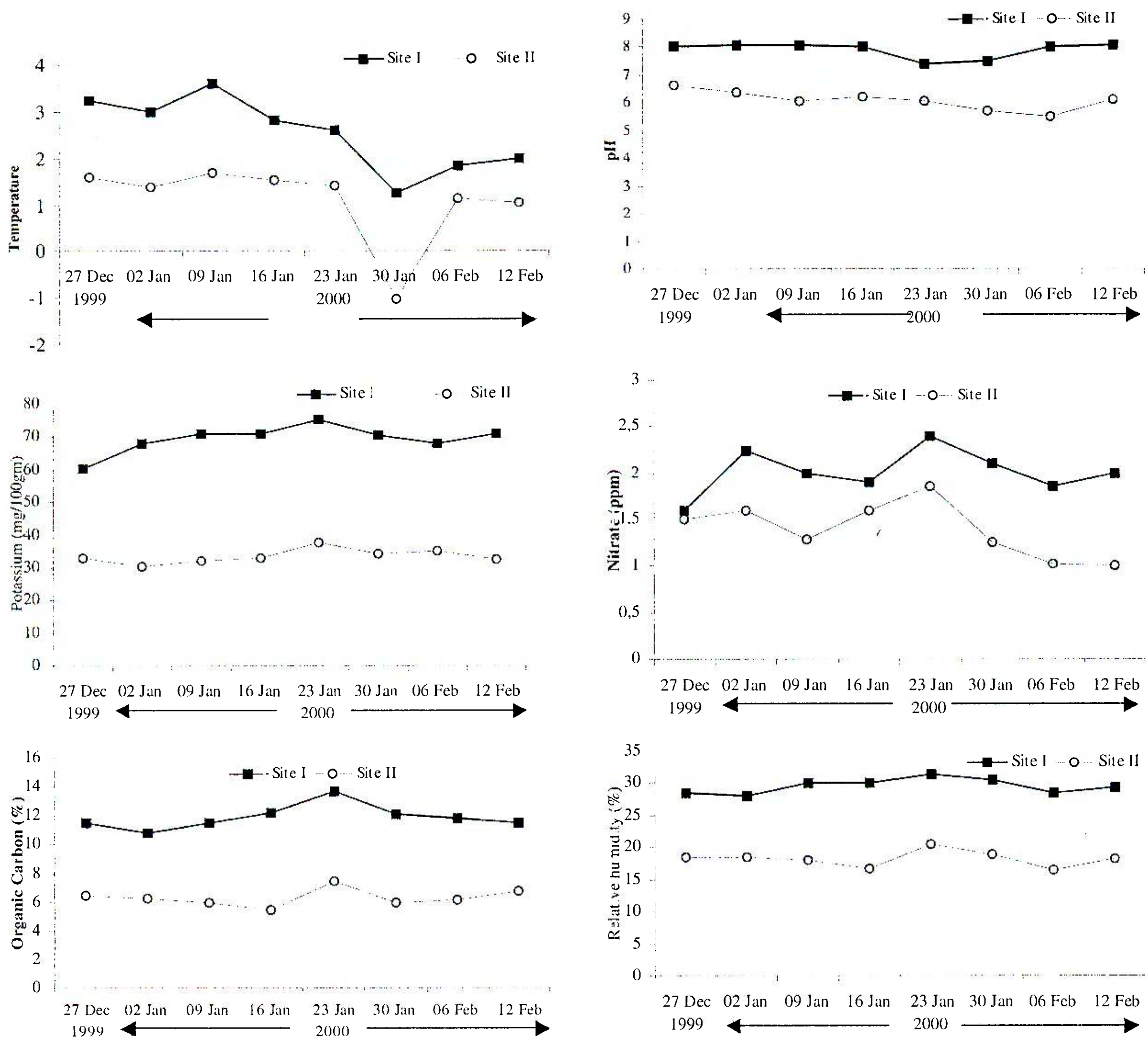

Fig. 2. Fluctuations of mean values of temperature (°C), pH, potassium (mg/100gm), nitrate (ppm), organic carbon (%) and relative humidity (%) in two sites, Schirmacher Oasis.

Fitzsimons [1971] and Young [1979] reported temperature tolerance in Antarctic mites. Due to this characteristics the mites in the present study exhibited a wide range of tolerance to temperature indicated by presence of both high and low soil temperature (Figs. 2, 4, 5). As to the role of other soil factors, it might be assumed that the factors analyzed in this study exerted significant effects either singly or in a cumulative way.

The significant negative correlation between the relative humidity content of soil and the mite density in the site I indicated that low temperature and low relative humidity led to mite number increase. Not similar result obtained for the site II might be due to the occasional inundation of the site and the cumulative effect of other soil factors. Hazra [1994] recorded a significant positive correlation between soil relative humidity and soil nematode poplulations at the Schirmacher Oasis. The content of organic carbon exhibited significant negative correlation with the mite abundance in the site I. Thus, not only soil organic carbon but other factors may influence the mite abundance. The results reported from India by Choudhuri and Banerjee [1977], Joy and Bhattacharyya [1981], Sanyal [1981], Choudhuri and Pande [1982], Hazra and Choudhuri [1990] and Banerjee and Sanyal [1991] support the positive correlation between organic carbon and mite abundance exists. In the site I the soil nitrate content correlated positively with the mite abundance. Similar data were reported by Hazra and Choudhuri [1990] and Hazra [1994]. The negative correlation in the site II might be due to polluted nature of the site. The negative correlation between potassium and pH and the mite abundance indicated that these two factors had little effect on mites.

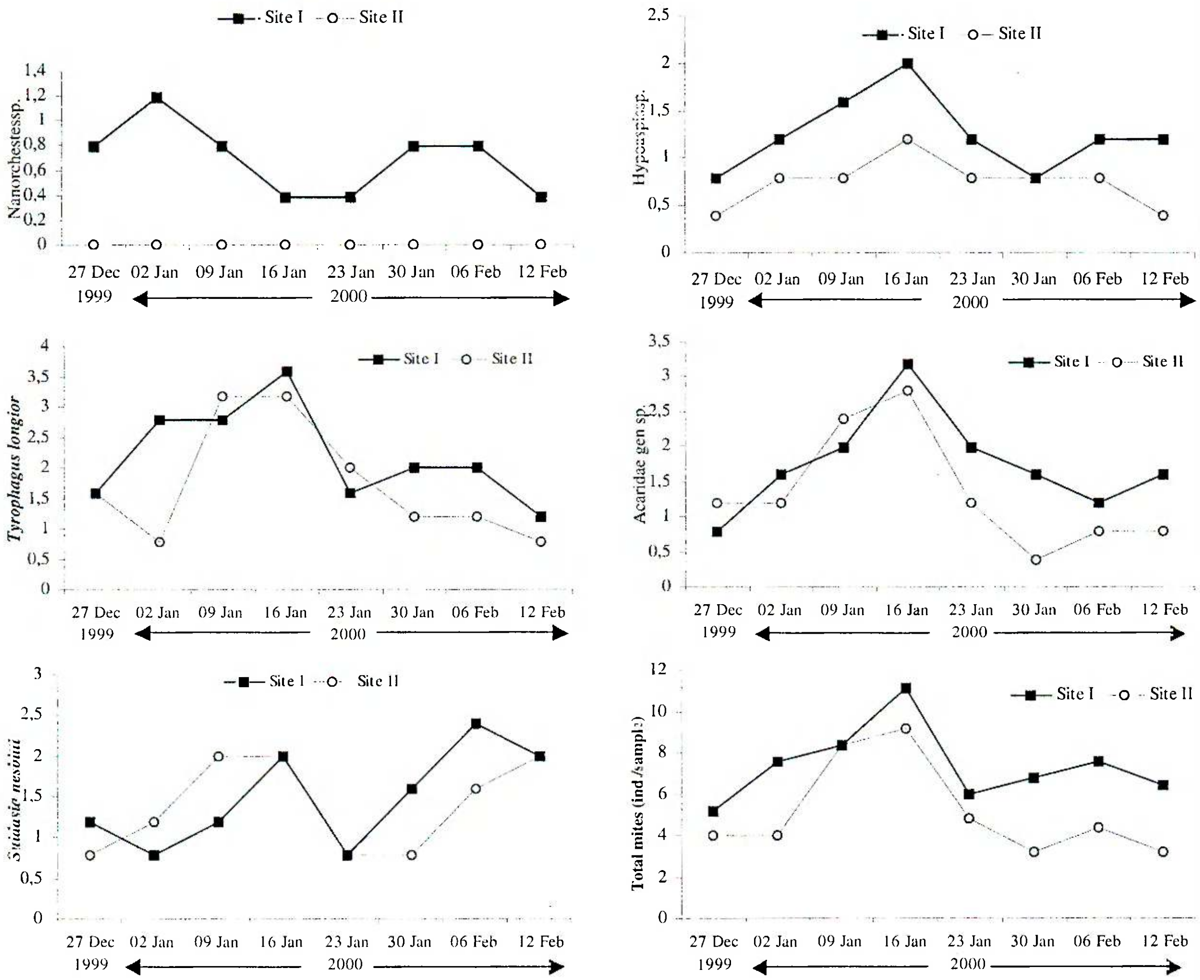

Fig. 3. Dynamics of the relative mite abundance (ind./sample), Schirmacher Oasis.

Table 2.
Mean values of different soil factors, Schirmacher Oasis

Dates	Temperature (°C)	R/H (%)	Organic Carbon (%)	Nitrate (ppm)	Potassium (mg/ 100 gm)	pH
			Site I			
27.12.1999	1.58	18.50	6.50	1.50	33.00	6.65
2.01.2000	1.39	18.50	6.30	1.60	30.50	6.40
9.01.2000	1.68	18.00	6.00	1.28	32.10	6.05
16.01.2000	1.52	16.80	5.50	1.60	33.00	6.20
23.01.2000	1.42	20.50	7.50	1.85	37.80	6.09
30.01.2000	−1.04	19.00	6.00	1.25	34.40	5.70
6.02.2000	1.15	16.50	6.20	1.02	35.00	5.50
12.02.2000	1.05	18.20	6.80	1.00	32.50	6.10
			Site I			
27.12.1999	3.25	28.50	11.50	1.60	60.50	8.00
2.01.2000	3.00	28.00	10.85	2.24	68.00	8.10
9.01.2000	3.60	30.20	11.50	2.00	71.10	8.10
16.01.2000	2.80	30.00	12.25	1.90	71.00	8.00
23.01.2000	2.60	31.50	13.72	2.40	75.10	7.40
30.01.2000	1.25	30.60	12.10	2.10	70.80	7.50
6.02.2000	1.85	28.5	11.85	1.85	68.00	8.00
12.02.2000	2.00	29.50	11.50	2.00	71.00	8.10

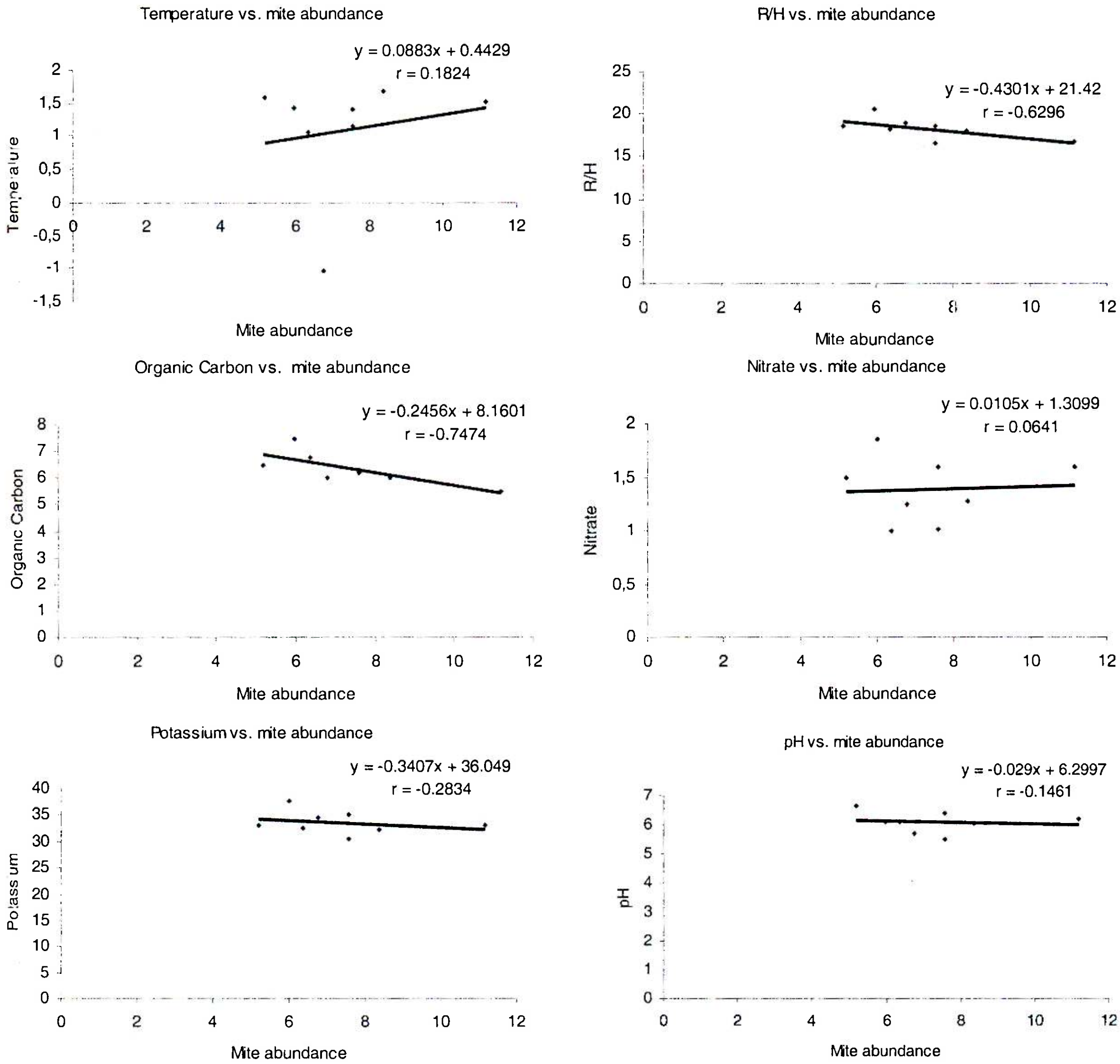

Fig. 4. Relationships between the total mite abundance (ind./sample) and soil abiotic factors, site I, Schirmacher Oasis.

Table 3.
Taxonomic diversity and abundance of soil mites (ind./sample), Schirmacher Oasis

Species	27.12.99	2.01.00	9.01.00	16.01.00	23.01.00	30.01.00	6.02.00	12.02.00
Site I								
Nanorchestes sp.	0.79	1.19	0.79	0.39	0.39	0.79	0.79	0.39
Suidasia nesbitti Hughes, 1948	1.19	0.79	1.19	1.99	0.79	1.59	2.39	1.99
Acaridae gen. sp.	0.79	1.59	1.99	3.18	1.99	1.59	1.19	1.59
Tyrophagus longior (Gervais, 1844)	1.59	2.79	2.79	3.59	1.59	1.99	1.99	1.19
Hypoaspis sp.	0.79	1.19	1.59	1.99	1.19	0.79	1.19	1.19
Site II								
Suidasia nesbitti Hughes, 1948	0.79	1.19	1.99	1.99	0.79	0.79	1.59	1.19
Acaridae gen. sp.	1.19	1.19	2.39	2.79	1.19	0.39	0.79	0.79
Tyrophagus longior (Gervais, 1844)	1.59	0.79	3.18	3.18	1.99	1.19	1.19	0.79
Hypoaspis sp.	0.39	0.79	0.79	1.19	0.79	0.79	0.79	0.39

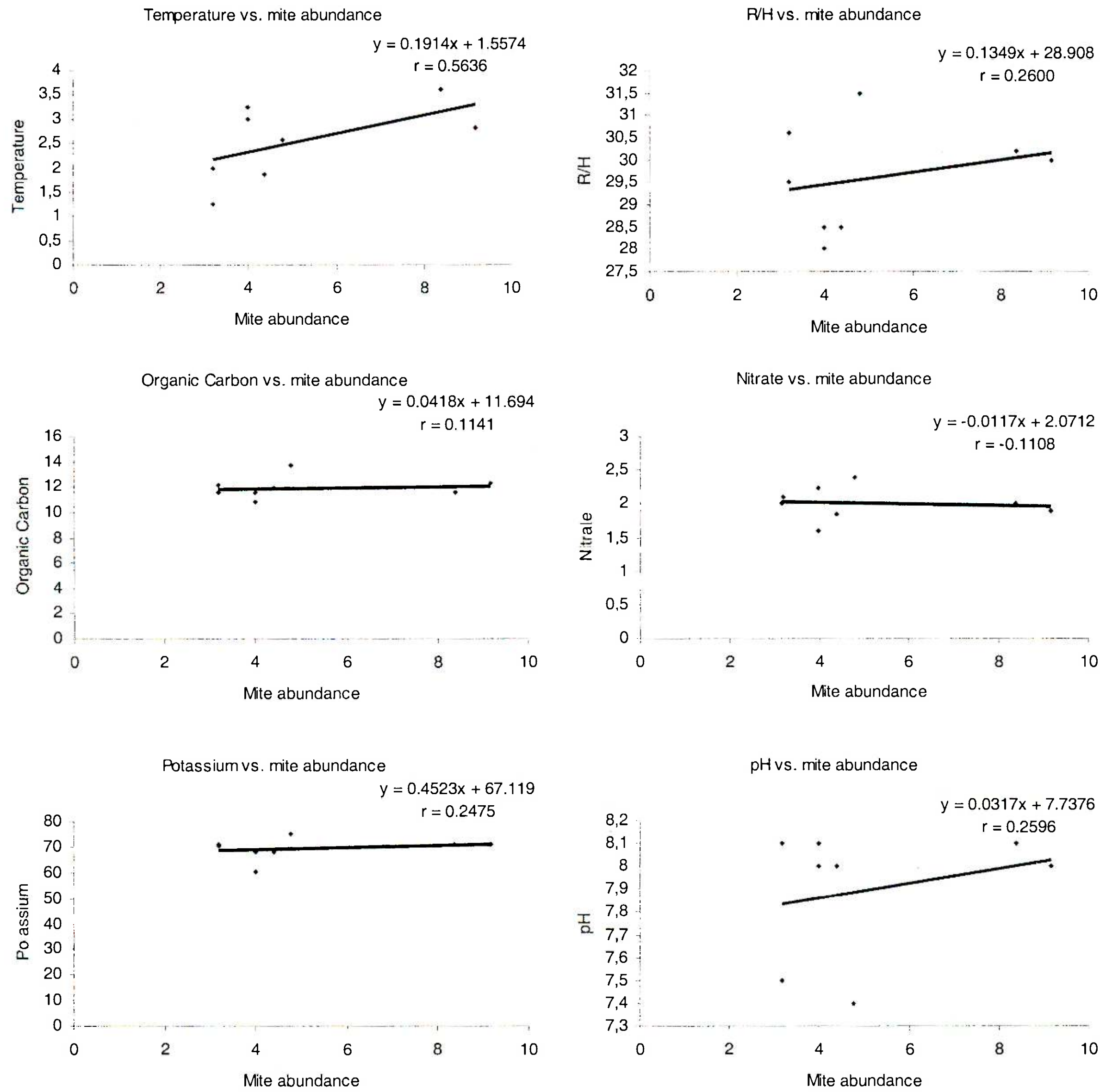

Fig. 5. Relationships between the total mite abundance (ind/sample) and soil abiotioc factors, site II, Schirmacher Oasis.

It can be concluded that the abiotic components collectively contribute to the process of formation of the fauna of soil mites, influence their abundance and fluctuations in the adverse environment of the Antarctic continental zone.

ACKNOWLEDGEMENTS

The author is grateful to Dr. J.R.B. Alfred, Director, Zoological Survey of India, for his constant inspiration for studying the soil mites of Antarctica and providing all necessary help for the study. The author expresses sincere thanks to scientists and technical staff of the same Institute, Dr. A.K. Hazra, Scientist-“E”, for encouragement, help and suggestions to improve the manuscript, Dr. S.K. Gupta, Emeritus Scientist, for identification of some mite specimens, and to Mr. Shri Anand Kumar Ayyaswamy, Mr. Shri Amitava Roy and Dr. Sandeep K. Tiwari for computation of data. The author is also thankful to Dr. S.C. Santra, Department of Environment, the University of Kalyani, for the chemical analysis of the soil samples.

The author is grateful to the Ministry of Environment and Forests, and to the Department of Ocean Development, the Government of India, for providing an opportunity to participate in the XIX Indian Scientific Expedition to Antarctica.

REFERENCES

Banerjee S., Sanyal A.K. 1991. Oribatid mites as bioindicator of soil organic matter. *In*: G.K. Veeresh, Rajagopal, C.A. Viraktamath (Eds.). Advances in Management and Conservation of soil fauna. Proc. 10th Int. Soil Zool. Colloq., Bangalore, pp. 877–880.

Table 4.
Relationships between the total mite abundance (ind./sample) and edaphic factors, Shirmacher Oasis

Parameters	Mean + S.D.	«r» value	Regression equation
	Site I		
Y: Mite abundance	7.37+1.83		
Soil temperature (°C)	1.09+0.88	0.1824	Y= 0.09x+0.44
Relative humidity (%)	18.25+1.25	− 0.6296*	Y= −0.43x+21.42
Organic carbon(%)	6.35+0.60	− 0.7474*	Y= −0.25x+8.16
Potassium (mg/100 gm)	33.53+2.20	−0.2834	Y= −0.34x=36.05
Nitrate (ppm)	1.38+0.30	0.0641	Y= 0.01+1.30
pH	6.08+0.36	−0.1461	Y= −0.03x+6.30
	Site II		
Y: Mite abundance	5.13+2.38		
Soil temperature (°C)	2.54+0.79	0.5636	Y= 0.19x+1.56
Relative humidity (%)	29.6+1.20	0.2600	Y= 0.14x+28.91
Organic carbon (%)	11.91+0.85	0.1141	Y= 0.04x+11.69
Potassium (mg/100 gm)	69.44+4.24	0.2475	Y= 0.45x+67.12
Nitrate (ppm)	2.01+0.24	− 0.1108	Y= −0.01x+2.07
pH	7.9 +0.28	0.2596	Y= 0.03x+7.74

5% significance

Chattopadhyay A., Hazra A.K., 1983. Subterranean arthropod communities in sewage effluent contaminated soil environment near Calcutta. *Environment and Ecology*, 1: 121–124.

Choudhuri D.K., Banerjee S. 1977. *Soil factors and soil oribatid mites under conditions of West Bengal.* The University of Burdwan Publication, 88 pp.

Choudhuri D.K., Pande T. 1982. An ecological studies of acarines from soil of Himalayan ecosystem. *Geobios new Reports,* 1: 24–26.

Fitzsimons J.M. 1971. Temperature and three species of antarctic arthropods. *Pacific Insects Monograph,* 25: 127–135.

Ghilarov M.S. 1973. General trends of changes in soil animal population of arable land. *In*: Progress in Soil Zoology. Proc. 5th International Colloquium on Soil Zoology, pp. 399–407.

Gressitt J.L. 1965. Terrestrial animals. *In*: T. Hatherton (Ed.). Antarctica, Methuen, London, pp. 351–371.

Gressitt J.L. (Ed.) 1970. Subantarctic entomology, particularly of South Georiga and Heard Island. *Pacific Insects*, 23: 1–374.

Hazra A.K. 1994. A study on the population ecology of soil nematode fauna in relation to some edaphic factors in Schirmacher Oasis, Antarctica. *IXth Indian Expedition to Antarctica, Scientific Report, Department of Ocean Development, Technical Publication,* 6: 65–90.

Hazra A.K., Choudhuri D.K. 1990. Ecology of subterranean macro- and microarthropod fauna in different degraded and polluted soil environment of West Bengal, India. *Rec. zool. Surv. India*, Occ. Paper, 120: 1–295.

Ingole B.S., Parulekar A.H. 1987. Microfauna of Schirmacher Oasis, Antarctica: Water-moss communities. *IVth Indian Expedition to Antarctica, Scientific Report, Department of Ocean Development, Technical Publication,* 4: 139–148.

Ingole B.S., Verlencar X.N., Parulekar A.H. 1987. Microfauna of Priyadarshini lake, Schirmacher Oasis, Antarctica. *IVth Indian Expedition to Antarctica, Scientific Report, Department of Ocean Development, Technical Publication,* 4: 149–154.

Janetschek H. 1967. Arthropod ecology of South Victoria land. *Antarctic Research Series*, 10: 205–293.

Joy S., Bhattacharya T. 1981. Cryptostigmatid polpulation of a Banana plantation in relation to some edaphic factors. *In*: G.K. Veeresh (Ed.). Progress in Soil Biology and Ecology in India, Bangalore, UAS Tech. Series, 37: 100–107.

Macfadyen A. 1953. Notes on methods for the extraction of small arthropods. *J. Anim. Ecol.*, 22: 65–67.

Sanyal A.K. 1981. Qualitative and quantitative composition of Oribatei in gangetic Delta of West Bengal in relation to edaphic factors. *Bull. zool. Surv. India*, 4: 295–307.

Walkley A, Black I. A. 1934. An examination of the Deg-jareff method for determining soil organic matter, and a proposed modification of the chromic and titration method. *Soil Sci.*, 37: 29–38.

Young S.R. 1979. Effect of temperature changes on the metabolic rate of an Antarctic Mite. *Journal of Comparative Physiology,* 131: 341–446.