

OCCASIONAL PAPER NO. 177

**RECORDS OF THE
ZOOLOGICAL SURVEY OF INDIA**

**Ecology of Soil Oribatid Mites (ACARI)
in Relation to some Edaphic Factors
in Gangetic Delta of West Bengal**

**A. K. SANYAL
B. G. KUNDU
S. ROY**

ZOOLOGICAL SURVEY OF INDIA

**RECORDS
OF THE
ZOOLOGICAL SURVEY OF INDIA**

OCCASIONAL PAPER NO. 177

**Ecology of Soil Oribatid Mites (ACARI) in Relation to
some Edaphic Factors in Gangetic Delta of West Bengal**

A. K. SANYAL and B. G. KUNDU
Zoological Survey of India, Calcutta

S. ROY
*Department of Zoology, University of Burdwan
Burdwan-713104, India*

Edited by the Director, Zoological Survey of India



सत्यमेव जयते

**Zoological Survey of India
Calcutta
1999**

CITATION

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. Rec. zool. Surv. India, Occ. Paper No. 177* : i-iv, 1-61 pp. (Published - Director, ZSI)

Published : September, 1999

ISBN : 81-85874-17-4

© Govt. of India, 1999

ALL RIGHTS RESERVED

- No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without the prior permission of the publisher.
- This book is sold subject to the condition that it shall not, by way of trade, be lent, re-sold, hired out or otherwise disposed of without the publisher's consent, in any form of binding or cover other than that in which it is published.
- The correct price of this publication is the price printed on this page. Any revised price indicated by a rubber stamp or by a sticker or by any other means is incorrect and should be unacceptable.

PRICE

Indian Rs. 250/-
Foreign \$ 15.00 £ 12.00

Published at the Publication Division, by the Director, Zoological Survey of India, 234/4 A. J. C. Bose Road, 2nd MSO Building, Nizam Palace (13th floor), Calcutta 700 020 after laser typesetting by Krishna Printing Works, Calcutta 700 006 and printed at Hooghly Printing Co. Ltd. (A govt. of India Enterprises), 41 Chowringhi Road, Calcutta 700 071.

Records of the Zoological Survey of India

OCCASIONAL PAPER

No. 177

1999

Pages 1-55

CONTENTS

1.	INTRODUCTION	1
2.	MATERIALS AND METHODS	1
3.	OBSERVATIONS	2
	(i) Sampling site : D-1	2
	(ii) Sampling site : D-2	16
4.	REGRESSION AND CORRELATION	25
5.	DISCUSSION	47
6.	SUMMARY	50
7.	ACKNOWLEDGEMENTS	51
8.	REFERENCES	51

INTRODUCTION

A series of autecological and synecological investigations of oribatid mites in different ecosystems have been made in different parts of the world specially in Europe, U. S. A., Latin America and Japan. As an outcome of those investigations there have been found publications and accumulation of pertaining literatures contributed by the eminent workers in those parts of the world who are fully aware of academic and practical utility. In contrast to this, in India the research contribution in respect of ecology of mites in general and oribatids in particular are rather insufficient despite their abundance in different habitats. Whatever informations are available in this respect are mainly due to the contributions made by different workers from time to time. Notable among them are Dhillon and Gibson (1962), Banerjee (1973, 1974a, 1974b, 1988), Choudhuri and Banerjee (1975, 1977), Joy and Bhattacharya (1977, 1981), Choudhuri and Pande (1979, 1982), Bhattacharya *et al.* (1980), Bhattacharya and Joy (1980a, 1980b), Bhattacharya and Bhattacharya (1981, 1984), Bhattacharya *et al.* (1981), Banerjee and Roy (1981), Ghatak and Roy (1981, 1991), Singh and Mahajan (1981), Sanyal (1981a, 1981b, 1982, 1988, 1991a, 1991b), Sanyal and Bhaduri (1982), Mitra *et al.* (1983), Sanyal and Sarkar (1983, 1993), Sengupta and Sanyal (1986, 1991), Choudhuri and Paul (1987a, 1987b), Mitra and Mukherjee (1987), Prabhoo *et al.* (1988), Hazra and Sanyal (1989), Sarkar (1990, 1991), Sheela and Haq (1991), Banerjee and Sanyal (1991) and Hatter *et al.* (1992), who made some observations on oribatid mites found in different habitats in India.

Sanyal (1994) published a review on the contributions made by Indian workers on ecology of soil oribatid mites. In spite of the attempts made by Indian workers more areas still remain unexplored. Therefore, more intensive investigation for obtaining a comprehensive and better picture as to the ecology of soil oribatid mites inhabiting tropical climates of India seems to be an unavoidable academic necessity. It is in this context the present investigation has been undertaken to study the distribution, density and seasonal fluctuation of soil oribatid mites in relation to the different soil factors, namely, temperature, moisture, pH and organic carbon in two undisturbed, uncultivated and well-vegetated sampling sites at Dakshineswar in the district of North 24-Parganas of West Bengal in India.

MATERIALS AND METHODS

The experimental fields were located in North 24-Parganas district in the State of West Bengal in India. A total number of 288 soil samples were drawn from 8 plots in two sampling

sites at monthly interval over a period of three years (January, 1989 to December, 1991), i.e., at the rate of four samples per month per site.

The undisturbed soil samples were drawn at random using stainless steel cores with an internal diameter of 5.8 cm. Each soil core was 26.43 sq cm in surface area and 10 cm in depth.

The extraction of soil samples were carried out by Tullgren funnel as modified by Murphy (1962). A 25 watt electric bulb was used as the source of heat and light. The cryptostigmatid mites, thus collected, were kept in a solution of 90% alcohol and lactic acid (v/v) as advocated by Balogh (1972). For microscopic examination, temporary mounting was done in lactic acid.

The temperature of the soil was measured by directly inserting a soil thermometer into the soil. The soil moisture was estimated by using an infrared moisture balance. pH value was measured with the help of Beckman pH meter. Rapid titration method of Walkley and Black (1934) was followed to determine the organic carbon content of the soil.

OBSERVATIONS

The present investigation involves the extraction of cryptostigmatid fauna from the soil samples of eight sampling plots in two different habitat types, such as, 1) Guava plantation site (D-1) and 2) Mixed plantation site (D-2) situated at Dakshineswar in North 24-Parganas district of West Bengal State in India (Figure 1).

District North 24-Parganas : The district of North 24-Parganas which forms southeast part of West Bengal is in the Gangetic plain. Geographically it is situated to the south of Tropic of Cancer and falls into "Torried Zone", but the presence of river Ganges and series of canals and tanks do not allow extreme climatic conditions to prevail upon. It is bounded by Nadia district in north, by Calcutta and South 24-Parganas district in south, by Bangladesh in the east and river Ganges in the west. Average annual rainfall ranges between 1150-1610 mm. Soils of this district is alluvial in nature and belong to Ganga family Alluvium.

i) Sampling site : D-1 (Guava plantation) – The sampling site was uncultivated and undisturbed and located at a place north of Dakshineswar town in between Dakshineswar and Ariadaha. The site was under the Jurisdiction of Kamarhati Municipality of Belghoria P.S. The Barrackpore Trunk Road runs about 1 km away from the site on eastern side and the river Ganges runs about 1 km away on the western side (Figure 1). It included 4 sampling plots each 12 metres square from where soil samples were collected.

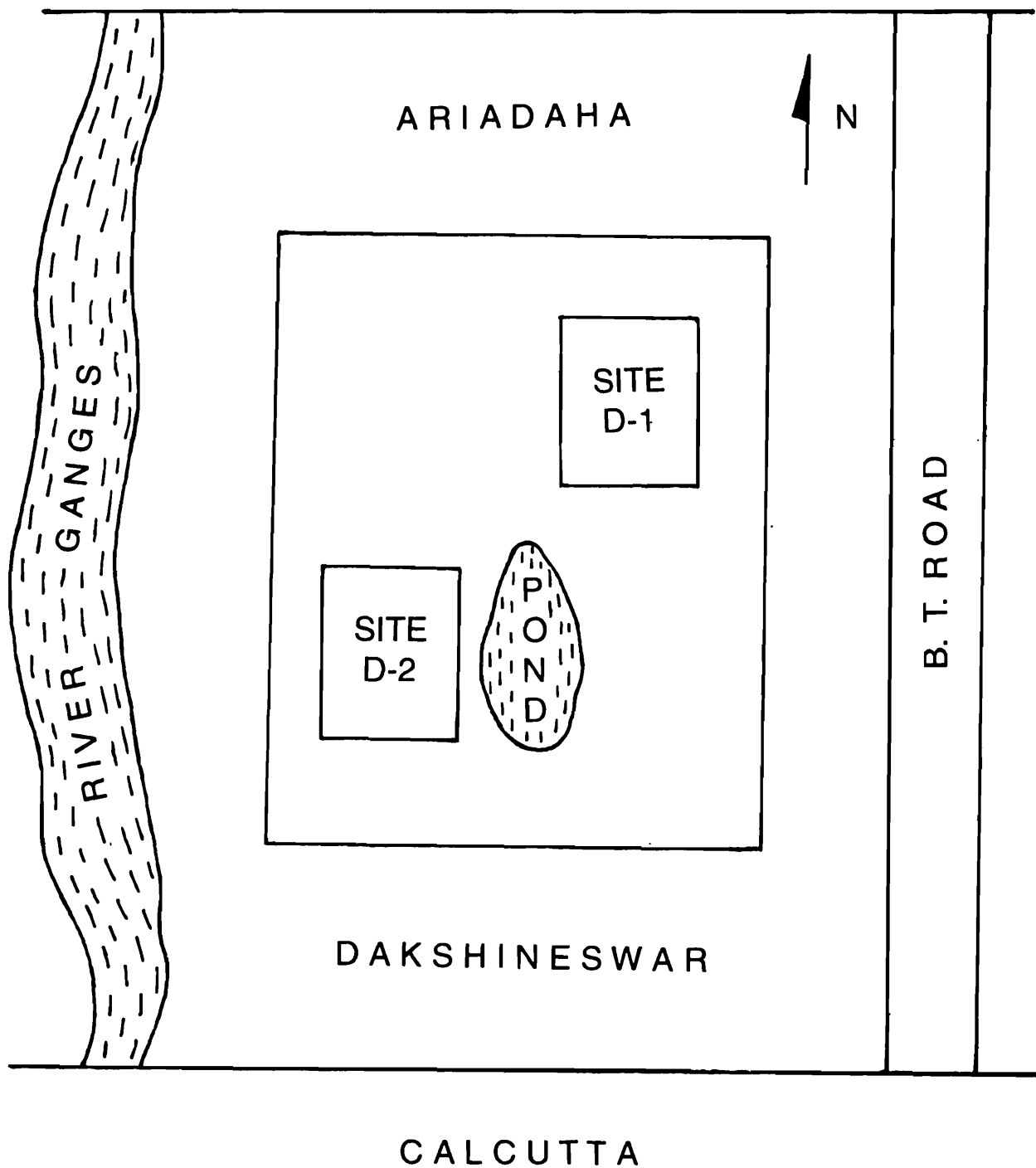


Fig. 1. Showing sampling site D-1 (Guava Plantation : *G Pl*) and sampling site D-2 (Mixed Plantation : *M Pl*) at Dakshineswar in North 24-Parganas, West Bengal.

Vegetation : The sampling site was well-vegetated and was covered with thin layer of grass and scattered herbs and shrubs. The plot mainly contained many guava (*Psidium guajava*) plants arranged in rows (Figures 2-3). Besides these plants the plot contained herbs and shrubs like *Rungia parviflora*, *Ruellia tuberosa*, *Amaranthus viridis*, *Alternanthera sessilis*, *Pupalia artopepuria*, *Herpestis monniera*, *Vernonia cinera*, *Ageratum conyzoides*, *Solanum nigrum*, *Acalypha indica*, *Phyllanthus reticulatus*, *Commelina obliqua*, *Digitaria sanguinalis*, *Ipomoea* sp. Shade was found to prevail throughout the day.

Soil factors : Soils of the plots were alluvial in nature, dark grey in colour and clayloam in texture, pH of the soil in three years varied between 5.77 – 6.85. Soil moisture was at the minimum level in June (18.6%) in 1989, in July (17.0%) in 1990 and in May (18.5%) in 1991. It was at the peak in September both in 1989 and 1990 and in August in 1991. Organic carbon content was fairly high in the month of February over whole sampling period (2.17% in 1989, 2.21% in 1990 and 2.20% in 1991). It was at the lowest level in August throughout the period of study. Highest soil temperature in all three years was recorded in June when organic carbon concentration was fairly low. Soil temperature in winter months (December – February) in each year was fairly low (Table 1 and Figures 4-7). Mean values of soil factors presented in Table 1 do not exhibit a wide range of variation in their concentration.

Oribatid population : Oribatid mites extracted from this sampling site belonged to 10 genera and species were identified as *Scheloribates albialatus* Hammer, 1961, *Tectocepheus velatus* (Michael, 1888), *Oppia yodai* Aoki, 1965, *Oppiella nova* (Oudemans, 1902), *Paralamellobates bengalensis* Bhaduri and Raychaudhuri, 1968, *Epilohmannia pallida indica* Bhattacharya and Banerjee, 1979, *Lanceoppia* sp., *Atropacarus (Hoplophorella) scapellatus* (Aoki, 1965), *Chaunoproctus abalai* Bhaduri, Bhattacharya and Chakrabarti, 1975, *Pergalumna* sp. (Table 2). The analysis of data pertaining to total number of oribatid mites of this site collected for three years clearly showed that of the 10 genera, the genus *Scheloribates* comprising about 32.56 % was the most dominant form and it was found in all the samples. The genera *Tectocepheus*, *Oppia*, *Oppiella*, and *Paralamellobates*, comprising 18.04 %, 13.88 %, 9.90 % and 7.57 % respectively of the total population, occupied the 2nd, 3rd, 4th and 5th position in order of dominance. Individuals of other forms like *Epilohmannia* (6.26%) and *Pergalumna* (2.28%) were encountered in all the samples but their numbers were fairly low. The remaining genera, viz., *Lanceoppia* (4.04%), *Atropacarus (Hoplophorella)* (3.07%) and *Chaunoproctus* (2.40%) were insignificant in number and altogether absent in many samples (Tables 2-3 and Figure 8).

Seasonal fluctuation : Total population of oribatids as well as the population of important genera extracted from the sampling site exhibited an irregular trend of fluctuation over the sampling



2



3

Figs. 2-3. Photographs showing sampling site D-1 (Guava Plantation).

Table 1

Showing mean values of soil factors and mean number of soil oribatids
of sampling site D-1 (Guava Plantation)
January, 1989 to December, 1989

Month	pH	Temp. (°c)	Moisture (%)	Organic Carbon (%)	Oribatid mites
Jan.	6.1	18.5	21.8	1.98	25
Feb.	5.8	22.0	22.3	2.17	55
Mar.	5.77	23.8	22.5	1.91	22
Apr.	6.72	25.0	22.0	1.85	20
May	6.70	30.0	21.0	1.60	15
Jun.	6.2	30.1	18.6	1.55	19
Jul.	6.78	29.8	19.0	1.66	12
Aug.	6.85	28.6	26.5	1.45	10
Sep.	6.02	28.8	29.6	1.57	14
Oct.	6.60	28.5	22.2	1.72	22
Nov.	6.1	24.5	24.8	1.98	31
Dec.	6.4	21.1	23.8	1.89	29

Table 1 (Contd.)

Showing mean values of soil factors and mean number of soil oribatids
of sampling site D-1 (Guava Plantation)
January, 1990 to December, 1990

Month	pH	Temp. (°c)	Moisture (%)	Organic Carbon (%)	Oribatid mites
Jan.	6.2	20.0	21.5	2.00	35
Feb.	6.0	21.1	24.3	2.21	48
Mar.	6.7	23.0	20.0	2.1	27
Apr.	6.68	28.6	19.0	1.75	18
May	6.62	29.6	19.5	1.70	19
Jun.	6.5	30.2	18.0	1.60	15
Jul.	6.77	29.3	17.0	1.64	13
Aug.	6.72	29.0	23.1	1.55	12
Sep.	6.60	28.7	27.0	1.61	14
Oct.	6.68	28.9	22.2	1.80	21
Nov.	6.00	21.2	23.0	2.1	37
Dec.	6.5	19.5	21.2	1.94	25

Table 1 (Contd.)

Showing mean values of soil factors and mean number of soil oribatids
of sampling site D-1 (Guava Plantation)
January, 1991 to December, 1991

Month	pH	Temp. (°c)	Moisture (%)	Organic Carbon (%)	Oribatid mites
Jan.	6.2	17.7	21.5	2.14	20
Feb.	6.0	20.4	22.5	2.20	45
Mar.	6.5	24.2	21.2	2.07	24
Apr.	6.72	30.0	19.1	1.91	14
May	6.6	30.3	18.5	1.80	10
Jun.	6.68	30.5	19.0	1.60	8
Jul.	6.5	29.0	20.0	1.65	15
Aug.	6.4	29.2	26.0	1.60	17
Sep.	6.0	28.5	25.7	1.75	22
Oct.	6.5	27.5	21.5	1.84	24
Nov.	6.35	24.0	24.2	2.0	28
Dec.	6.2	20.5	23.0	1.95	38

Soil pH range in 36 months of *G PI*

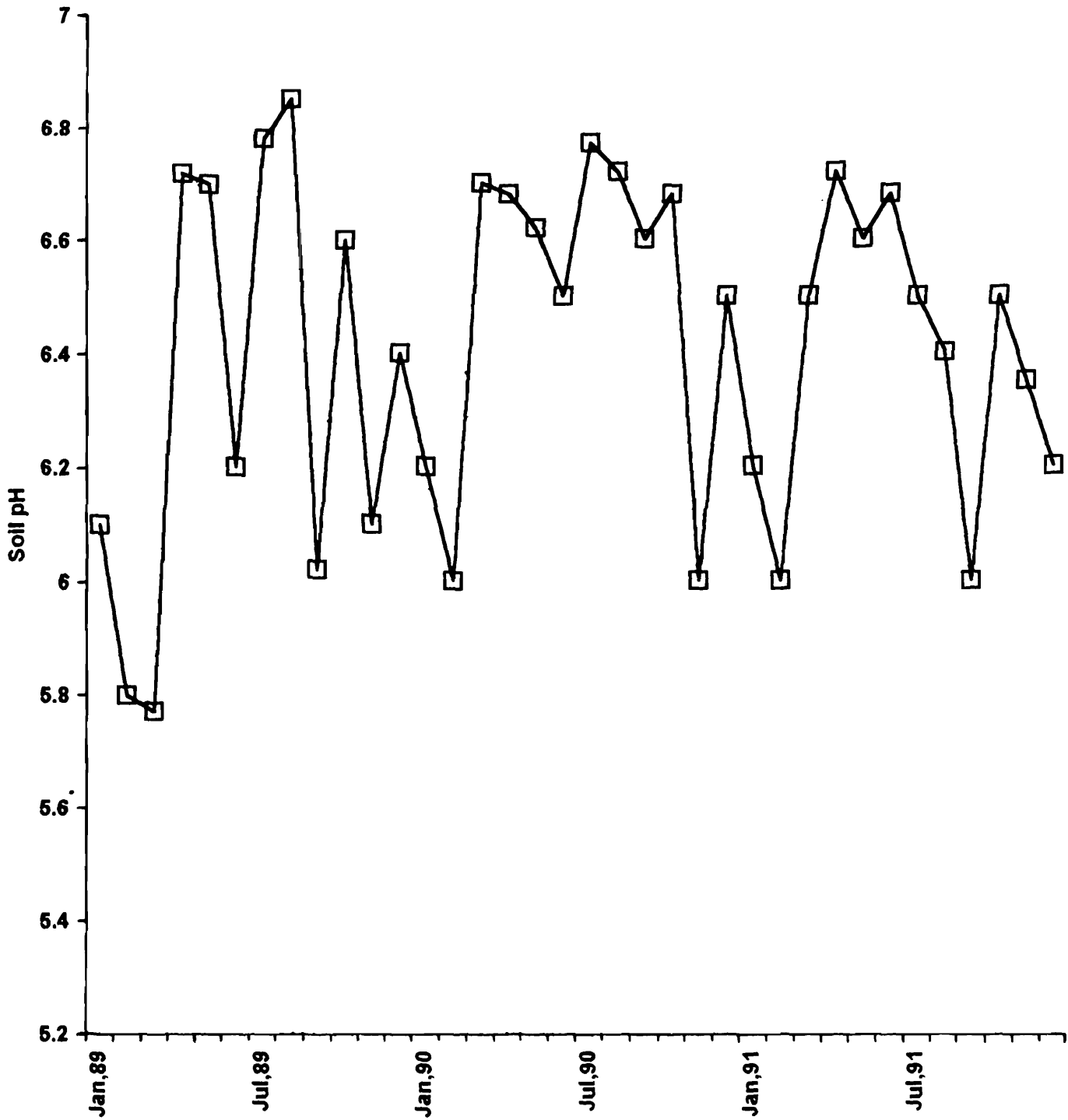


Fig. 4. Graph showing Soil pH range in 36 months (January, 1989 to December, 1991) of sampling site D-1 : Guava Plantation (*G PI*).

Soil Moisture range in 36 months of G Pl

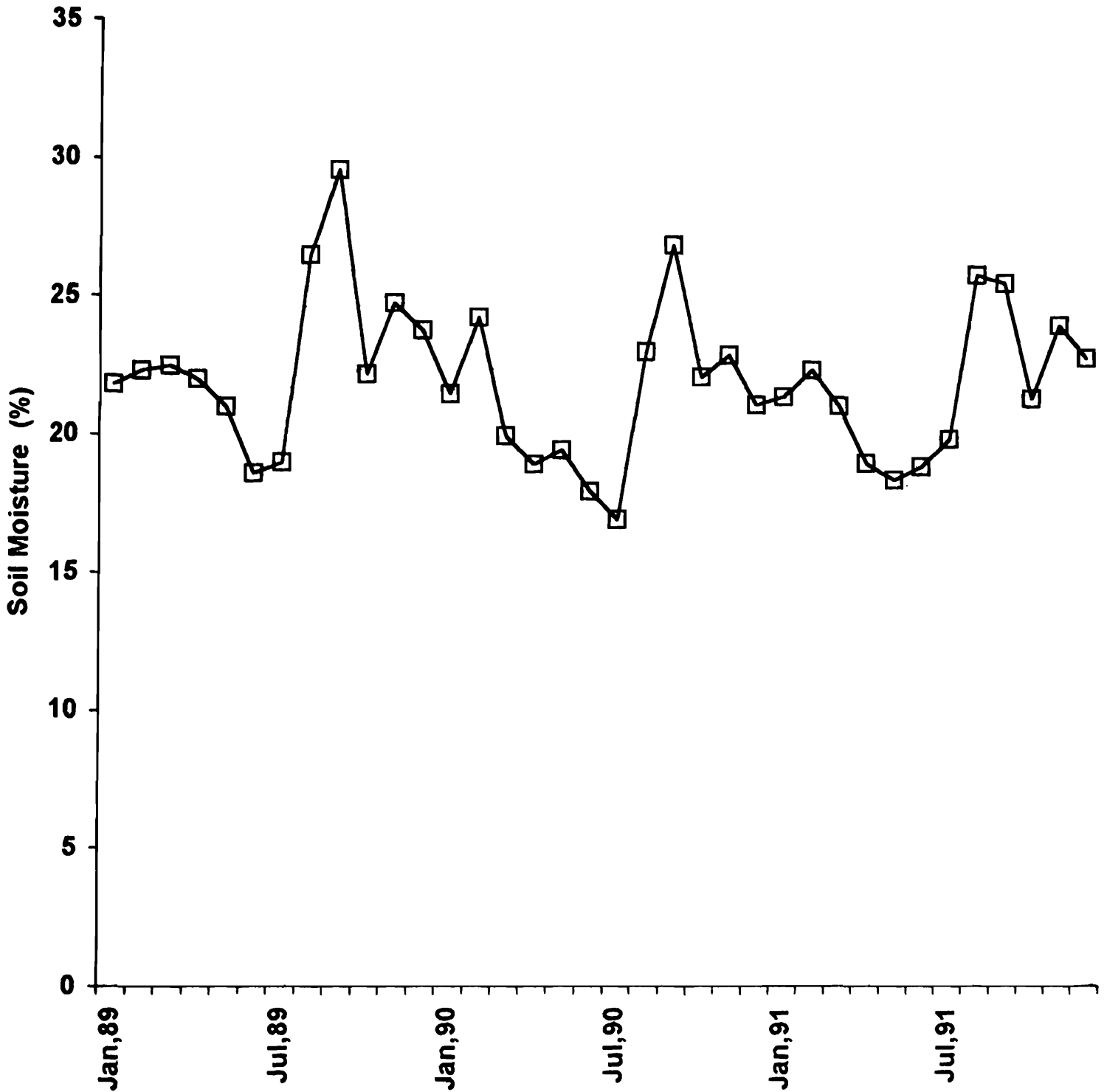


Fig. 5. Graph showing Soil Moisture (S Moist %) range in 36 months (January, 1989 to December, 1991) of sampling site D-1 : Guava Plantation (G Pl).

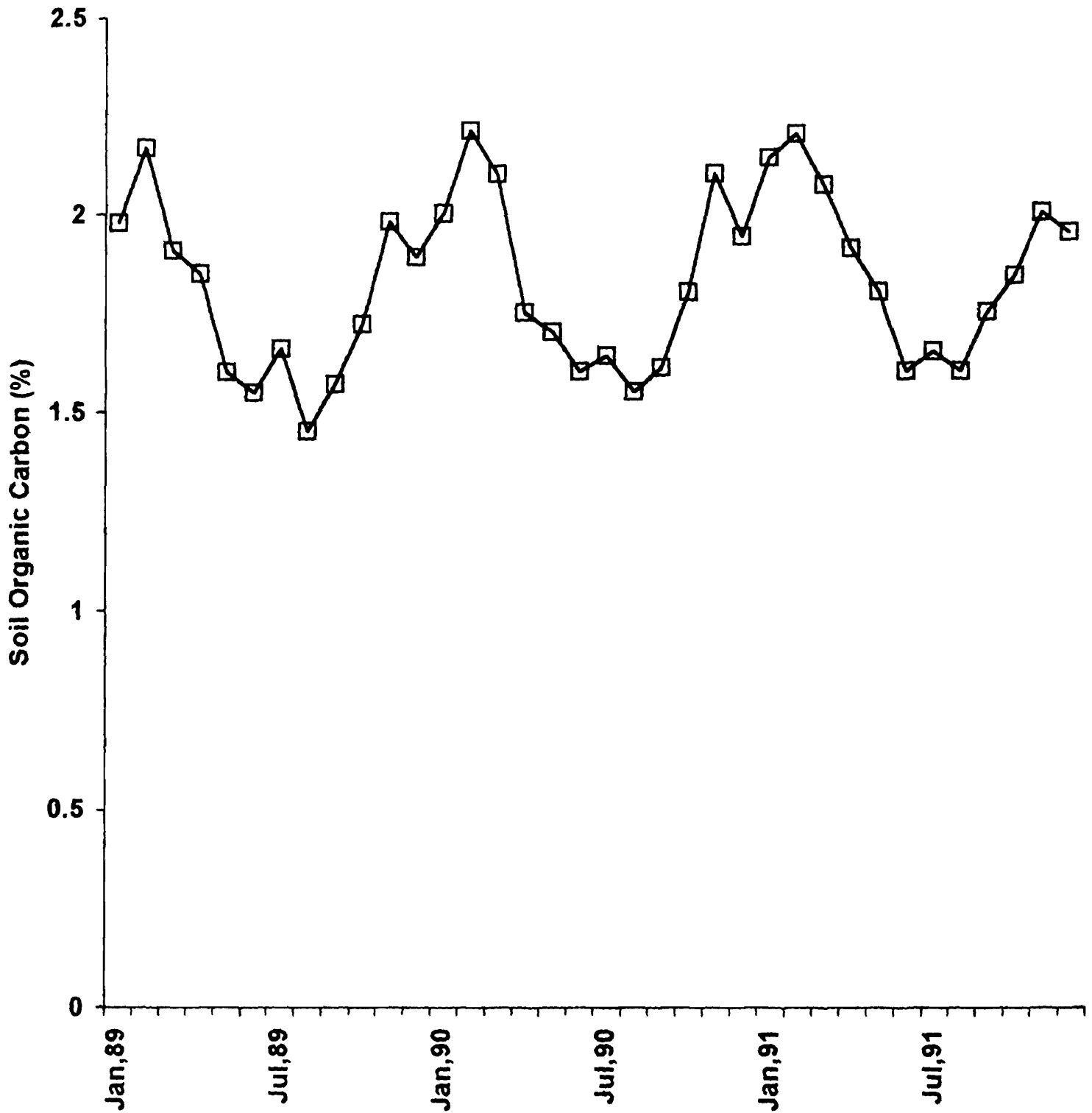
Soil Organic Carbon range in 36 months of *G Pl*

Fig. 6. Graph showing Soil Organic Carbon (Org Carb %) range in 36 months (January, 1989 to December, 1991) of sampling site D-1 : Guava Plantation (*G Pl*).

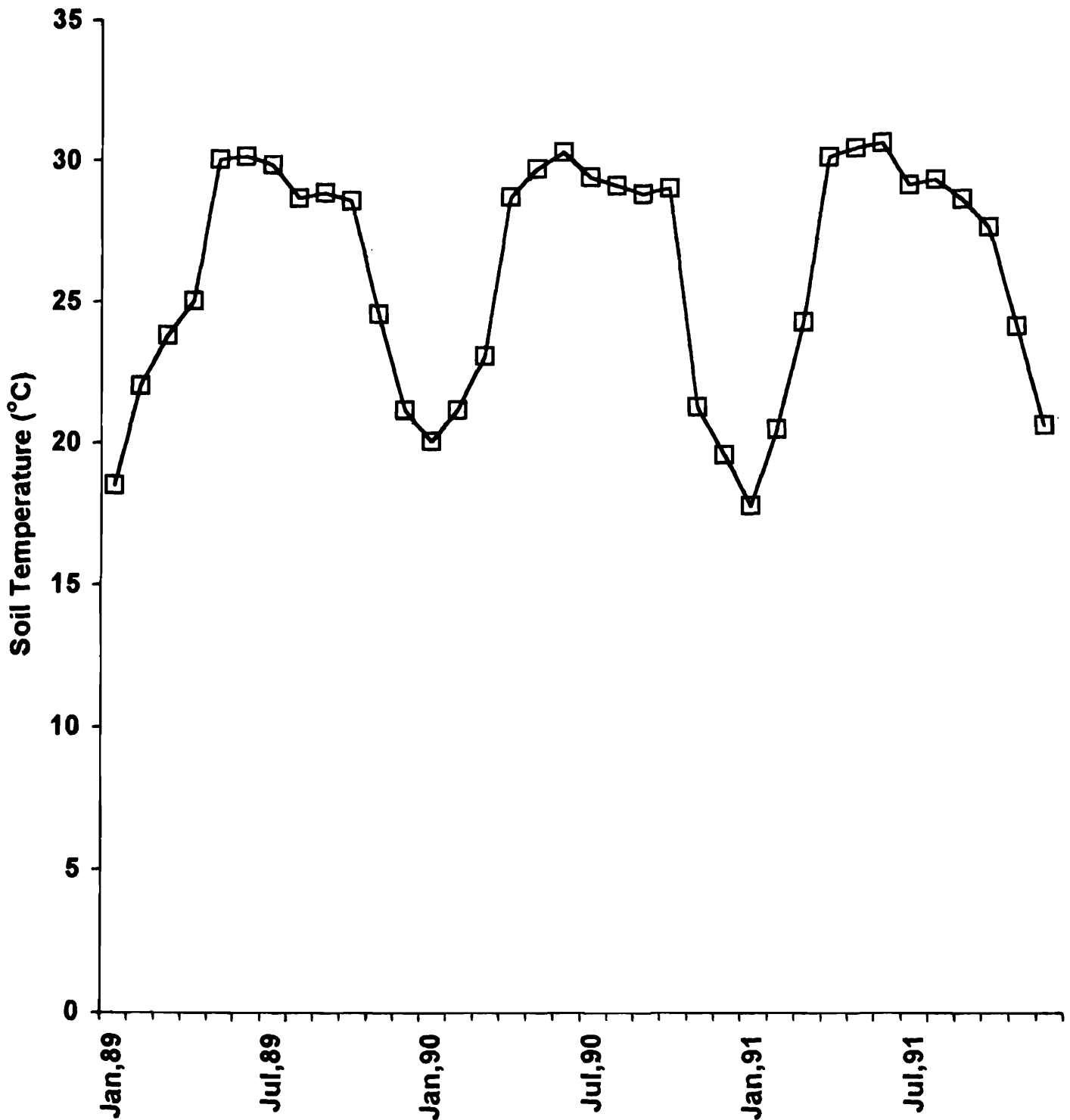
Soil Temperature range in 36 months of G Pl

Fig. 7. Graph showing Soil Temperature (S Temp °C) range in 36 months (January, 1989 to December, 1991) of sampling site D-1 : Guava Plantation (G Pl).

Table 2

Showing species of soil oribatid mites and their monthwise number of population
of sampling site D-1 (Guava Plantation)
January, 1989 to December, 1989

Name of the species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1. <i>Scheloribates albialatus</i>	35	65	30	26	23	18	15	10	20	32	40	36
2. <i>Tectocephus velatus</i>	15	40	17	12	10	11	10	8	10	16	13	18
3. <i>Oppia yodai</i>	11	28	12	14	8	13	8	10	9	13	16	14
4. <i>Oppiella nova</i>	9	20	8	10	6	10	5	3	5	6	12	10
5. <i>Paralamellobates bengalensis</i>	6	16	4	6	3	7	3	4	6	7	8	6
6. <i>Epilohmannia pallida indica</i>	7	19	6	4	3	5	2	1	1	4	11	10
7. <i>Lanceoppia</i> sp.	8	10	4	2	2	4	1	1	—	3	7	6
8. <i>Atropacarus (Hoplophorella)</i> <i>scapellatus</i>	4	12	3	2	—	2	1	—	3	2	5	4
9. <i>Chaunoproctus abalai</i>	3	6	2	2	1	3	1	—	—	3	8	7
10. <i>Pergalumna</i> sp.	2	4	2	2	4	3	2	3	2	2	4	5
Total	100	220	88	80	60	76	48	40	56	88	124	116

Table 2 (Contd.)

Showing species of soil oribatid mites and their monthwise number of population
of sampling site D-1 (Guava Plantation)
January, 1990 to December, 1990

Name of the species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1. <i>Scheloribates albialatus</i>	48	74	36	22	23	18	16	15	13	22	55	33
2. <i>Tectocepheus velatus</i>	21	32	20	15	16	12	10	11	12	16	24	21
3. <i>Oppia yodai</i>	17	26	14	11	10	8	7	8	9	12	16	11
4. <i>Oppiella nova</i>	12	15	10	7	8	7	6	6	7	9	15	10
5. <i>Paralamellobates bengalensis</i>	10	12	8	5	6	5	4	4	5	9	11	7
6. <i>Epilohmannia pallida indica</i>	10	10	7	4	4	4	3	3	4	7	9	5
7. <i>Lanceoppia</i> sp.	9	8	5	3	4	3	3	—	2	3	8	4
8. <i>Atropacarus (Hoplophorella)</i> <i>scapellatus</i>	7	10	4	2	1	—	1	—	1	3	4	5
9. <i>Chaunoproctus abalai</i>	4	3	3	1	2	2	—	—	1	2	3	2
10. <i>Pergalumna</i> sp.	2	2	1	2	2	1	2	1	2	1	3	2
Total	140	192	108	72	76	60	52	48	56	84	148	100

Table 2 (Contd.)

Showing species of soil oribatid mites and their monthwise number of population
of sampling site D-1 (Guava Plantation)
January, 1991 to December, 1991

Name of the species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1. <i>Schelorbates albialatus</i>	24	62	32	15	12	10	21	22	30	32	40	47
2. <i>Tectocephus velatus</i>	14	32	18	11	8	6	10	12	18	21	24	30
3. <i>Oppia yodai</i>	12	25	12	10	7	5	8	8	11	14	16	24
4. <i>Oppiella nova</i>	10	18	10	5	4	2	6	8	10	11	10	16
5. <i>Paralamellobates bengalensis</i>	7	14	8	5	4	4	6	7	7	6	7	12
6. <i>Epilohmannia pallida indica</i>	5	10	6	3	2	2	5	6	5	6	5	8
7. <i>Lanceoppia</i> sp.	3	8	4	2	1	—	—	2	3	2	3	5
8. <i>Atropacarus (Hoplophorella)</i> <i>scapellatus</i>	2	6	3	2	1	1	—	2	—	1	3	4
9. <i>Chaunoproctus abalai</i>	2	3	2	1	—	—	2	—	2	2	2	4
10. <i>Pergalumna</i> sp.	1	2	1	2	1	2	2	1	2	1	2	2
Total	80	180	96	56	40	32	60	68	88	96	112	152

Table 3

Showing species of soil oribatid mites and their total number of population
in percentage in three sampling years
Sampling site D-1 (Guava Plantation)

Species	1989		1990		1991	
	Number	% of total	Number	% of total	Number	% of total
1. <i>Scheloribates albialatus</i>	350	31.93	375	33.01	347	32.74
2. <i>Tectocephus velatus</i>	180	16.42	210	18.49	204	19.24
3. <i>Oppia yodai</i>	156	14.23	149	13.12	152	14.34
4. <i>Oppiella nova</i>	104	9.49	112	9.86	110	10.38
5. <i>Paralamellobates bengalensis</i>	76	6.94	86	7.57	87	8.21
6. <i>Epilohmannia pallida indica</i>	73	6.66	70	6.16	63	5.94
7. <i>Lanceoppia</i> sp.	48	4.38	52	4.58	33	3.11
8. <i>Atropacarus (Hoplophorella)</i> <i>scapellatus</i>	38	3.47	38	3.34	25	2.36
9. <i>Chaunoproctus abalai</i>	36	3.29	23	2.02	20	1.89
10. <i>Pergalumna</i> sp.	35	3.19	21	1.85	19	1.79
Total	1096	100	1136	100	1060	100

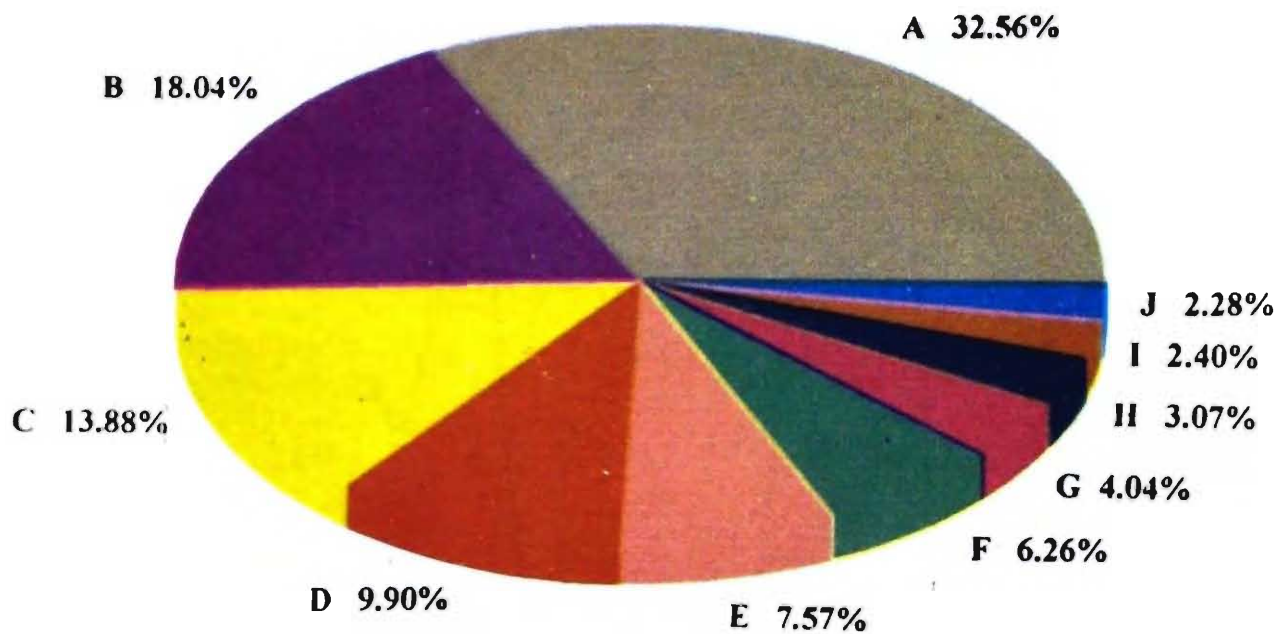
period (Table 1). In all the years the population was maximum in February and minimum in August in 1989 and 1990 and in June in 1991. It actually exhibited gradual increase from October reaching its peak in February followed by gradual decline. The postmonsoon months (November – January) witnessed a partial increase in population (Figure 9).

ii) Sampling site : D-2 (Mixed plantation) – The second site under study was situated on the southwestern side of the first site (D-1) about 100 metres away from the former. A tank was situated very close to the sampling site at its eastern side. It included 4 plots each 10 metres square from where soil samples were collected.

Vegetation : This site was relatively more thickly vegetated than the first site and contained many different types of plants, such as, *Mangifera indica*, *Musa paradisiaca*, *Punica granatum*, *Cocos nucifera*, *Carica papaya*, *Zizyphus mauritiana*, *Hibiscus rosa-sinensis*, *Hibiscus mutabilis* (Figures 10-11). The plot was covered with thick carpet of grass and contained many herbs and shrubs like *Blumea lacera*, *Vernonia cineria*, *Amaranthus viridis*, *Achyranthes aspera*, *Alternanthera sessilis*, *Evolvulus nummularius*, *Nicotiana plumbaginifolia*, *Hemigraphis hirta*, *Scoparia dulcis*, *Euphorbia hirta*, *Cardiospermum helicacabum*, *Kyllinga monocephala*, *Digitaria sanguinalis*, *Cynodon dactylon*, *Imperata arundinaceae*, *Eragrostis tenella*, *Panicum colonum*, *Panicum flavescens*. Fallen leaves and twigs of the plants formed a moderately thick litter layer on the surface.

Soil factors : The nature of the soil, its colour and texture of this site was more or less identical to that of first site. Soil pH ranged between 6.3 – 7.5. Soil temperature was maximum in June in 1989 and 1991 (31° C and 30.8° C respectively) and in April in 1990 (31.6° C). It was at the minimum level in winter months (December – January). Moisture content of the samples was at the peak in September in 1989, 1990 while in 1991 it was maximum in January. Minimum level of moisture was recorded in April in 1989 and in July in 1990 and in June in 1991. Organic carbon content of the soil samples reached at the peak in January in 1989, 1991 and in February in 1990. Mean values of soil factors presented in Table 4 and Figures 12-15 show that neither organic carbon nor pH varied substantially, but both temperature and moisture exhibited a moderate variation.

Oribatid population : Since the second sampling site was very close to the first site and since both of them experienced same climatic condition, the faunal make-up also was more or less identical in species composition. In this case also the oribatid fauna was represented by 10 genera and species, viz., *Scheloribates albialatus* Hammer, 1961, *Oppia yodai* Aoki, 1965, *Berlesozetes*



A = *Scheloribates*

F = *Epilohmannia*

B = *Tectocepheus*

G = *Lanceoppia*

C = *Oppia*

H = *Atropacarus (Hoplophorella)*

D = *Oppiella*

I = *Chaunoproctus*

E = *Paralamellobates*

J = *Pergalumna*

Fig. 8. Pie-chart showing Population (%) of oribatid genera in sampling site D-1 (Guava Plantation).

Population range in 36 months of G PI

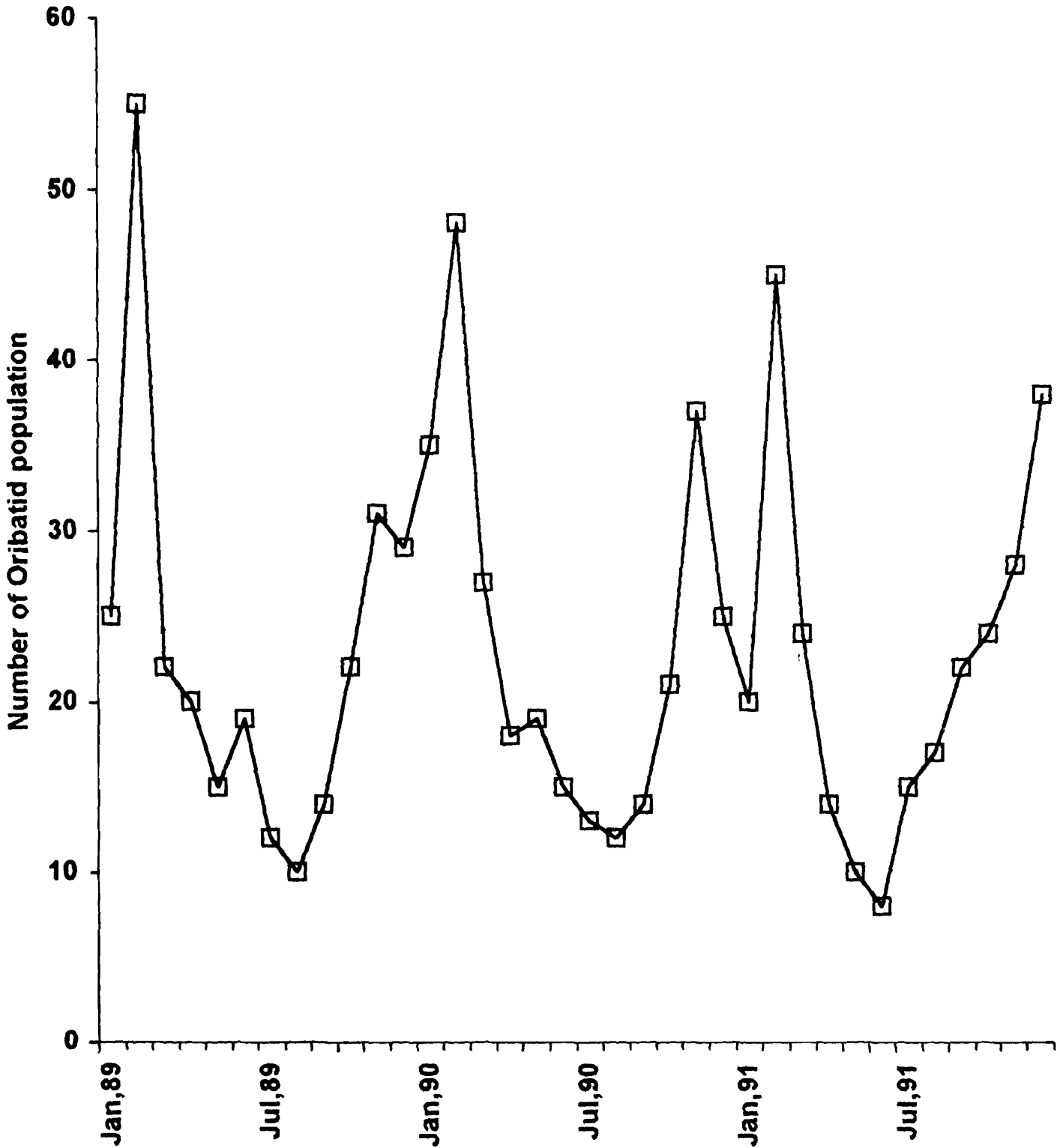


Fig. 9. Graph showing Population range of oribatid mites (Popul OM) in 36 months (January, 1989 to December, 1991) of sampling site D-1 : Guava Plantation (G PI).

Table 4

Showing mean values of soil factors and mean number of soil oribatids
of sampling site D-2 (Mixed Plantation)
January, 1989 to December, 1989

Month	pH	Temp. (°c)	Moisture (%)	Organic Carbon (%)	Oribatid mites
Jan.	6.5	19.6	24.8	2.15	65
Feb.	6.87	22.8	23.0	2.00	47
Mar.	6.6	26.0	19.0	1.90	34
Apr.	6.7	29.5	16.1	1.92	21
May	6.8	30.5	21.0	2.07	27
Jun.	7.0	31.0	18.0	1.80	20
Jul.	7.26	29.8	18.5	1.70	10
Aug.	7.35	29.3	28.0	1.48	8
Sep.	7.0	28.6	29.0	1.60	19
Oct.	6.8	25.8	22.0	1.92	22
Nov.	6.7	20.7	27.0	2.10	45
Dec.	6.9	22.5	26.2	2.00	41



10



11

Figs. 10-11. Photographs showing sampling site D-2 (Mixed Plantation).

Table 4 (Contd.)

Showing mean values of soil factors and mean number of soil oribatids
of sampling site D-2 (Mixed Plantation)
January, 1990 to December, 1990

Month	pH	Temp. (°c)	Moisture (%)	Organic Carbon (%)	Oribatid mites
Jan.	6.65	21.8	25.2	2.10	94
Feb.	6.5	24.5	27.8	2.28	166
Mar.	6.7	30.2	26.0	2.10	47
Apr.	6.65	31.6	22.0	1.99	27
May	7.5	28.1	22.0	2.11	36
Jun.	6.9	30.5	20.0	1.76	22
Jul.	7.5	30.0	17.0	1.59	13
Aug.	7.2	29.5	26.2	1.69	16
Sep.	7.5	28.0	28.0	1.70	20
Oct.	7.0	27.2	22.0	1.90	27
Nov.	6.7	23.3	26.0	2.12	52
Dec.	6.8	20.8	25.5	2.00	44

Table 4 (Contd.)

Showing mean values of soil factors and mean number of soil oribatids
of sampling site D-2 (Mixed Plantation)
January, 1991 to December, 1991

Month	pH	Temp. (°c)	Moisture (%)	Organic Carbon (%)	Oribatid mites
Jan.	6.4	19.3	27.0	2.20	74
Feb.	6.5	22.0	25.0	2.15	52
Mar.	6.3	28.5	20.0	2.12	35
Apr.	6.62	30.6	17.2	2.00	24
May	6.82	29.7	17.0	2.06	32
Jun.	6.9	30.8	15.9	1.80	23
Jul.	7.3	30.2	16.2	1.60	16
Aug.	7.4	29.8	25.5	1.50	11
Sep.	7.05	28.5	25.0	1.60	17
Oct.	6.9	26.0	23.2	1.82	25
Nov.	6.5	23.0	26.1	2.10	46
Dec.	7.1	20.0	23.9	1.80	32

Soil pH range in 36 months of *M PL*

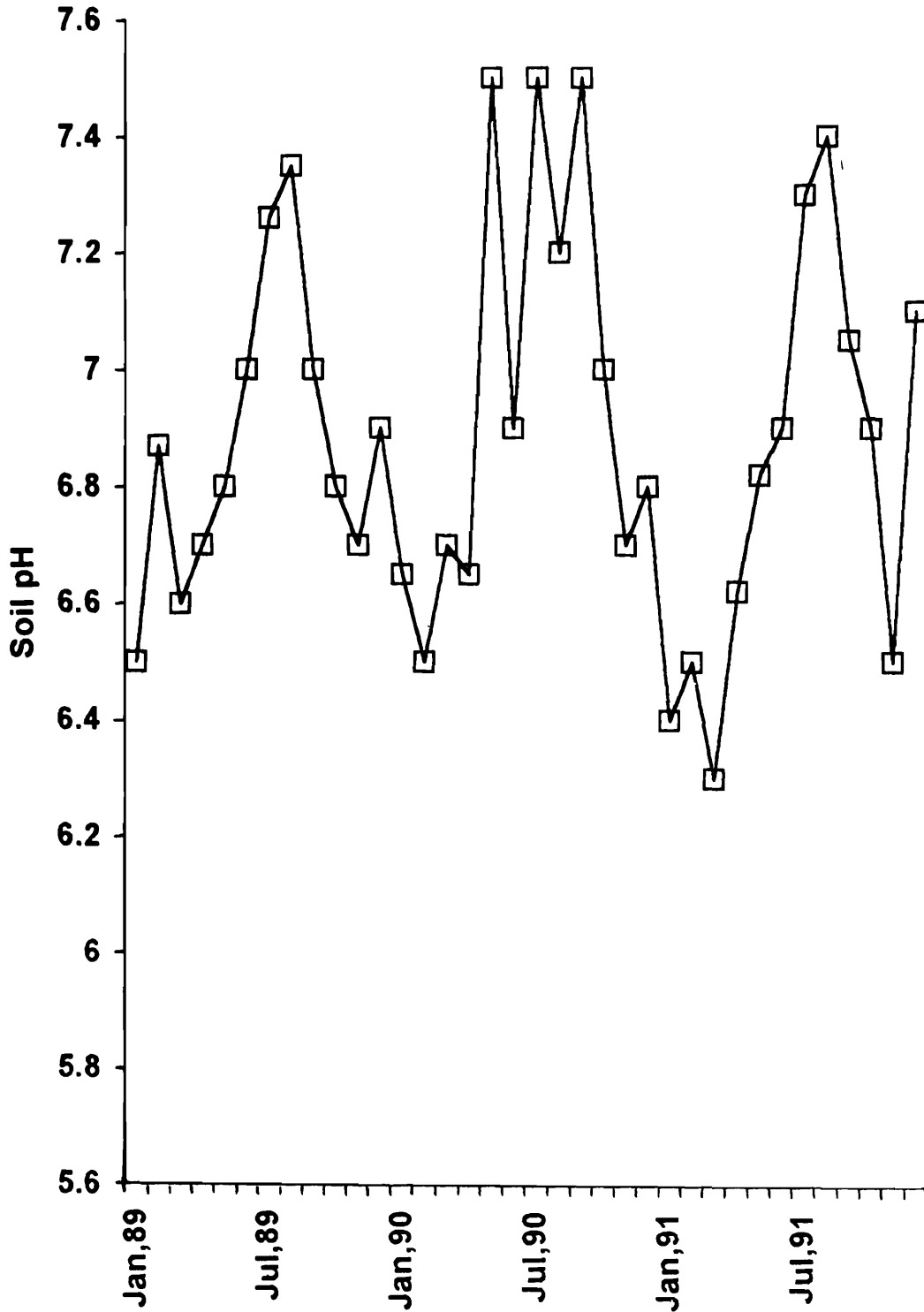


Fig. 12. Graph showing Soil pH range in 36 months (January, 1989 to December, 1991) of sampling site D-2 : Mixed Plantation (*M PL*).

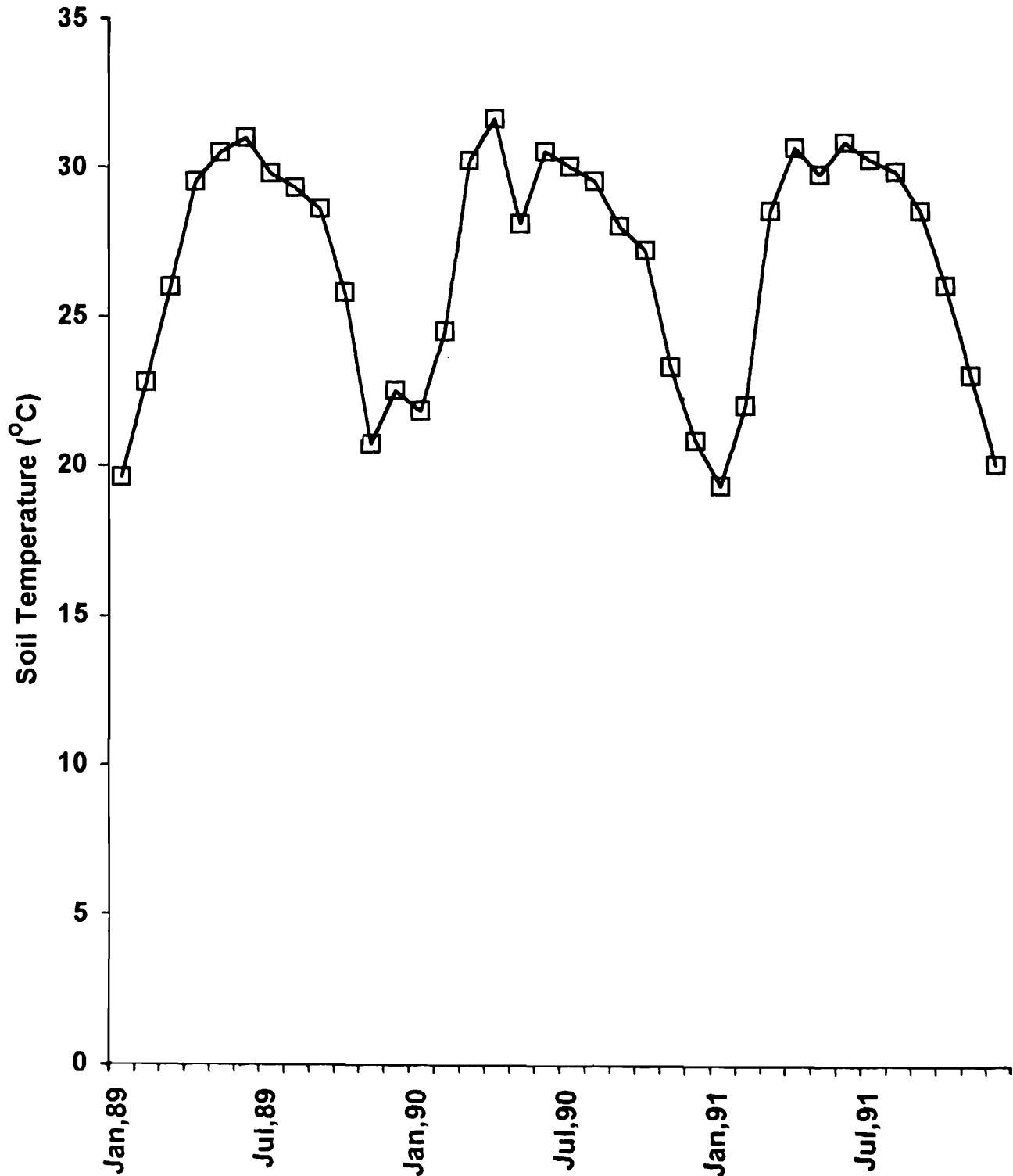
Soil Temperature range in 36 months of *M PL*

Fig. 13. Graph showing Soil Temperature (S Temp °C) range in 36 months (January, 1989 to December, 1991) of sampling site D-2 : Mixed Plantation (*M Pl*).

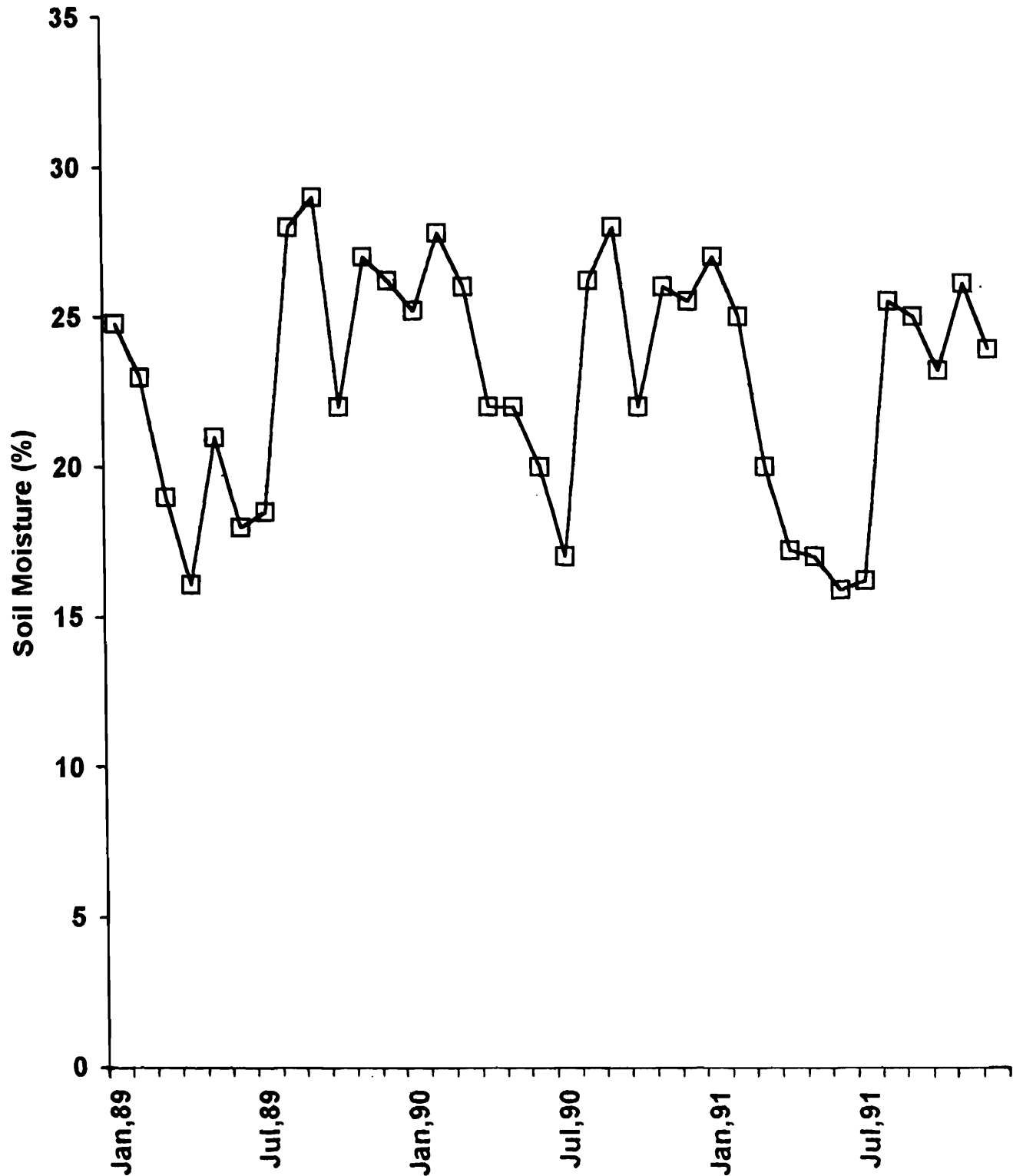
Soil Moisture range in 36 months of *M PL*

Fig. 14. Graph showing Soil Moisture (S Moist %) range in 36 months (January, 1989 to December, 1991) of sampling site D-2 : Mixed Plantation (*M PL*).

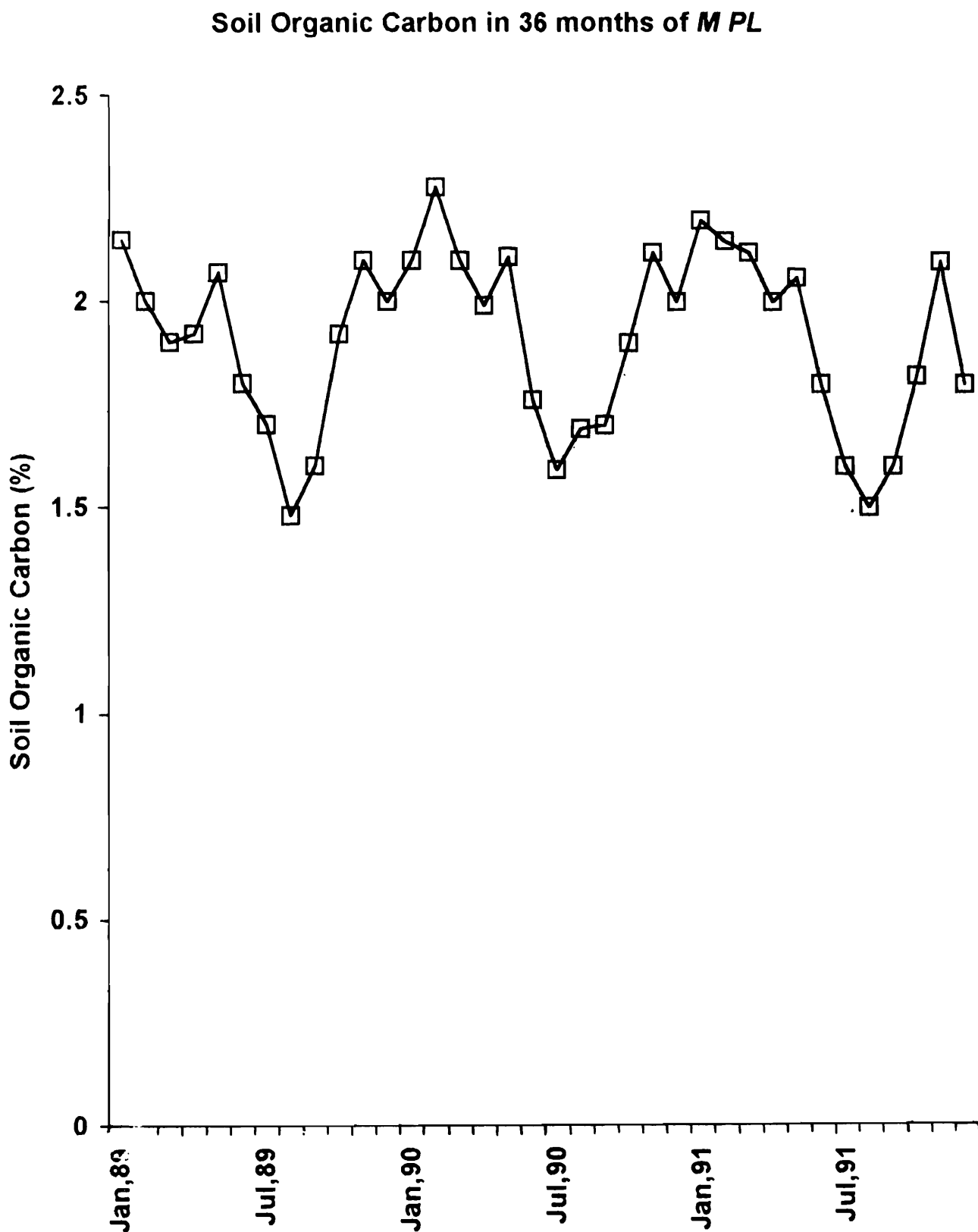


Fig. 15. Graph showing Soil Organic Carbon (Org Carb %) range in 36 months (January, 1989 to December, 1991) of sampling site D-2 : Mixed Plantation (*M PL*).

auxiliaris (Grandjean, 1936), *Tectocepheus velatus* (Michael, 1888), *Oppiella nova* (Oudemans, 1902), *Epilohmannia pallida indica* Bhattacharya and Banerjee, 1979, *Suctobelba variosetosa* Hammer, 1961, *Annectacarus longisetosus* Bhattacharya, Bhaduri and Raychaudhuri, 1974, *Atropacarus (Hoplophorella) scapellatus* (Aoki, 1965) and *Galumna flabellifera* Hammer, 1958 (Table 5). The analysis of data pertaining to total number of oribatid mites of this site collected for three years clearly showed that of the 10 genera, the genus *Scheloribates* was obtained in highest number (36.74%) being followed by *Oppia* (20.48%), *Berlesozetes* (13.30%), *Tectocepheus* (9.58%), *Oppiella* (6.75%). These forms were extracted from all the samples collected during the period of study. Of the remaining five, the genera *Epilohmannia* (4.90%) and *Suctobelba* (3.24%) were numerically low but were encountered in all the samples. The other 3 genera, viz., *Annectacarus* (1.91%), *Atropacarus (Hoplophorella)* (1.76%) and *Galumna* (1.34%) showed very irregular distribution and were absent in many samples. Of the three years of study, the year 1990 witnessed maximum population so far as numerical abundance is concerned (Tables 5-6 and figure 16).

Seasonal fluctuation : The individual population of the important genera as well as the population of total oribatids exhibited more or less same trend of fluctuation being maximum in January-February and minimum in July-August (Table 4). The population graph was found to be irregular, it showed an increasing trend from September reaching a moderate peak in November and ultimately spurted up in January-February. From March onward it maintained a declining trend till August (Figure 17).

REGRESSION AND CORRELATION

In order to find out the regression and correlation the data concerning edaphic factors and oribatid densities of each site were subjected to statistical analysis. The dependence of number of soil oribatid mites on each of four edaphic factors considered here was studied. Appropriate statistical test was performed to verify whether the relationship between the number of oribatid mites and different variables remained same throughout the period of study. The regression coefficient and analysis of variance are presented in the Tables 7-14 and regression lines are shown in Figures 18-25.

Table 5

Showing species of soil oribatid mites and their monthwise number of population
of sampling site D-2 (Mixed Plantation)
January, 1989 to December, 1989

Name of the species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1. <i>Scheloribates albialatus</i>	96	80	52	30	39	26	14	10	27	31	81	74
2. <i>Oppia yodai</i>	70	51	34	21	26	19	8	5	10	13	27	25
3. <i>Berlesozetes auxiliaris</i>	30	18	17	12	14	11	5	4	9	10	21	20
4. <i>Tectocepheus velatus</i>	21	15	12	8	11	10	6	5	7	6	16	14
5. <i>Oppiella nova</i>	16	10	6	3	6	8	3	2	5	8	10	8
6. <i>Epilohmannia pallida indica</i>	10	5	8	4	2	3	2	1	6	7	12	10
7. <i>Suctobelba variosetosa</i>	6	3	2	1	4	2	1	3	2	4	5	3
8. <i>Annectacarus longisetosus</i>	5	3	1	2	1	—	—	2	3	4	3	3
9. <i>Atropacarus (Hoplophorella)</i> <i>scapellatus</i>	4	2	2	1	2	—	1	—	4	2	3	5
10. <i>Galumna flabellifera</i>	2	1	2	2	3	1	—	—	3	3	2	2
Total	260	188	136	84	108	80	40	32	76	88	180	164

Table 5 (Contd.)

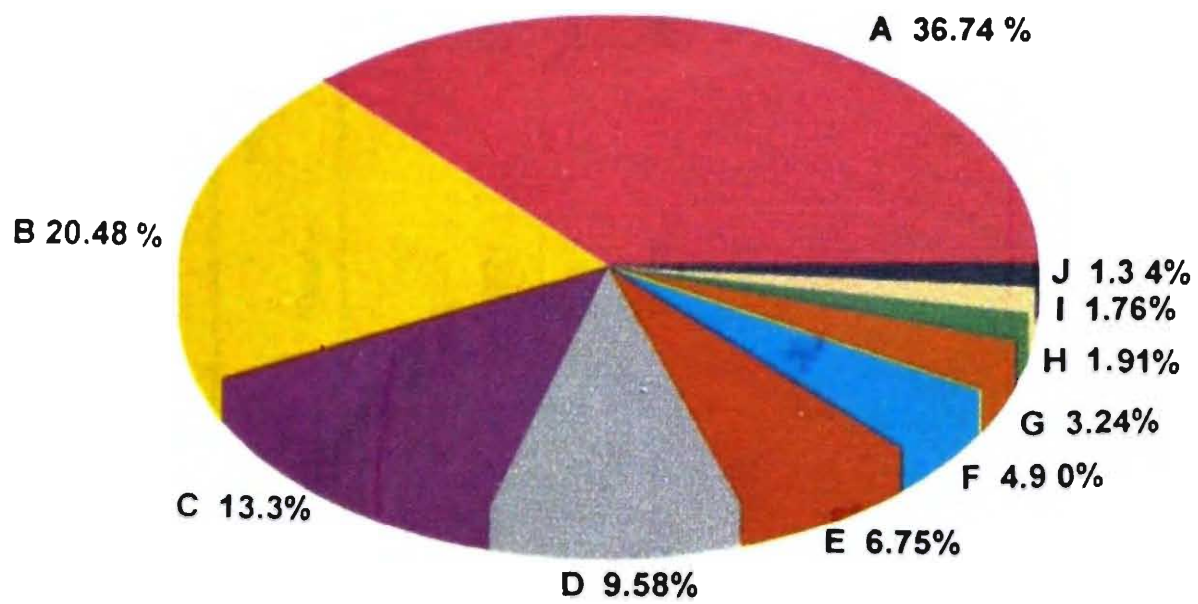
Showing species of soil oribatid mites and their monthwise number of population
of sampling site D-2 (Mixed Plantation)
January, 1990 to December, 1990

Name of the species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1. <i>Scheloribates albialatus</i>	138	220	70	40	48	32	20	14	26	38	80	72
2. <i>Oppia yodai</i>	80	150	35	12	23	18	8	12	11	15	33	24
3. <i>Berlesozetes auxiliaris</i>	62	112	22	14	18	12	7	10	9	12	24	21
4. <i>Tectocephus velatus</i>	30	62	20	11	12	9	6	11	13	10	21	18
5. <i>Oppiella nova</i>	22	41	16	10	11	6	4	7	8	11	18	14
6. <i>Epilohmannia pallida indica</i>	18	30	12	7	13	4	2	6	3	6	8	10
7. <i>Suctobelba variosetosa</i>	10	21	6	5	9	4	3	2	4	5	12	6
8. <i>Annectacarus longisetosus</i>	6	12	4	3	5	—	1	2	3	5	3	4
9. <i>Atropacarus (Hoplophorella) scapellatus</i>	8	10	2	4	3	2	—	—	1	3	5	4
10. <i>Galumna flabellifera</i>	2	6	1	2	2	1	1	—	2	3	4	3
Total	376	664	188	108	144	88	52	64	80	108	208	176

Table 5 (Contd).

Showing species of soil oribatid mites and their monthwise number of population
of sampling site D-2 (Mixed Plantation)
January, 1991 to December, 1991

Name of the species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1. <i>Scheloribates albialatus</i>	108	81	51	33	47	34	22	15	24	39	69	44
2. <i>Oppia yodai</i>	72	52	35	20	29	21	14	10	13	18	32	27
3. <i>Berlesozetes auxiliaris</i>	39	22	18	13	16	10	10	7	11	12	27	18
4. <i>Tectocepheus velatus</i>	26	19	14	10	12	9	7	3	8	9	19	12
5. <i>Oppiella nova</i>	19	11	8	6	9	8	5	2	4	7	13	9
6. <i>Epilohmannia pallida indica</i>	12	10	7	5	3	4	2	2	3	5	7	8
7. <i>Suctobelba variosetosa</i>	9	6	3	4	5	3	2	1	2	3	6	3
8. <i>Annectacarus longisetosus</i>	4	2	1	2	3	1	–	2	–	3	5	2
9. <i>Atropacarus (Hoplophorella)</i> <i>scapellatus</i>	4	3	2	1	2	2	–	–	2	2	3	3
10. <i>Galumna flabellifera</i>	3	2	1	2	2	–	2	2	1	2	3	2
Total	296	208	140	96	128	92	64	44	68	100	184	128



A = *Scheloribates*

F = *Epilohmannia*

B = *Oppia*

G = *Suctobelba*

C = *Berlesozetes*

H = *Annectacarus*

D = *Tectocephus*

I = *Atropacarus (Hoplophorella)*

E = *Oppiella*

J = *Galumna*

Fig. 16. Pie-chart showing Population (%) of oribatid genera in sampling site D-2 (Mixed Plantation).

Table 6

Showing species of soil oribatid mites and their total population
in percentage in three sampling years
Sampling site D-2 (Mixed Plantation)

Species	1989		1990		1991	
	Number	% of total	Number	% of total	Number	% of total
1. <i>Scheloribates albialatus</i>	560	39.00	798	35.37	567	36.63
2. <i>Oppia yodai</i>	309	21.52	421	18.66	343	22.16
3. <i>Berlesozetes auxiliaris</i>	171	11.91	323	14.32	203	13.11
4. <i>Tectocepheus velatus</i>	131	9.12	223	9.88	148	9.56
5. <i>Oppiella nova</i>	85	5.92	168	7.45	101	6.52
6. <i>Epilohmannia pallida indica</i>	70	4.87	119	5.27	68	4.39
7. <i>Suctobelba variosetosa</i>	36	2.51	87	3.86	47	3.04
8. <i>Annectacarus longisetosus</i>	27	1.88	48	2.13	25	1.62
9. <i>Atropacarus (Hoplophorella) scapellatus</i>	26	1.81	42	1.86	24	1.55
10. <i>Galumna flabellifera</i>	21	1.46	27	1.20	22	1.42
Total	1436	100	2256	100	1548	100

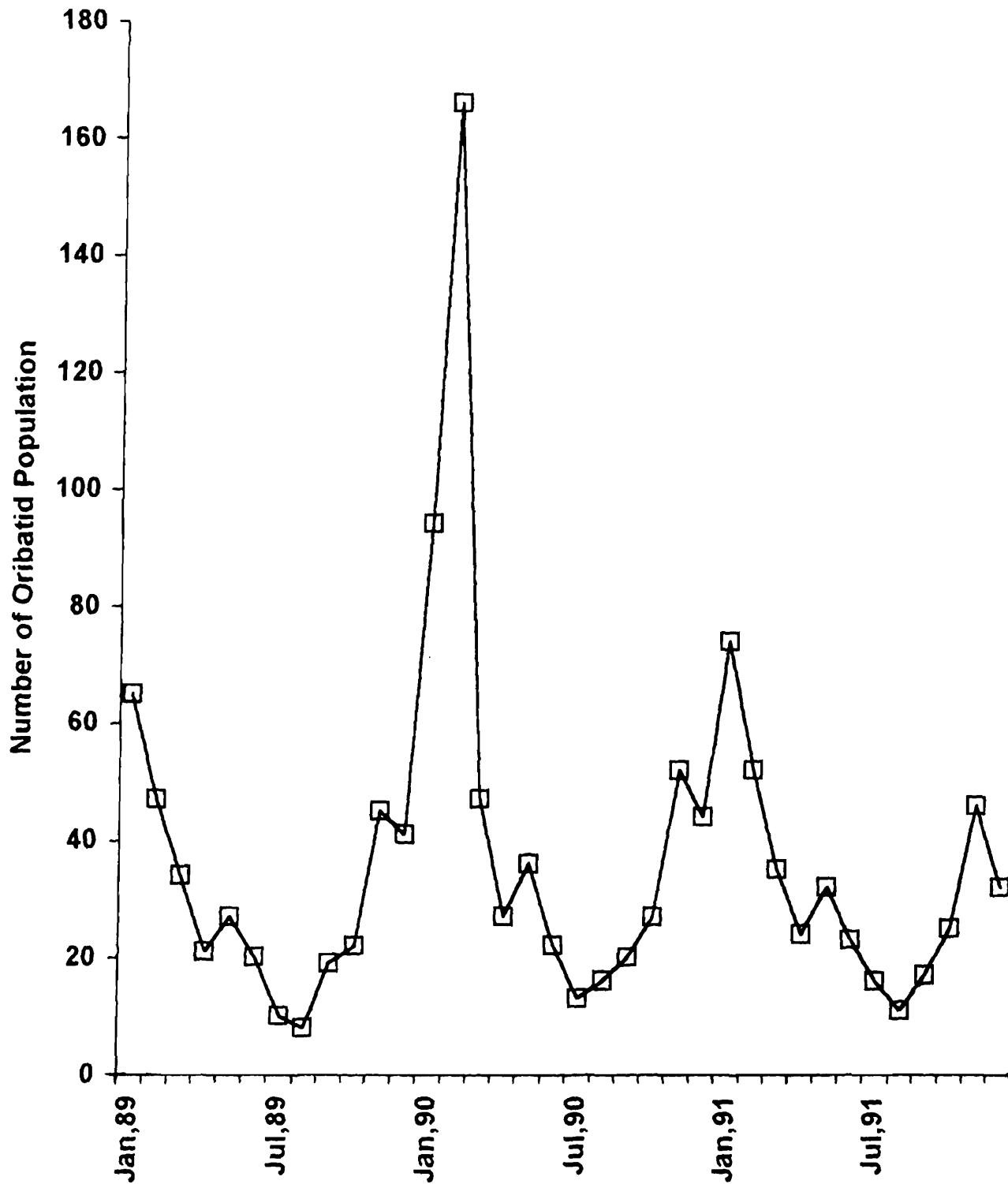
Population Range in 36 months of *M PL*

Fig. 17. Graph showing Population range of oribatid mites (Popul OM) in 36 months (January, 1989 to December, 1991) of sampling site D-2 : Mixed Plantation (*M PL*).

The correlation coefficient data as presented in the Tables 7-14 reveal that of the four variables, organic carbon in both the sampling sites (Site D-1 and Site D-2) was significant and positively correlated. The moisture in both the cases had weak positive correlation. The value of soil temperature and pH in D-1 and D-2 sites exhibited significant negative correlation with soil oribatid population.

Analysis of variance presented in Tables 7-14 showed that there was a monthly and yearly variation in population as well as concentration of edaphic factors were either noticeable or insignificant.

Table 7 Showing Regression Coefficient (r) and Analysis of Variance of oribatid population (Popul OM) on Soil pH at sampling site D-1 (Guava Plantation).

REGRESSION ANALYSIS

HEADER DATA FOR : C : DZSI LABEL : Guava Plantation
 NUMBER OF CASES : 36 NUMBER OF VARIABLES : 5

INDEX	NAME	MEAN	STD.DEV.
1	Popul OM	22.8611	11.0922
DEP. VAR. :	pH	6.4072	.3074

DEPENDENT VARIABLE : pH

VAR.	REGRESSION COEFFICIENT	STD. ERROR	T (DF = 34)	PROB.
Popul OM	-.0189	.0035	-5.452	.00000
CONSTANT	6.8399			

STD. ERROR OF EST. = .2278

r SQUARED = .4664
 r = -.6829

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	1.5422	1	1.5422	29.720	4.448E-06
RESIDUAL	1.7643	34	.0519		
TOTAL	3.3065	35			

STANDARDIZED RESIDUALS

	OBSERVED	CALCULATED	RESIDUAL	-2.0	0	2.0
1.	6.100	6.367	-.2667			
2.	5.800	5.799	9.84280E-04			
3.	5.770	6.424	-.6535	+<		
4.	6.720	6.461	.2586			+
5.	6.700	6.556	.1440			+
6.	6.200	6.480	-.2803	+		
7.	6.780	6.613	.1672			+
8.	6.850	6.651	.1994			+
9.	6.020	6.575	-.5549	+<		
10.	6.600	6.424	.1765			+
11.	6.100	6.253	-.1532		+	
12.	6.400	6.291	.1090			+
13.	6.200	6.178	.0225		+	
14.	6.000	5.931	.0685		+	
15.	6.700	6.329	.3711			+
16.	6.680	6.499	.1808			+
17.	6.620	6.480	.1397			+
18.	6.500	6.556	-.0560		+	
19.	6.770	6.594	.1762			+
20.	6.720	6.613	.1072			+
21.	6.600	6.575	.0251		+	
22.	6.680	6.442	.2376			+
23.	6.000	6.140	-.1397		+	
24.	6.500	6.367	.1333			+
25.	6.200	6.461	-.2614	+		
26.	6.000	5.988	.0117		+	
27.	6.500	6.386	.1143			+
28.	6.720	6.575	.1451			+
29.	6.600	6.651	-.0506		+	
30.	6.680	6.688	-.0085		+	
31.	6.500	6.556	-.0560		+	
32.	6.400	6.518	-.1181		+	
33.	6.000	6.424	-.4235	+		
34.	6.500	6.386	.1143			+
35.	6.350	6.310	.0400			+
36.	6.200	6.121	.0793			+

Fig. 18. Regression line of oribatid population on Soil pH at site D-1 (Guava Plantation).

Table 8 Showing Regression Coefficient (r) and Analysis of Variance of oribatid population (Popul OM) on Soil Temperature (S Temp °C) at sampling site D-1 (Guava Plantation).

REGRESSION ANALYSIS

HEADER DATA FOR : C : DZS1 LABEL : Guava Plantation
 NUMBER OF CASES : 36 NUMBER OF VARIABLES : 5

INDEX	NAME	MEAN	STD.DEV.
1	Popul OM	22.8611	11.0922
DEP. VAR. :	S Temp	25.8778	4.1383

DEPENDENT VARIABLE : S Temp (°C)

VAR.	REGRESSION COEFFICIENT	STD. ERROR	T (DF = 34)	PROB.
Popul OM	-.2720	.0438	-6.213	.00000
CONSTANT	32.0970			

STD. ERROR OF EST. = 2.8732

r SQUARED = .5317

r = -.7292

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	318.7043	1	318.7043	38.606	4.557E-07
RESIDUAL	280.6779	34	8.2552		
TOTAL	599.3822	35			

STANDARDIZED RESIDUALS

	OBSERVED	CALCULATED	RESIDUAL	-2.0	0	2.0
1.	18.500	25.296	-6.7959	+<		
2.	22.000	17.135	4.8655			+
3.	23.800	26.112	-2.3120		+	
4.	25.000	26.656	-1.6561		+	
5.	30.000	28.016	1.9836			+
6.	30.100	26.928	3.1718			+
7.	29.800	28.832	.9675		+	
8.	28.600	29.377	-.7766		+	
9.	28.800	28.288	.5116		+	
10.	28.500	26.112	2.3880			+
11.	24.500	23.664	.8346		+	
12.	21.000	24.208	-3.1077	+		
13.	20.000	22.575	-2.5754	+		
14.	21.100	19.039	2.0611			+
15.	23.000	24.752	-1.7518		+	
16.	28.600	27.200	1.3998			+
17.	29.600	26.928	2.6718			+
18.	30.200	28.016	2.1836			+
19.	29.300	28.560	.7396		+	
20.	29.000	28.832	.1675		+	
21.	28.700	28.288	.4116		+	
22.	28.900	26.384	2.5159			+
23.	21.200	22.031	-.8314		+	
24.	19.500	25.296	-5.7959	+<		
25.	17.700	26.656	-8.9561	+<		
26.	20.400	19.855	.5450		+	
27.	24.200	25.568	-1.3679		+	
28.	30.000	28.288	1.7116			+
29.	30.300	29.377	.9234		+	
30.	30.500	29.921	.5793		+	
31.	29.000	28.016	.9836		+	
32.	29.200	27.472	1.7277			+
33.	28.500	26.112	2.3880			+
34.	27.500	25.568	1.9321			+
35.	24.000	24.480	-.4798		+	
36.	20.500	21.759	-1.2593		+	

Fig. 19. Regression line of oribatid population on Soil Temperature ($^{\circ}\text{C}$) at site D-1 (Guava Plantation).

Table 9 Showing Regression Coefficient (r) and Analysis of Variance of oribatid population (Popul OM) on Soil Moisture (S Moist %) at sampling site D-1 (Guava Plantation).

REGRESSION ANALYSIS

HEADER DATA FOR : C : DZSI LABEL : Guava Plantation
NUMBER OF CASES : 36 NUMBER OF VARIABLES : 5

INDEX	NAME	MEAN	STD.DEV.
1	Popul OM	22.8611	11.0922
DEP. VAR. :	S Moist	22.0028	2.8047

DEPENDENT VARIABLE : S Moist (%)

VAR.	REGRESSION COEFFICIENT	STD. ERROR	T (DF = 34)	PROB.
Popul OM	.0504	.0425	1.185	.24410
CONSTANT	20.8512			

STD. ERROR OF EST. = 2.7887

r SQUARED = .0397

r = .1992

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	10.9262	1	10.9262	1.405	.2441
RESIDUAL	264.4035	34	7.7766		
TOTAL	275.3297	35			

STANDARDIZED RESIDUALS

	OBSERVED	CALCULATED	RESIDUAL	-2.0	0	2.0
1.	21.800	22.111	-.3105		+	
2.	22.300	23.622	-1.3217		+	
3.	22.500	21.959	.5406			+
4.	22.000	21.859	.1413		+	
5.	21.000	21.607	-.6068		+	
6.	18.600	21.808	-3.2083	+		
7.	19.000	21.456	-2.4557	+		
8.	26.500	21.355	5.1451			+
9.	29.600	21.556	8.0436			> +
10.	22.200	21.959	.2406		+	
11.	24.800	22.413	2.3873			+
12.	23.800	22.312	1.4880			+
13.	21.500	22.614	-1.1142		+	
14.	24.300	23.269	1.0309			+
15.	20.000	22.211	-2.2113		+	
16.	19.000	21.758	-2.7579	+		
17.	19.500	21.808	-2.3083		+	
18.	18.000	21.607	-3.6068	+		
19.	17.000	21.506	-4.5061	+		
20.	23.100	21.456	1.6443			+
21.	27.000	21.556	5.4436			+
22.	22.200	21.909	.2910		+	
23.	23.000	22.715	.2850		+	
24.	21.200	22.111	-.9105		+	
25.	21.500	21.859	-.3587		+	
26.	22.500	23.118	-.6179		+	
27.	21.200	22.060	-.8601		+	
28.	19.100	21.556	-2.4564	+		
29.	18.500	21.355	-2.8549	+		
30.	19.000	21.254	-2.2542	+		
31.	20.000	21.607	-1.6068		+	
32.	26.000	21.708	4.2925			+
33.	25.700	21.959	3.7406			+
34.	21.500	22.060	-.5601		+	
35.	24.200	22.262	1.9384			+
36.	23.000	22.765	.2347		+	

Fig. 20. Regression line of oribatid population on Soil Moisture (%) at site D-1 (Guava Plantation).

Table 10 Showing Regression Coefficient (r) and Analysis of Variance of oribatid population (Popul OM) on Soil Organic Carbon (Org Carb %) at sampling site D-1 (Guava Plantation).

REGRESSION ANALYSIS

HEADER DATA FOR : C : DZS1 LABEL : Guava Plantation
NUMBER OF CASES : 36 NUMBER OF VARIABLES : 5

INDEX	NAME	MEAN	STD.DEV.
1	Popul OM	22.8611	11.0922
DEP. VAR. :	Org Carb	1.8289	.2146

DEPENDENT VARIABLE : Org Carb (%)

VAR.	REGRESSION COEFFICIENT	STD. ERROR	T (DF = 34)	PROB.
Popul OM	.0156	.0020	8.002	.00000
CONSTANT	1.4714			

STD. ERROR OF EST. = .1282

r SQUARED = .6532

r = .8082 *

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	1.0532	1	1.0532	64.036	2.517E-09
RESIDUAL	.5592	34	.0164		
TOTAL	1.6124	35			

* Significant at 1 % level

				STANDARDIZED RESIDUALS		
OBSERVED	CALCULATED	RESIDUAL	-2.0	0	2.0	
1.	1.980	1.862	.1177		+	
2.	2.170	2.331	-.1615	+		
3.	1.910	1.815	.0946		+	
4.	1.850	1.784	.0659		+	
5.	1.600	1.706	-.1060		+	
6.	1.550	1.769	-.2185	+		
7.	1.660	1.659	9.63316E-04		+	
8.	1.450	1.628	-.1778	+		
9.	1.570	1.690	-.1203		+	
10.	1.720	1.815	-.0954		+	
11.	1.980	1.956	.0238		+	
12.	1.890	1.925	-.0349		+	
13.	2.000	2.019	-.0187		+	
14.	2.210	2.222	-.0120		+	
15.	2.100	1.894	.2064		+	
16.	1.750	1.753	-.0029		+	
17.	1.700	1.769	-.0685		+	
18.	1.600	1.706	-.1060		+	
19.	1.640	1.675	-.0347		+	
20.	1.550	1.659	-.1090		+	
21.	1.610	1.690	-.0803		+	
22.	1.800	1.800	2.16220E-04		+	
23.	2.100	2.050	.0500		+	
24.	1.940	1.862	.0777		+	
25.	2.140	1.784	.3559		>+	
26.	2.200	2.175	.0249		+	
27.	2.070	1.847	.2233		+	
28.	1.910	1.690	.2197		+	
29.	1.800	1.628	.1722		+	
30.	1.600	1.596	.0035		+	
31.	1.650	1.706	-.0560		+	
32.	1.600	1.737	-.1372		+	
33.	1.750	1.815	.0654		+	
34.	1.840	1.847	-.0067		+	
35.	2.000	1.909	.0907		+	
36.	1.950	2.066	-.1156		+	

Fig. 21. Regression line of oribatid population on Soil Organic Carbon (%) at site D-1 (Guava Plantation).

Table 11 Showing Regression Coefficient (r) and Analysis of Variance of oribatid population (Popul OM) on Soil pH at sampling site D-2 (Mixed Plantation).

REGRESSION ANALYSIS

HEADER DATA FOR : C : DZS2 LABEL : Mixed Plantation
NUMBER OF CASES : 36 NUMBER OF VARIABLES : 5

INDEX	NAME	MEAN	STD.DEV.
1	Popul OM	36.3889	29.0195
DEP. VAR. :	pH	6.8853	.3268

DEPENDENT VARIABLE : pH

VAR	REGRESSION COEFFICIENT	STD. ERROR	T (DF = 34)	PROB.
Popul OM	-.0062	.0016	- 3.851	.00050
CONSTANT	7.1111			

STD. ERROR OF EST. = .2767

r SQUARED = .3037

r = -.5511

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	1.1350	1	1.1350	14.828	4.956E-04
RESIDUAL	2.6025	34	.0765		
TOTAL	3.7375	35			

STANDARDIZED RESIDUALS

	OBSERVED	CALCULATED	RESIDUAL	-2.0	0	2.0
1.	6.500	6.708	-.2077			
2.	6.870	6.819	.0506			
3.	6.600	6.900	-.3001			
4.	6.700	6.981	.2808			
5.	6.800	6.944	-.1435			
6.	7.000	6.987	.0130			
7.	7.260	7.049	.2110			
8.	7.350	7.061	.2886			
9.	7.000	6.993	.0068			
10.	6.800	6.975	-.1746			
11.	6.700	6.832	-.1318			
12.	6.900	6.857	.0433			
13.	6.650	6.528	.1222			
14.	6.500	6.081	.4190			
15.	6.700	6.819	-.1194			
16.	6.650	6.944	-.2935			
17.	7.500	6.888	.6123			
18.	6.900	6.975	-.0746			
19.	7.500	7.030	.4696			
20.	7.200	7.012	.1882			
21.	7.500	6.987	.5130			
22.	7.000	6.944	.0565			
23.	6.700	6.788	-.0884			
24.	6.800	6.838	-.0380			
25.	6.400	6.652	-.2519			
26.	6.500	6.788	-.2884			
27.	6.300	6.894	-.5939	+<		
28.	6.620	6.962	-.3422			
29.	6.820	6.913	-.0925			
30.	6.900	6.968	-.0684			
31.	7.300	7.012	.2882			
32.	7.400	7.043	.3572			
33.	7.050	7.006	.0444			
34.	6.900	6.956	-.0560			
35.	6.500	6.826	-.3256			
36.	7.100	6.913	.1875			

Fig. 22. Regression line of oribatid population on Soil pH at site D-2 (Mixed Plantation).

Table 12 Showing Regression Coefficient (r) and Analysis of Variance of oribatid population (Popul OM) on Soil Temperature' (S Temp °C) at sampling site D-2 (Mixed Plantation).

REGRESSION ANALYSIS

HEADER DATA FOR : C : DZS2 LABEL : Mixed Plantation
NUMBER OF CASES : 36 NUMBER OF VARIABLES : 5

INDEX	NAME	MEAN	STD.DEV.
1	Popul OM	36.3889	29.0195
DEP. VAR. :	S Temp	26.6667	3.9101

DEPENDENT VARIABLE : S Temp (°C)

VAR.	REGRESSION COEFFICIENT	STD. ERROR	T (DF = 34)	PROB.
Popul OM	-.0740	.0193	- 3.835	.00052
CONSTANT	29.3609			

STD. ERROR OF EST. = 3.3145

r SQUARED = .3020

r = -.5495

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	161.5827	1	161.5827	14.708	5.180E-04
RESIDUAL	373.5173	34	10.9858		
TOTAL	535.1000	35			

				STANDARDIZED RESIDUALS		
OBSERVED	CALCULATED	RESIDUAL	-2.0	0	2.0	
1.	19.600	24.548	-4.9483	+		
2.	22.800	25.881	-3.0810		+	
3.	26.000	26.844	-.8435			+
4.	29.500	27.806	1.6939			+
5.	30.500	27.362	3.1382			+
6.	31.000	27.880	3.1199			+
7.	29.800	28.621	1.1795		+	
8.	29.300	28.769	.5314		+	
9.	28.600	27.954	.6458		+	
10.	25.800	27.732	-1.9320		+	
11.	20.700	26.029	-5.3291	+		
12.	22.500	26.325	-3.8253		+	
13.	21.800	22.401	-.6011			+
14.	24.500	17.070	7.4299			>+
15.	30.200	25.881	4.3190			+
16.	31.600	27.362	4.2382			+
17.	28.100	26.695	1.4045			+
18.	30.500	27.732	2.7680			+
19.	30.000	28.398	1.6016			+
20.	29.500	28.176	1.3237			+
21.	28.000	27.880	.1199		+	
22.	27.200	27.362	-.1618		+	
23.	23.300	25.511	-2.2108			+
24.	20.800	26.103	-5.3031	+		
25.	19.300	23.882	-4.5819		+	
26.	22.000	25.511	-3.5108			+
27.	28.500	26.770	1.7305			+
28.	30.600	27.584	3.0160			+
29.	29.700	26.992	2.7084			+
30.	30.800	27.658	3.1420			+
31.	30.200	28.176	2.0237			+
32.	29.800	28.546	1.2535			+
33.	28.500	28.102	.3978		+	
34.	26.000	27.510	-1.5099			+
35.	23.000	25.955	-2.9550			+
36.	20.000	26.992	-6.9916	+<		

Fig. 23. Regression line of oribatid population on Soil Temperature ($^{\circ}\text{C}$) at site D-2 (Mixed Plantation).

Table 13 Showing Regression Coefficient (r) and Analysis of Variance of oribatid population (Popul OM) on Soil Moisture (S Moist %) at sampling site D-2 (Mixed Plantation).

REGRESSION ANALYSIS .

HEADER DATA FOR : C : DZS2 LABEL : Mixed Plantation
NUMBER OF CASES : 36 NUMBER OF VARIABLES : 5

INDEX	NAME	MEAN	STD.DEV.
1	Popul OM	36.3889	29.0195
DEP. VAR. :	S Moist	22.8417	3.9814

DEPENDENT VARIABLE : S Moist (%)

VAR.	REGRESSION COEFFICIENT	STD. ERROR	T (DF = 34)	PROB.
Popul OM	.0524	.0217	2.411	.02147
CONSTANT	20.9341			

STD. ERROR OF EST. = 3.7330

r SQUARED = .1460
 r = .3821

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	80.9982	1	80.9982	5.812	.0215
RESIDUAL	473.8093	34	13.9356		
TOTAL	554.8075	35			

STANDARDIZED RESIDUALS

	OBSERVED	CALCULATED	RESIDUAL	-2.0	0	2.0
1.	24.800	24.342	.4585		+	
2.	23.000	23.398	-.3979		+	
3.	19.000	22.716	-3.7164			
4.	16.100	22.035	-5.9349	+		
5.	21.000	22.349	-1.3495		+	
6.	18.000	21.983	-3.9825		+	
7.	18.500	21.458	-2.9583		+	
8.	28.000	21.353	6.6465			+
9.	29.000	21.930	7.0699			+
10.	22.000	22.087	-.0874		+	
11.	27.000	23.293	3.7069			+
12.	26.200	23.083	3.1166			+
13.	25.200	25.862	-.6618		+	
14.	27.800	29.636	-1.8361		+	
15.	26.000	23.398	2.6021			+
16.	22.000	22.349	-.3495		+	
17.	22.000	22.821	-.8213		+	
18.	20.000	22.087	-2.0874		+	
19.	17.000	21.616	-4.6156	+		
20.	26.200	21.773	4.4272			+
21.	28.000	21.983	6.0175			+
22.	22.000	22.349	-.3495		+	
23.	26.000	23.660	2.3400			+
24.	25.500	23.241	2.2593			+
25.	27.000	24.813	2.1867			+
26.	25.000	23.660	1.3400		+	
27.	20.000	22.769	-2.7689		+	
28.	17.200	22.192	-4.9922	+		
29.	17.000	22.612	-5.6116	+		
30.	15.900	22.140	-6.2398	+		
31.	16.200	21.773	-5.5728	+		
32.	25.500	21.511	3.9893			+
33.	25.000	21.825	3.1747			+
34.	23.200	22.245	.9554		+	
35.	26.100	23.346	2.7545			+
36.	23.900	22.612	1.2884		+	

Fig. 24. Regression line of oribatid population on Soil Moisture (%) at site D-2 (Mixed Plantation).

Table 14 Showing Regression Coefficient (*r*) and Analysis of Variance of oribatid population (Popul OM) on Soil Organic Carbon (Org Carb %) at sampling site D-2 (Mixed Plantation).

REGRESSION ANALYSIS

HEADER DATA FOR : C : DZS2 LABEL : Mixed Plantation
NUMBER OF CASES : 36 NUMBER OF VARIABLES : 5

INDEX	NAME	MEAN	STD.DEV.
1	Popul OM	36.3889	29.0195
DEP. VAR. :	Org Carb	1.9092	.2167

DEPENDENT VARIABLE : Org Carb (%)

VAR.	REGRESSION COEFFICIENT	STD. ERROR	T (DF = 34)	PROB.
Popul OM	.0053	9.09691E-04	5.777	.00000
CONSTANT	1.7179			

STD. ERROR OF EST. = .1562

r SQUARED = .4953

r = .7038 **

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	.8140	1	.8140	33.371	1.679E-06
RESIDUAL	.8293	34	.0244		
TOTAL	1.6433	35			

* * Significant at 1 % Level

				STANDARDIZED RESIDUALS		
OBSERVED	CALCULATED	RESIDUAL	-2.0	0	2.0	
1.	2.150	2.060	.0905		+	
2.	2.000	1.965	.0351		+	
3.	1.900	1.897	.0034		+	
4.	1.920	1.828	.0917		+	
5.	2.070	1.860	.2102		+	
6.	1.800	1.823	-.0230		+	
7.	1.700	1.770	-.0705		+	
8.	1.480	1.760	-.2800	+		
9.	1.600	1.818	-.2178	+		
10.	1.920	1.834	.0864		+	
11.	2.100	1.954	.1456		+	
12.	2.000	1.933	.0666		+	
13.	2.100	2.212	-.1119		+	
14.	2.280	2.590	-.3103	+		
15.	2.100	1.965	.1351		+	
16.	1.990	1.860	.1302		+	
17.	2.110	1.907	.2029		+	
18.	1.760	1.834	-.0736		+	
19.	1.590	1.786	-.1963	+		
20.	1.690	1.802	-.1120		+	
21.	1.700	1.823	-.1230		+	
22.	1.900	1.860	.0402		+	
23.	2.120	1.991	.1288		+	
24.	2.000	1.949	.0508		+	
25.	2.200	2.107	.0932		+	
26.	2.150	1.991	.1588		+	
27.	2.120	1.902	.2181		+	
28.	2.000	1.844	.1559		+	
29.	2.060	1.886	.1739		+	
30.	1.800	1.839	-.0388		+	
31.	1.600	1.802	-.2020	+		
32.	1.500	1.776	-.2757	+		
33.	1.600	1.807	-.2073	+		
34.	1.820	1.849	-.0293		+	
35.	2.100	1.960	.1403		+	
36.	1.800	1.886	-.0861		+	

Fig. 25. Regression line of oribatid population on Soil Organic Carbon (%) at site D-2 (Mixed Plantation).

DISCUSSION

In this investigation the studies on soil oribatid mites have been made in two undisturbed, uncultivated and well-vegetated sampling sites in the district of North 24-Parganas from where altogether 288 samples were collected at monthly interval over a period of three years (January, 1989 to December, 1991). The plots under study being located in Gangetic plain were subjected to tropical climates with relatively high humidity, fairly high temperature and moderate amount of rainfall. The soils are alluvial in nature and more or less clayloam in texture and appear to be compact throughout excepting winter in site D-1 and summer in site D-2. Since both the sites were well-vegetated, they supported a moderate population. But how far the species composition of a plot is related to vegetation is yet to be established. Choudhuri and Roy (1972) opined that vegetation exerts an indirect influence on the soil arthropods through its effects on pore space, humus formation and soil moisture. There might be a moderate agreement between plant and oribatid community in the sense that intensity of the vegetation might directly or indirectly influence the population. The site D-2 being thickly vegetated supported a fauna which are numerically high. So vegetation in this case might have exerted some influence not on species composition but numerical abundance.

The oribatid fauna obtained from the two sampling sites (D-1 and D-2) taken together belong to 14 genera, of which 6 were found to occur in both the sites. The analysis of the population of the 6 common genera showed that the genus *Scheloribates* occupied the top most position in numerical abundance of the total population. The other 5 genera in accordance with their population were *Oppia*, *Tectocephus*, *Oppiella*, *Epilohmannia* and *Atropacarus (Hoplophorella)* (Figure 26). On the contrary, the population abundance of the oribatid genera in two sampling sites when considered separately, a different picture was observed. The quantitative estimate of each genus in percentage (%) of total population of each sampling site was shown separately in Figures 8 and 16. The genus *Tectocephus* being represented by *T. velatus* occupied the second position in site D-1 and fourth position in site D-2. The species *Oppia yodai* was next to *Scheloribates* in site D-2, while in D-1 it occupied the third position.

The population size of all the 14 genera encountered in the study was analysed in percentage (%) of total population. The genus *Scheloribates* was found to occupy the highest position comprising 35.12% of the total population. It was represented by a single species *S. albialatus* in both the sampling sites. The occurrence of the genus *Scheloribates* as a dominant form in different sampling sites of Gangetic West Bengal was previously reported by

the workers like Choudhuri and Banerjee (1977), Banerjee and Roy (1981), Ghatak and Ray (1981), Sanyal (1981a) and Sanyal and Bhaduri (1982). The position of other 13 genera according to their percentage (%) of total population, was shown in Figure 27.

Besides the 6 common genera in both the sites the genera present only in site D-1 were *Paralamellobates bengalensis*, *Lanceoppia* sp., *Chaunoproctus abalai* and *Pergalumna* sp. and in site D-2 were *Berlesozetes auxiliaris*, *Suctobelba variosetosa*, *Annectacarus longisetosus* and *Galumna flabellifera*. The genera restricted to one or other plot in many instances were numerically low or altogether absent in many samples excepting the genera *Berlesozetes* and *Suctobelba* (in D-2) which were moderate in number. The total population of soil oribatids of three sampling years in both the sites when considered separately was found to be higher in sites D-2 (Table 6 and Figure 16).

The population of soil oribatids exhibited qualitative and quantitative variations with change of season (Figures 9 and 17). The fluctuation was not strictly regular in both the sites where population peaked in January - February and the partial increase was also observed in November - December. In both the sites least number of individuals were extracted in the months of June - August.. The winter maxima as observed in this study was a bit different from the findings of Choudhuri and Banerjee (1977), Choudhuri and Pande (1979), Roy and Ghatak (1980) and Sanyal (1981a, 1981b, 1982) who reported monsoon maxima in some sampling sites of West Bengal. In this investigation samples collected in monsoon months (July - September) witnessed a lean population in spite of a fair amount of rainfall. This might be due to water logging of the pore spaces and subsequent poor aeration which led to a probable increased mortality or migration elsewhere. Monsoon minima of oribatids was also observed by Sarkar (1990) in some sampling plots of Tripura. In the winter months (November - February) population levels were high probably due to optimum level of moisture associated with high level of organic carbon. Sanyal and Bhaduri (1982) and Sarkar (1990) recorded population maxima in November. Sengupta and Sanyal (1991), Hatter *et al.* (1992) and Sanyal and Sarkar (1993) also reported a high population in winter months. In summer months also soil moisture and organic carbon content were fairly low and soil temperature was moderately high and thereby created more or less unfavourable situation for the existence of a larger population of oribatid mites. These might have led to a decline in summer population.

In the present investigation the pH of the soil samples did not exhibit a very wide range of variation, it was as low as 5.77 in site D-1 and as high as 7.5 in site D-2. This range of pH is believed to be well within the tolerance range of most of the species as reported by Choudhuri

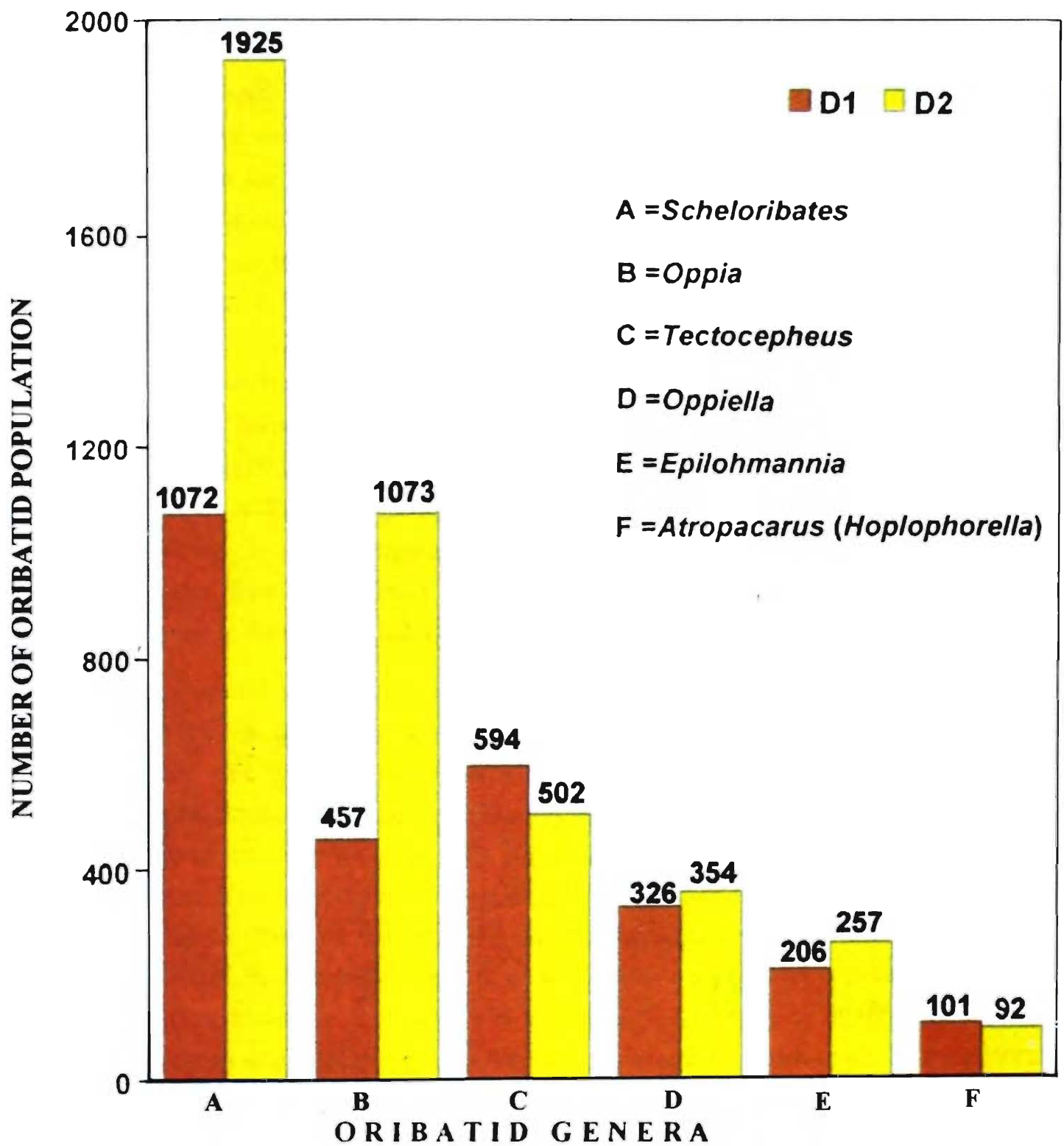


Fig. 26. Bar-diagram showing Population of six common oribatid genera in the two sampling sites (D-1 : Guava Plantation and D-2 : Mixed Plantation).

and Banerjee (1977) and Sanyal (1994). Statistical analysis revealed (Tables 7 and 11) a significant negative correlation of pH with oribatid population which is further evident from the occurrence of lean population in the samples with higher pH values. Sanyal (1994) in his review also reported significant negative correlation of pH with oribatid population and suggested that higher pH may have inhibitory role on population increase.

Among the edaphic factors studied temperature probably exhibited marked change with change of season and varied between 17.7°C to 31.6°C. Temperature and moisture are considered to be two important factors exerting combined effect on population. In both the sites samples yielded a fairly low population when soil temperature was appreciably high which is evident from the samples collected from months of April – May to July – August where temperature was recorded at a higher level and the population was relatively low (Tables 1 and 4). Statistical analysis tables 8 and 12 also corroborated this finding and indicated a significant negative correlation of temperature with oribatid population. This correlation though appears peculiar is not an unique one, because oribatid mites are known to exhibit wide variation in temperature tolerance. Sanyal (1994) is also of opinion that some species exhibit preferences to low temperature and as such high temperature may decrease the population density while others may exhibit a preference to higher temperature and as a result increased population may be seen at high temperatures. Low population in winter months in this study also indicate the probability of the occurrence of forms showing preference to low temperature.

In both the sampling sites moisture content of soil also showed relatively wide range of variation from 15.9 % to 29.6 %. It was interesting to note that the soil moisture in this case showed a rather weak positive correlation with oribatid population (Tables 9 and 13), though workers like Choudhuri and Banerjee (1977), Joy and Bhattacharya (1981) and Sanyal (1981b) observed a strong positive correlation with population in some sampling sites of West Bengal. But workers like Hammer (1953), Dhillon and Gibson (1962), Choudhuri and Pande (1982), Sarkar (1991) and Sanyal and Sarkar (1993) observed negative correlation of soil moisture with oribatid population. So it appears that role of soil moisture on oribatid population is still in a state of confusion. Moreover, the capacity to withstand the condition of drought or desiccation as well as higher moisture level may vary from species to species which might be considered as a probable reason for population fluctuation. In this study, monsoon months witnessed a lean population when the moisture level was appreciably high, while winter samples supported a higher population when the moisture concentration was moderate. It can, therefore, be assumed that soil moisture which is dependant on rainfall, percolation, evaporation, etc. may exert significant or insignificant effect on oribatid population.

The organic carbon content of soil in both the sites varied between 1.45 % to 2.28 % and most cases exhibited a strong positive correlation (Tables 10 and 14) with population. Organic carbon being the most important constituent of soil organic matter, any increase in the percentage of organic carbon obviously leads to the greater organic matter content. Increased population of oribatids with increased concentration of organic carbon has also been reported by Choudhuri and Banerjee (1977), Joy and Bhattacharya (1981), Sanyal (1981a), Choudhuri and Pande (1982) and Banerjee and Sanyal (1991). It can be well assumed that soil organic matter exerts direct and indirect influence on oribatid population through its effects on vegetation and various soil condition such as soil temperature, moisture holding capacity, soil reaction and microbial population, etc. Again the feeding habit of oribatid also suggests its dependance on the availability of the organic matter. Therefore it appears that organic matter as a source of potential food may exert direct or indirect influence on oribatid population.

SUMMARY

The paper contains results of an ecological study of soil oribatid population in two undisturbed, uncultivated and well-vegetated sampling sites, *D-1* : Guava plantation and *D-2* : Mixed plantation at Dakshineswar in North 24-Parganas district, West Bengal, India. Four plots in each site were selected from where a total of 288 soil samples were drawn at monthly interval over a period of three years (January, 1989 to December, 1991).

Soil factors studied were pH, temperature, moisture and organic carbon. All these were found to vary seasonally and sampling site-wise.

The soil oribatid mites encountered from both the sites were represented by 14 genera, of which 6 were common. In order of dominance, the genus *Scheloribates* came first being followed by *Tectocepheus* and *Oppia* in Guava plantation site (*D-1*) and by *Oppia* and *Berlesozetes* in Mixed plantation site (*D-2*). The latter site showed a relatively higher population, but number of genera encountered were 10 in both the sites.

The total population of soil oribatid mites in both the sites exhibited maximum population sometimes in January and February in all three sampling years. The population was at the minimum level in summer or monsoon months. It exhibited a trend of increase from October reaching its peak in January – February followed by gradual decline. In winter months (January – February) both soil temperature and moisture were moderate and organic carbon fairly high and supported a larger population.

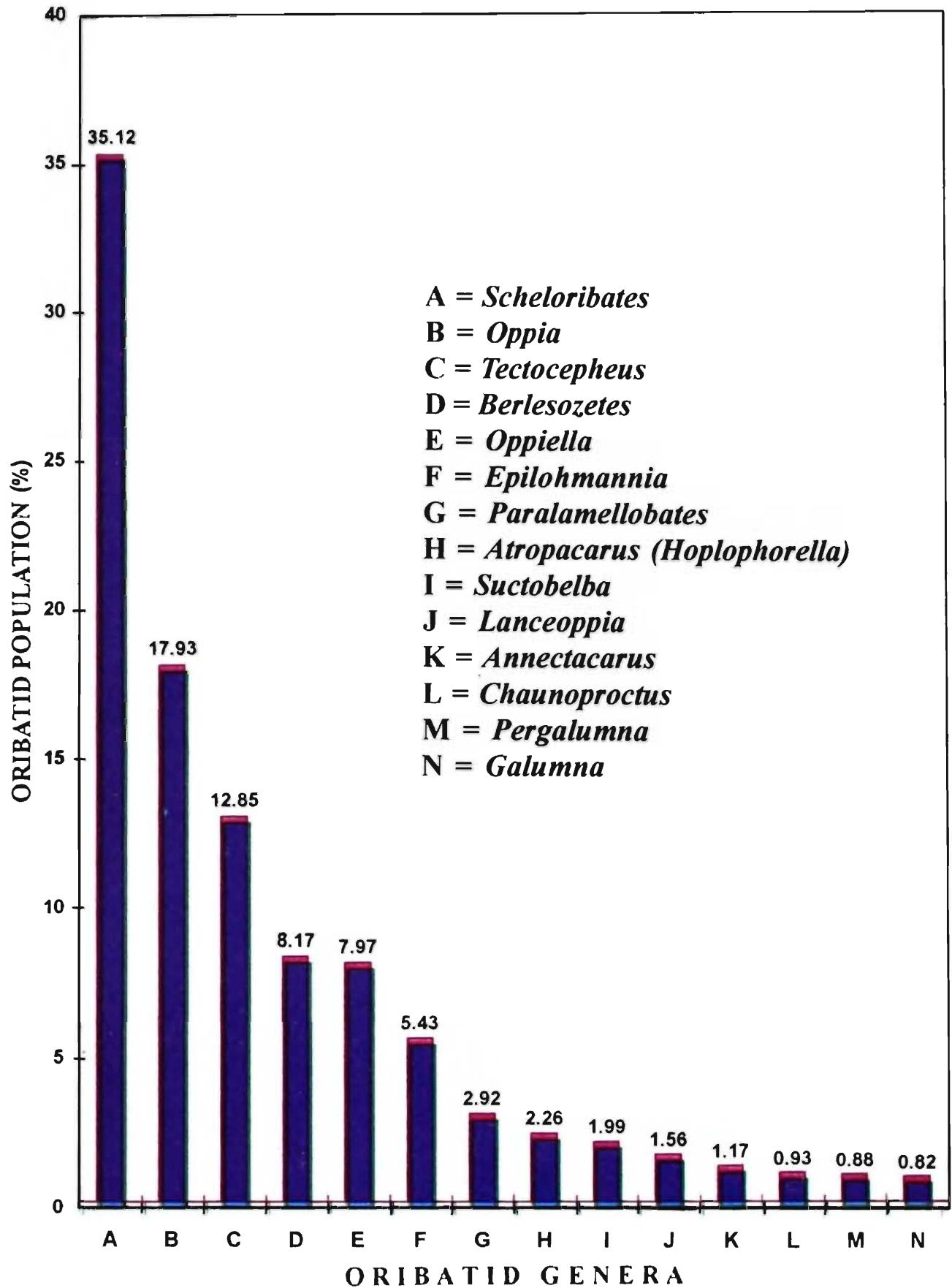


Fig. 27. Bar-diagram showing combined Population (%) of oribatid genera in the two sampling sites (D-1 : Guava Plantion and D-2 : Mixed Plantation).

Of the four soil factors studied in both the sites, only soil organic carbon showed a positive and significant correlation with soil oribatid population. The relation of moisture though positive was weak or insignificant. Both temperature and pH in their turn showed negative and significant correlation with oribatid population.

This study further revealed that cumulative influence of different soil factors on population was more important than influence of particular factor. The slight differences observed in faunal make-up as well as in seasonal variation might be due to prevalence of local microclimatic conditions different from one sampling site to other.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. J. R. B. Alfred, Director, Zoological Survey of India, Calcutta for providing the laboratory facilities and encouragement. The authors are grateful to Prof. D. K. Choudhuri, former Dean, Faculty of Science, Burdwan University, Dr. P. K. Choudhuri and Dr. M. Banerjee, former Heads, Department of Zoology, Burdwan University, Burdwan for providing all sorts of laboratory facilities and necessary requirements during the execution of this work. Thanks are due to Dr. S. C. Chatterjee, Department of Botany, City College, Calcutta for identifying all Botanical specimens. The authors are also thankful to Mr. B. J. Sarkar, Mr. S. N. Ghosh and Mr. Amitava Roy, Zoological Survey of India, Calcutta and Mrs. Sharmistha Sarkar, Calcutta for their help and assistance.

REFERENCES

- Balogh, J. 1972. The Oribatid Genera of the World. *Akademiai Kiado, Budapest, Hungary* : 1-188, pls. 1-71.
- Banerjee, J. and Roy, S. 1981. Acarine community of a forest ecosystem in Burdwan. *Contributions to Acarology in India*, Bangalore (Ed. G. P. Channa Basavanna) : 28-32.
- Banerjee, S. 1973. Seasonal variations of Acari and soil Nitrate. *Acta Arachnol.*, **25** (1) : 37-40.
- Banerjee, S. 1974a. Qualitative composition and seasonal fluctuation of Oribatei (Acarina) in Burdwan soil, West Bengal (India). *Acta Arachnol.*, **25** (2) : 68-72.

- Banerjee, S. 1974b. Oribatid mites and organic carbon content of soil. *Acta Arachnol.*, **26** (1) : 47-50.
- Banerjee, S. 1988. Distribution of Acari in relation to soil conditions in 24-Parganas, West Bengal, India. *Progress in Acarology* (Eds. G. P. Channa Basavanna and C. A. Viraktamath), **1** : 451-457.
- Banerjee, S. and Sanyal, A. K. 1991. Oribatid mites as bioindicator of soil organic matter. In : *Advances in Management and Conservation of Soil Fauna* (Eds. G. K. Veeresh, D. Rajagopal and C. A. Viraktamath). *Proc. 10th Int. Soil Zool. Colloq.*, Bangalore : 877-880.
- Bhattacharya, T. and Bhattacharya, J. 1981. Role of soil Cryptostigmatid mites in the Assessment of Industrial pollution. *J. of the IPHE India*, **1981** (3) : 51-56.
- Bhattacharya, T. and Bhattacharya, J. 1984. Community structure of soil Oribatida as influenced by Industrial waste water. *Entomon.*, **8** (4) : 337-348.
- Bhattacharya, T., Joy, S. and Joy, V. C. 1981. Community structure of soil Cryptostigmata under different vegetational conditions at Shantiniketan. *J. Soil Biol. Ecol.*, **1** : 27-42.
- Bhattacharya, T. and Joy, V. C. 1980a. Changes in the abundance of soil inhabiting Acari of a paddy field in response to the application of two herbicides. In : *Pesticide Residues in the Environment in India*, Bangalore, 1980 (Eds. C. A. Edwards, G. K. Veeresh and H. R. Krueger). *UAS Tech. Series*, No. **32** : 505-513.
- Bhattacharya, T. and Joy, V. C. 1980b. Effect of two herbicides on the soil inhabiting Cryptostigmatid mites. *Soil Biology as related to land use practices* (Ed. D. L. Dindal). *United States Environmental Protection Agency*, Washington : 109-118.
- Bhattacharya, T., Joy, V. C. and Joy, S. 1980. Soil inhabiting Cryptostigmata (Acari) of the rice field ecosystem in relation to agro-technical measures. *Tropical Ecology and Development* : 981-987.
- Choudhuri, D. K. and Banerjee, S. 1975. Qualitative and quantitative composition of Acari and Collembola in relation to soil organic matter-microbes complex. *Oriental Ins.*, **9** (3) : 313-316.
- Choudhuri, D. K. and Banerjee, S. 1977. Soil factors of soil oribatid mites under conditions of West Bengal. *The University of Burdwan Publication* : 1-88.
- Choudhuri, D. K. and Pande, T. 1979. High altitude soil animals and their relationship with soil factors, with special reference to mites. *Rev. Ecol. Biol. Sol.*, **16** (2) : 219-226.

- Choudhuri, D. K. and Pande, T. 1982. An ecological study of Acarines from soil of Himalayan ecosystem. *Geobios new Reports*, **1** : 24-26.
- Choudhuri, D. K. and Paul, A. 1987a. Changes in the community structure of oribatid mites in relation to fungal flora and their role in fertility and productivity of soil in some polluted and unpolluted sites of Gangetic West Bengal. *Indian Biol.*, **19** (1) : 1-4.
- Choudhuri, D. K. and Paul, A. 1987b. An ecological study of soil fauna and their relation with soil factors with special reference to mites and microbes complex in some polluted and unpolluted sites of Gangetic soil of West Bengal. *Indian Biol.*, **19** (1) : 5-10.
- Choudhuri, D. K. and Roy, S. 1972. An ecological study on Collembola of West Bengal, India. *Rec. zool. Surv. India*, **66** (1-4) : 81-101.
- Dhillon, B. S. and Gibson, N. H. E. 1962. A study of the Acarina and Collembola of agricultural soil. .1. Numbers and distribution of undisturbed grassland. *Pedobiologia*, **1** : 189-209.
- Ghatak, T. K. and Roy, S. 1981. Acarine fauna of a cultivated field of Hooghly district, West Bengal. *Contributions to Acarology in India*, Bangalore (Ed. G. P. Channa Basavanna) : 24-28.
- Ghatak, T. K. and Roy, S. 1991. The role of soil moisture and organic matter on the distribution of Acari fauna in a forest floor of Hooghly district, West Bengal. In : *Contribution to Acarological Researches in India* (Eds. A. B. Mukherjee, A. K. Som Choudhury and P. K. Sarkar), Kalyani, West Bengal : 143-158.
- Hammer, M. 1953. Investigations of the microfauna of Northern Canada. Part I and II. *Acta Arctica*, **4** : 1-108.
- Hatter, S. J. S., Alfred, J. R. B. and Darlong, V. T. 1992. Soil acarina and collembola in forest and cultivated land of Khasi Hills, Meghalaya. *Rec. zool. Surv. India*, **92** (1-4) : 89-97.
- Hazra, A. K. and Sanyal, A. K. 1989. Population fluctuation of some predominant species of acarina and collembola on the embankment of a drainage system at Eden Gardens, Calcutta. *Environment and Ecology*, **7** (2) : 366-368.
- Joy, S. and Bhattacharya, T. 1977. A qualitative and quantitative survey of soil inhabiting Cryptostigmatid mites in four contrasting sites of Shantiniketan, West Bengal. In : *Proceeding Second Oriental Entomology Symposium*, Madras (Ed. T. N. Ananthkrishnan). : 75-76.
- Joy, S. and Bhattacharya, T. 1981. Cryptostigmatid population of a Banana plantation in relation to some edaphic factors. In : *Progress in soil Biology and Ecology in India*, Bangalore (Ed. G. K. Veeresh). *UAS Tech. Series*, No. **37** : 100-107.

- Mitra, S. K., Hazra, A. K. and Mondal, S. B. 1983. Changes in the population structure of collembola and acarina in a grassland and rain water drainage at Calcutta. In : *New Trends in soil Biology* (Eds. Ph. Lebrun *et al.*) : 664-667.
- Mitra, S. K. and Mukherjee, R. N. 1987. Dynamics of Collembola and Acarina in grassland area of Calcutta. *Bull. zool. Surv. India*, 8 (1-3) : 187-195.
- Murphy, P. W. 1962. The split funnel extractor – A modified Tullgren funnel. *Progress in Soil Zoology* (Ed. P. W. Murphy). Butterworths, London : pp. 178.
- Prabhoo, N. R., Pai, C. G. A. and Namboory, K. D. 1988. Ecology of Acaro-fauna of fire prone tropical forests in the Western Ghats in Kerala with special reference to Oribatei (Acari). *Progress in Acarology* (Eds. G. P. Channa Basavanna and C. A. Viraktamath), Bangalore, 1 : 475-481.
- Roy, S. and Ghatak, T. K. 1980. Soil microarthropod community of a forest ecosystem of West Bengal. *Proc. Symp. Environ. Biol.*, Trivandrum : 20-30.
- Sanyal, A. K. 1981a. Ecology of soil oribatid mites in an uncultivated field of gangetic delta of West Bengal in relation to soil pH and salinity. In : *Progress in soil Biology and Ecology in India*, Bangalore (Ed. G. K. Veeresh). *UAS Tech. Series*, No. 37 : 107-112.
- Sanyal, A. K. 1981b. Qualitative and quantitative composition of Oribatei in gangetic delta of West Bengal in relation to edaphic factors. *Bull. zool. Surv. India*, 4 (3) : 295-307.
- Sanyal, A. K. 1982. Soil oribatid mites and their relation with soil factors in West Bengal. *J. Soil Biol. Ecol.*, 2 (1) : 8-17.
- Sanyal, A. K. 1988. Relationship between soil factors and oribatei (Acari) in Deltaic soil of West Bengal, India. In : *Progress in Acarology* (Eds. G. P. Channa Basavanna and C. A. Viraktamath), 1 : 491-498.
- Sanyal, A. K. 1991a. Influence of agricultural practices on the population of soil mites in West Bengal, India. In : *Advances in Management and conservation of Soil Fauna* (Eds. G. K. Veeresh, D. Rajagopal, C. A. Viraktamath). *Proc. 10th Int. Soil Zool. Colloq.*, Bangalore : 333-340.
- Sanyal, A. K. 1991b. Ecology of soil oribatid fauna in two contrasting environment in Calcutta. In : *Contribution to Acarological Researches in India* (Eds. A. B. Mukherjee, A. K. Som Choudhury and P. K. Sarkar), Kalyani, West Bengal : 73-86.
- Sanyal, A. K. 1994. Ecological studies on soil mites (Acari) in India : A Review. *Advances in Ecology and Environmental Sciences*, Chapter 6 : 79-96.

- Sanyal, A. K. and Bhaduri, A. K. 1982. Seasonal changes in the density of soil oribatid mites in relation to temperature and water content of soil at Sagar Island, 24-Parganas, West Bengal. *Proc. Symp. Ecol. Anim. Popul. Zool. Surv. India*. pt. 3 : 119-126.
- Sanyal, A. K. and Sarkar, B. J. 1983. Qualitative composition and seasonal fluctuation of oribatid mites in saline soil in West Bengal. *Indian J. Acar.*, 8 : 31-39.
- Sanyal, A. K. and Sarkar, B. J. 1993. Ecology of soil oribatid mites in three contrasting sites at Botanical Gardens, Howrah, West Bengal. *Environment and Ecology*, 11 (2) : 427-434.
- Sarkar, Sadhana 1990. Studies on microarthropod community in one undisturbed habitat of Tripura (India) with special reference to oribatid mites. *Rev. Ecol. Biol. Sol.*, 27 (3) : 307-329.
- Sarkar, Sadhana 1991. Studies on microarthropod community in one undisturbed habitat of Tripura with special reference to oribatid mites. In : *Advances in Management and Conservation of Soil Fauna* (Eds. G. K. Veeresh, D. Rajagopal and C. A. Viraktamath). *Proc. 10th Int. Soil Zool. Colloq.*, Bangalore : 777-788.
- Sengupta, D. and Sanyal, A. K. 1986. Distribution of soil acari in South Bihar, with special reference to Cryptostigmata and Mesostigmata – A preliminary report. *J. Acarol.*, 11 (1 & 2) 1986 (1989) : 59-66.
- Sengupta, D. and Sanyal, A. K. 1991. Studies on the soil microarthropod fauna of a paddy field in West Bengal, India. In : *Advances in Management and Conservation of Soil Fauna* (Eds. G. K. Veeresh, D. Rajagopal and C. A. Viraktamath). *Proc. 10th Int. Soil Zool. Colloq.*, Bangalore : 789-796.
- Sheela, K. and Haq, M. A. 1991. Oribatid mites as bioindicator of soil moisture. In : *Advances in Management and Conservation of Soil Fauna* (Eds. G. K. Veeresh, D. Rajagopal and C. A. Viraktamath). *Proc. 10th Int. Soil Zool. Colloq.*, Bangalore : 871-876.
- Singh, J. and Mahajan, S. V. 1981. Frequency and relative abundance of soil acari in tropical arable and deciduous forest soil. In : *Contribution to Acarology in India* (Ed. G. P. Channa Basavanna), Bangalore : 157-158.
- Walkley, A. and Black, I. A. 1934. An examination of the Degtijareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Sci.*, 37 : 29-38.

