Rec. zool. Surv. India : **100** (Part 3–4) : 145–159, 2002

DIVERSITY AND COLONIZATION OF THE TERESTRIAL INVERTEBRATE FAUNA AT SCHIRMACHER OASIS, EAST ANTARCTICA

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INTRODUCTION

The knowledge about Antarctic invertebrate fauna in general and East Antarctic in particular specially on the limnology bio-ecology, faunal diversity, species richness, distribution pattern of invertebrate fauna is still fragmentory (Somme, 1985). The fresh water lakes of the Antarctic continent representing a biological integration of an entire drainage area, are particularly attractive ecological unit for basic study (Priddle and Heywood, 1980).

Keeping these in view, the scientists of the Zoological Survey of India have been undertaking a continuing programme to explore the terrestrial invertebrate fauna of the Schirmacher Oasis of East Antarctic with special reference to bio-ecological studies since 1990. The present communication is an attempt to deal with the distribution pattern of different invertebrate faunal groups occurring in about 36 sites, on the embankment of various lakes particularly on the moss turf habitats during the period from January to February 1996. An attempt has also been made to incorporate the ecology of some dominant nematode species studied during the period from January to February 1990.

LITERATURE REVIEW

A perusal of literature reveals that lakes of maritime and sub Antarctic islands were more intensively surveyed than continental Antarctica particularly Schirmacher Oasis.

Bardin and Leflat (1965) are the first workers to study the chemical characteristics of Schirmacher Oasis. Komarek and Ruzicka (1966) are pioneers in studying freshwater algae of the area. Matonkdar and Gomes (1983) are the first Indian to conduct biological studies on lakes, while Ingole and Parulekar (1987, 1990, 1993) dealt with composition and spatial distribution of microfauna of 10 fresh water lakes. A review on the biological studies carried out from I to VIth Indian Scientific expedition to Antarctic waters (Dhargalkar, 1988) shows that the data collected during summer to

*The paper was presented by the first author in the VIIth SCAR Biology Symposium, Christchurch, New Zealand (27.8.98 to 8.9.98).

not show continukty. Thus lacunae that exists, can be removed in by taking up systematic and biological programmes. Richter *et al* (1990) reported some unidentified mites and springtail from Schirmacher Oasis. During the above mentioned investigation Ingole and Parulekar (Opcit) reported 7 microfaunal groups, viz. Protozoa, Turbellaria, Nematoda, Oligochaeta, Tardigrada, Rotifera, Acarina and identified only 8 species upto generic level. Hazra (1994) recorded and studied the ecology of 5 genera of soil nematodes of this region. Arif (1995) reported some groups of invertebrate fauna without proper taxonomic identity. Venkataraman (1998) reported Tardigrada (2 spp.), Nematoda (3 spp.), Rotifer (1 sp.), Mitra (1999) reported six microfaunal groups viz., Protozoa (17 spp.), Nematoda (5 spp.), Rotifera (1 sp.), Tardigrada (2 spp.), Collembola (2 spp.) and Acarina (2 spp.) from different lake water system of Schirmacher Oasis.

PHYSIOGRAPHY : CLIMATE & VEGETATION

The core of the Antarctic is the high ice covered continent which is subdivided into two broad divisions : East and West. There is a sharp contrast between these two divisions both geologically and physically. East Antractic contains part of an ancient continental shield, overlain by younger rocks, whereas West Antarctica contains continental material that has been joined to the East Antarctic shield late in its history. The term 'Oasis' was first used by 'Stephenson' (a member of British Antarctic expedition team, 1934–1937) to cover both dry and wet snow free areas on the Antarctic continent. The Schirmacher Oasis of east Antarctic was discovered by a German expedition team 1939. It is situated in between shelf and land ice having an ice free area of 36 sq. km with lakes, lagoons, ponds and water streams. It lies in between 70°34' S and 70°77' S latitudes and 11°22'E and 11°55'E longitudes and 90 km south of Princess Astrid Coast. The Schirmacher Oasis of East Antarctica is a group of low lying, dome shaped hills, essentially snow- and ice free high polar rock deserts in the eastern Dronning Maud land. It is about 100 km away from the Antarctic shore.

The climate is relatively mild due to low altitude, with air temperature over the glacier ice between –7.7 and +8.2°C during mid summer (December to January) when melt water is abundant. Fresh water lakes, ponds and pools cover approximately 3.4 km^2 of Oasis area. The altitude lies in between the local Zero level and 228 metre with an average of 100 metre. Its surface is rough and undulated. January is the warmest month (monthly mean air temperature 0.7°C, maximum 8.2°C) and August the coldest (monthly mean air temperature –16.3°C, minimum –34.5°C). The average wind velocity over the year is around 9.7 m/s. The wind at Schirmacher Oasis are normally easterly, south easterly during summer. Extreme air temperature recorded at the Maitri station was – 34°C and +0.8°C.

Despite the fact that scientists have been visiting Antarctica for nearly 100 years, there are still gaps in what is known of Antarctic plants. Best studied are the mosses, liverworts and lichens, but little is known about the algae, fungi and bacteria. The distribution of plants are controlled by a

number of factors such as temperature, availability of water, wind, heat from the sun, and the influence of animals such as birds and seals. The most common large plants found around greater Antarctica are mosses and lichens. These are distributed chiefly around the edge of the continent, as well as on the Antarctic peninsula. Mosses have been reported from as far south as 84°42' S and lichens from 86°69' S at a height of 1980 metres.

MATERIAL AND METHODS

A total of 36 sites (33 lakes and 3 swampy areas) were chosen for the present investigation (Map 1). A total of 135 sample were collected of which 120 samples from floating, submerged mosses and mosses of marginal areas of the lakes and 15 moss sample were collected from 3 swampy areas as stated.

Soil samples were drawn at the rate of 3 samples per site on different dates, during the period from January 1990 to February 1990. January 1992 to February 1992 and January to February 1996. The samples were drawn by using stainless steel corers (e.s. diameter 8.55 cm) from a depth of 5 cm. Separate sample units were drawn on several dates from different sites to study the vertical distribution of nematodes. The 3 samples per plot were drawn from a depth of 10 cm and sub-divided into two 5 cm sub samples as per method described by Curry (1971). The soil inhabiting microarthopod fauna were extracted by Macfadyen's (1953) expedition funnel apparatus with slight modifications.

The protozoans, tardigrades and rotifers were extracted from the freshly collected moss sample by floating this on a 50 ml glass Jar by following standard methods for each group. The methodology followed by Cobb's (1918) for sieving and decantation the Bermann funnel technique of Christic and Perry (1951) were used for extraction of nematodes.

LOCATION AND CHARACTERISTICS OF SAMPLING SITES

The sampling sites were located at Schirmacher Oasis, east Antarctica, where the Indian station 'MAITRI' is present (Lat. 70°44' 30"–70°46' 30" S and Long. 11°22' 44 "–11°54' 44" E). There are over 58 fresh water lakes at different sizes within the Oasis. 36 such lakes were chosen for the present study. Each sampling plot of moss turf was measured 5 m × 5 m areas in the periphery of the lakes. The lakes and the swampy areas have been categorised according to their location (Table 1) in respect of closeness to Polar ice caps (A) – 14 sites; Shelf ice (B) – 7 sites; and in between A & B (C) – 15 sites. The position in respect of Indian station such as east of Maitri (E) – 19 sites; west of Maitri (W) – 13 sites and north of Maitri (N) – 4 sites. The swampy areas have designated in this study it means this sites having a very little depth of water and smaller in size in comparison to the true lake areas.

Table 1. Showing the location, position of the collection sites and presence of fauna in different lake water systems.

Site	Location			Position			Fauna
	A	B	C	E	W	N	
1	+				+		+
2			+		+		+
3			+		+		+
4			+		+		+
5		+				+	
6			+		+		+
7	+				+		+
8			+		+		+
9	+				+		+
10	+				+		+
11			+		+		+
12			+		+		
13			+	+			
14			+	+			+
15			+	+			+
16			+	+			
17		+		+			
18		+		+			
19			+	+			
20	+			+			+
21	+			+			
22	+			+			+
23	+			+			
24	+			+			
25	+			+			
26	+			+			
27	+			+			+
28			+			+	+
29	+				+		
30			+	+			
31	+			+			
32		+				+	+
33		+				+	
34			+		+		+
35		+		+			+
36		+		+			+

Abbreviations used : A = Near to Polar ice cap; B = Near to Shelf; C = In between A & B; E = East of Maitri; W = West of Maitri; N = North of Maitri.

RESULTS

Faunal composition

It is evident from table 1, the invertebrate fauna were obtained from 20 localities out of 36 lake sites sampled during the investigation. The invertebrate fauna obtained from all the sites of Schirmacher Oasis are given in table (2).

The protozoans were most dominant and represented by 17 species followed by Nematoda comprising of 5 genera species. The Collembola, Acarina and Tardigrada each was represented by two genera species. The Rotifera was represented by only one species, viz., *Philodina gregarina.*

In connection with the analysis of Protozoan distribution in different lake system (Table 2) it has been observed that the maximum number of testacid protozoans (7 species) were obtained from the lake no. 28 followed by six species were recorded from the lake no. 34. *Oxytricha fallax* Stein and *Stylonychia* sp. (Ciliates) were recorded only from the lake no. 1. while *Assulina muscorum* Greef was most widely distributed species which obtained from seven different localities. The only rotifer species *Philodina gregarnia* was obtained from six different sites. From the Schirmacher Oasis only 2 species of tardigrades viz. *Hipsibius chilensis* (Plate) (3 localities) and *Macrobiotus polaris* (Murray) (2 localities) have been collected so far during the present study. The Acarina was obtained from two localities (11 and 27) and the Collembola were also found in two localities (8 and 11) (Table 2).

Ecology of nematode population

The nematode fauna obtained from different sites of Schirmacher Oasis are shown in fig. 1. The genus *Tylenchorhyncus* was most dominant and its representation was 41% of the total nematode fauna obtained. The genus *Dorylaimoides, Drylaimellus* and *Paramylonchulus* contributed 27.87%, 18.83% and 12.52% respectively of total nematode fauna.

Population fluctuation

Fig. 2 showed that datewise changes in number of total nematode fauna recorded from different sites. The total nematode fauna had its highest peak on 27th January followed by 3rd January and minimum population were obtained during 25th February. The species wise fluctuation are given in Fig. 1. *Paramylonchulus* showed a steady population up to the end of January and declines graudally unit it reaches minimum in the end of February. *Tylenchorhyncus* showed two clear peaks are on 3rd January and others on 27th January thereafter the population declines sharply from 1st February. *Dorylaimoides* and *Drylaimellus* were similar each with an early January and a late January peak in numbers.

Table 2. Showing the distribution of invertebrate fauna in different lakes and swampy areas of Schirmacher Oasis.

SPECIES	L				A							K					E			S
	1	2	3	4	6	7	8	9	10	11	14	15	20	22	27	28	32	34	35	36	No. of sites
GR. A PROTOZOA	+	+	+	+				+	+	+	+				+	+	+	+	+		13
Arcella arenaria Greff		+						+	+		+					+	+				6
Arcella catinus Penard		+								+	+							+			4
Arcella sp		+																	+		2
Diplochlamys sp	+							+													2
Parmulina sp																+					1
Centropyxis aerophila (Diflandre)			+													+	+	+			4
Centropyxis sp	+		+															+	+		4
Difflugia sp (I)																+					1
D. Sp. (2)																	+				1
Nebela Sp								+													1
Corythion dubium Taranek		+		+					+	+						+					5
Assulina muscorum Greff			+							+	+				+	+		+	+		7
Euglypha sp.																+		+	+		3
Trinema sp.																		+	+		2
Colpoda sp.		+	+	+								+			+						5
Oxytricha fallax Stein	+																				1

Table 2. *Contd.*

SPECIES	L						A				K					E				S
	1	2	3	4	6	7	8	9	10	11	14	15	20	22	27	28	32	34	35	36	No. of sites
Stylonychia sp.	+																				1
GR. B : ROTIFERA			+						+			+				+	+	+			6
Philodina gregarina			+						+			+				+	+	+			6
GR. C : TARDIGRADA			+					+								+	+				4
Hypsibius chilensis (Plate)			+					+								+					3
Macrobiotus polaris (Murray)			+														+				2
GR. D : ACARINA										+					+						2
Tyrophagus sp.										+											1
Fam : Scutacaridae										+					+						2
GR. E : COLLEMBOLA							+			+											2
Cryptopygus sp.							+														1
Unidentified sp.										+											1
GR. F : NEMATODA	+	+	+	+	+	+		+	+		+		+	+	+	+			+	+	15
Drylaimellus sp.	+															+			+		3
Dorylaimoides sp.				+								+	+								3
Paramylonchulus											+										1
Tylenchorhynchus sp.			+		+	+		+	+						+					+	7
Aporcelaimellus sp.		+																			1
No. of Species	5	6	6	5	1	1	1	5	4	6	5	1	1	1	4	10	5	7	6	1	

Vertical distribution

Depth wise distribution of mean population of nematodes obtained from different study sites reveals that maximum nematode fauna (76.65%) was recorded from upper most layer (0–5 cm). Monthly variation in the vertical distribution of nematode showed maximum in upper most layer during the month of January and February. *Paramylonchulus* was not found on 15.1.90 from both the layers. *Dorylaimellus* sp. were not found in 5–10 cm layer and the genus *Tylenchorhynchus* was absent in 5–10 cm layer. It is interesting to know that the relative abundance of nematode in the upper layer was associated with preponderance of immature forms (Fig. 3–5).

DISCUSSION

The results presented here are based on sample survey of 36 sample sites of Schirmacher Oasis.

The invertebrate fauna encountered in this study belong to 6 different groups, viz., Protozoa, Rotifera, Tardigrada, Nematoda, Acarina and Collembola. The protozoans were the most dominant invertebrate fauna in the present study. It was represented by 17 genera/species and occurred from 13 different localities. The genera like *Parmulina, Difflugia* (1 & 2), *Nebella, Oxytricha, Stylonychia* were obtained from a single site of different lake system. Therefore these species are highly restricted in their distribution pattern. On the contrary, *Assulina muscorum* and *Arcella arenaria* were found to be widely distributed in different localities of the lake system and may be termed as ubiquitous. This might be due to their capacity to utilize different food sources and microhabitats for survival (Addison, 1980). No ciliate species including the cosmopolitan soil inhabiting genus *Colpoda* has been recorded from swampy areas. The testacids *Corythion dubium* was found to be most dominant and cosmopolitan followed by *Assulina muscorum* and *Arcella* spp. This is worth mentioning here that all but one genus (*Parmulina* Penard) of Protozoa identified so far from Schirmacher Oasis are cosmopolitan soil and moss dwelling forms which are not only reported from maritime Antarctic and Sub-Antarctic zones but also from other parts of the globe. The Rotifera, Tardigrada, Acarina and Collembola were extracted significantly low in number. The distribution of these species were also restricted to only few sites. Rotifera were obtained from six different lakes, Tardigrades were collected from four sites and the Acarina and Collembola were obtained only from two sites (Table 2). This might be due to the fact that these groups are able to withstand extreme microfloral changes in the habitat.

The nematode fauna encountered in this study belong to 5 genera and obtained from 15 different localities of which *Tylenchorhynchus* sp. was most dominant species. Some genera markedly differ in this abundance from one site to other as well as one date to other date. The maximum nematode population were recorded at the end of January when the surrounding temperature were high and moss vegetation were in full grown stage. Thereafter, the population

starts declining and reached to a minimum number in the last week of February when low temperature was recorded. These findings are compatible to the observations of Maslen (1979, 1981) from Signi Island. He also observed maximum population density of nematodes during austral summer and low in winter.

It is evident from the table 1 that sixteen sites were devoid of any faunal components during the present investigation. This is presumably due to the presence of poor vegetational cover as most of these site were nearer to polar ice caps. This corresponds with the observation of Block (1966) who suggested direct correlations amongst the vegetational cover microflora and Acarina.

The changes in vertical disatribution pattern of nematode population showed higher proportion on the upper 5 cm layer of moss soil in the present study (Fig. 3–5). This is in consistence with the result of the earlier works of sub-Antarctic islands (Spaull, 1973 B and Maslen 1981). But it was not possible to ascertain in the present study whether the vertical distribution pattern was the same throughout the year as this study has been conducted during the limited period of summer months only. The reason for maximum aggregation of population in the upper layer during summer in Antarctic region might be related to the density of texture of moss which acts as a source of food for nematodes and other invertebrate fauna (Maslen, 1981) and the numerical variation of nematodes in different strata in different dates might be due to effects of temperature in the present study.

In general it is evident from the tables 1 and 3 that maximum number of invertebrate groups were obtained from lake no. 3 and 28. This might be due to the fact that, both the sites were located in area C (in between Polar ice cap and Shelf ice). It can be concluded from the present investigation that the nematodes were widely distributed invertebrate fauna and recorded from 15 different sites on the contrary the protozoans showed high species diversity with 17 genera/species distributed over 13 localities. This might be due to the reason that the colonization of Antarctic terrestrial environment considers habitat favourability as a function of its heterogeneity in both space and time (Walton, 1984).

Lastly, it might be inferred that the factorial components considered here, in conjunction with the other biotic and abiotic components not considered in this study, collectively contributed to the distribution and colonization of invertebrate fauna in Schirmacher Oasis.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. J. R. B. Alfred, Director, Zoological Survey of India for providing all sorts of facilities in connection with this investigation. Thanks are also due to the Secretary, Ministry of Environment and Forest. New Delhi for deputing the first author for the presentation of the paper in VIIth SCAR Biology symposium.

Thanks are also due to Dr. S. K. Mitra, Scientist 'SF' for helping in identification Collembola specimens and to Dr. A. K. Das. Scientist 'E' for extracting protozoan specimens from the moss samples brought to the laboratory of Zoological Survey of India in Kolkata and identifying all the protozoan species reported here. Last but not the least to Dr. A. K. Sanyal, Scientist 'E' and Mr Subhash Ghosh for helping in various ways for this work and also helped in identification of Acarina and Nematode specimens.

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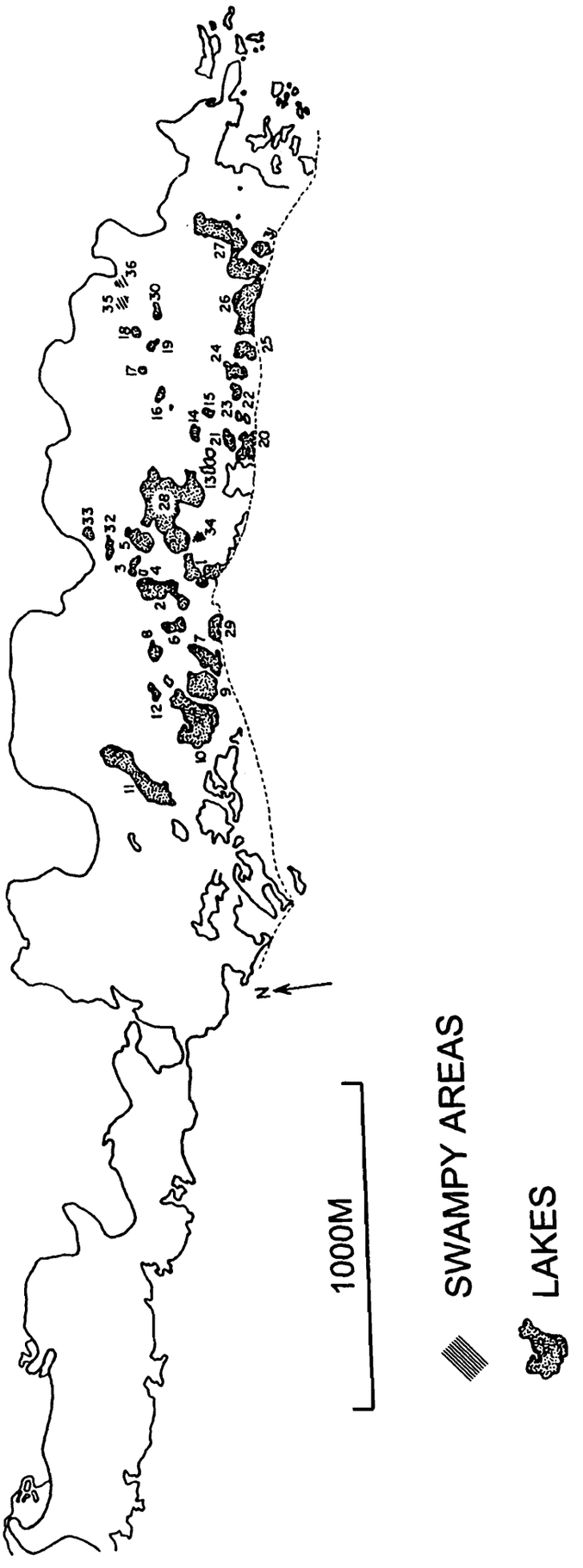

Map 1. Sampling sites at Schirmacher Oasis.

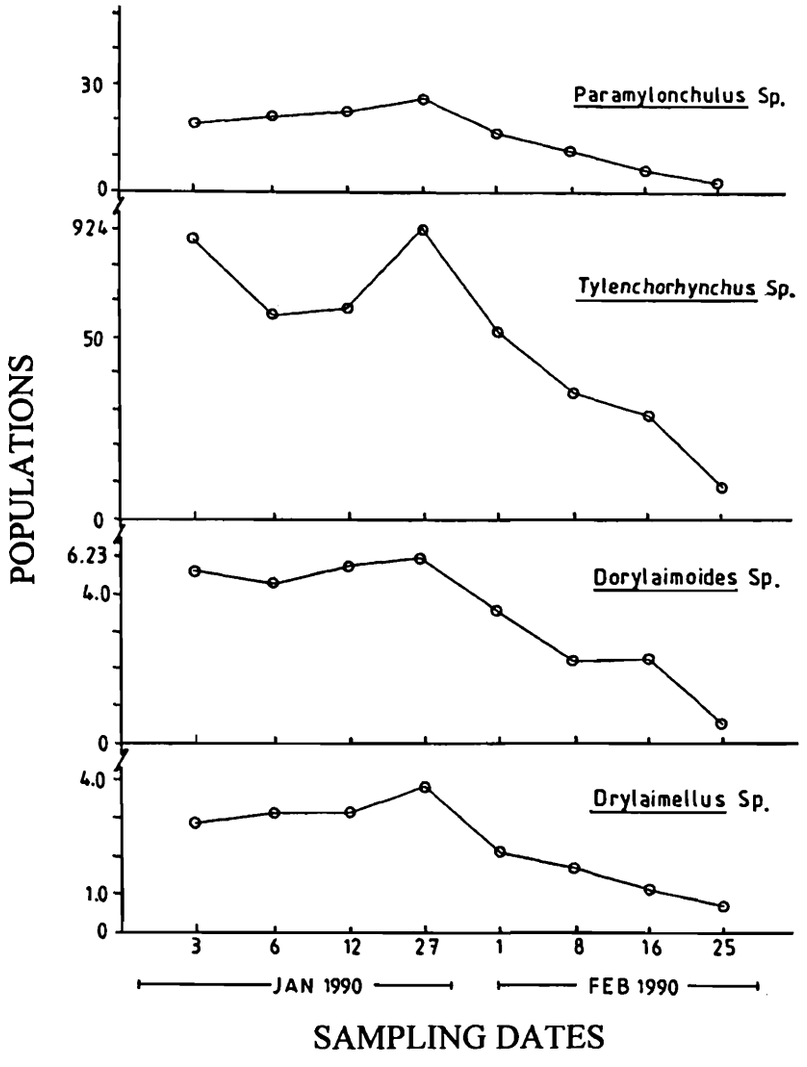

Fig. 1. Fluctuations of population of each nematode genus at Schirmacher Oasis (%).

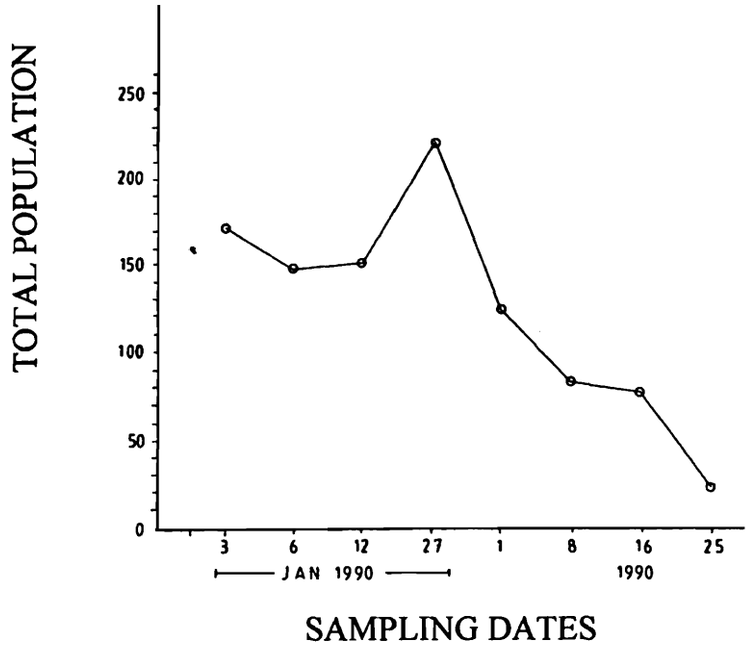

Fig. 2. Fluctuation of total nematode population at Schirmacher Oasis (%).

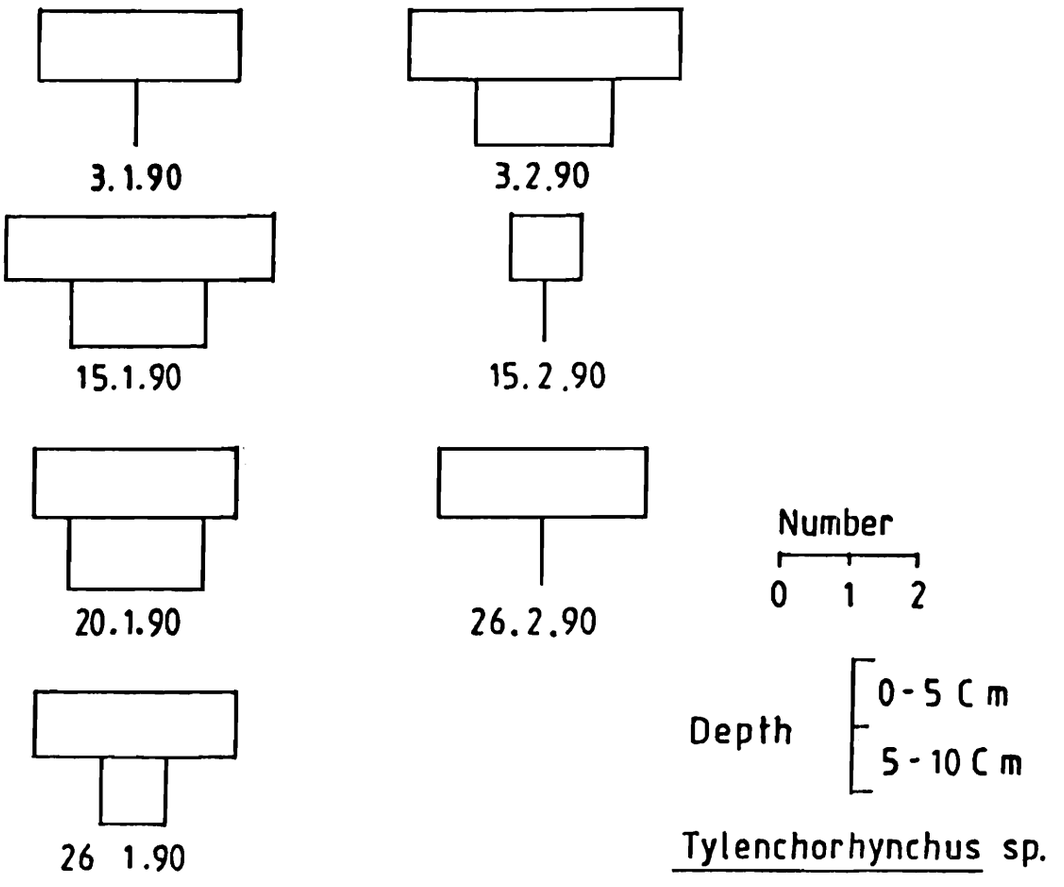

Fig. 3. Vertical distribution of *Tylenchorhynchus* at Schirmacher Oasis.

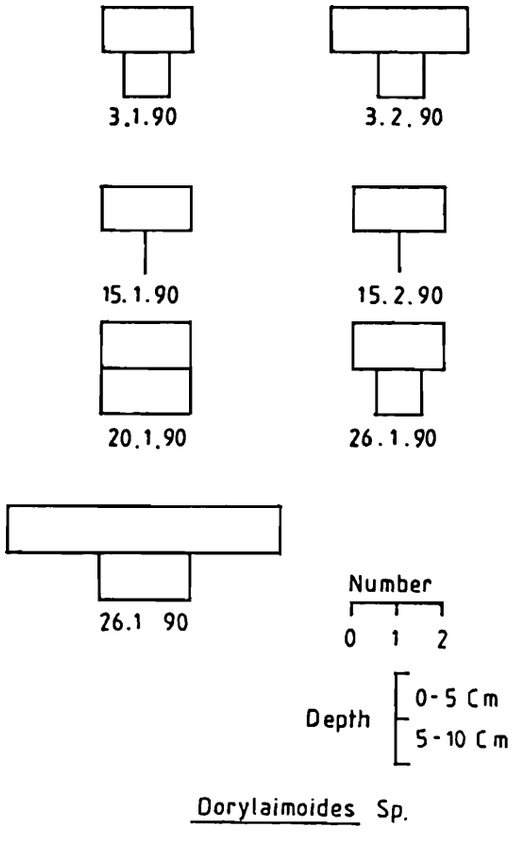

Fig. 4. Vertical distribution of *Dorylaimoides* at Schirmacher Oasis.

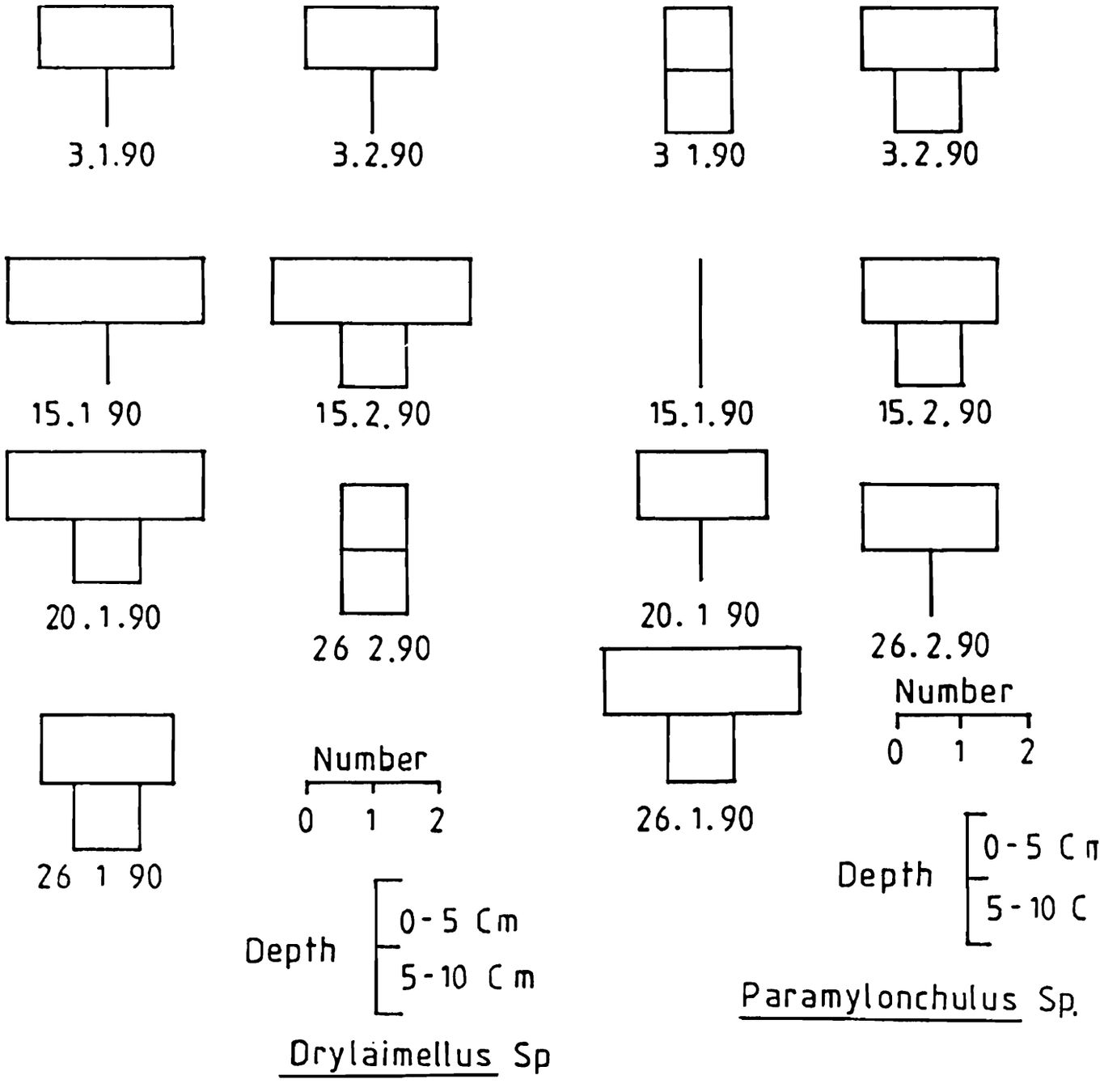

Fig. 5. Vertical distribution of *Dorylaimellus* and *Paramylonchulus* at Schirmacher Oasis.