Fifteenth Indian Expedition to Antarctica, Scientific Report, 1999
Department of Ocean Development, Technical Publication No. 13, pp 93-108

STUDIES ON MOSS INHABITING INVERTEBRATE FAUNA OF SCHIRMACHER OASIS

Bulganin Mitra

Zoological Survey of India

Abstract

During the 15th Indian Scientific Expedition to Antarctica (1995-1996), a total of 36 sites (33 lakes and 3 swampy areas) in Schirmacher Oasis area were surveyed. The diversity and distribution of invertebrate fauna in different habitats of this area were studied. Some physicochemical parameters such, as *pH* (soil and water), temperature (atmospheric and water), etc., were also analysed. In the present study a total of 2 species of rotifera, 2 species of tardigrada, 17 species of protozoa, 5 genera of nematoda, 2 species of mites and 2 families of collembola have been reported from the area.

Introduction

The term 'Oasis' was first used by 'Stephenson' (a member of British, Antarctic Expedition, 1934-1937) to cover both dry and wet snow free areas on the Antarctic continent. The Schirmacher Oasis was discovered in 1939 by a German expedition team. It is situated in between shelf and continental ice, having an ice-free area of 36 sq. km with lakes, lagoons, ponds, water streams, dome shaped hills of Central Dronning Maud Land of East Antarctica. It lies in between 70° 34' to 70° 77' south latitude and 11 ° 22' to 11°55' east longitude. It is 90 km south of Astrid coast area.

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. Matondkar & Gomes (1983) were the first Indian to conduct biological studies on lakes, while Ignole and Parulekar (1987, 1990, 1993) dealt with composition and spatial distribution of microfauna of 10 freshwater lakes. A review on the biological studies carried out from 1st to 6th Indian Scientific Expeditions to Antarctic waters (Dhargalkar, 1988) shows that the data collected during summer do not

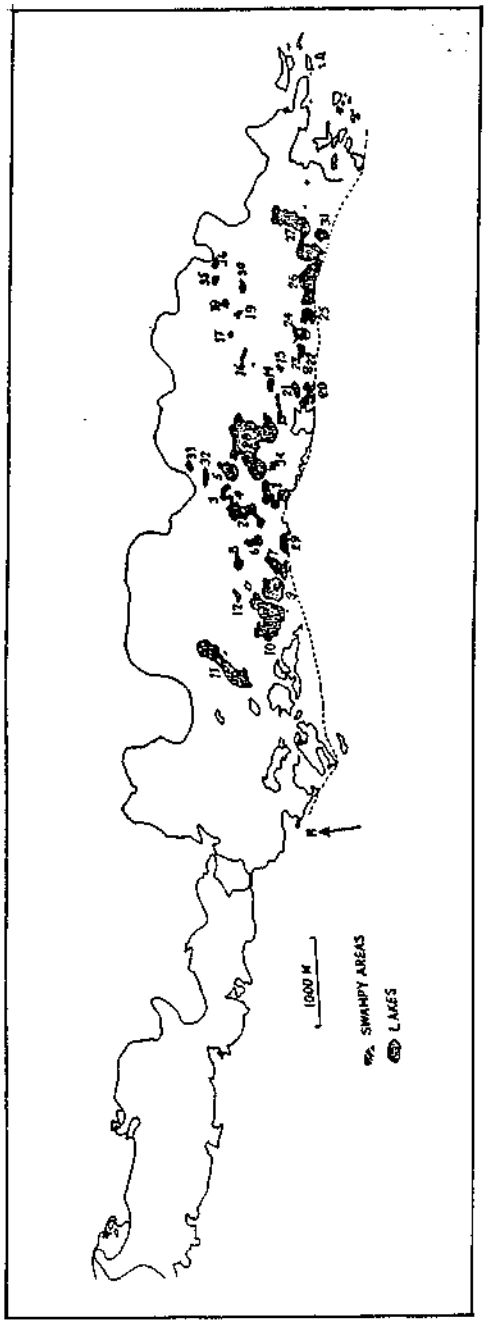
show continuity. Thus lacunae that exist, can be filled in by taking up systematic biological programmes. Richter *et al.* (1990) reported some unidentified mites and springtail from Schirmacher Oasis. Hazra (1994) recorded and studied the ecology of 5 genera of soil nematodes of this region. During the above mentioned investigations Ingole & Parulekar (*op. cit.)* reported 7 microfaunal groups, viz. Protozoa, Turbellaria, Nematoda, Oligochaeta, Tardigrada, Rotifera and Acarina and identified only 8 species upto generic level. Arif (1995) reported some groups of invertebrate fauna such as Earthworm, Nematode, Mite, Collembola, Diptera (adult & larvae) and Lepidoptera (Moth) without proper taxonomic identity. Mostly these collections were made from soil and moss of lake areas, used materials and green houses of Russian and Indian station. Some of the groups are the first report from this area (Arif, 1995). Due to paucity of information on invertebrate fauna of Antarctica, Burndin (1970) was unable to include several faunal groups, such as, Protozoa, Rotifera, Tardigrade and Nematoda in his discussion in the recent invertebrate fauna in relation to the history of Antarctic land fauna. This has also been the problem of all other workers dealing with invertebrates occurring in the Antarctic region. Somme (1985) has pointed out that our knowledge on Antarctic invertebrates is still fragmentary and more work on their taxonomy, zoogeography, population and physiography is needed.

Thus keeping these points in view, an attempt has been made to study the bioecology and diversity of moss-inhabiting microfauna as well as to bring out a comprehensive account of invertebrate fauna of the area.

Material and Methods

A total of 36 sites (33 lakes and 3 swampy areas) were surveyed in the present expedition (Map.1). Out of these, bank and peripheral zones of 30 sites (27 lakes and 3 swampy areas) were found with luxuriant growth of mosses (Table-1). Accordingly, 120 samples of floating, submerged mosses and mosses of the marginal areas of the lakes were collected. Moreover, 15 moss samples were taken from 3 swampy areas (Sites 34, 35, 36).

Primordial soil samples were drawn from depth of 5 cm (with stainless steel cores). All the samples were kept in polythene bags and properly closed with rubber bands and stored in refrigerator of the ship to avoid evaporation. Freshly collected moss samples were examined and slides of protozoa were prepared under binocular microscope. The extraction of soil samples is partly made at Maitri and rest were made in the laboratory of the Zoological Survey of India in Calcutta. Separate standard extraction and preservation methods were followed for different groups of invertebrates. Methods followed from the



Map. 1

Table 1: Showing the location, position and vegetation of the collection sites

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

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; M: Moss.

hand book of 'Collection and Preservation of Animals' of Zoological Survey of India.

Adelie Penguin guano was also collected from different rookeries and lake areas to study the parasitic protozoa. The physiochemical analysis of soil, water of lake areas are being continued. Detailed taxonomic studies of the invertebrate fauna are in progress.

Brief Description of the Lakes and Swampy Areas

The lakes in Antarctica vary from brackish to freshwater in nature, depending upon their distance from the coast. In Schirmacher Oasis the hill slopes remain covered with ice in winter, but in summer melting water gets accumulated in the depression areas between the hills and forming the large and small lakes. The shape, size and the formation of the lakes depend very much upon the quantity of melting water. The majority of the lakes are arheic, possessing no outflow, and the annual ablation rate is generally balanced by the summer ephemeral inflow of glacial melt-streams. Some lakes are very shallow, small in size and subjected to periodic drying. All the lakes and swampy areas surveyed during this expedition were freshwater in nature.

The lakes and swampy areas have been categorised according to their location **(Table-1)** in respect of closeness to Polar ice cap (A, 14 sites), shelf (B, 7 sites) and in between A & B (C, 15 sites) and position in respect of Maitri station such as east of Maitri (E, 1 sites) west of Maitri (W, 13 sites) and north of Maitri (N, 4 sites). Compared to lake areas, the swampy areas are having a very little depth and are small in size.

Survey and Status of Invertebrate Fauna (Group-Wise) In Antarctic & Schirmacher Oasis

Protozoa:

The terrestrial Protozoa was recorded for the first time from the continent by Richter (1907). Smith (1978) listed 124 species from sub-Antarctic and maritime Antarctic islands. On the other hand, Protozoa of Schirmacher Oasis were almost untouched; Ingole and Parulekar (1987) were the first to report Protozoa, from this region and recorded only one species of Ciliate, viz., *Oxytricha fallax* Stein and noted that protozoa are the most dominant fauna, comprising 22.31% of the total lacustrine microfauna. During the present investigation 17 species of protozoa have been collected, out of which 16 species are reported for the first time from this area.

Table 2: Showing protozoan diversity in different lake systems and swampy areas

Protozoan species	Lakes											Swampy Areas	
	1	**2**	**3**	**4**	**9**	**10**	**11**	**14**	**27**	**28**	**32**	**34**	**35**
Arcella arenaria Greef		+			+	+		+		+	+		
Arcella sp(1)		+					+	+				+	
Arcella sp (2)		+											+
Diplochlamys sp.	+				+								
Parmulina sp.										+			
Centropyxis sp. (Diflandre)				+						+	+	+	
Centropyxis sp.	+			+								+	+
Difflugiasp. (1)										+			
Difflugiasp.{2)											+		
Nebela sp.					+								
Corythion dubium Taranek	+			+		+	+			+			
Assulina muscorum Greef		+					+	+	+	+		+	+
Euglypha sp.										+		+	+
Trinema sp.												+	+
Collopoda sp.		+	+	+				+	+				
Oxytricha fallax Stein	+												
Stylonychia sp.	+												

Numerical number indicates the serial number of collecting sites as shown in Map.

In connection with the analysis of protozoan distribution in different lake systems, it has been observed **(Table-2)** that maximum number of testacid protozoan species (7 spp) are found in lake no. 28. This is followed by site no. 34 where 6 species of rhizopods have been recorded from. Amongst ciliates *Oxytricha fallax* Stein and *Stylonychia* were observed only in lake no. 1 while *Assulina muscorum* Greef were found to be distributed in several lakes (7 Nos.).

No ciliate species including the cosmopolitan soil inhabiting genus *Collopoda* has been recorded from swampy areas. Amongst testacids *Corythion dubium* Taranek was found to be most dominant and cosmopolitan followed by *Assulina muscorum* Greef and *Arcella* sp. It is worth mentioning here that all but one genus *(Parmulina* Penard) of protozoa identified so far from Schirmacher area 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 including the Indian part of the Himalaya. However, several species appear to be endemic as shown in **Table-5.**

Rotifer :

The Rotifer, are a group of small usually microscopic, pseudocoelomate animals. They are also called 'rotatoria' or wheel animalcules. Murray recorded the first Antarctic rotifers in the year 1910. Sudzuki (1964) recorded 13' species of rotifers from moss. Jennings (1976) reported there was no marked seasonal changes in population density of rotifer fauna. Only one species viz., *Philodina gregaria* has been observed and collected from 5 lakes and 1 swampy areas during the present investigation. This is the only species known from the Schirmacher Oasis.

Tardigrada :

They arc commonly called as 'water bear' and are minute in size (about 1 mm long) with head and four trunk segments. So far 28 species of tradigrades under seven genera have been reported from the Antarctic (Jennings, 1976). Most of them have world-wide distribution, and only a few of them are restricted to the Antarctica. A review of literature reveals that seven species reported from this continent are also available in high altitude of Himalaya (Ramazotti, 1972). So far very little work has been done on tradigrade diversity in the Antarctic (Morikawa, 1951). From the Schirmacher Oasis only 2 species, viz., H*ypsihius chilensis* (Plate), and *Macrobiotus polaris* (Murray) have been collected so far during the present and preceding Indian Scientific Expeditions.

Nematoda :

Terrestrial nematods were first described from the maritime Antarctic zone by de Mann (1904) and from the sub Antarctic zone by Jagerskjiold (1905); and the first valid description from the continental Antarctica was made by Steiner (1916). Tilbrook (1970) stated : "The presence of nematodes in this maritime region has been reported on many occasions, but nothing has been published on their taxonomy". Spaull (1972) discovered a new genus and species, *Antarctenchus hooperi* Maslen (1980) provided upto date record of Nematodes of Antarctica, distributed in three zones, viz., Sub-Antarctic, maritime.Antarctic and Continental Antarctic. According to him 40 species have been recorded from the Maritime zone, of which 34 were endemic; 10 species were recorded from continental zone, of which 7 were endemic and 22 species from Sub-Antarctic zone of which 12 were endemic. Hazra (1990) recorded 5 genera from, Schirmacher Oasis for the first time. Additional 5 genera of nematodes have been found in this area during the present expedition (Table-5).

Acarina:

The first mite species discovered from-the Antarctic region was a Cryptostigmatid, *Oribata antarctica* collected in the Belgica expedition of 1897-1899. In the 100 year of expeditions, 528 species of Acari have been reported from the Antarctica, sub-Antarctica and the southern ocean (Pugh, 1993). This is the first report of two species of mites viz., *Tyrophagus sp.* and another unidentified species of family Scutacaridae from Schirmacher Oasis during the present investigation. Both the species seem to be new ones.

Collembola:

The credit for the first discovery of insects from the Antarctic which included Collembola goes to Willem (1901). The Antarctic collembola have been reviewed in detail by Wise (1971). Block (1984) pointed out that collembola together with the Acari have penetrated to terrestrial habitats further, south than any other arthropods. It was observed that the species *Cryptopyqus antarcticus* Willem, was the dominant arthropod in the Antarctic region. According to Wallwork (1973), amongst Antarctic collembolan fauna encounted so far, 70% are endemic. So far 37 species from maritime and 10 species from continental Antarctic were reported. Two species out of two families viz., Isotomidae and Entomobryidae have been observed and collected from Schirmacher Oasis during the present investigation. This is the first record of this insect group from this area.

Discussion

During the present investigation six different microfaunal groups viz., Protozoa, Nematoda, Rotifera, Tardigrada, Collembola and Mites have been recorded from Schirmacher Oasis area (Figs. 1-12). It is evident from **Table-3** that maximum no. of groups of invertebrate (4 nos.) were obtained from Lake no. 3 and 28. On the other hand, minimum number of invertebrate groups was found in lake nos. 6,7,8,14,15,20 and 36. Since each was represented with 'only one faunal group. It is also evident from **Table-3** that nematodes were encountered in 15 different sites followed by protozoans which were collected from 13 sites. On the contrary, springtails and mites were recorded only from 2 different sites. It may be concluded that nematodes and protozoans have higher range of adaptability in this harsh environmental condition.

Table-4 shows that most of the microfaunal groups were found from ice free, mostly covered by ice and partly covered by ice condition of the water, except mites which were not found in ice free water. Collembola Avas not found in sites mostly-covered with ice water.

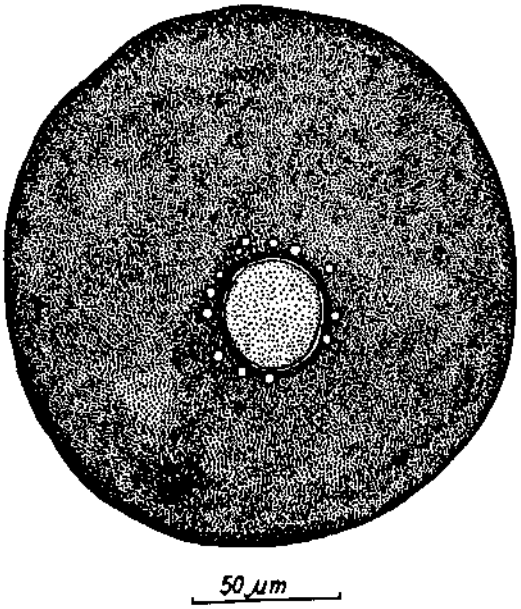


Fig. 1

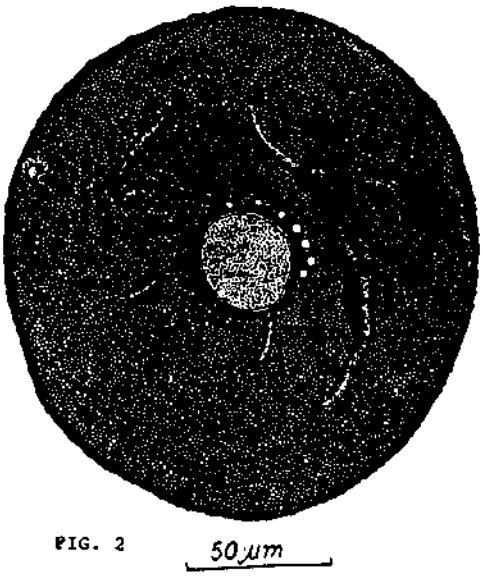


Fig.2

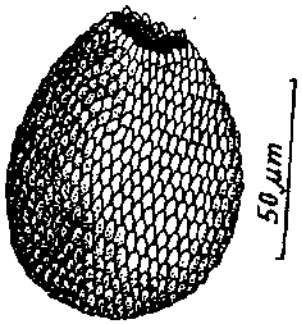


Fig. 3

Fig. 4

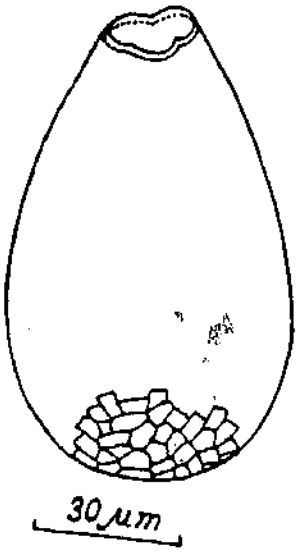


Fig.5

It needs mention here that Tardigrades, Collembola and mites were not found in free floating moss during this expedition. If the flowing status of water is taken into consideration it has been noticed that all the microfaunal groups were found in both running and stagnant water except mites, which were available only in running water. Thus from the present data **(Table-4)** it may be concluded that Protozoa, Rotifera and Nematoda were distributed in generalised way in all different conditions of the water and moss habitat type.

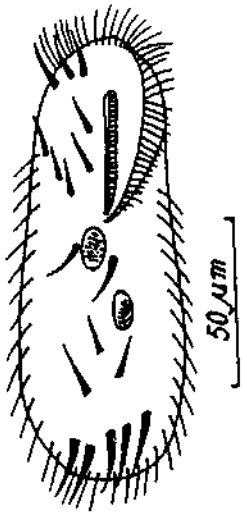


Fig. 6

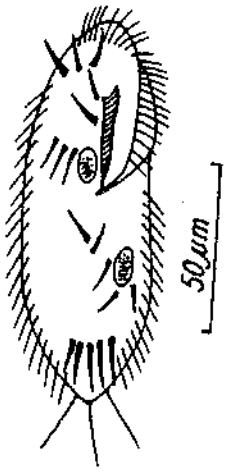


Fig.7

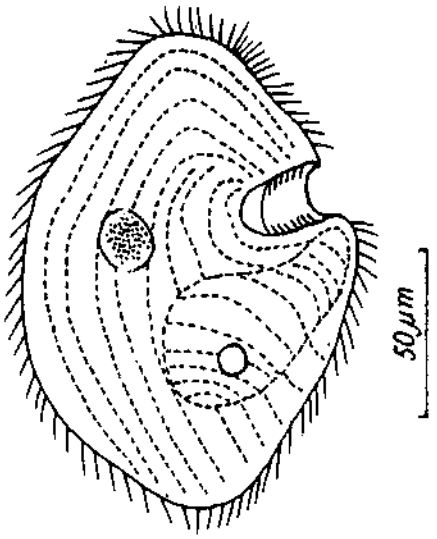


Fig. 8

During the present expedition the dominance of immature forms in the population particularly in the groups, like Protozoa, Nematoda and Mites indicates the over-lapping of generation.

Table-S gives an inventory of invertebrate fauna collected during the present expedition. This inventory includes maximum number of species as

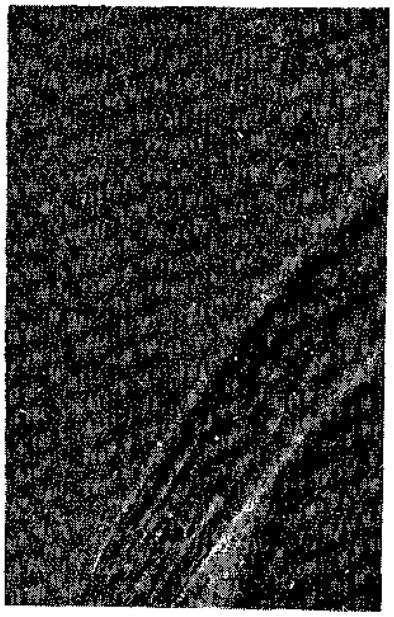


Fig.10

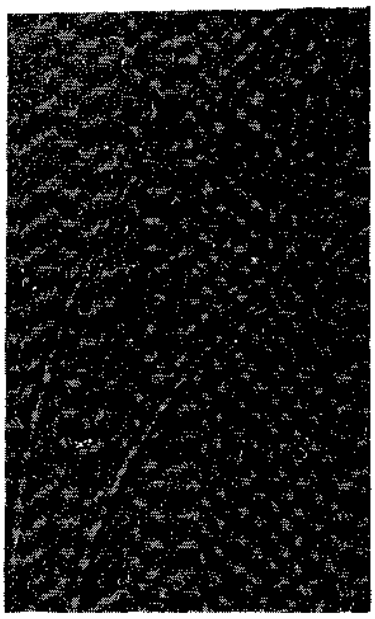


Fig.12

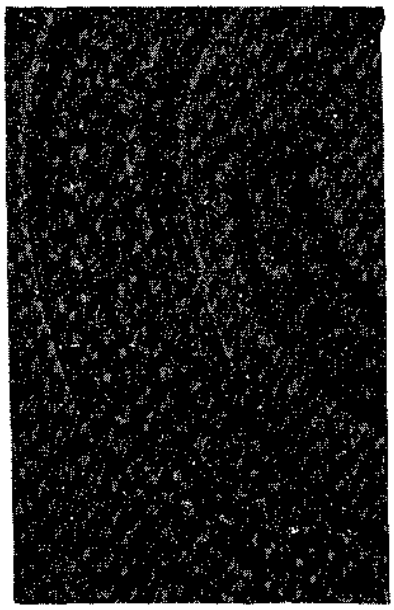


Fig. 9

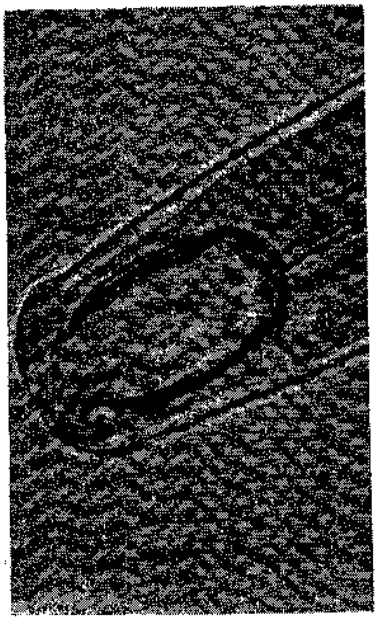


Fig.11

Table 3: Showing distribution of Invertebrate fauna in different lakes and swampy areas of Schirmacher Oasis

Faunal Groups	Lakes																				No. of Site
	1	2	3	4	6	7	8	9	10	11	14	15	20	22	27	28	32	34	35	36	
Protozoa	+	+	+	+				+	+	+	+				+	+	+	+	+		13
Rotifera			+						+			+				+	+	+			6
Tardi-grada			+					+								+	+				4
Nema-toda	+	+	+	+	+	+		+	+		+		+	+	+	+			+	+	15
Collem-bola							+			+											2
Mites										+					+						2
No. of Groups	2	2	4	2	1	1	1	3	3	3	1	1	1	3	4	3	2	2	1		

Table 4: Showing the invertebrate faunal distribution in different condition of the water bodies and moss-habitat.

Faunal Groups	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2
Protozoa	+	+	+	+	+	+	+	+
Rotifera	+	+	+	+	+	+	+	+
Tardigrada	+	+	+	+	-	+	+	+
Nematoda	+	+	+	+	+	+	+	+
Collembola	-	+	+	+	-	+	-	+
Mites	+	+	-	+	-	+	+	+

Abbreviations used:

A_1-A_3 : Freezing status of water: A_1: Surface and periphery of the water body mostly covered with ice; A_2: surface water mostly free of ice but periphery of water body partly with ice; A_3: ice free water body.

B_1-B_3 : Moss-Habitate type: B_1: Moss submerged in the periphery of marginal area or in water of little depth; B_2: mosses in free float condition ; B_3 : mosses wet or dry in condition grown in marginal area of water body, but not submerged.

C_1-C_2 ; Flowing status of water: C_1 : Running water coming from melting ice or through connection between two water bodies; C_2 : stagnant water.

'sp' which appear to be new species in the globe. The remaining few species (4 species of protozoa, 1 species of rotifera and 2 species of tardigrada) which have been identified upto specific level are cosmopolitan in distribution.

Finally, it needs mention here that no serious attempt has so far been made to identify and study microfauna of this region. The result of the present study

Table 5: List of moss-inhabiting invertebrate fauna (Present study)

GROUP: A. PROTOZOA	**B. POTIFERA**
]. *Arcella arenaria* Greff	1. *Philodina gregarina*
2. Arcella sp. (1)	**C. TARD1GRADA**
3. *Arcella sp.* (2)	1. *Hypsibius Chilensis* (Plate)
4. *Diplochlamys sp.*	2. *Macrobiotus polaris (*Murroy)
5. *Parmulina sp.*	**D. NEMATODA**
6. *Centropyxis aerophila*	1. *Helicotylenchus sp.*
(Diflandre)	*2. Rotylenchus sp.*
7. *Centropyxis sp.*	3. *Dorylaimus sp.*
8. *Difflugia sp.* (1)	4. R*habditis sp.*
9. Difflugia sp. (2)	*5. Monochid sp.*
10. *Nebella sp.*	**E. MITES (Order : Astigmata)**
11. *Corythion dubium* Taranck	1. Family : Acaridídae
12. *Assulina muscorum* Greef	a. *Tyrophagus sp.*
13. *Euglyphasp.*	*2.* Family: Scutacaridae
14. *Trviema sp.*	a. Not yet identified.
15. *Colpoda sp.*	F. **COLLEMBOLA**
16. *Oxytrichafallax* Stein	1. Family : Isotornidae
17. *Stylonychia sp.*	2. Family: Entomobryidae

would, therefore, give base line information and data for undertaking a long term taxonomic and ecological research programme on this group at Schirmacher Oasis.

Acknowledgements

The author is grateful to Dr. J.R.B. Alfred, Director, Zoological Survey of India for providing laboratory facilities in connection with this work. Thanks are also due to Dr. A.K. Ghosh, former Director of this Institution for sending me in the 15th expedition to Antarctica. The author is also grateful to the Ministry of Environment and Forest and to the Department of Ocean Development, New Delhi for providing all sorts of help for participating in the15th Expedition. The author gratefully acknowledges to Dr. A.K. Hazra, Scientist 'SE' and incharge of Antarctic Research Unit for his constant inspiration and moral support regarding the expedition. Thanks are also due to Dr. S.K. Mitra, Scientist 'SF', Dr. A.K. Das, Scientist 'SE', Dr. A.K. Sanyal, Scientist 'SE', Shri Subash Ghosh, Zoological Assistant for extraction and identification of the respective faunal groups and last but not least to Shri Arun Chaturvedi, Leader of the 15th Antarctic Expedition for rendering the required logistic support.

References

Arif, M (1995) Occurrence of invertebrate fauna in Schirmacher Oasis, Antarctica Department of Ocean Development Tech Pub No 9 301-311

Bardin, V I and Leflat, ON (1965) Khimizm vod Oazisa Schirmakhera (Chemical characteristics of water in Schirmacher Oasis), Informationnyy Byulleten Sovestskoy Antarkucheskoy Ekspeditsu 52 51-55 (English translation 5 361-362,1966)

Block, W (1984) Terrestrial habitats in • Antarctic Ecology, Vol I 163-236 (Ed.) R M Laws

Burdin, L (1970) Antarctic land faunas and their history (In Holdgate, M W , ed Antarctic ecology London and New York Academic press pp 41-53)

DeMan, J G (1904) Nematodes libres, Result voyage S Y Belgica, Zoologie, 55 pp

Dhaigalkar, V K (1988) Biological studies in the Antarctic waters A review, proceeding ot workshop on Antarctic studies D. 0. D. C. S. I. R New Delhi, 407-418

Hazra, A. K. (1994) A study on the population ecology of soil nematode fauna in relation to someedaphic factors in Schirmacher Oasis, Antarctica D.O.D Tech Pub. No. 6 pp 65-90

Ingole, B S and Parulekar, A H (1987) Microfauna of Schirmachei Oasis, Antarctica . 1 Water moss communities, Scientific report of Indian expedition to Antarctica, Tech pub no 4, pp 139-148

Ingole, B S and Parulekar, A H (1990) Limnology of Pnyadarshini lake, Schinmachei Oasis, Antarctica, Polar Record 26 13-17

Ingole, B S and Parulekar, A H (1993) Limnology of freshwater lakes at Schirmacher Oasis, East Antarctica Proc Indian natn Sci Acad, B 59, No 6, pp 589-600.

Jagerskjiold, LA (1905) Bunonema richtersi n g, n sp Em eigestumlicher new Land nematode aus dc Schwarzwald von Kerguelen und Possession Island (Crozet Inseln) Zool An7 28 nos 16/17,557-61

Jennings, PG (1976) Tradigrada from the Antarctic peninsula and Scotia Ridge region, Bull Br Antarct Surv 44 77-95

Komarek, J and Ruzicka, J (1966) Freshwater algae from a lake in proximity of the Novolazarevskaya station, Antarctica, presha 38, 233-247

Maslen, N R (1979) Additions to the nematode fauna of the Antarctic region with keys to taxa Bull Brit antarct Surv 49 207-229

Matondkar, S G P and Gomes, II R (1983) Biological studies on the ice shelf and in the freshwater lake at Princes Astid Coast, Dronning Maud land, Antarctica, In scientific report of first Indian expedition to Antarctica, pp 186-190

Monkawa, K (1951) Notes on some Tardigrades from the Antarctic region, Biol Res Jap Antarct Exp Series F 17 3-6

Murray, J (Ed) (1910) Antarctic Rotifera In British Antarctic expedition 1907-1909 Reports on the scientific investigations Biology, 41-65 Heinemann, London

Pugh, P J A (1993) A synoptic catalogue of the Acari from Antarctica, the sub-Antarctic islands and the southern ocean Journ Nat Hist 27 323-421

Ramazotti, C. (1972). 1 Phylum Tardigrada. Mem. Inst. Italiana idrobiol, 28 : 731 pp.

Richter, W., Haendel, D. and Jughans, P. (1990). The animals of the Schirmacher Oasis (East Antarctica). Ant. Res. Proc. Symp. held at Potsdam GDR, VII pp. 495-503.

Smith, H.G. (1978). The distribution and ecology of terrestrial protzoa of sub Antarctic and maritime Antarctic islands. British Antarctic Survey Scientific reports, 95 : 1-104.

Somme, L. (1985). Terrestrial habitats of invertebrates in key environment, Antarctica 106-117 (eds) Bonner, W.N. and D.W.H. Walton, Pergamon Press.

Spaull, V.W. (1972). Antarctenchus hooped n.g.n.sp. (Nematoda : Dolichodoridae) from Signy island, South Orkney islands Britisy, Antarctic Survey Bulletin. Nos. 33 and 34. 177-84.

Steiner, G. (1916). Beitragezur geographischen verbreitung freilebenden Nematoden. Zool Anz,46 nos. 10/11,311-35.

Sudzuki, M. (1964). On the microfauna of the Antarctic region. I moss-water community at Langhoude, Bull. Res. Jap. Antarct. Exp Series E 19 : 1-41.

Tilbrook, P.J. (1970). The terrestrial environment and invertebrate fauna of the maritinte Antarctic. (In Holdgate M.W., ed. Antarctic ecology. London and New York. Academic Press 886-96).

Wallwork, J. A. (1973). Zoogeography of some terrestrial micro- arthropoda in Antarctica. Biological Reviews. 48 : 233-259.

Willem, V. (1901). Les Collemboles recueillis par 1 expedition antarctique Beige. Annals of the society for Entomology of Belgium, 45 : 260-262.

Wise, K.A.J. (1971). The collembola of Antarctica. Pacif. Insects, 25 : 57-74.