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Biotic Features of Selective Surface Water Bodies around Indian Station Maitri in Schirmacher Oasis, Antarctica

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Abstract

Commensurate to environmental protocol to Antarctic Treaty, monitoring of biota at different water bodies around Indian Station Maitri was carried out in January-February 1994. Studies covered enumeration of individual phytoplankton, zooplankton & meiobenthic organisms; application of Shannon weaver diversity index & similarity index, and evaluation of food web trophic levels & ecological pyramid. Sixteen, 7 and 1 varieties of phytoplankton, zooplankton and meiofauna respectively were recorded in Zub lake. The lake which receives water from nearby glaciers and measures 0.35 sq.km. is the source of water for Maitri. Besides plankton, the lake represented detritus and moss at different trophic levels. Considering producer and first consumers as the two-step trophic structure, ecological pyramid on the basis of biomass has been formulated for Zub lake. Details towards variations of flora and fauna among different water bodies, probable reasons for such variations and ecological efficiency have been discussed.

Introduction

The continuously increasing interest in, and exploitation of, the natural resources of the Antarctic continent and its surrounding waters by a number of nations, requires a comprehensive knowledge of the Antarctic ecosystem if that ecosystem is to be effectively managed and conserved. Few attempts were made to investigate biota at shallow freshwater lakes in Schirmacher Oasis of Antarctica (Komarek and Ruzicka 1966, Kaup 1988, Ingolc and Parulekar 1993). Although species composition and, to a limited extent, ecology of the biota have been determined in a few studies, quantitative data are still inadequate. In general, Antarctic lakes possess relatively short and simple food chain. Kok and Grobbelaar (1978) stated that the zooplankton occupy the top of the food chain due to the absence of fish in Marion island's lakes. They found a significant correlation between average primary production rates measured by Grobbelaar (1974) and zooplankton biomass in various water bodies, and

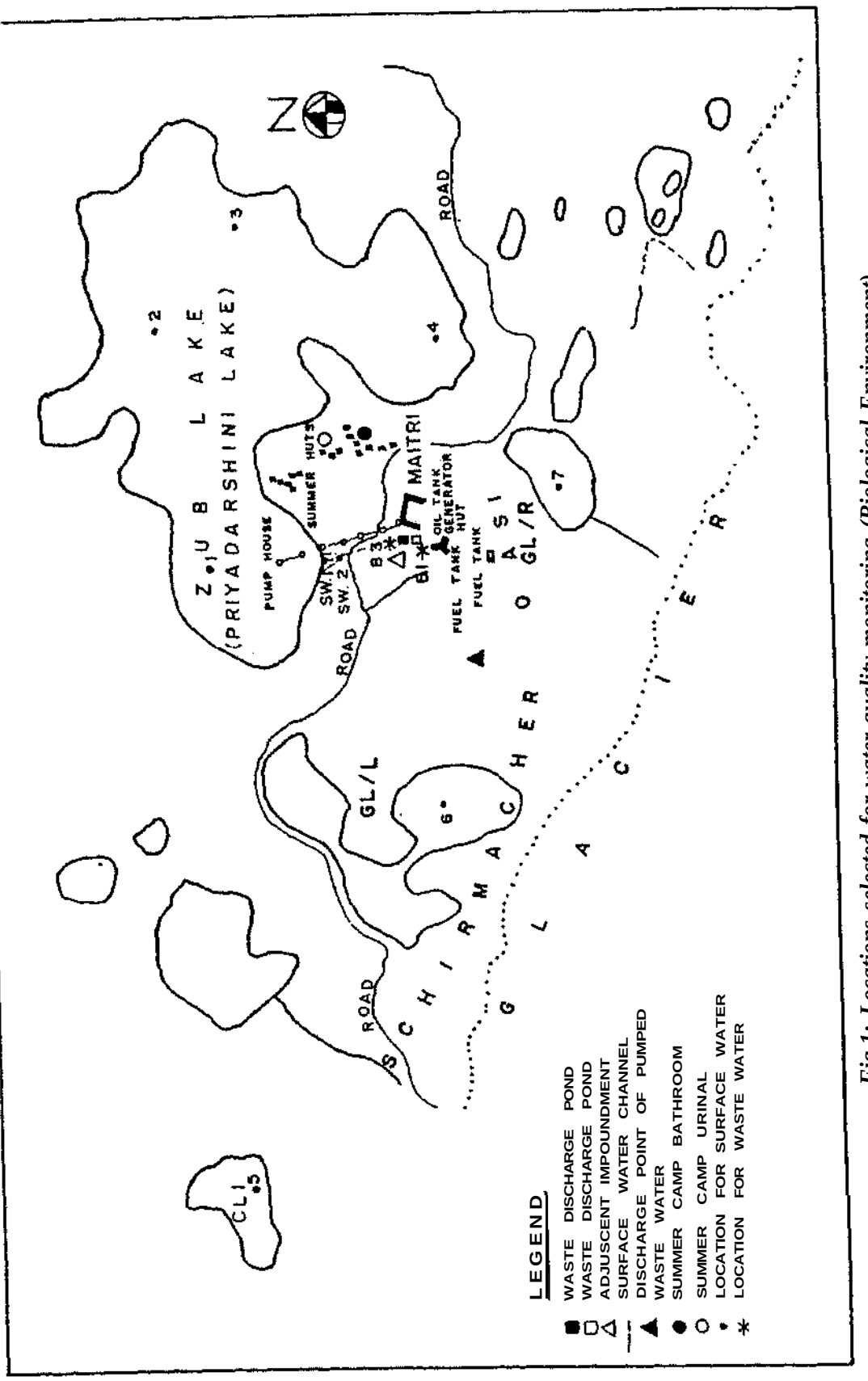

Fig.1: Locations selected for water quality monitoring (Biological Environment)

concluded that zooplankton rely heavily on algal production and play an important role as consumers of primary producers.

Since scientific expeditions to Schirmacher Oasis are being undertaken by Indians, Russians and Germans since decades and permanent stations have been established, it warrants to monitor the ecological characteristics surrounding the stations at regular interval. Present studies on biota towards diversity, density and trophic levels were undertaken as a part of Environmental Impact Assessment studies around Indian station Maitri in accordance to Article 5, Annexure I of the protocol on Environmental protection to the Antarctic Treaty.

Materials and Methods

Water samples were collected from Zub lake, close to Indian station Maitri, and also from a lake (control) about 1.5 km away towards western side of the station for phytoplankton, zooplankton and meiobenthos analyses. Additionally phytoplankton were analysed from glacier waters feeding to Zub lake. While 4 sampling points (Fig. 1) were selected at Zub lake (designated as 1 through 4), GL (L) and GL (R) represent glacier waters at western and eastern sides respectively of the station.

The parameters studied for evaluation were numerical count of individual species and groups, Shannon-weaver diversity index, similarity index, food web trophic levels and ecological pyramid (Hellawell 1978, Sorensen 1948, Odum 1971). As macrobenthos (above 500 u size) were absent in lakes, only meiobenthic samples (45 to 500 u size), collected from Zub lake, two waste-water ponds, one abandoned impoundment and a seepage water channel joined to Zub lake, were assessed.

Results and Discussion

Phytoplankton

The abundance and diversity of algae recorded at different samples are depicted in Tables 1 and 2. A wide variation of the composition was recorded at different sampling points and depths of the Zub lake. The density appeared to be maximum at sampling point 1 (near pump house) where human activities, in the form of water pumping and immersion of substrates & heating elements are conspicuous. Barring sampling point 3, chlorophyceae group followed by cyanophyceae dominated all the Samples. Phytoplankton levels increased substantially in both the bottom samples collected at sampling points 1 and 4. Luxuriant growth of benthic vegetation (moss and algae) in and around Zub lake, as was evident during 1985-87 (Ingole and Parulekar 1990), was con-

Table 1: Diversity of Phytoplankton at Different Sampling Points of Selective Surface Waters around Indian Station Maitri in Antarctica

Source & Sampling point		Total count per ml	% plankton in groups			Shannon Weaver Diversity Index
			Bacillario-phyceae	Cyano-phyceae	Chloro-phyceae	
Zub lake						
1	Surface	41	5	46	49	1.80
1	Middle	4	—	—	100	Nil
1	Bottom	64	—	21	79	1.98
2	Surface	12	—	16	84	2.25
3	Surface	2	100	—	—	Nil
4	Surface	13	—	26	74	1.89
4	Bottom	40	5	40	55	2.54
Lake at western side of Zub lake						
1	Surface	46	4	91	5	1.52
2	Surface	24	—	84	16	2.41
Glacier water						
Left side of Maitri		317	—	83	17	1.87
Right side of Maitri		8	—	—	100	2.00
Seepage Water Channel						
Confluence to Zub lake		120	9	55	36	2 . 273
2 m before confluence		250	—	99	01	1.356
Before road		132	—	87	11	1.897

firmed during present investigation in January 1994. Similar type of algal mat from bottom layer of Antarctic lake at McMurdo station was recorded by Dillon and Bierle (1980), However, the samples of control lake were dominated by algae of cyanophyceae group. Phytoplankton were identified at generic level during present investigation, however, different species as shown for *Phormidium in Plate 1 were also recorded in samples. A sudden rise (317 number* per ml) of different algae from cyanophyceae group was observed 0at glacier water (L). The same water at right side of the station (GL/R) contained negligible number (8 number per ml) of algae represented by chlorophyceae group. The water samples at GL/L also contained enhanced levels of nutrients and dissolved solids exhibiting comparatively higher electrical conductivity. This might be attributed to contamination of lake water through seepage of wastewater, discharged at a site of higher contour, 210m away from the location of GL/L.

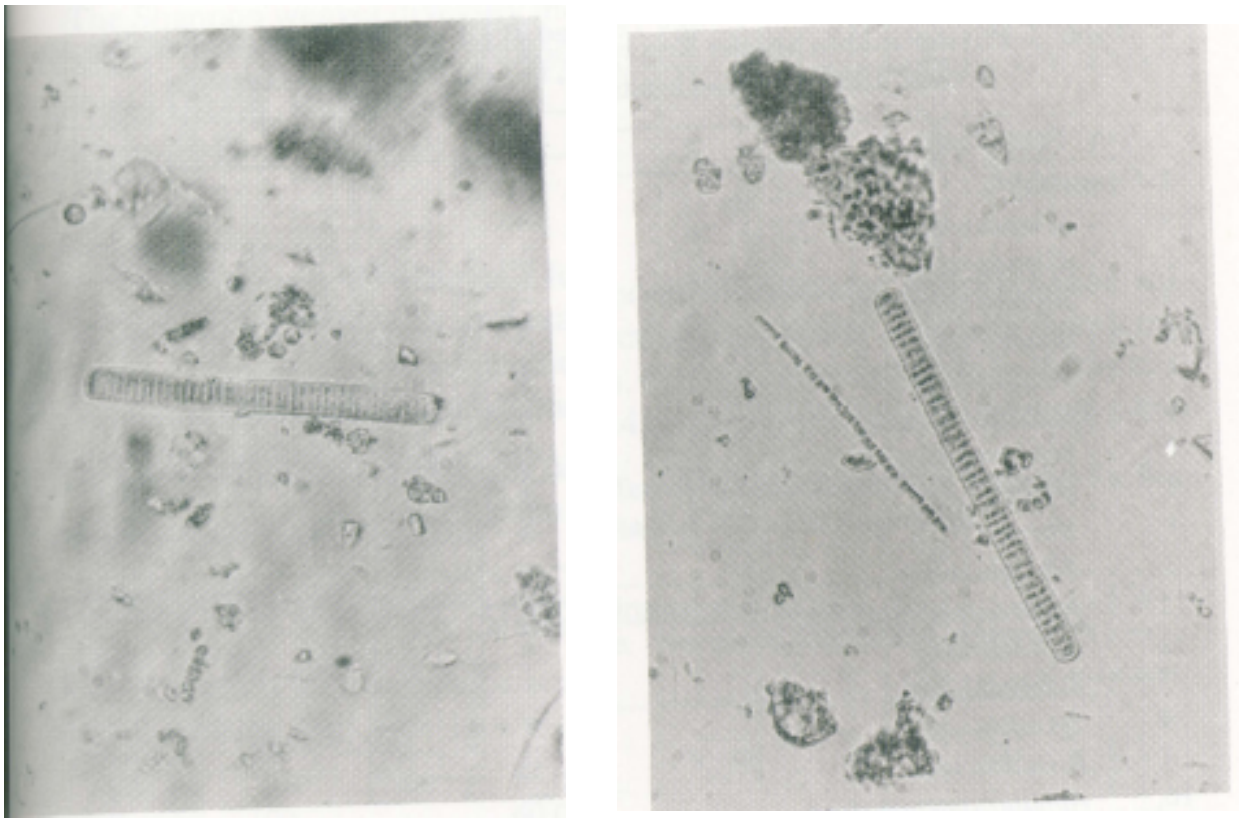

Plate 1: Three species of the gems Phormidium recorded in Zub lake water

Table 2: Phytoplankton Species Recorded at Different Surface Water Samples Around Indian Station Maitri, in Schirmacher, Antarctica

Sr.No	Phytoplankton	Z	CL	GL/L	GL/R	SW
I. Cyanoptayfa						
1.	*Chroococcus* sp.	+	—	—	—	—
2.	*Gleocapsa* sp.	+	—	—	—	—
3.	*Merismopedia* sp.	+	+	—	—	—
4.	*Gleocystis* sp.	—	+	—	—	+
5.	*Phormidium* sp.	+	+	—	+	+
6.	*Oscillatoria* sp.	+	—	—	—	+
7.	*Schizothrix* sp.	—	—	—	—	+
8.	*Nodularia* sp.	—	+	—	—	+
9	*Nostoc* sp.	—	—	+	—	+
10.	*Albrightia* sp.	—	—	—	—	+
11.	*Nostocopsis* sp.	—	+	+	—	+
12.	*Scytonema* sp.	—	+	—	—	+
13.	*Tolypothrix* sp.	—	+	—	—	+
14.	*Spirulina* sp.	—	+	—	—	—
15.	*Rivuluria* sp.	—	—	+	—	+
16.	*Aphanozomenon* sp.	—	—	—	—	+
II. Chlorophyta						
18.	*Chlorococcum* sp.	+	—	—	—	+
19.	*Chlorella* sp.	+	+	+	—	—
20.	*Cosmarium* sp.	+	—	—	—	—
21.	*Palmodictyon* sp.	+	—	—	—	+
22.	*Actinastrum* sp.	+	—	—+		—
23.	*Scenedesmus* sp.	+	—	—	+	—
24.	*Ankistrodemus* sp.	+	—	—	+	—
25.	*Eudorina* sp.					
26.	*Kirchneriella* sp.	—	+	—	—	—
27.	*Diogenes* sp.	—	—	—	—	
28.	*Chrysospham* sp.	—	—	—	+	—
III. Euglenophyceae						
29.	*Euglena* sp.	+	—	—	—	—
IV. Bacillariophyceae						
30.	*Nitzschia* sp.	+	—	—	—	+
33.	*Navicula* sp.	+	—	—	—	—
32.	*Actinocyclus* sp.	—	+	—	—	—
33.	*Cerataulina* sp. ++	—	—	—	—	—

Z = Zub lake **'+' present** **'—' absent**
CL = Control lake
GUL = Glacier lake (left side of station)
GL/R = Glacier lake (right side of station)
SW = Seapage water channel

The Shannon weaver diversity index values of the samples varied between zero and 2.54 indicating poor productivity and, less number and uneven distribution of the species.

Zooplankton

Being at the top level of aquatic food chain organisms, the role of zooplankton appears to be important at Antarctic lakes. While Zub lake represented rotiferans, cladocerans and copepodids, the lakes at western side contained only one species of nematode (Tables 3 and 4). Altogether 8 varieties of zooplankton

Table 3: Diversity of Zooplankton at Different Sampling Points of Selective Surface Waters around Indian Station Maitri in Antarctica

Source & Sampling point		Total count perm^3	% Organisms in erouos					S-W Diversity Index
			Protozoa	Rotifera	Nematoda	Cladocera	Copepoda	
Zub lake								
1	Surface	65	—	—	92.30	—	7.70	0.39
2	Surface	80	25.00	75.00	—	—	—	0.81
3	Surface	100	—	60.00	—	—	40.00	0.97
4	Surface	100	—	80.00	—	20.00	—	1.37
Lake at western side of Zub lake								
1	Surface	Nil	—	—	—	—	—	—
2	Surface	17	—	—	100	—	—	0

Table 4: Zooplankton Species Recorded at Two Lakes Near Indian Station, Maitri in Schirmacher, Antarctica

Zooplankton species	Zub lake	Lake at western side of Zub lake
Protozoa		
Chilophrya sp.	+	—
Nematoda		
Plectus sp.	—	+
Tripyla sp.	+	—
Rotifera		
Epiphanes sp.	+	—
Keratella cochlearis	+	—
Cladocera		
Alona sp.	+	—
Copepoda		
Cyclopoid copepod	+	—
Nauplius larva	+	—

'+' : present

'—' : absent

were recorded in surface water samples. Majority of the 10 zooplankton as recorded by Ingole and Parulekar (1990) during 1985-87 in Zub lake were replaced by different varieties during present investigation in January 1994. Although Antarctic lake at Cape Royd, Ross Island was dominated by ciliates (Dillon and Bierle 1980) comprising 48 species, the group represented poorly during present survey. Diversity index values varying from nil to 1.37 for zooplankton indicate non productive water bodies. While applying similarity index, zooplankton of sampling points 1&2,1&3 and l&4of Zub lake exhibited nil similarity, however, 0.4 to 0.5 similarity indices were recorded amongst sampling points 2, 3 and 4. Studies indicate that zooplankton present at sampling point 1 were totally different from remaining sampling points of Zub lake.

Meiobenthos

Meiobenthic fauna were represented by 5 species from 4 groups (Tables 5 and 6), viz. nematoda, rotifera, tardigrada and copepoda. The impoundment at N-W side of B_1B_3 ponds and sampling point 3 of Zub lake were devoid of meiofauna. In general meiofauna concentration was more in surface water channel followed by wastewater ponds. Barring B3 pond, SW diversity index value was observed to be nil in remaining samples.

Table 5: Levels of Meiobenthos at Various Sampling Points of Selective Surface Water Bodies around Indian Station Maitri in Schirmacher Oasis, Antarctica

Source & Sampling point	Total count per m^2	% organism in groups				s. w. Diversity Index
		Rotifera	Nematoda	Tardigrada	Copepoda	
Zub lake	m					
1	1000	—	100	—	—	0
3	Nil	—	—	—	—	—
Seepage water channel						
Confluence to Zub lake	1000	—	100	—	—	0
2 meter before confluencem	4000	—	—	100	—	0
Before road	2000	—	100	—	—	0
Wastewater ponds						
B_l pond	1000	—	—	—	100	0
B_3 pond	2000	50	—	—	50	1
Abandoned Impoundmentat North West side of B1,B3 ponds	Nil	—	—	—	—	—

Table 6: Meiobenthic Fauna Recorded at Various Water Bodies around Indian Station Maitri in Schirmacher Oasis, Antarctica

Meiofauna	Zub lake	Surface water channel	Wastewater ponds	
			B1	B3
Nematoda				
Plectus sp.	—	+	—	—
Teratocephalus sp	+	—	—	—
Rotifera				
Filinia longiseta	— —		—	+
Tardigrada	— —		+ —	—
Isohypsibius sp.	—	+		
Copepoda				
Nauplius larva				+

+ : present
'—' : absent

Table 6: Meiobenthic Fauna Recorded at Various Water Bodies around Indian Station MaJtri in Schirmacher Oasis, Antarctica

Meiofauna	Zub lake	Surface water channel	Wastewater ponds	
			B1	B3
Nematoda				
Plectus sp.	—	+	—	—
Teratocephalus sp.	+	—	—	—
Rotifera				
Filinia longiseta	—	—*	—	+
Tardigrada				
Isohypsibius sp.	—	+	—	—
Copepoda				
Nauplius larva	—	—	+	+

V : present
'—' : absent

Food Web Trophic Levels

The food web is the total set of feeding relationships among and between the species composing a biotic community. All organisms that share the same general source of nutrition are said to be at the same trophic level. At each step in the food chain, a considerable portion of the potential energy being transferred in the food is lost as heat. The first trophic level in the natural system is represented by primary producers (P). The second trophic level is the primary consumer (C1) or herbivores that eat plants and convert potential energy Of plant tissues in animal tissues. The trophic levels of secondary (C2) and tertiary consumers (C3) feed on preceding levels. While 4 to 5 ti ophic levels are usually observed in natural surface waters in India, only 2 levels (P and C1) represented in Zub lake. Detritus is the organic matter caused due to death of plankton, benthos & moss and then releases nutrients for primary and secondary producers as depicted in schematic diagram (Fig.2A).

In order to demonstrate the trophic pyramid, the graphical presentation of trophic structure, the area & water volume of Zub lake and biomass of living organisms were estimated. The studies revealed that primary producer (P) and first level consumer (C1) represented 48.24 and 2.80 mg dry wt.m-2 respectively n the lake (Fig.2B). The ecological efficiency (percent biomass transfer in succeeding trophic level) was measured as 5.8 percent indicating higher levels of phytoplankton as compared to inhabiting fauna. The incoming water received from a drainage canal and glacier might be the sources of nutrients for diverse algal flora in Zub lake.

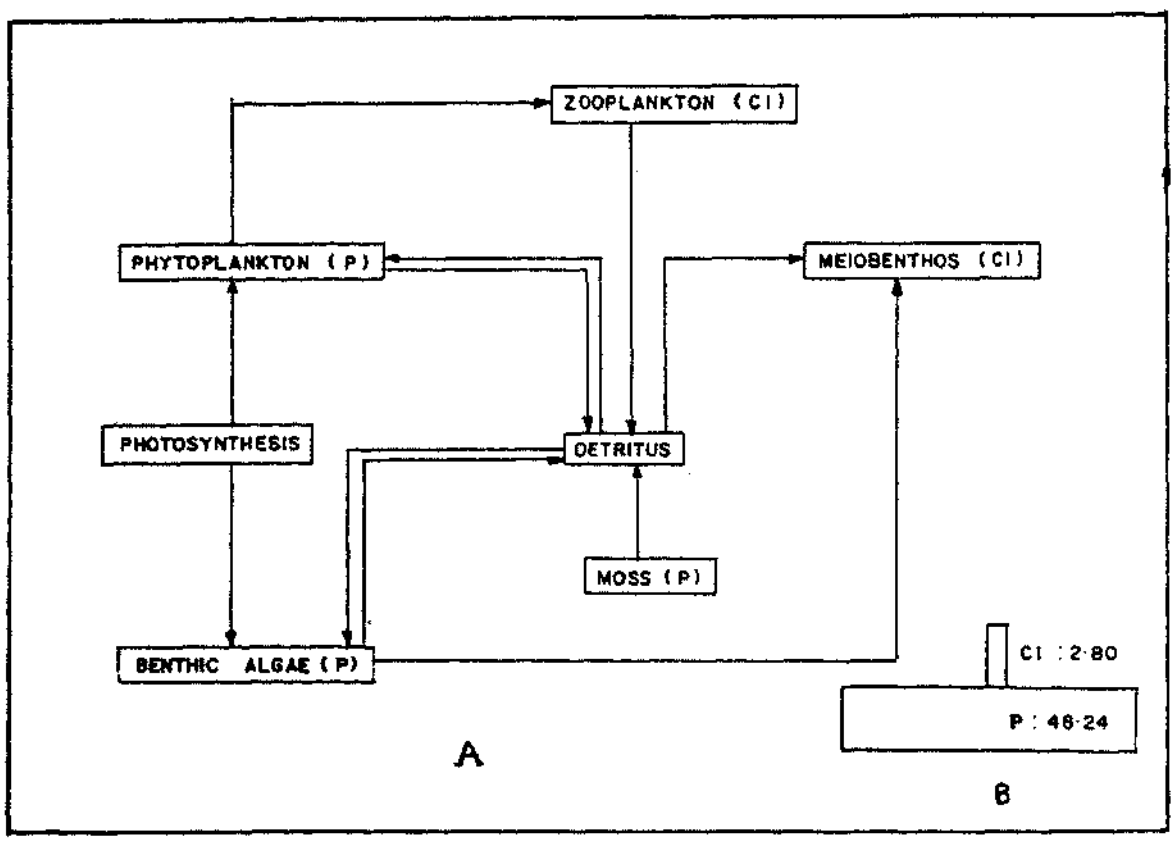

Fig.2: The principal food web (A) and trophic pyramid (B) based on biomass (mg dry wt. m^{-2})for Zub lake in Schirmacher Oasis, Antarctica

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