

Proceedings of the Committee of Scientists
of the Ministry of Education
of the Republic of Poland

ABSTRACT

BIOLOGICAL SCIENCES

Freshwater Diatom Communities of Schirmacher Oasis, East Antarctica

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ABSTRACT

A floristic and taxonomic survey was made on the diatom communities of freshwater lakes, pools and streams of Schirmacher Oasis, East Antarctica during the XXV Indian Scientific Expedition to Antarctica. A total of 21 taxa belonging to 12 genera were distinguished, viz. 1. *Achnanthes* (2 spp.), 2. *Fragilaria* (3 spp.), 3. *Synedra* (1 sp.), 4. *Luticola* (2 spp.), 5. *Navicula* (3 spp.), 6. *Stauroneis* (1 sp.), 7. *Diadesmis* (2 spp.), 8. *Pinnularia* (2 spp.), 9. *Gamphomema* (1 sp.), 10. *Hantzschia* (1 sp.), 11. *Nitzschia* (2 spp.) and 12. *Cymbella* (1 sp.). Two species i.e. *Cymbella* sp belonging to the family Surirellaceae and *Diadesmis gallica* belonging to Naviculaceae are reported for the first time from Schirmacher Oasis. The study reveals that the diatom diversity is more in the western part than the central and eastern part of the Schirmacher Oasis. Of the 12 genera *Hantzschia*, *Luticola*, *Navicula*, *Nitzschia* and *Pinnularia* were abundant in fresh water bodies of the Oasis.

INTRODUCTION

Freshwater lake environments in Antarctica react quickly to climate and environmental change (Quayle *et al.* 2002 and Spaulding and Mcknight 1999): However, they are biologically still poorly investigated, which is often due to their remote location at the margin of the Antarctic continent in the polar Oasis. The ice-free polar oases are subjected constantly to low temperatures, extremes in irradiance and short period for vegetative growth. Consequently, lakes in continental Antarctica are oligotrophic to ultra-oligotrophic and are characterized by extended periods of ice-cover, low nutrient input and low organic carbon production (Doran *et al.* 2000 and Verleyen *et al.* 2003). The biodiversity of Antarctic lacustrine biota communities is low and the lakes are generally dominated by the microbes.

Diatoms (Bacillariophyceae) are unicellular algae, characterized by siliceous outer shell or frustule (Round *et al.*1990). Diatoms form an important component of benthic freshwater phytoplankton communities in the Antarctic and sub-Antarctic (Spaulding and Mcknight 1999). They comprise one of the most abundant algal groups globally and are important in benthic and planktonic algal communities in freshwater, marine and terrestrial habitats. Our knowledge on the biogeography and ecology of fresh water diatoms in East Antarctica is still limited and restricted to Oasis, such as the Windmill Islands (Roberts *et al.* 2001), the Vestfold Hills (Roberts and McMinn 1999), the Larsemann Hills (Sabbe *et al.* 2003; Verleyen *et al.* 2003) and the McMurdo Dry Valleys (Kellogg *et al.*1980; Spaulding *et al.*1997). A major problem in comparing lake sediment-derived environmental histories of remotely located regions is the inconsistency of diatom taxonomy, biogeography and ecology (Sabbe *et al.* 2003). The aim of this study is thus to describe the diatom composition and investigate the possible diatom communities that are present in different lake and moss habitats of Schirmacher Oasis, East Antarctic region.

MATERIALS AND METHODS

Study Area

The Schirmacher Oasis 70° 46'04"-70° 44' 21"S; 11° 49'54"-11° 26'03"E), Dronning Maud Land is approximately 72 km south of Princess Astrid Kyst. It consists of a number of rocky hills and valleys, varying in altitude from 0 – 461 m above the sea level. It has a maximum width of 3 km and a length of 20 km and is oriented in an east-west direction. The northeastern and northwestern corners border ice – shelf while the southwestern extremity borders the polar ice-sheet. The southeastern end lies on a rocky portion. The region can be divided in to four distinct topographic units—the southern continental ice sheet, rocky hill slopes, lakes and northern undulatory shelf ice. The Oasis has three types of lakes *viz.* pro-glacial, land locked and epi-shelf lakes, all of which are in closed basins. The average annual temperature is -9°C and the mean wind velocity is about 10 ms⁻¹. The average precipitation (snow) ranges between 250-310 mm and relative air humidity is 15-20%. During the short summer, melt water flows into the lakes. The valleys are ice-free because the mountains block ice flow from the polar plateau and the low precipitation and strong katabatic winds lead to little snow accumulation.

During XXV Indian Scientific Expedition to Antarctica (2005-2006), field work was carried out from 14th January to 12th February 2006 to study the diatom flora. Algal growths are abundant and readily visible on the surface of the rocks, boulders, weathered soils and moss carpets. A total of 102 samples of visible algal mats, pieces of moss, upper layer of bottom sediments (using spoon) and water samples were collected from different lakes, ponds, streams and area of moss carpets of Schirmacher Oasis, all the collected samples were stored in sterile plastic sample containers. The samples were fixed with 4% formalin solution and brought to the Botanical Survey of India, Port Blair, India for taxonomical studies. At each site, temperature, pH, salinity and TDS were recorded (Table 1) using water analysis kit (Labtronics LT-59). Part of the samples was oxidized in a mixture of sulphuric acid and potassium dichromate (volume 3:1) to remove the organic matter. Then the material was centrifuged and digested again. It was then rinsed with distilled water several times, to get rid of acid. The cleaned samples were examined under light microscope (Olympus CX 41). Taxa were identified using published literature (Desikachary, 1986-89; Prasad and Srivastava, 1992; Anand, 1998; Kawecka *et al.* 1998; Sabbe *et al.* 2003 and Antarctic diatom web: <http://www-personal.umich.edu>). All the sampling sites were categorized in to three parts only (Part I - Eastern part of Schirmacher Oasis; Part II - Middle part of Schirmacher Oasis and Part III - Western part of Schirmacher Oasis).

Table 1—Physico-chemical Parameters of different places of Schirmacher Oasis, East Antarctica

Altitudes(m)	Water Temp. (°C)	pH	Salinity (ppm)	TDS (ppm)	Conductivity (mV)
0 -100m	3.0-9.5	4.83-14.78	0.67-30.1	0.57-173.6	0.271-82.6
100 -125m	3.2-5.7	8.5-9.32	3.9-25.1	0.71-92.4	1.1-147.3
125-150m	2.7-6.8	5.03-10.25	0.23-24.1	0.2-175.1	0.25-180.9
150-175	6.0-7.3	5.62-7.8	0.19- 10.4	0.15-101.4	0.25-127.5

RESULTS AND DISCUSSION

The development of microalgae is generally triggered by the temperature, light and nutrients. Variations in the temperature, pH, salinity, conductivity (mV) and TDS were observed during sample collection in

**Table 2—List of Diatoms from different part of Schirmacher Oasis,
East Antarctica**

Sl. No.	Diatom taxa	Locations			Remarks
		Part I	Part II	Part III	
	CLASS: BACILLARIOPHYCEAE ORDER: BACILLARIALES FAMILY: ACHNANTHACEAE				
1.	<i>Achnanthes exigua</i> Grun.	+	+	+	Frequent
2.	<i>Achnanthes minutissima</i> (Kuetz.)Grun.	+	+	+	Frequent
	FAMILY: NITZSCHIAACEAE				
3.	<i>Hantzschia amphioxys</i> (Ehr.) Gurn.	+	+	+	Abundant
4.	<i>Nitzschia capitellata</i> Hust.	+	+	+	Frequent
5.	<i>Nitzschia obtuse</i> W.Simth.	+	+	+	Abundant
	FAMILY: FRAGILARIAACEAE				
6.	<i>Fragilaria intermedia</i> Grun.	+	+	+	Frequent
7.	<i>Fragilaria intermedia</i> Grun. var. <i>robusta</i> Venks.	-	+	+	Frequent
8.	<i>Fragilaria virescens</i> Ralfs.	+	+	+	Rare
9.	<i>Synedra ulna</i> (Nitzsch.)Ehrenb.	-	-	+	Rare
	FAMILY: GOMPONEMACEAE				
10.	<i>Gomphonema lanceolatum</i> Ehren.	+	+	+	Frequent
	FAMILY: NAVICULACESE				
11.	<i>Diademsis contenta</i> (Grun.ex Van Heurck) D.G.Mann	+	+	+	Frequent
12.	<i>Diademsis gallica</i> W.Smith	+	+	+	Frequent
13.	<i>Luticola muticopsis</i> (Van Huerck) D.G.Mann	+	+	+	Abundant
14.	<i>L. muticopsis</i> f. <i>capitata</i> (Carlson) D.G.Mann	-	+	+	Abundant
15.	<i>Navicula cuspidate</i> var. <i>ambigua</i> (Ehren.) Cleve	+	+	+	Frequent
16.	<i>Navicula cryptocephala</i> Kuetz.	+	-	+	Frequent
17.	<i>Navicula radiosa</i> Kuetz.	+	+	+	Abundant
18.	<i>Pinnularia borealis</i> Ehren.	+	+	+	Abundant
19.	<i>Pinnularia microstauron</i> (Ehren.) Cleve	-	-	+	Rare
20.	<i>Stauroneis anceps</i> Ehren.	-	-	+	Rare
	FAMILY: SURIRELLACEAE				
21.	<i>Cymbella</i> sp.	-	+	+	Rare

+ Present - Absent

Part. I (Eastern part of Schirmacher Oasis); Part II (Middle part of Schirmacher Oasis)
and Part III (Western part of Schirmacher Oasis).

different places of Schirmacher Oasis (Tab.1). Acidic pH was recorded in the high altitudes (125-150 m). Water temperature, salinity, TDS and conductivity did not show any correlation with the diversity and distribution of diatoms. Due to higher salt concentration the algal diversity was more in land locked lakes compared to the ice covered lakes.

A total of 21 species (Table 2) were observed in the lakes, pools, streams and moss carpets of Schirmacher Oasis. All the species were present in part III, 16 species at part II and 14 species at part I of the oasis. The total number of taxa recorded during the present study is comparable to the species numbers reported from the freshwater and saline lakes in the Larsemann Hills and Rauer islands, East Antarctica (Sabbe *et al.* 2003). While Vinocur and Izaguirre (1994) have reported 23 taxa in the samples from the Antarctic Peninsula. However, it is much lower than the numbers reported from the maritime Antarctic and sub Antarctic [up to 234 taxa in the south Shetland and south Orkney Islands (Hakansson and Jones 1994 and up to 279 taxa in Iles Kerguelen (Le Cohu and Maillard 1983, 1986)]. This is in accordance with the decreasing trend in species numbers observed as one moves southwards in the Antarctic (Hirano 1965, Jones 1996, Van de Vijver and Beyens 1999). This phenomenon of low species diversity has been attributed to the harshness of the environment and geographic isolation, as well as to factors related to latitude such as period of ice cover and light intensity (Jones 1996). The current study revealed that the cosmopolitan species *i.e.* *Hantzschia amphioxys*, *Nitzschia obtuse*, *Luticola muticopsis* and *Pinnularia borealis* are present in this Oasis, but presence of diatoms are differing from various factors. In two recent reviews on diversity and biogeography of Antarctic and sub-Antarctic diatoms it was stated that cosmopolitanism is the norm in Antarctica (Jones 1996, Van de Vijver and Beyens 1999), although it is acknowledged that a more fine-brained morphology might lead to a higher proportion of endemics (Jones 1996). In the present study, 25 % of diatom taxa from the Schirmacher Oasis are shown to be endemic to Antarctica. Previous estimates of endemism in continental Antarctica ranged from 18-45% for East Antarctica (Soya region and Shinnan rocks) to 60-81% in the McMurdo Dry Valley region (Fukushima 1967). Van de Vijver and Beyens (1999) concluded that the Antarctic is characterized by a higher proportion of cosmopolitan species. On the basis of the present study, we propose that endemism in freshwater diatoms has been underestimated in Antarctic diatoms.

ACKNOWLEDGEMENTS

The author is grateful to Dr. M. Sanjappa, Director and Dr. D. K. Singh, Additional Director, Botanical Survey of India, Kolkata and Dr. G. V. S. Murthy, Joint Director, Botanical Survey of India, Southern Regional Centre, Coimbatore for providing necessary facilities and their encouragements; Dr. P. S. Goel, Secretary, Ministry of Earth Science, New Delhi, Dr. Rasik Ravindra Director, National Centre for Antarctic Ocean Research (NCAOR), Vasco-da-Gama, Goa, for their help and logistic support, Mr. L. Prem Kishore, leader of XXV Indian Antarctic Expedition and fellow members for their untiring help and cooperation during the course of expedition, especially the field work.

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**PLATE 1—SAMPLED AREA IN SCHIRMACHER OASIS,
EAST ANTARCTICA**



Lake covered with ice border Stream Running towards North



Land-Lock Lake in Eastern side of Maitri



Land-Lock Lake in Western side of Oasis