Fifteenth Indian Expedition to Antarctica, Scientific Report, 1999
Department of Ocean Development, Technical Publication No. 13, pp 109-116

ALGAL COLONIZATION OF SCHIRMACHER OASIS, ANTARCTICA

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Abstract

Algae are the major component of Antarctic freshwater and soil microflora. The relative ease with which these organisms can grow on dust and soil, adhere to vegetables, clothing and shoes of expeditioners, there is a possibility of transportation of algal propagules to Antarctic environment. Observations were made on alternate days for the detection of algal propagules growing on soil adhered to vegetables and dust deposited on containers, equipments and shoes and clothing of expeditioners by microscopic analysis of soil and dust samples, throughout the voyage to Antarctica. Algal microflora of thirty lakes was analysed and a list of algal species present in different lakes was prepared after microscopic observations of the samples. Camera - Lucida drawings were made for morphological characterisation and life-cycle pattern studies. Aerial biota was also studied by placing sticky slides at different locations around 'Maitri'.

Introduction

It is now well established that microbial and bryophyte diaspores are reaching Antarctica from land masses. (Walton, 1990). Air current and migrating birds are supposed to be the most effective vectors for the transportation of the spores and propagules of 'alien' organisms to the Antarctic environment (Schlichting, 1978; Broady & Smith, 1994). Since the start of expeditions to Antarctica and establishment of permanent manned stations, there is a possibility of dispersal of alien micro-organism to Antarctica through human agency (Cameron *et al,* 1977).

Detection and assessment of impacts of invading micro-organisms in Antarctica was emphasised long-back by Rudolph and Benninghoff (1977). It was suggested that Antarctica is the remotest region of the earth where human assisted biological invasion can be studied (Vincent, 1988), Among the organisms entering the Antarctic environment due to human activities, few may colonise due to their ability to survive at low and fluctuating temperature and extreme desiccation. Scientific Committee on Antarctic Research (SCAR) has

recommended that Antarctic environment should be protected from 'alien' species and efforts should be initiated for preventing the introduction and establishment of non-indigenous species to greatest extent possible (Broady, 1992). The baseline identification of indigenous species and identification of human introductions help in the assessment of impact of introductions on the native populations. Systematic microbiology is one of the critical factors for the detection and use of indicator species in environment impact assessment and also for an up-to-date record of indigenous flora as well as introduced species that survived.

Material and Methods

I. Analysis of the propagule bank of snow and ice :

Ice and snow were collected using asceptic precautions. Samples were melted and filtered through membrane filters (micropore filters) and was examined microscopically for the presence of recognisable algae and was also used for inoculating cultures. For inoculation, the filters laid on the surface of the moist sterilised soils and on the surface of agarized mineral salt media (BG-11) (Rippka *et al., 1979*) and incubated in BOD incubator at 20-25°C for four to five days and observations were made under the microscope.

II. Analysis of the "propagule bank" of soils :

The algal flora in the vicinity of Maitri station and at other sites of Schirmacher Oasis was analysed floristically using direct microscopic examination of samples, and using "moist plate enrichment cultures" and mineral salt nutrients.

III. The detection of non-indigenous algae brought to Antarctica by human vectors :

Samples were taken from : containers, scrapping from people's shoes, clothes, equipments, ship, fresh vegetables used in the station, soil from the house plants (green house). Samples were examined under microscope and inoculated using following techniques:

(a) Agarized media (BG11 + N)

(b) Liquid mineral salt nutrient (BG-11 + N)

(c) Moist plate enrichment cultures using soil from green house of Maitri as substrata.

IV. The detection of airborne algae :

Sticky slides were used for trapping the airborne algal propagules at various sites and investigated under microscope.

V. Test for the ability of airborne algae to colonise soils :

Moistened sterile soils was exposed to the atmosphere for standard period (2-24 h). Petri dishes containing mineral nutrient medium and also soil placed at various sampling sites in order to the optimise the deposition of propagules onto the soil surfaces. After the exposure the soil surfaces were covered and treated as moist plate enrichment culture i.e., incubated in the light at warm temperature (20±5°C). The development algae was identified under microscope.

Results

(A) Algae detected on board :

The algal species viz. *Chlorella vulagaris, Chlorococcum sp.* and *Phormidium uncinatum* were recorded in the soil and dust samples removed from the surface of vegetables, containers and equipments, life-boats and anchor of the ship. One marine form of *Oscillatoria* was detected in ballast water deposited around the anchor at Goa. No algal species was detected in soil adhering to the shoes of the expeditioners. Two cyanobacteria *Phormidium sp.* and *Aphanothece sp.* were detected in the moss-peat which was carried to Antarctica for experimental purpose.

(B) Algal microflora of Schirmacher Oasis :

Microscopic observations of the soil, water, moss and lichen samples collected from thirty lakes of Schirmacher Oasis, Antarctica revealed presence of a total of sixteen algal species. A list of the species encountered in different lakes has been presented in **Table-1.** Apart from this samples of stagnant water

Table-1: Algal sp. observed on materials carried during voyage to Antarctica

S.N.	Name of Algae	Class	Observed on
1	*Chlorell vulgaris*	Chlorophyceae	soil adhered to vegetables
2	*Chlorococcum sp.*	Chlorophyceae	soil adhered to vegetables
3	*Phormidium uncinatum*	Cyanophyceae	soil adhered to anchor
4	*Oscillatoria sp.*	Cyanophyceae	soil adhered to anchor
5	*Phormidium sp.*	Cyanophyceae	peat moss
6	*Aphanothece sp.*	Cyanophyceae	peat moss

Table—2

Species/Organism	Lake Number																														
	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
A.CHLOROPHYCEAE																														
1. *Chlorella sp.*	-	-	+	+	+	-	-	-	+	-	-	+	+	-	-	-	+	+	-	-	-	-	-	+	-	-	-	+	-	-
2. *Chlorcoccum sp.*	-	-	+	+	+	+	+		+	-	-	+	+	-	-	-	+	-	-	+		+	+	+	-	-	-	+	+	+
3. *Urospora sp.*	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-
4. *Cylindrocapsa geminella*	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
B. CYANOPHYCEAE																														
1. *Anabaena sp.*	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	+	-
2. *Aphanothece sp.*	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	+	+	-
3. *Calothrix brevissima*	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4. *Chrococcus macrococcus*	-	+	+	+	+	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-
5. *Chrococcus limnticus**	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6. *Chrococcus giganticus*	-	-	-	-	+	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7. *Gloeocapsa sp.*	+	+	-	+	+	+	+	-	+	-	-	+	+	-	-	-	-	-	-	-	+	+	+	-	-	+	+	-	+	-
8. *Gloeocapsa kuetzngiana*	+	+	+	-	-	+	-	-	-	-	-	+		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9. *Lyngbya martensiana*	+	+	+	-	+	+	+	-	+	-	-	+	+	-	-	-	-	+	-	-	+	+	+	+	-	-	-	-	+	-
10.*Nostoc commune*	+	+	+	+	+	+	+	-	+	-	-	+	+	-	-	-	-	+	-	-	-	+	-	-	-	-	-	+	+	-
11. *Oscillatoria sp.*	+	+	+	+	+	+	+	+	+	-	+	+	+	-	-	-	-	+	-	-	+	+	+	-	+	+	+	+	+	-
12. *Phormidium sp.*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	+	+	+	+	+	+	-	+	+	+	+	+	-
13. *Stigonema sansabaricus*	-	-	-	-	-	+	-	-	-	+	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
14. *Stigonema lavaralei*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15. *Stigonema harmoides*	-	-	-	+	-	+	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16. *Synechococcus sp.*	-	+	+	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-
C. BACILLARIOPHY-CEAE																														
1. *Hanrzschia sp.*	-	+	+	+	+	-	-	+	+	-	-	+	+	-	-	-	-	-	-	-	-	+	+	+	+	+	-	-	-	-
2. *Navicula sp.*	-	-	-	+	+	+	-	-	+	-	-	-	+	-	-	-	+	+	-	-	+	-	-	-	+	+	-	-	+	-
3. *Pinnularia sp.*	+	+	+	+	+	+	+	+	+	-	-	-	+	+	-	-	+	+	+	-	-	+	-	+	-	+	+	-	+	-
Total Number of Species Persent	7	11	15	15	16	10	10	5	13	5	4	11	12	3	0	0	5	7	2	6	5	11	6	6	5	6	4	8	9	-

*Epiphyte on Moss, ** Epiphyte on Lichen

pools (which received kitchen water of Maitri) were also analysed under microscope. These pools exhibited a greater species diversity than the adjoining lakes.

(C) **Aerial translocation of algal propagules** :

Two cyanobacterial species viz. Oscillatoria sp. and Phormidium sp. were detected on the sticky slides placed at four locations around 'Maitri' (i.e. IMD balloon launching laboratory, Generator room 'Aditya', above summer hut kitchen "Annapurna" and on the roof of 'Gimar'). Analysis of soil collected from approximately 30 m height on the east, west, north and south faces of 'Trishul Hill' revealed maximum algal diversity on the west face followed by south. The list of the organisms encountered have been presented in **TabIe-2.**

Discussion

Schirmacher Oasis is one of ice-free regions of Antarctica **(Fig.l).** Two permanent manned stations 'Novalazarevskaya' and 'Maitri' are situated in this . region. A huge quantity of food material, equipments and other life supporting articles are transported to these permanent stations. Presence of algae on vegetables, ballast water and soil adhered to anchor confirms that algae can be introduced into Antarctic environment through human activities. Algal diversity varied among lakes and lakes inhabited by mosses and lichens exhibited maximum diversity **(Table-1).** Stagnant water pools are probably most perturbed ecosystem and provide most favourable conditions for establishment of non-indigenous micro-organisms.

Aerial translocation seems to be an important mode of dispersal of algae to different locations in the Oasis (Fig.2). Presence of four algal taxa on different sides (i.e. North, South, East and West facing) of 'Trishul-Hill' at a height of 30 m suggests that air is an important factor for dispersal of some algal species **(Table-3).** South-west wind direction appears to be most effective in dispersal of algae as the diversity was maximum on southward face followed by west.

Table-3 : Algal species present on different sides of Trishul Hill' at 30 m height

Side	Organism
North	*Phormidium* sp., *Oscillatoria*
South	*Phormidium* sp., *Oscillatoria, Gloeocapsa* sp., *Chiorococcum* sp.
East	*Phormidium* sp.
West	*Phormidium* sp., *Gloeocapsa* sp., *Chroococus limneticus*

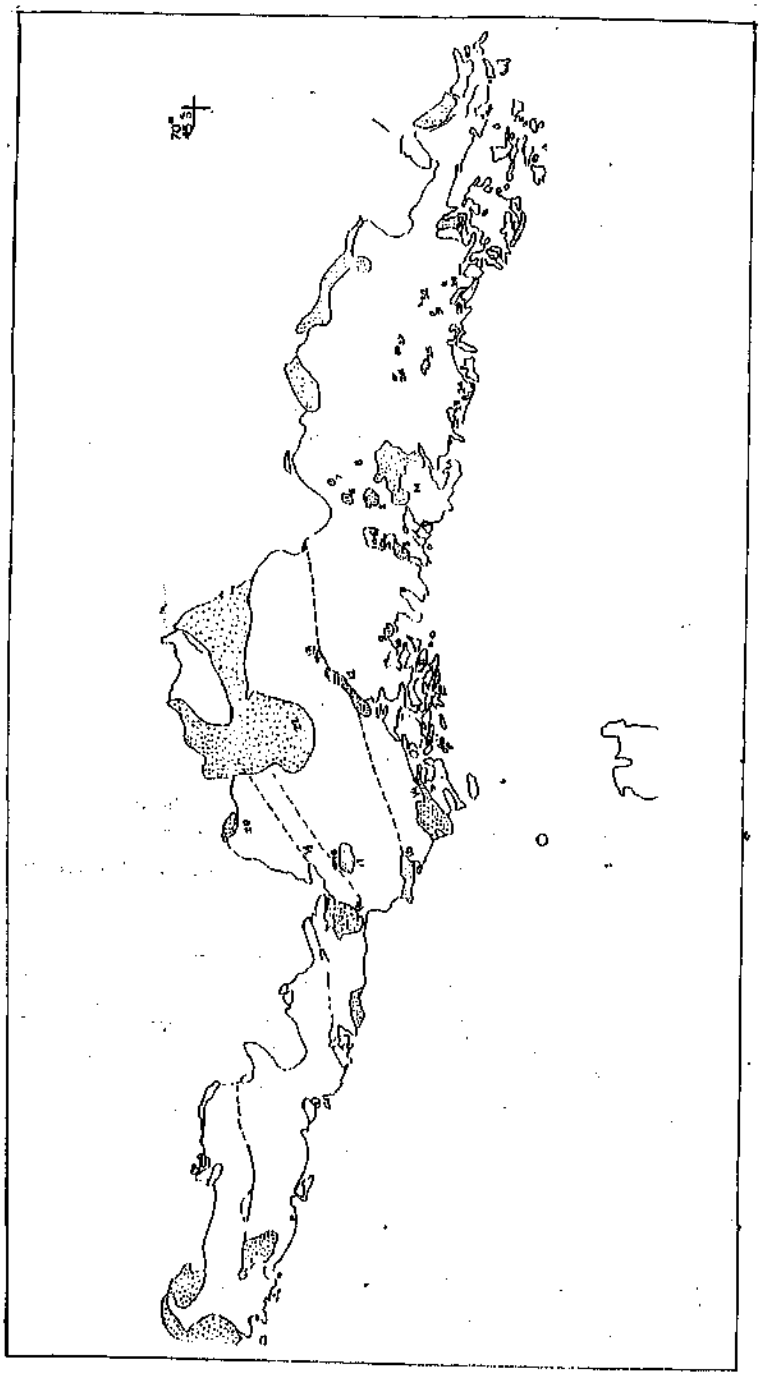

Fig.1 :Map of Schirmacher Oasis (70° 46' 05" S, 11° 43' 15"E). Dotted spots show the location of lakes. **The lakes sampled have been numbered serially**

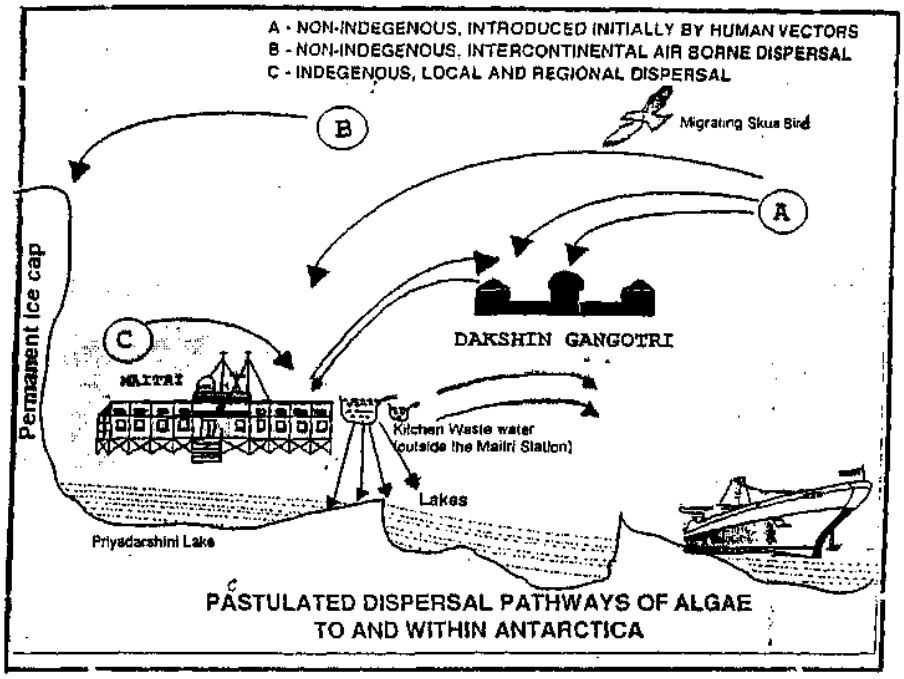

Fig.2 :Postulated dispersal pathways of algae to and within Antarctica. Arrows indicate direction of dispersal from one site to another

Assessment of potential of survival and growth of non-indigenous algae under natural environment of this continent is not recommended (conservation of Antarctic fauna and flora, Article-IX) therefore a detailed physiological characterisation of potential Antarctic colonisers in required by exposing them to laboratory conditions which closely match the conditions, they would encounter in Antarctica. These studies should also include the test for survival and growth under realistic physicochemical conditions by using natural Antarctic water and soils. The ability of exogenous algae to colonise in the presence of native populations also needs an investigation.

Acknowledgements

Authors are thankful to Department of Ocean Development and Sri Arun Chaturvedi, Leader, 15th Antarctic Expedition for providing the facilities. SPS is thankful to Sri B. Mitra (ZSI) and Mr. M.K. Pant (DARL) for co-operation and helps in collection of samples. Thanks are also due to CSIR for financial assistance.

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