

## Benthic marine algae of the inshore water at the Vestfold Hills, Antarctica

V K Dhargalkar

Biological Oceanography Division, National Institute of Oceanography, Dona Paula, Goa 403 004, India

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Distribution and composition of benthic marine algae were studied at 4 stations in the Ellis Fjord (lat. 68° 35' and 68° 38' E; long. 77° 50' and 78° 15' S) Vestfold Hills, Antarctica. Algae were collected through drilled hole in sea ice from May to December 1983 and during summer in the intertidal zone. Of the 14 algal species recorded, brown algae *Himantothallus grandifolius* and *Desmarestia menziesii* were abundant near the mouth of the fjord, but apparently absent inside the fjord. Red algae *Palmaria decipiens* and *Phyllophora antarctica* were the dominant species of the region. *Porphyra endiviifolium* occurred in the upper littoral zone while *Urospora penicilliformis* and *Enteromorpha bulbosa* occurred in the intertidal rock crevices and furrows. *Monostroma hariotii* was present both in the intertidal pool and in infralittoral zone. Decrease in nitrate concentration was related with the luxuriant growth of *U. penicilliformis* during December, which was evident from the increase in photosynthetic activity resulting into high dissolved oxygen and pH of the water.

Earlier reports on benthic algae of the Southern Ocean are mainly of descriptive nature<sup>1-6</sup>. Even though Antarctic benthic algae are one of the renewable living resources, very little is known about their role in the coastal ecosystem. The present investigation is an attempt to study benthic algal distribution and seasonal abundance in different water bodies namely oceanic and fjord. Presence of macrophytes under sea ice for 9 months of the year and their growth and associated fauna are also studied.

### Materials and Methods

Sampling was carried out from May to December 1983 at 4 stations in Ellis Fjord (Fig. 1). Station D was sampled occasionally while regular monthly sampling was carried out at other stations.

Marine benthic macrophytes and water samples for environmental parameters were collected through a 10 cm diam. hole drilled in 2 m thick sea ice. Kammerer bottle (2 l) with installed thermometer was used to collect water samples. Water was drained into 300 ml reagent bottles for dissolved oxygen determination and in 500 ml polyethylene bottles for pH, salinity and nutrient estimation. Dissolved oxygen, salinity and nutrients ( $PO_4$ ,  $NO_2$ ,  $NO_3$ ,  $NH_4$ ) were analysed following the standard procedures<sup>7</sup>. pH was measured on pH meter (Metrohm E 588). In the field, prior to water sampling sea ice thickness, snow cover and total depth were measured<sup>8</sup>. Light intensity was measured with Licor quantum photometer (LI-185A).

Holes (6-7) were drilled at each site in a radius of 5 m and benthic algae were sampled with a grab through the hole. Soon after break-out of the sea ice in late December the littoral belt at 3 sampling stations (A, B and C) were studied for species composition and distribution.

### Results

There were marked seasonal differences in the composition of marine benthic algae at different stations (Table 1). Rhodophyta dominated the entire region and maximum number of species was recorded at st A.

Oceanic st A was 10 m deep having sandy-rocky (boulders, pebbles) substrate with large number of molluscan shells and polychaete tubes from May to

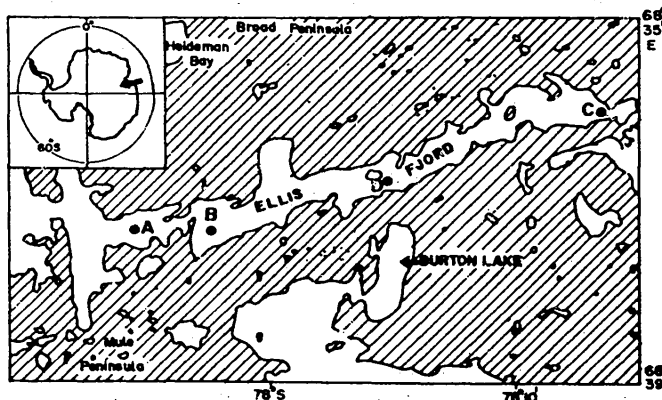


Fig. 1—Location of sampling stations

## DHARGALKAR: MARINE ALGAE OF ANTARCTICA

 Table 1—Distribution of benthic algae at 4 stations in Ellis Fjord, Vestfold Hills, Antarctica  
 (A, B, C, D-indicates presence of algae at the respective stations, and — = algae not present)

Species	1983	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<b>CHLOROPHYTA</b>									
<i>Urospora penicilliformis</i> (Roth) Areschoug		ABC	C	C	C	C	C	C	C
<i>Cladophora subsimplex</i> Kützing		AB	B	B	—	C	A	BC	—ABC
<i>Monostroma hariotii</i> Gain		C	—	—	—	—	—	—	AB
<i>Enteromorpha bulbosa</i> (Suhr) Montagne		AB	AB	A	—	B	A	ABC	ABC
<b>PHAEOPHYTA</b>									
<i>Geminocarpus austrogeorgeae</i> Skottberg		AB	ABC	C	CD	C	AC	ABCD	ABC
<i>Himantothallus grandifolius</i> (A. & E.S. Gepp) Zinov		A	—	—	—	—	—	A	A
<i>Desmarestia menziesii</i> J. Agardh		A	—	—	—	—	—	A	A
<b>RHODOPHYTA</b>									
<i>Palmaria decipiens</i> (Reinsch) Ricker		AB	AB	A	A	AB	AB	AB	AB
<i>Phyllophora antarctica</i> A.E.S. Gepp		AB	ABD	A	A	ABD	AB	ABD	AB
<i>Iridaea cordata</i> (Truner) Borg.		AB	AB	A	A	AB	A	AB	AB
<i>Plocamium cartilagineum</i> (Linnaeus) Dixon		AB	AB	A	—	A	A	AB	AB
<i>Ballia callitricha</i> (C. Agardh) Kützing		A	AD	—	—	D	A	A	AB
<i>Porphyra endiviifolium</i> (A & E.S. Gepp) Chamberlain		AB	AB	—	—	—	—	—	AB
<i>Lithothamnium</i> sp.		—	—	—	—	—	D	D	D

June, which got covered with silt forming sandy-silty substrate from July to September and thereafter remained sandy-rocky through the summer.

Red alga, *Phyllophora antarctica*, in association with *Palmaria decipiens* and *Iridaea cordata*, dominated this station and was present throughout the year. During September-October *Plocamium cartilagineum* was found associated with this assemblage. Specimens of *P. decipiens* collected during winter (June-July) were found to have only basal portion while others were in crumpled condition.

Brown algae at this station were represented by *Himantothallus grandifolius*, *Desmarestia menziesii* and *Geminocarpus austrogeorgeae*. No specimens of larger brown algae were collected with grab when the area was covered with sea ice. However, *H. grandifolius* was noticed during summer in open waters with patchy occurrence of *D. menziesii*. The detailed observations of these algae showed variety of epiphytic

fauna while filamentous brown alga, *G. austrogeorgeae*, even though present throughout the year, never had any associated fauna.

During summer (Dec.-Jan.) the littoral belt at st A was closely studied for species composition and dominance. Red alga *Porphyra endiviifolium* dominated at the upper littoral zone while green algae *Enteromorpha bulbosa* and *Urospora penicilliformis* appeared in crevices and rock pools. *Monostroma hariotii* was seen growing in infra littoral zone along with *Plocamium cartilagineum*.

St B, inside the Ellis Fjord having 9 m depth, showed mixed filamentous and thalloid algal composition, *P. decipiens*, *P. antarctica* and *Cladophora* sp. were collected on many occasions through fast ice and regular collection of these algal species were made during open water in January, while *I. cordata* and *Ballia callitricha* were collected on 3 occasions. Compared to the oceanic station (st A) algae growing

at this locality had stunted growth and bushy appearance.

*Urospora penicilliformis*, *Enteromorpha* sp. and a crustose coralline algae (*Lithothamnium* sp.) showed luxuriant growth during summer months at the high tide level in rock crevices and furrows. The infralittoral zone was dominated with *P. decipiens* and *P. antarctica* while patchy occurrence of *C. subsimplex* and *B. callitricha* was noticed. A few juvenile *Monostroma* plants were seen on shells of *Laevilacunaria* sp. while matured thalli were growing on boulders. In the upper littoral belt few plants of *P. endiviifolium* were seen growing on the scattered boulders. Even though plants were few in number the growth was better than at the oceanic station.

St C showed dominance of filamentous algae (Table 1). Depth at this station was 6 m having sandy substrate during May and June which ultimately got covered with sandy-silt with strong foul smell, from July to November. December onwards once again sandy substrate prevailed with absence of foul smelling. *Urospora penicilliformis* was the dominant alga of this region throughout the year showing luxuriant growth and covering entire area during late December. Most of the time during the year *G. austrogeorgeae* was collected while *E. bulbosa* and *C. subsimplex* were collected occasionally. Filamentous algae were never found associated with fauna except on a few occasions during winter when *C. subsimplex* was seen associated with gastropod *Laevilacunaria* sp. The littoral belt at this site was found covered with ice until the end of January and therefore was not examined.

St D having 11 m depth and sandy substrate with polychaete tubes was sampled occasionally. Only *P. antarctica* was collected from this station. Fauna associated with *P. antarctica* at this station was similar to that of the st A but was less abundant. Few tide pools studied showed dominance of *Enteromorpha*, *Cladophora* and *Porphyra* spp. In the shallow pools *Monostroma* showed scanty growth; while growth was luxuriant in the tide pools that were situated at the higher level.

Environmental parameter did not show significant variation throughout the sampling period (Fig. 2) except for the under water light intensity which varied seasonally with maximum intensity in December (Table 2).

**Discussion**

In the present investigation, green alga *M. hariotii* occurred annually during early summer growing on *Laevilacunaria* and other shells and within few weeks it grew 8 to 12 cm in size. This alga was never collected from st C. Probably, the absence of suitable substrat-

um, fresh water influx through Ellis Rapids and extensive growth of *U. penicilliformis* in the upper water column, obstruct light penetration.

Red alga, *P. antarctica* showed luxuriant growth throughout the year at st A, while in sts B and D the growth was patchy. The luxuriant growth at st A may be due to the vast beds of polychaete tubes that provide favourable substrate. Absence of this alga at st C can be attributed to the absence of substratum and perhaps to the anoxic layer in the water that existed during July to November.

*Palmaria decipiens* grow luxuriantly during summer months. However, the collection made during

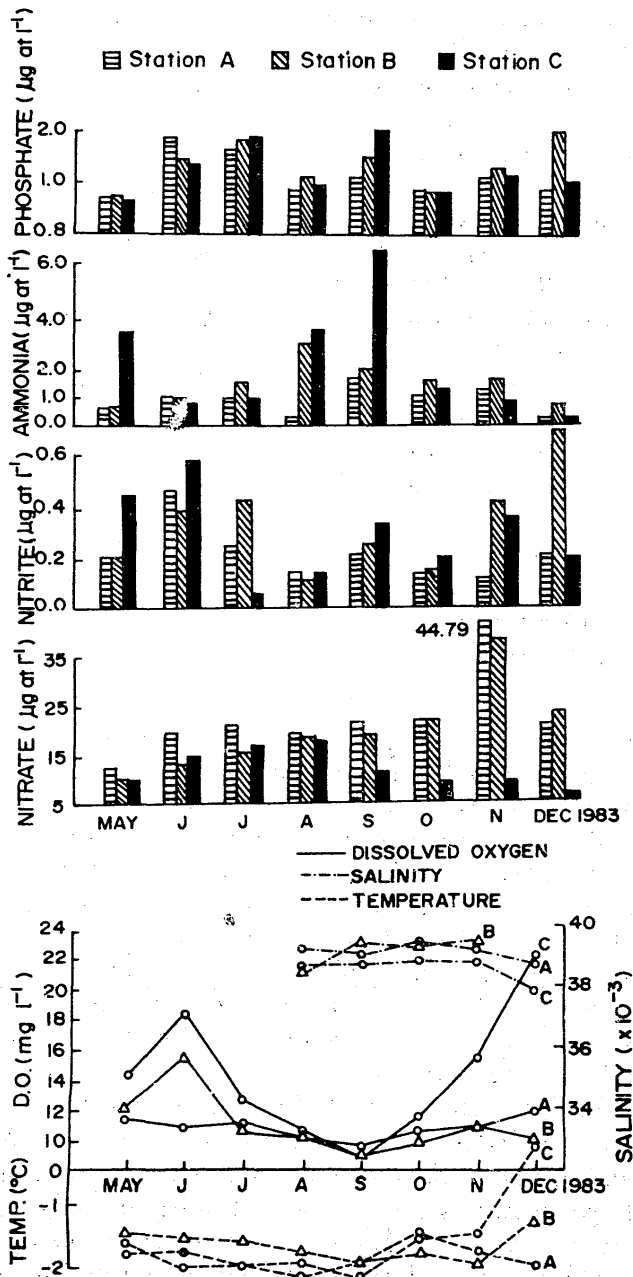


Fig. 2—Nutrients, dissolved oxygen, salinity and water temperature during different months

Table 2—Average underwater light intensity ( $\mu\text{E m}^{-2}\text{s}^{-1}$ ) during May-December 1983

Depths (m)	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0	1.19	1.54	0.91	3.19	256.20	44.10	193.20	413.70
1	0.70	0.07	0.67	1.33	37.80	0.00	18.20	11.20
2	0.21	0.00	0.31	0.79	21.00	—	13.44	8.40
3	0.17	—	0.21	0.62	12.60	—	9.24	5.32
4	0.08	—	0.15	0.53	14.70	—	7.56	4.90
5	0.00	—	0.15	0.45	8.40	—	6.30	5.04
6	—	—	0.03	0.28	4.20	—	5.88	4.48
7	—	—	0.00	0.08	2.10	—	5.46	4.28
8	—	—	—	0.00	0.00	—	0.00	3.22
9	—	—	—	—	—	—	—	0.00

— = not measured

winter (June-July) indicated stunted growth and on many occasions withered basal portions were collected. Probably, non availability of light, grazing by the fauna and erosion of meristematic tissue due to the water movement might affect the growth.

Animal taxa recorded on red algae varied seasonally probably due to the availability of food resources on the algal thallus during different seasons. The high faunal density on *P. decipiens* during July-August than at other time of the year indicated that fauna takes shelter during winter conditions and grazes extensively to survive<sup>10</sup>. The faunal density on brown algal thalli was very low while, highest faunal density was recorded in holdfast of *H. grandifolius* and *D. menziesii* with nematodes dominating. Seasonal variation in faunal composition could not be worked out as these large algae could not be collected through the drilled holes in the sea ice.

The brown algae, *H. grandifolius* and *D. menziesii* showed luxuriant growth during summer at st A and in the Ellis Narrows. The large size recorded for these algae during summer indicated their presence under sea ice during winter/spring, and grows faster when increased light and high temperature aided by high nutrients were available in summer. Over all, there was an increase in underwater light intensity from Sept ( $256.2 \mu\text{E m}^{-2}\text{s}^{-1}$ ) to December ( $413.7 \mu\text{E m}^{-2}\text{s}^{-1}$ ) at 0 m (just below the sea ice) and at the subsequent depths (Table 2).

During summer, annuals such as *M. hariotii* emerged during late December and grew extensively within a short time to complete the growth cycle. Similarly, it was also seen with perennial *H. grandifolius* where high rate of growth was seen during summer growing up to 7 m in length. This could be due to the cumulative effect of high nutrients, comparatively high temperature and light that aids growth.

At st C, nitrate decreased in December which might have been utilized by filamentous alga *U. penicillifor-*

*mis*, that showed luxuriant growth covering large area at this station. Probably, nitrate was taken up by this alga to multiply fast aided by high temperature in summer<sup>11</sup>. Similarly, high dissolved oxygen and pH recorded during summer indicate high photosynthetic activity that increases dissolved oxygen and pH of the water<sup>12,13</sup>. Comparatively high salinity values were recorded from sts A-C which might be due to the exudation of salt during the formation of sea ice and also non-mixing of the fjord water due to the presence of sill.

Putrefaction in bottom water from July to early November was detected at st C, indicating poor water circulation. The tidal water which moves into the basin was restricted by a sill that separates the surface layer from the bottom anoxic layer<sup>14</sup>. The anoxic layer prevents algal growth except for the filamentous algae *U. penicilliformis* and *G. austrogeorgeae*, which were collected along with large number of green spores present in the sediments. This indicates that these algae and spores had an ability to survive in this condition.

Based on the data presented here it is clear that coastal water of the Vestfold Hills, in spite of the adverse seasonal changes, harbours rich and varied benthic algal communities. However, the species composition varied seasonally depending on the changes taking place in the environmental parameters and substratum. The animal species found in association with these benthic algae indicate their dependence on these algae at least during some parts of their life span.

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