Seasonal fluctuation and vertical distribution of Paraphysomonas (Chrysophyceae) off the coast near Syowa Station, East Ongul Island, Antarctica: -(Preliminary report)

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Summary

Four species of Paraphysomonas collected from the fast-ice covered area Syowa Station, East Ongul Island (69°00'S, 39°35'), Antarctica occurred in the seawater throughout the year and occasionally in the sea ice. P. antarctica is distributed to a water depth of 35m at St.3 during the period from August 1983 to January 1984 and also down to 600m at St.5 in September 1983 at cell concentrations of 300-350 cells/ml. The Paraphysomonas spp. were dominant during the period from July to November 1983 in the area studied. The mode of the occurrence and vertical distribution of Paraphysomonas apparently coresponds to those of the bacteria and organic debris-like matter in the seawater. The main components of the plankton population in the area studied, under ice-covered conditions, are Paraphysomonas, Choanoflagellates and bacteria. This work clarified that Paraphysomonas is one of the most important bacterivores in the microbial loop of the Antarctic marine ecosystem.

Key Words: Antarctic Ocean, bacteria, Chrysophyta, Lützow-Holm Bay, Paraphysomonas, seasonal change, vertical distribution.

Introduction

The phytoplankton community in the Antrctic Ocean is made up mainly of diatoms and dinoflagellates, and other conspicuous microplankton such as the Prasinophytes. In addition to these autotrophic members, the hetero- and mixo-trophic microflagellates, which maintain those members of the community in a healthy state by preying on populations of bacteria, have been considered to play a very important role in the marine food web. (El-Sayed and Fryxell 1993, Palmisano and Garrison 1993, Verity 1991).

In the BIOMASS survey of the Antarctic Ocean, the present author, who carried out taxonomic and ecological studies on the nano/microplankters at the Syowa Station, Antarctica, recorded a dozen choanoflagellates (the phagotrophic members) and four

species of Paraphysomonas (colourless chrysophycean flagellates) from the pack ice area near Syowa Station, East Ongul Island, Antarctica,(Takahashi 1981,1987).

The present paper deals with the seasonal fluctuation and vertical distribution of Paraphysomonas during a year of study,from February 1983 to January 1984, in the fast-ice covered coastal area north of East Ongul Island.

Materials and Methods

Seawater and sea ice core samples were collected at three sampling sites (Stations 1, 3, 5) in the fast ice covered coastal area north of Syowa Station, East Ongul Island (60°00'S, 39°35'E) in the Lützow-Holm Bay, during the period from February 1983 to January 1984 (Fig. 1). At each station on the fast-ice, which varied from 50 to 120cm in thickness throughout the year studied, a 2m x 2m square hole was created. At Sts.1, 3 and 5 the depths to the sea bottom were ca.12, 38 and more than 700 meters respectively. Seawater samples (0.5L) were collected with a Van Dorn bottle from the following depths at each station: 2, 5, 8 and 11m at St.1; 2, 5, 10, 15, 25 and 35m at St.3; 2, 5, 10, 25, 50, 75, 100, 150, 200, 400 and 600m at St.5; and in addition to these samples, 0.5L of surface water samples were taken from ca.10cm deep layers at each station. The climatic and oceanographic conditions in this area have been described in another paper (Watanabe et al. 1986).

The sea water samples were examined using scanning and transmission electron microscopes (Takahashi et al. 1986, Takahashi 1987). Almost all of the water samples were examined with a JSM -T100 SEM, which was brought to Syowa Station from Japan.

Results and Discussion

The thickness of sea ice varied from ca.50 to 120cm throughout the year studied, and except for one day, May 3rd 1983, when the pack ice was blown offshore, the Ongul Island remained icebound.

The water temperature of the surface layer (10cm deep) ranged between -2.11 (July 29th) and -1.38°C (January 1st), the salinity between 33.89 (January 1st) and 34.50‰ (July 29th), and the pH between 7.9 (September 9th, 600m deep) and 8.07 (June 6th, 25 m deep and July 29th, 150m deep) at St.5. (Fig. 2) (Watanabe et al. 1986).

Four species of Paraphysomonas occurred at the three stations: P. antarctica Takahashi 1987, P. butcherii Pennick et Clarke 1972, P. oligocycla Takahashi 1987 and P. vestita (Stokes) De Saedeleer 1929.

At St.1, all of them appeared in the water column and in the sea ice. In April, P. antarctica and P. vestita appeared at the surface water layer, and also they and P. oligocycla in the sea ice, in May P. butcheri in both the surface water layer and the sea ice, in December P. antarctica and P. vestita at the surface water layer and in January P. vestita and P. oligocyclaat the surface water layer and also P. antarctica in the top 5 meters of the seawater.

At station 3, which is 35 meters deep, only one species, P. antarctica appeared in the water column. In March, it was found at the surface layer and at 35 meters and in June at the surface only, but was distributed from the surface to 35 meters depth during the period from September to January.

At Station 5, which is over 600 meters deep, two species were found (Fig. 3). P. oligocycla was only found at the surface in January, while P. antarctica appeared during the period from June to January and also was widely distributed down to 150 meters deep in November and to 200 meters deep in September and October, and occurred once at 600 meters deep in September. The cohabitant in September and October was bacteria which were 10 to 30 times more numerous than Paraphysomonas. In addition to these living organisms, the existence of large numbers of amorphous organic debris-like matters were observed in the water samples in September and October in the scanning electron microscope.

Besides the Paraphysomonas and bacteria, several species of choanoflagellates were found at three stations during a year studied.

The vertical distribution of bacteria, organic debris-like matters, Paraphysomonas and choanoflagellates at Station 5 were as follows (Table 1):

Table 1. Vertical distributions of bacteria, organic debris, Paraphysomonas and choanoflagellates at St. 5.

1983-1984 : month	Range (depth in meters) of vertical distribution: bacteria(bac), organic debris-like matter(org)		Paraphysomonas(Para), choanoflagellates(choa)	
June	bac	0 to 100m deep	Para	10 to 25m deep
			choa	down to 50m
July	bac	0 to 600m	Para	0 to 25m
			choa	0 to 400m
September	bac	5 to 600m	Para	25 to 600m
	org	0 to 600m		
October	bac	10 to 150m; 600m	Para	25 to 200m
	org	0 to 600m		
November	bac	0 to 200m	Para	15 to 150m
December	bac	0 to 35m	Para	10m only
			choa	0 to 35m
January	bac	down to 5m	Para	0m only
			choa	0m only

This data indicates that the occurrence and increase of Paraphysomonas are closely correlated to those of bacteria and organic debris.

Since P. vestita was described in 1929, other marine species of the genus have been recorded from many parts of both the northern and southern hemispheres (Chrétiennot-Dinet 1990, Preisig et al. 1991). And also it has recently been reported that they play an important ecological role within the marine food web, especially in the microbial loop (Sieburth 1979, Sanders 1991, Palmisano & Garrison 1993). The nanoplankton population in the fast-ice covered area studied has a low diversity, and the Paraphysomonas appears to dominate during winter season and is distributed down to a depth of 600 meters. The present results clarify that they are one of the most important components in the Antarctic Ocean ecosystem, although a more detailed investigation is required.

As cells of Paraphysomonas are small in size (1.7– 5 μm diameters), easily broken and require both light and electron microscopy for their identification, there are many interesting problems on Paraphysomonas and other nanoflagellates living in the Antarctic Ocean which remain unsolved.

References

Chrétiennot-Dinet, M-J. 1990. Atlas du Phytoplancton Marin. CNRS, Paris.

El-Sayed, S. Z. & Fryxell, G. A. 1993. Phytoplankton. In (Ed.) Friedmann, E. I. Antarctic Microbiology, Wiley-Liss, New York, pp. 65-122.

Palmisano, A. C. & Garrison, D. L. 1933. Microorganisms in Antarctic sea ice. In (Ed.) Friedmann, E. I. Antarctic Microbiology, Wiley-Liss, New York, pp.168-218.

Preisig, H. R., Vørs, N. and Hällfors, G. 1991. Diversity of heterotrophic heterokont flagellates. In (Eds.) Patterson, D. J. & Larsen, J. The Biology of Free-living Heterotrophic Flagellates, Systematic Ass. Spec. vol. 45, Clarendon Press, Oxford, pp.361-399.

Sanders, R. W. 1991. Trophic strategies among heterotrophic flagellates. In (Eds.) Patterson, D. J. & Larsen, J. The Biology of Free-living Heterotrophic Flagellates, Systematic Ass. Spec. Vol. 45, Clarendon Press, Oxford, pp.21-38.

Sieburth , J. M. 1979. Sea Microbes. Oxford Univ.Press, New York.

Takahashi, E. 1981. Loricate and scale-bearing protists from Lützow-Holm Bay, Antarctica I. Species of the Acanthoecidae and the Centrohelida found at a site selected on the fast ice. Antarctic Rep. 73(1): 1-22.

Takahashi, E. 1987. Loricate and scale-bearing protists from Lützow-Holm Bay, Antarctica II. Four marine species of Paraphysomomas (Chrysophyceae) including two new species from the fast-ice covered coastal area. Jap. J. Phycol. 35:155-166.

Takahashi, E., Watanabe, K. & Satoh, H. 1986. Siliceous cysts from Kita-no-seto Strait, north of Syowa Station, Antarctica. Mem. Natl. Inst. polar Res., Spec. issue 40: 84-95.

Watanabe, K., Satoh, H., Kanda, H. & Takahashi, E. 1986. Oceanographic and marine biological data from routine observations near Syowa Station between February 1983 to January 1984 (JARE 24). JARE Data Rep. 114 (Mar. Biol. 8): 1-22.

Verity, P. G. 1991. Feeding in planktonic protozoans: Evidence for non-random acquisition of prey. J. Protozool. 38(1):69-76.

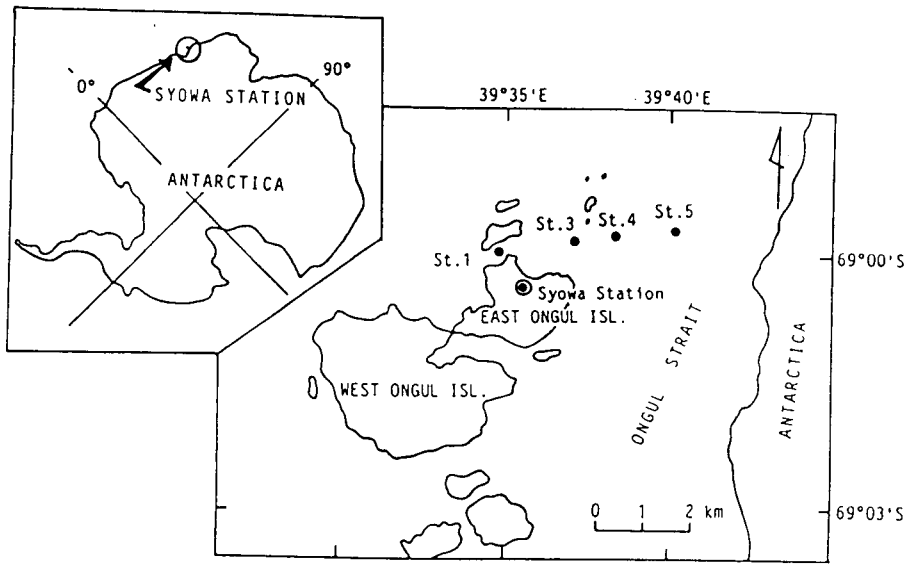
Figure legends

Fig.1. Map showing three sampling sites on the fast-ice in the coastal area north of East Ongul Island.

Fig.2. Seasonal changes of ice thickness (A), water temperature (B) and pH of water (C) at St.3, 1983-1984.

Fig.3. The period of occurrence (A) and vertical distributions (B) of Paraphysomonas, choanoflagellates and bacteria at St.5, 1983-1984.

- Paraphysomonas antarctica
- P. butcheri
- P. oligocycla
- P. vestita
- ● - cyst (stomatocyst)
- ○b- bacteria
- ○c- choanoflagellates



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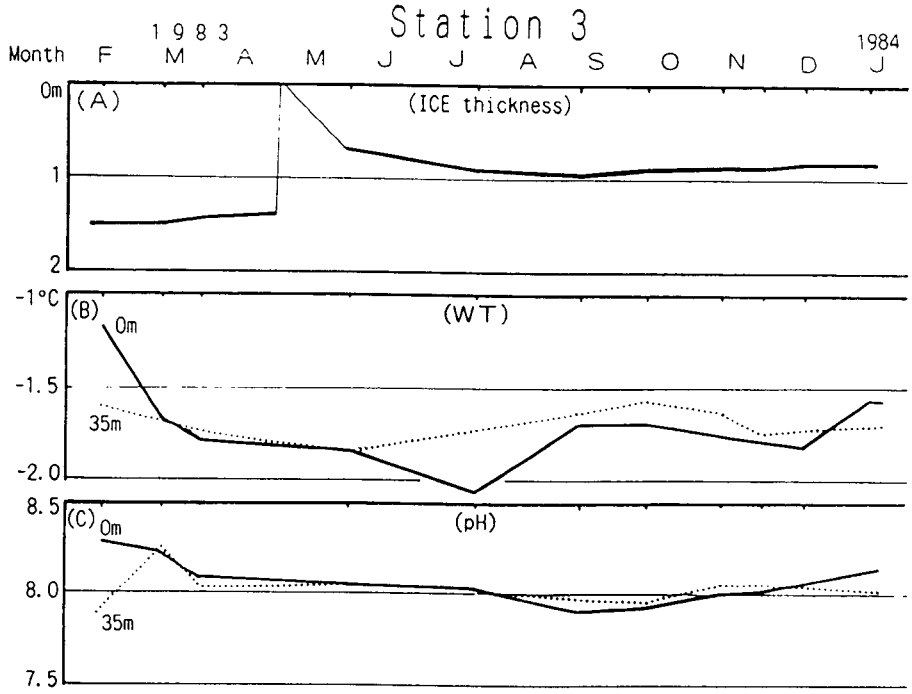

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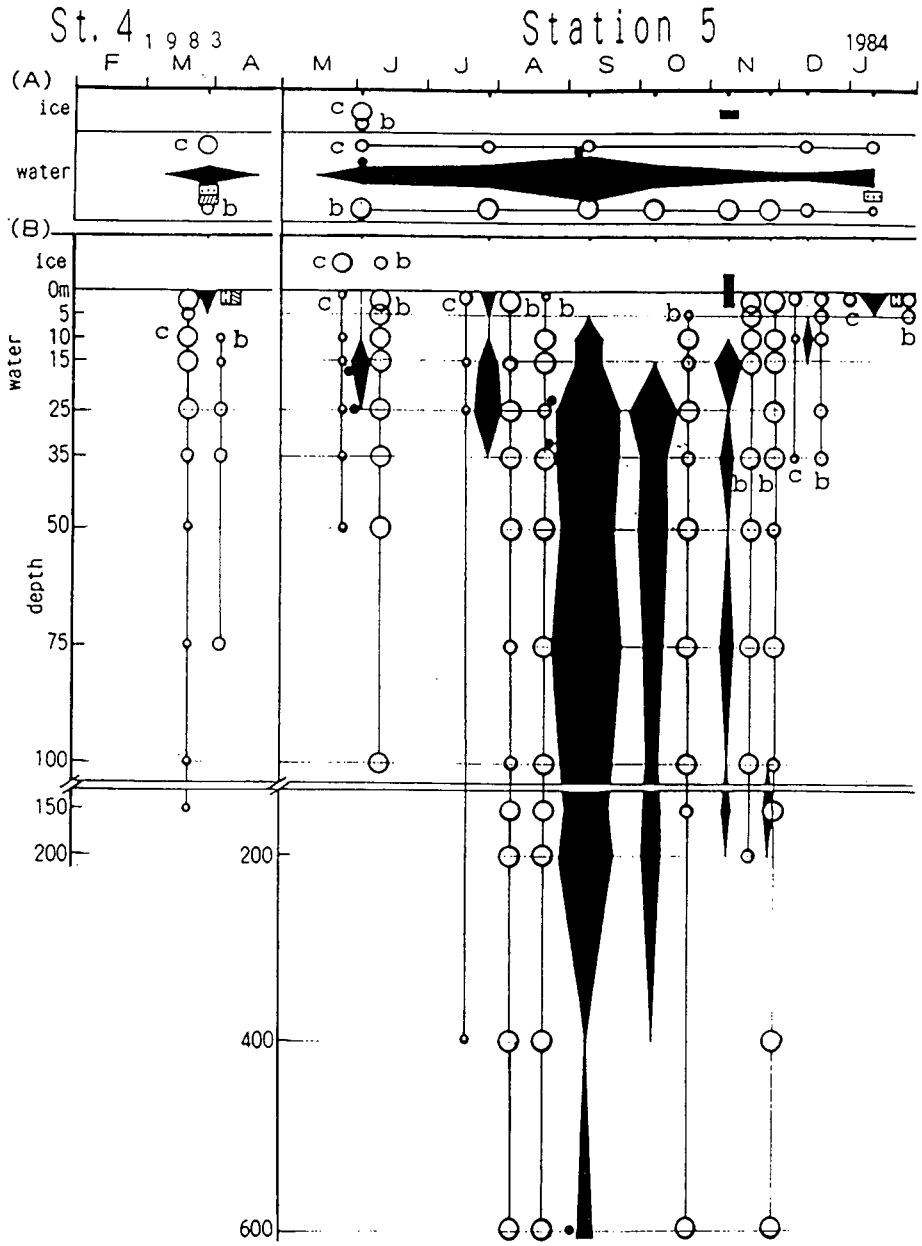

Fig.3. The period of occurrence (A) and vertical distributions (B) of Paraphysomonas, choanoflagellates and bacteria at St.5, 1983-1984.

- Paraphysomonas antarctica
- P. butcheri
- P. oligocycla
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- cyst (stomatocyst)
- b- bacteria
- c- choanoflagellates