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SEASONAL VARIATION IN PARTICULATE ORGANIC MATTER UNDER THE ANTARCTIC FAST ICE WITH SPECIAL REFERENCE TO C: N: P RATIO AND PHYTOPLANKTON ACTIVITY*
(EXTENDED ABSTRACT)

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Primary production under the Antarctic fast ice is mainly brought by phytoplankton and ice algae only in a relatively short period of summertime in a year (BUNT and LEE, 1970; FUKUCHI *et al*, 1985). This production then presumably influences the seasonal variation in both the nature and standing stock of particulate organic matter in water column. From the viewpoint that the seasonal variation of organic matter plays an important role on the energy flow and food availability in the ecosystem under ice, a year-round observation on particulate organic matter was carried out from February 1984 to January 1985 at three stations in the Kita-no-ura Cove off East Ongul Island in Lutzow-Holm Bay during the 25th Japanese Antarctic Research Expedition at Syowa Station (69°00′S, 39°35′E).

In the present study, seasonal variations in POC (particulate organic carbon), PON (particulate organic nitrogen) and PP (particulate phosphorus) were monitored with special reference to the C: N: P ratio and chlorophyll *a* standing stock. A part of the results of the observation on POC and PON was reported elsewhere (MATSUDA *et al.*, 1987a).

As a result, marked seasonal variations of particulate matter, particularly chlorophyll *a* was observed in the surface water. The concentration of particulate matter was generally high in summer especially in the surface water but low in winter. Although the seasonal variation in particulate matter was understood to be basically due to seasonal variation of primary production, the examination of the ratios of POC, PON and PP to chl. *a* revealed that suspended particles were rich in fresh algae and nutrients only in summer due to proliferation of phytoplankton and ice algae, whereas in winter, suspended particles were dominated by detrital component which contained organic carbon and nitrogen but little chl *a*.

Among POC, PON and PP, the variation in PP showed the most remarkable seasonality (Fig 1) and also indicated the significant linear relationship with chl. *a*,

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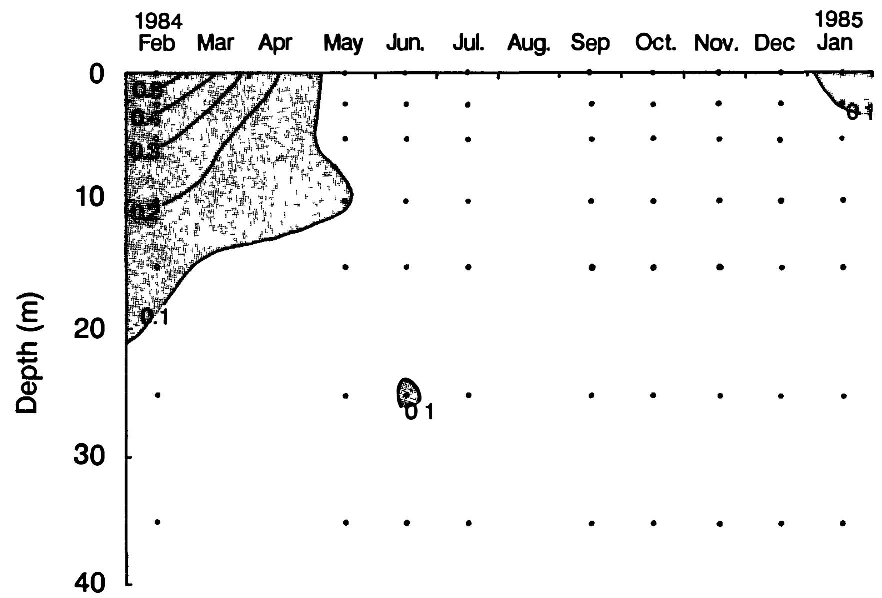

Fig. 1. Seasonal variation in particulate phosphorus (PP) concentration (μg-at/l) in the surface seawater under the Antarctic fast ice observed at Stn. 3

Table 1. Relationship between chlorophyll a *and particulate phosphorus (PP) in surface seawater under the Antarctic fast ice.*

Station No.	Linear regression	Correlation coefficient
1	PP (μg/l)= 1.07+2.40 chl *a* (μg/l)	$r=0.98$
2	PP (μg/l)= 1.18+4.03 chl. *a* (μg/l)	$r=0.98$
3	PP (μg/l)=$-$1.00+3.68 chl *a* (μg/l)	$r=0.91$

particularly in the surface water (Table 1). These results suggest that the transformation from dissolved to particulate phosphorus depends largely on algal photosynthetic activity.

Analysis of the seasonal variation in the percentage composition of three forms of phosphorus in seawater, viz., dissolved inorganic phosphorus (DIP), dissolved organic phosphorus (DOP) and PP, elucidated that DIP is not completely depleted except in an extreme case in the surface water (Fig. 2) and even in that extreme case, plenty of DIP still remained just below the surface.

The mean C: N: P atomic ratio of suspended matter is presented in Table 2. In these ratios, P was relatively higher and N was slightly lower than the Redfield ratio (C: N: P=106: 16: 1) during summer when microalgae prevail. Whereas, both N and P were lower than the Redfield ratio in winter. By combining these results with the results of inorganic nutrient analysis (MATSUDA *et al*, 1987b), it could be inferred that neither phosphorus nor nitrogen is considered to be a limiting factor to primary production. Solar radiation may primarily be controlling the above seasonal variation under ice in the study area as suggested by SULLIVAN *et al.* (1985).

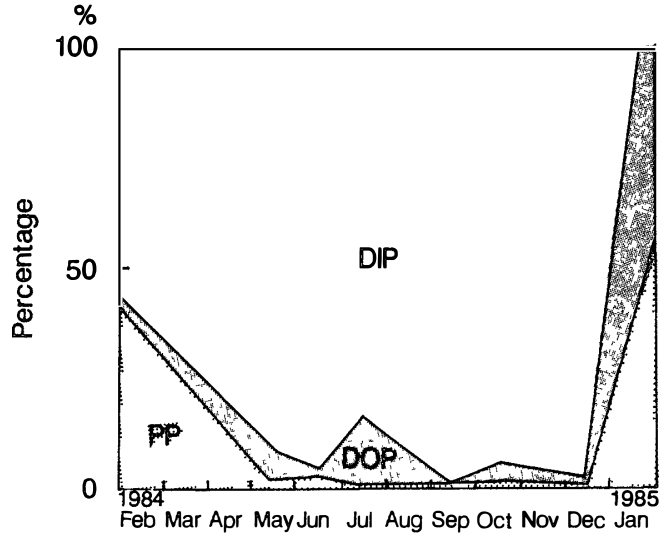

Fig. 2. Seasonal variation in the percentage composition of three forms of phosphorus in surface seawater under the Antarctic fast ice at Stn 3 DIP dissolved inorganic phosphorus DOP dissolved organic phosphorus PP particulate phosphorus

Table 2 C N·P atomic ratio of particulate matter in seawater observed under the Antarctic fast ice

Sample	Stn No.	Summer C : N : P	Winter C · N : P
Surface water*	1	106 · 13 4 4	106 6 5 . 0 7
	2	106 : 10 · 1 4	106 : 8 2 . 0 7
	3	106 · 3 0 . 0 7	106 · 6 1 . 0 5
Water column**	1	106 : 10 : 2 6	106 6 9 · 0 8
	2	106 · 10 . 1 2	106 6 5 : 0 9
	3	106 6 7 . 1 4	106 . 8 6 0 7

* Surface water indicates the water collected from water surface (0–0 5 m) in the observation ice hole using a 6-litre Van Dorn bottle

** The ratios in the water column indicate weighed means of C: N: P ratios from different depths (Stn 1· surface, 2, 5, 7, 11 m, Stns 2 and 3 surface, 2 5, 5, 10, 15, 25, 35 m)

References

BUNT, J. S and LEE, C C (1970) Seasonal primary production within and beneath Antarctic sea ice J. Mar Res , **28**, 304–320

FUKUCHI, M , TANIMURA, A and OHTSUKA, H (1985) Marine biological and oceanographical investigations in Lutzow-Holm Bay, Antarctica Antarctic Nutrient Cycles and Food Webs, ed by W R SIEGFRIEDS *et al* Berlin, Springer, 52–59

MATSUDA, O , ISHIKAWA, S and KAWAGUCHI, K (1987a) Seasonal variation of downward flux of particulate organic matter under the Antarctic fast ice Proc NIPR Symp Polar Biol , **1**, 23–34

MATSUDA, O., ISHIKAWA S and KAWAGUCHI, K (1987b)· Oceanographic and marine biological data based on the routine observation near Syowa Station between February 1984 and January 1985 (JARE-25) JARE Data Rep , **121** (Mar Biol , **10**), 21 p

SULLIVAN, C. W , PALMISANO, A C , KOTTMEIER, S , MCGRATHGROSSI, S and MOE, R (1985): The influence of light on growth and development of the sea-ice microbial community of McMurdo Sound Antarctic Nutrient Cycles and Food Webs, ed by W R. SIEGFRIED *et al* Berlin, Springer, 78–83

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