Proc. NIPR Symp. Polar Biol., 8, 48–50, 1995

EFFECT OF SALINITY AND SILICATE ON ICE ALGAL GROWTH IN SAROMA KO LAGOON, HOKKAIDO, JAPAN (EXTENDED ABSTRACT)

Satoru TAGUCHI[1], Ralph E. H. SMITH[2] and Kunio SHIRASAWA[3]

[1] *Hokkaido National Fisheries Research Institute, Kushiro 085*
[2] *Biology Department, University of Waterloo, Waterloo, Ontario, Canada, N2L 3G1*
[3] *Sea Ice Research Laboratory, Hokkaido University, Monbetsu 094*

Ice algae may go through a drastic change of environment when ice starts melting. This is particularly true in the vicinity of fresh water runoff (RUNGE and INGRAM, 1991). The melting ice produces low salinity and low nutrient water immediately underneath the ice since the ice does not contain much nutrients (COTA *et al.*, 1990). The life time of this low saline and nutrient limited layer may be a function of advection of sea water in the water column. When a stable condition lasts longer than one day, low salinity and nutrient deficiency are expected to affect the physiology of ice algae at the ice-water interface. Particularly, silicate deficiency may occur within 24 h (BADOUR, 1968; WERNER, 1970; TAGUCHI *et al.*, 1987) since other nutrients take longer to be effective than silicate. Silicate defficiency may subsequently play a significant role in competition between species (EGGE and AKSNES, 1992). In Saroma Ko lagoon, Hokkaido, Japan, runoff of fresh water but high silicate content is underlaid by low saline-nutrient lenses. Therefore, once the ice algae in Saroma Ko lagoon are released from the sea ice, they may enter the low saline-nutrient lenses, the low saline but nutrient rich water, and finally the nutrient rich intermediate water. Little is known about what kind of physiological change ice algal cells undergo during these phases.

The purpose of the present study is to test the hypothesis that less saline water reduces the growth of ice algae, the decrease being a function of the silicate enrichment. The present experiment is designed to predict the effect of less saline water in relation to silicate enrichment during the ice melting period in Saroma Ko lagoon.

The size distribution of ice algae at the beginning of the incubation was 52% $>10\,\mu$m, 39% 10–2 μm, and 9% 2–0.2 μm, respectively. Within two weeks the 2–0.2 μm fraction became least and less than 1%, while the $>10\,\mu$m fraction increased to more than 90% (Table 1).

Once ice algal cells were introduced to low salinity water (22 ppt), regardless of silicate concentration, chlorophyll *a* contents of ice algae were reduced sharply to 50% of the initial value within the first day, and then decreased gradually. The degree of decrease was a function of silicate concentration after the first day. Low concentrations of salinity and silicate reduced the chlorophyll *a* biomass and

Table 1. Size distribution of chlorophyll a *(%) with enrichment of zero, 18 μM, and 54 μM silicate during the experiment lasted for 16 days. >10, 10–2, and 2–0.2 indicate cells larger than 10 μm, cell smaller than 10 μm but larger than 2 μm, and cells smaller than 2 μm but larger than 0.2 μm, respectively.*

Date	Control			18 μM			54 μM		
	>10	10–2	2–0.2	>10	10–2	2–0.2	>10	10–2	2–0.2
0	52.2	39.1	8.7	52.2	39.1	8.7	52.2	39.1	8.7
1	56.7	36.9	6.5	56.3	37.1	6.6	56.3	36.4	7.3
6	93.0	6.5	0.45	91.3	6.6	2.1	92.0	7.1	0.90
12	90.2	8.4	1.40	96.1	3.5	0.36	91.3	8.4	0.30
16	84.7	11.9	3.32	96.9	2.22	0.85	95.3	4.31	0.37

Table 2. Photosynthetic activity, average concentration of chlorophyll a*, and photosynthetic rate with enrichment of zero, 18 μM, and 54 μM silicate on 6, 12, and 16th day.*

Date	Photosynthetic activity ($mgC\,m^{-3}d^{-1}$)	Average chlorophyll *a* ($mgCHL\,a\,m^{-3}$)	Photosynthetic Rate ($mgC\,[mgCHL\,a]^{-1}d^{-1}$)
Control			
6	<0.01	11.7	<0.0008
12	0	4.50	0
16	0	1.44	0
18 μM			
6	1.20	14.4	0.083
12	0.605	10.8	0.056
16	0.909	7.42	0.109
54 μM			
6	1.43	14.1	0.101
12	1.36	11.5	0.118
16	1.56	9.36	0.167

photosynthetic activity. High silicate concentration even in low salinity, however, enhanced photosynthetic rate ($mgC\,[mgCHL\,a]^{-1}d^{-1}$) (Table 2) and the relative abundance of the size group of >10 μm cells (Table 1).

The present result may suggest that ice algae cannot survive in the low salinity lens immediately below the ice when the ice starts melting due to osmotic damage if silicate is limited. However, ice algal cells may recover from the damage when they sink to the silicate rich underlaying water in Saroma Ko lagoon. The life of those less saline-silicate lenses may be controlled by advection of sea water in the water column (HUDIER *et al.*, 1994). Depression areas are quite often observed underneath the ice; they trap the less saline-silicate lenses. The nutrient depletion occurred in those less saline-silicate lenses may cause the ice algal cell to become sticky and form aggregates (SMETACEK, 1985). This process may be accelerated once the ice algae are released into a water column and become significant in the sedimentation of ice algal cells (RIEBESELL *et al.*, 1991). The ecological role of low salinity water could be that repacking of ice algal cells into large, rapidly sinking particles is mainly achieved without the cells passing through animal guts in Saroma Ko lagoon.

References

BADOUR, S. S. (1968): Experimental separation of cell division and silica shell formation in *Cyclotella cryptica*. Arch. Microbiol., **62**, 17–23.

COTA, G. F., ANNING, J. L. HARRIS, L. R. HARRISON, W. G. and SMITH, R. E. H. (1990): Impact of ice algae on inorganic nutrients in seawater and sea ice in Barrow Strait, NWT, Canada, during spring. Can. J. Fish. Aquat. Sci., **47**, 1402–1415.

EGGE, J. K. and AKSNES, D. L. (1992): Silicate as regulating nutrient in phytoplankton competition. Mar. Ecol. Prog. Ser., **83**, 281–289.

HUDIER, E. J.-J., INGRAM, R. G. and SHIRASAWA, K. (1994). Upward flushing; Effects of an upward flux of sea water through first year ice. Atmosphere-Ocean (in press).

RIEBESELL, U., SCHLOSS, L. and SMETACEK, V. (1991): Aggregation of algae released from melting sea ice: Implications for seeding and sedimentation. Polar Biol., **11**, 239–248.

RUNGE, J. A. and INGRAM, R. G. (1991): Under-ice feeding and diel migration by the planktonic copepods *Calanus glacilis* and *Pseudocalanus minutus* in relation to the ice algal production cycle in souteastern Hudson Bay, Canada. Mar. Biol., **108**, 217–225.

SMETACEK, V. S. (1985): Role of sinking in diatom life-history cycles: Ecological, evolutionary and geological significance. Mar. Biol., **84**, 239–251.

TAGUCHI, S., HIRATA, J. A. and LAWS, E. A. (1987): Silicate deficiency and lipid synthesis of marine diatoms. J. Phycol., **23**, 260–267.

WERNER, D. (1970): Productivity studies on diatom cultures. Helgolander Wiss. Meeresunters., **20**, 97–103.

(Received May 18, 1994; Revised manuscript received August 19, 1994)