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EFFECT OF NITROGEN ENRICHMENT UNDER DIFFERENT CONCENTRATIONS OF SILICATE ON THE RELATIVE GROWTH OF ICE ALGAE IN RESOLUTE PASSAGE, CANADIAN ARCTIC (EXTENDED ABSTRACT)

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Nitrogen nutrition of ice algae is still controversial although studies have been conducted in both the Antarctic (COTA *et al.*, 1990; PRISCU *et al.*, 1989, 1991), and the Arctic (HARRISON *et al.*, 1990) and subarctic (DEMERS *et al.*, 1989). In the present study photosynthate allocation was determined to study nitrogen nutrition of ice algae.

Enrichment experiments with ammonium, nitrate, and silicate were conducted to determine their effect on the end products of photosynthesis with ice alga collected from Resolute Passage, Canadian Arctic during the summer of 1992. End products of photosynthesis were determined by the method described by SMITH *et al.* (1987). It is conventional to refer to the four resulting fractions as follows: methanol−water=low molecular weight compounds (LMWC), chloroform−soluble=lipid, TCA−soluble=polysaccharide with nucleic acids, and TCA−insoluble=protein. The samples of lipid fraction were further analyzed for four lipid classes including triacyglycerols (TG), free fatty acids (FFA), acetone-mobile polar lipids (AMPL), and phospholipids (PL) by the method described by SMITH *et al.* (1993).

Excess ammonium (more than 50 μM) inhibited the protein production, which was the most dominant fraction of the end products in the ammonium enrichment experiment. No inhibition was detected with up to 200 μM of nitrate added. Enrichment experiments with ammonium and nitrate reveal the enhancement in photosynthate allocation to protein to be $48 \pm 5\%$ and $51 \pm 4\%$, respectively.

Silicate enriched to more than 5 μM enhanced the protein production to more than 45%, when 50 μM of ammonium was also added. However the protein production did not respond to the silicate enrichment when 50 μM of nitrate was added. The most dominant fraction was polysaccharide plus nucleic acids, which was more than 35% of total photosynthate, for the silicate enrichment experiment with nitrate. The lipid fraction was not much affected by either nitrogen or silicate in any of the experiments. Neutral lipid, however, decreased while membrane-associated lipids increased with silicate enrichment under ammonium-sufficient condition (Table 1).

The degree of enhancement in photosynthate allocation to protein can be

Table 1. Lipid class composition of ice algal communities as percent of total lipid. TG: triacylglycerols: FFA: free fatty acids; AMPL: acetone-mobile polar lipids; PL: phospholipids.

Treatment	Duration (h)	Silicate (μM)	TG	FFA	AMPL	PL
Nitrate	24	0	18	6.3	13	62
		2.5	30	3.9	14	53
		10	17	5.6	14	64
		50	27	3.9	14	55
Ammonium	24	0	29	6.6	15	49
		2 5	19	8.3	14	58
		10	14	4.8	15	67
		50	15	5.0	16	64

*Table 2. Mean and maximum % protein allocation and estimated relative growth rate of ice algal communities. *indicates a significant difference between silicate/nitrate and silicate/ammonium enrichment experiments at 0.01.*

Date	Treatment	% Protein allocation (%)	Maximum % protein allocation (%)	Relative growth rate (μ/μ_{MAX})
May 17	Nitrate	51±3.7	57	1.0
May 18	Ammonium	48±5.3	55	0.94
May 20	Silicate/nitrate	30±5.0*	36	0.43
May 20	Silicate/ammonium	40±8.1*	48	0.71

estimated by the relative growth rate, since algal protein synthesis is directly related to their growth. The high values mentioned above may suggest high relative growth rate of 0.94–1.0 μ/μ_{MAX} (DITULLIO and LAWS, 1986). Ice algae performed the maximum relative growth rate by responding to the nitrate or ammonium enrichment (Table 2).

The results from the ammonium and nitrate enrichment experiments may suggest the simultaneous enhancement of allocation to protein by ammonium and nitrate. When the combined effects of various nutrients are considered, during the ice algal population decline in the high Arctic, ammonium controls ice algal growth with silicate limitation (Table 2).

Ice algae in Resolute Passage, Canadian Arctic were likely limited by ammonium and silicate during the algal population decline period. This may be due to a systematic shift from predominantly nitrate metabolism during the early growth stage of ice algae to predominantly ammonium metabolism during the algal population decline as observed by HARRISON *et al.* (1990).

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