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4.5.13　2006 年 Lützow-Holm 湾周辺海域における植物プランクトンの成長速度と動物プランクトンの捕食速度

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Phytoplankton growth rate and microzooplankton grazing rate around the Lützow-Holm Bay in 2006

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Introduction

To know regulate of variations in phytoplankton biomass are the difference between their growth and loss processes which are due to grazing by zooplankton. Phytoplankton biomass and their productivity are a fundamental biological property in the surface of the marine ecosystem. Most all of the estimates of phytoplankton production have been obtained by the ^{14}C (or ^{13}C in Japan) tracer incubation technique (Steemann Nielsen, 1952), however it is necessary to know on heterotrophic grazing processes by microzooplankton as mortality rate of the phytoplankton community. The dilution approach protocol (Landry & Hassett 1982) is based on the experimental determination of phytoplankton growth rate in a dilution series. The dilution series is made up by combining the natural microbial community with seawater that has been filtered free of microbial components. The theoretical and practical considerations of this technique are fully described in Landry and Hassett (1982) and updated in Landry (1993). Essentially, phytoplankton growth is assumed to be density independent with specific growth rates that are constant for all dilution conditions.

Methods and preliminary results

All samples were collected in Niskin bottles that had been retrofitted with silicon o-rings and silicon tubes as closing mechanisms. The seawater sample collected surface and Chlorophyll maximum depth (CMD) that confirmed in vivo chlorophyll fluorescence form CTD cast at Sta. S3, S4, S5, S6, S7, and S8. The natural water sample has to be diluted with filtered water of the same origin to the following dilution steps: 0.25, 0.5, 0.75, and 1.00 (where 1.00 is undiluted). Dilution step is defined as the fraction of unfiltered water. Filtered water can be acquired by means of Whatman GF/F filters. Filtered water should first be poured into rinsed 500mL polycarbonate bottles, and then the remaining volume of unfiltered water is poured in a gentle manner. Macro nutrients was not added to each bottle in this time because Antarctic Ocean is generally enough nutrients concentration as maintaining a constant maximal phytoplankton growth rate during the incubation. For each dilution step at least two incubation bottles were taken as replicates for Sta. S3, S4, S5, and S7 (however, Sta. S6 and S8 were singular). The initial Chl a concentration N_0 as replicates were measured for four dilution steps. A 500 ml water sample was filtered with a Whatman GF/F filter (25-mm-diameter) with <100 mmHg of vacuum pressure. Chlorophyll a was extracted from the filter in 6 ml of N,N-dimethylformamide in the dark at -20°C (Suzuki and Ishimaru, 1990). The Chl a concentration was determined fluorometrically using a Turner Design Model 10R fluorometer (Parsons et al., 1984), which had been calibrated with pure Chl a (Sigma Chemical Co.). The incubation had last a complete light–dark (24 h) period and then measured Chl a concentration as N_{24}. After analysis of the samples, the growth rate and grazing rate were calculated using the model proposed by Landry & Hassett (1982): $N_t=N_0\, e^{(k-g)t}$, where N_t is the Chl a abundance at time t_{24}, N_0 the Chl a abundance at time t_0, k the prey growth rate, and g the grazing rate. In practice, the grazing rate g is equivalent to the negative slope of the linear regression between the apparent growth rate of heterotrophic prey calculated for each dilution using the generalized exponential growth model and the proportion of seawater in the various dilutions.

The regression lines at each station were showed in Figure 1. Initial conditions and results of dilution experiments are summarized in Table 1. The estimation of phytoplankton growth rate and using dilution theory gave almost similar values at all dilutions, that supports growth rates of phytoplankton are density-independent. However, it needs to determine some statistical analysis to clear significant difference of each sample.

Table 1 Summary of observations

Station	GMT		Lat. (S)		Long. (E)		Surface temp (oC)	Chl a concentration in Surface(ug/l)	surface growth rate (d-1)	surface grazing mortality (d-1)	Chlorophyll Maximum Depth (m)	CMD temp (oC)	Chl a concentration in CMD (ug/l)	CMD growth rate (d-1)	CMD grazing mortality (d-1)
S3	2006/1/20	6:58	64	33.5835	60	13.9793	0.03	0.14	–	–	100	−0.68	0.20	0.00	0.22
S4	2006/1/20	19:05	63	31.7115	66	0.8643	0.52	0.90	–	–	27	0.43	1.14	0.19	0.20
S5	2006/1/21	6:03	62	29.6651	70	49.7684	0.77	0.57	0.09	0.01	37	0.59	0.44	0.11	0.11
S6	2006/1/21	18:30	61	0.9608	75	57.5089	0.98	0.20	0.23	0.15	50	−0.18	0.24	–	0.01
S7	2006/1/22	5:27	59	54.0036	79	36.1668	1.50	0.45	–	–	30	1.41	0.26	–	–
S8	2006/1/22	17:59	58	22.8197	84	19.8619	1.77	0.53	0.08	–	43	−0.19	0.81	–	0.06

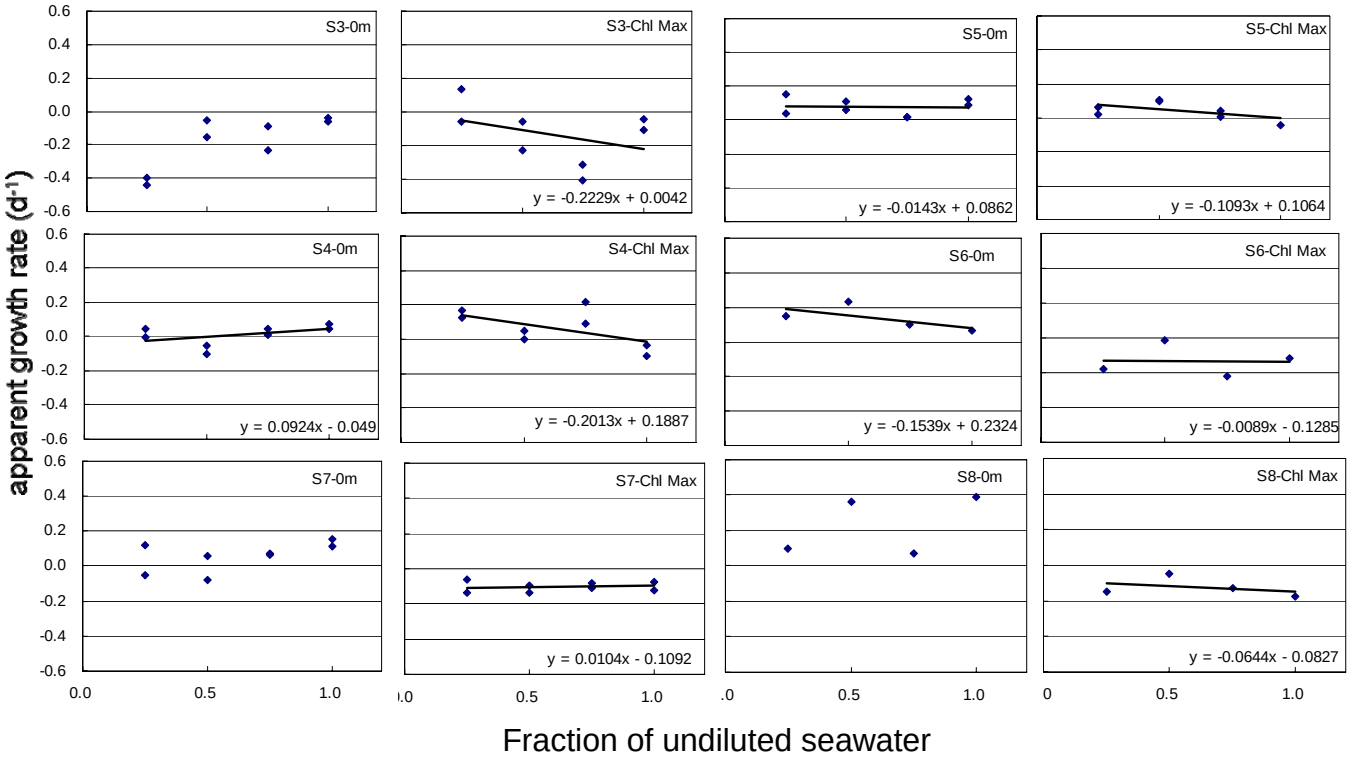

Figure 1 The relationship between apparent growth rate (d^{-1}) phytoplankton and degree of dilution of natural seawater with filtered seawater at each station.