Project #: B55

Title: Summer Microzooplankton in the Bering Sea

Principal Investigator(s) and Recipient Organization(s):

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Contract Period and Amount of Funding:

1 October 2007-September 30, 2009 (first installment); $197,307 (first installment)

Report Period: April 1-September 30, 2008

Report Date: September 30, 2008

Lead Author of Report: Diane K. Stoecker

Proposed timeline and milestones within report period:

-Preparation (ordering supplies, shipping equipment and supplies) during spring 2008 for summer 2008 cruise.
-Participation in research cruise (Healy 0803, July 3-31 2008), sampling of microzooplankton (MZ) and conduction of 2-point dilution grazing experiments in order to determine MZ grazing coefficients (g, d^{-1}) and to estimate fraction of phytoplankton production grazed by MZ (g:μ). Specifically, dilution grazing experiments were to be conducted at ~ 15 "process" stations with water collected from the depth corresponding to 50% surface irradiance (50% I_0). Additional samples for MZ (but not for grazing experiments) were to be collected from the middle of the mixed layer if it was above the 50% I_0 depth and, if it is present, a sample collected from the depth of the chlorophyll fluorescence maximum.
-Ship MZ samples from cruise to HPL, UMCES for analysis.
-Continue data analysis from dilution experiments and begin microscopic analysis of MZ samples from cruise.
-Prepare semi-annual progress report.

Project Summary:

This project addresses the BSIERP hypothesis that "Climate-induced changes in physical forcing will modify the availability and partitioning of food for all trophic levels through bottom-up processes". MZ are responsible for most of the grazing on phytoplankton in the sea and are an important link in the food chain between phytoplankton and zooplankton, which are food for zooplanktivorous fish which support top predators. The project contributes to the goals of BSIERP by providing summer data on standing stocks of MZ and their grazing activities. A key goal is to determine how the MZ link in Bering Sea food webs is influenced by climate-induced changes in physical forcing.

Progress Summary:

We met the timeline and milestones within the report period. Specifically, we participated in the summer cruise and conducted 21 dilution grazing experiments. We examined microplankton samples onboard to characterize phytoplankton and microzooplankton assemblages and to determine which cell types had chlorophyll (were photosynthetic) and which lacked chlorophyll and thus were strictly heterotrophic. We collected samples for determination of MZ abundance and biomass and shipped them from Dutch Harbor Alaska to UMCES, HPL for analyses.

We have calculated net phytoplankton growth (NGR), intrinsic phytoplankton growth rate (μ) and the mortality rate of phytoplankton due to MZ grazing (g) in treatments with and without added nutrients as well as estimated the fraction of phytoplankton growth grazed per day (g/μ). We are in the process of further analyzing these data to elucidate the relationship of these parameters to total and size fractionated chlorophyll (an indicator of phytoplankton biomass), physical and chemical parameters, water column structure, phytoplankton/MZ community type and spatial variability/domain.

During August, the faculty research assistant, Ms. Kristen Blattner, was trained to identify and enumerate MZ in the preserved samples from the cruise. To date, MZ have been enumerated and sized in 1 replicate MZ sample from 20 of the 21 dilution experiments.

Lessons learned and project adjustments:

We proposed to employ 2-point dilution grazing experiments, with a whole seawater (WSW) and a diluted, 5% WSW and 95% filtered seawater treatment. In the first three experiments of the cruise we did this, but it was difficult to get good chlorophyll measurements for the 5% WSW treatment because of the low phytoplankton abundance. In subsequent experiments we used a 20% WSW treatment, which gave better results.

We proposed to estimate growth and grazing on total chlorophyll, the <20 μm chlorophyll fraction (pico- and nanophytoplankton) and the > 20 μm chlorophyll fraction (microphytoplankton). However, in most of our experiments, the microphytoplankton was so scarce that we could not obtain good estimates of growth and grazing on this fraction. In some dilution experiments in which the water contained *Phaeocystis* colonies, we probably underestimated the chlorophyll in the >20 μm size fraction by prescreening our water samples through a 202 μm mesh net to remove larger zooplankton. However, this prescreening is necessary to obtain MZ grazing rates.

We proposed approximately 15 experiments at "process" stations but were able to conduct 21 experiments.

We proposed dilution experiments without and with added nutrients (N to P) to prevent nutrient limitation of phytoplankton growth due to lowered nutrient regeneration by grazers in the diluted treatment and underestimation of MZ grazing. Growth rate of phytoplankton is expected to increase with nutrient addition. However in our first five experiments we observed that nutrient addition often had no effect or was inhibitory to phytoplankton growth. Sometimes MZ grazing was also inhibited. Based on *in situ* nutrient levels, we reasoned that N rather than P should be limiting and that perhaps the added P was making iron or another trace metal unavailable. So, in subsequent experiments we only added N. However, in some experiments, we still observed inhibition rather than stimulation. To elucidate this, we collaborated with Dr. J Goes who measured the ratio of variable fluorescence to maximum fluorescence (this ratio is an indicator of phytoplankton physiological state). Preliminary examination of the data indicate that at some stations the phytoplankton were in very poor physiological state, which may explain their lack of growth in response to nutrient addition. These data need to be further examined because they may provide insight into how stratification and nutrient limitation during summer can affect both primary

production and the MZ link in summer Bering Sea planktonic food webs. Because nutrient addition sometimes had a negative affect on phytoplankton growth (μ) and MZ grazing (g) in our experiments, we will report the rates from the treatments without nutrient addition. We are considering leaving the nutrient addition treatments out of our dilution experiments next year.

At about half the process stations sampled during the 2008 summer cruise in July, there was a chlorophyll maximum layer around the pycnocline, which was well below the depth corresponding to 50% surface irradiance, the depth we sampled for the dilution grazing experiments. In late summer, this layer may be an important site of elevated MZ abundance and biomass, and therefore for trophic transfer to larger zooplankton. We are considering adding dilution experiments with water from the chlorophyll maximum layer next year. However, this presents problems, since both temperature and irradiance at depth would be low and variable compared to mixed layer samples. We are thinking about possible ways to standardize incubation regimes for these samples. However, if the summer cruise in 2009 is earlier than it was in 2008, then the chlorophyll maximum layer may be relatively less developed and important than it was on the 2008 summer cruise.

We had trouble with the hoses on our on-deck incubators kinking and will buy better quality hoses for next year's cruise.

Integration activity: Diane Stoecker is attending the Bering Sea Ecosystem Partnership principal investigator meeting on October 14-16, 2008. We plan to deliver the grazing rate data from our July 2008 cruise to the BSIERP data manager in late October after discussing formats at the October PI meeting.

Education and Outreach: Diane Stoecker and Kristen Blattner participated in outreach during the summer cruise by preparing presentations and talking with oceanography summer camp students, teachers and citizens of St. Georges Island. Diane Stoecker collaborated with Thomas Van Pelt to produce a blog for the BSIERP website on microzooplankton in Bering Sea food webs. Diane Stoecker participated in an outreach webinar during the summer cruise. Diane Stoecker will use material from the cruise in teaching a graduate course in Biological Oceanography at University of Maryland. Diane Stoecker has digital micrographs of Bering Sea plankton (obtained in collaboration with John Casey) and digital photographs of research activities from the cruise which were made available to other researchers on the cruise and which are available to the BSIERP program.

Next year's Work plan: On a separate page, we have appended our workplan for the coming year.

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2009 Tasks, Assignments, Timeline

What	*Who*	*Start (2009)*	*Other key dates*
Prepare for Summer 2009 cruise, order supplies and ship to Seattle	**Blattner**	March-May	
Analyze 2008 MZ samples and data analyses	**Stoecker, Blattner**	January-May	
Prepare spreadsheets on MZ abundance and biomass from 2008 cruise for data manager ; write a paper?	**Stoecker, Blattner**	January-June	
BEST/BSIERP 2009 summer cruise; ship MZ samples to HPL, UMCES	**Stoecker, Blattner**	June-July	July 15-July 19
Analyze data from 2009 dilution experiments; submit data to data manager	**Stoecker, Blattner**	July-October	
Attend annual PI meeting	**Stoecker**	Fall? Winter?	
Analyze MZ samples from 2009 summer cruise	**Blattner**	July-December	