BEST-BSIERP Bering Sea PROJECT
UNDERSTANDING ECOSYSTEM PROCESSES IN THE BERING SEA 2007–2013

Summer Microzooplankton in the Bering Sea THEIR SURPRISING ROLE

In spring, large diatom blooms occur in the Bering Sea that supply food for large zooplankton that in turn are food for many small fish, seabirds and whales. In summer, the big diatoms blooms are gone from the surface waters and most of the phytoplankton are too small for zooplankton to eat. What do zooplankton eat in summer in the Bering Sea? We thought that part of the answer might be microzooplankton, which are microscopic, one-celled organisms that eat small phytoplankton. The microzooplankton, although tiny by our standards, are big enough to be captured and ingested by large zooplankton. In fact, many large zooplankton prefer to eat microzooplankton over phytoplankton. Microzooplankton can be an important link between phytoplankton production and higher trophic levels, especially when phytoplankton are scarce or small in size. Our goal was to determine if microzooplankton are important as a potential food source for large zooplankton in summer.

How We Did It

We went on month-long cruises in summers of 2008, 2009 and 2010 on which we collected water from different depths with Niskin bottles on a a conductivity, temperature, and depth recorder (CTD) rosette (Figure 1). We used the water to

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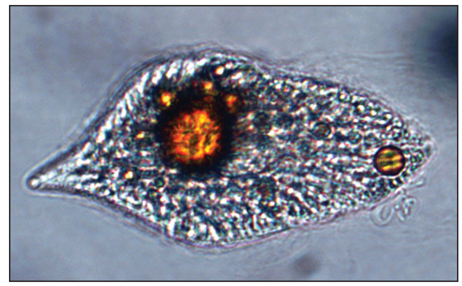
Fig. 1

Diane Stoecker

Kristen Blattner removes water from a Niskin bottle on the CTD rosette to determine the quantity of microzooplankton.



Diane Stoecker

Microzooplankton include heterotrophic dinoflagellates, such as this Gyrodinium *with ingested prey.*

The Big Picture

We addressed a gap in knowledge of planktonic food webs in the Bering Sea by examining the role of microzooplankton in summer. We found that microzooplankton were very abundant, particularly in shelf waters, and were a major food source available to larger zooplankton. By examining differences in the role of microzooplankton in regions with different physical forcing (i.e., stratification, mixing, and other oceanographic features) and comparing the role of microzooplankton among years, our study specifically addressed the Bering Sea Project hypothesis that "climate-induced changes in physical forcing will modify the availability and partitioning of food for all trophic levels through bottom-up processes." We found that there are important regional differences in the Eastern Bering Sea, with differences in physical forcing affecting the role of microzooplankton. Comparison of our data from three "cold" years to previously collected data from "warm" years show that microzooplankton are an important component of planktonic food webs in the Eastern Bering Sea in both "warm" and "cold" years.

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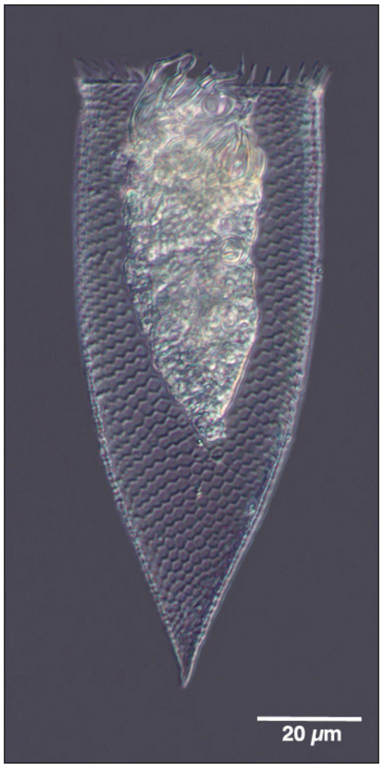
Fig. 2



Microzooplankton include planktonic ciliates, such as this tintinnid from the Bering Sea.

conduct grazing experiments at sea to estimate the amount of phytoplankton eaten by microzooplankton. We did this by incubating the water in flowing seawater incubators on-deck and measuring changes in chlorophyll *a* (green plant pigment that is a proxy for phytoplankton biomass) in bottles with different concentrations of microzooplankton. Some of the water we preserved and brought back to our laboratory at the University of Maryland Center for Environmental Science, so that we could examine it under a microscope. We used our microscopic observations to identify, count, and estimate the biomass of microzooplankton.

Why We Did It

We set out to determine the abundance and biomass of microzooplankton, and to compare their biomass to phytoplankton biomass so that we would know how important they were relative to phytoplankton as a potential food source for zooplankton. We also wanted to determine how much of the phytoplankton production was eaten by microzooplankton. Although phytoplankton stocks are low in summer, there are "hotspots" along the shelf edge and near the Pribilof Islands where there are more phytoplankton than on most of the shelf. We wanted to determine if the importance of microzooplankton was greater in areas with lower phytoplankton stocks than in areas with higher phytoplankton stocks.

We observed that in summer the presence of microzooplankton was very important in surface waters over much of the Bering Sea Shelf because they dominated the size class of plankton that is the right size food for large zooplankton. On the middle and inner shelf, where phytoplankton are scarce in summer, microzooplankton biomass was higher than phytoplankton biomass! This was a bit puzzling, because in food webs, there is usually a higher biomass of "grass" than "cows." Part of the answer to this puzzle is that many of the microzooplankton were large, green ciliates (Figure 2) that are grazers on small phytoplankton but are photosynthetic and can also produce their own food. We found that in surface waters on the middle shelf, ciliates sometimes contributed over 50% of the chlorophyll!

Microzooplankton were also important as grazers on phytoplankton; they consumed almost all of the daily phytoplankton production on the middle and inner shelf. Although phytoplankton were generally low in abundance in surface waters on the shelf, on the northern shelf there were high concentrations of phytoplankton at depth. These deep concentrations of phytoplankton were probably remains of the spring bloom that had sunk out of the surface waters. Microzooplankton are an important component in these deep, cold layers of plankton that may serve as "refrigerators full of food" for zooplankton in summer, forming an important link in food webs that support higher trophic levels in summer on the Eastern Bering Sea Shelf.

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A thecate heterotrophic dinoflagellate, also a member of the microzooplankton.