Phytoplankton Collected by a Time-Series Sediment Trap Deployed in the Southeast Bering Sea during 1997

Stacy Smith and Susan Henrichs
University of Alaska Fairbanks
Alaska, U.S.A.
e-mail: sstacy33@ims.uaf.edu

Introduction

The Bering Sea shelf, over 500 km wide, is separated into three distinct biological regimes (inner, middle and outer shelf areas) by density fronts. Its middle shelf (located between the 50- and 100-m isobaths) averages 30–50 g C m^{-2} $year^{-1}$ in new production, derived mainly from the annual spring bloom in April and May. Two unusual events occurred over the middle shelf in 1997: The first was an intense though short-lived midsummer bloom of mainly small diatoms; the second was the first-ever-recorded coccolithophorid bloom. Anomalous sea surface temperatures - possibly due to El Niño and a relatively storm-free summer – could be the cause of these events.

Methods

We deployed a time-series sediment trap at 35 m depth from April 1997 through February 1998. The deployment site was Mooring 2 (Figure 1) on the southeast Bering Sea middle shelf region where the bottom depth was 70 m. The trap was outfitted with a rotating carousel containing 12 sample tubes for sub-sampling. Trap sub-sample intervals lasted either one or two weeks. The number of phytoplankton in each sample was counted (Figure 2). The $\delta^{15}N$ and $\delta^{13}C$ of each sub-sample were measured. Also, a scanning electron microscope was used to identify the coccolithophorid, *Emiliania huxleyi* (Figure 2).

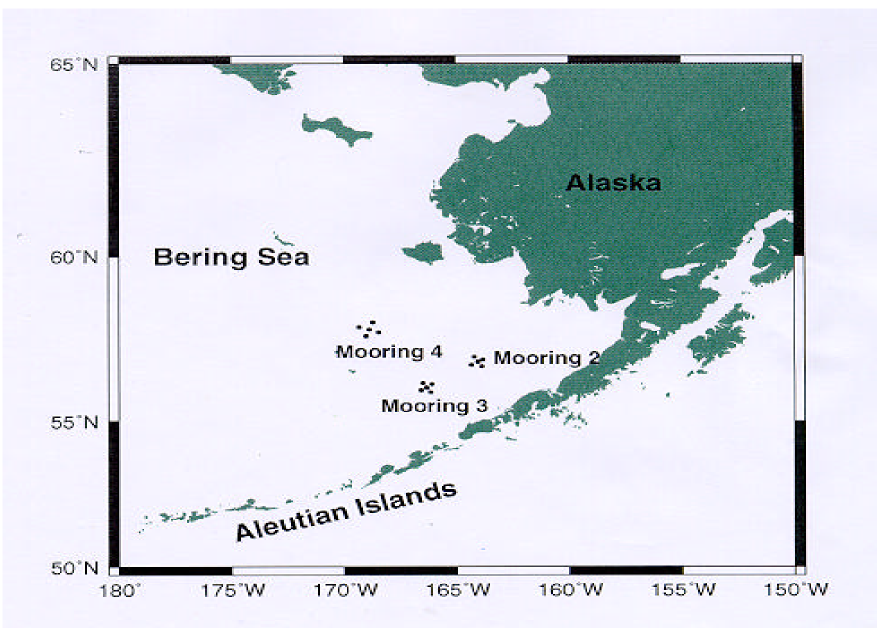
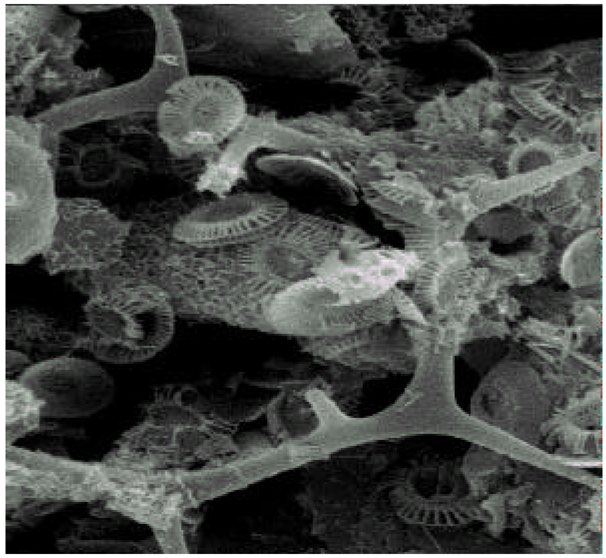


Figure 1. *Location of mooring site 2 in the southeast Bering Sea.*

(a)



(b)

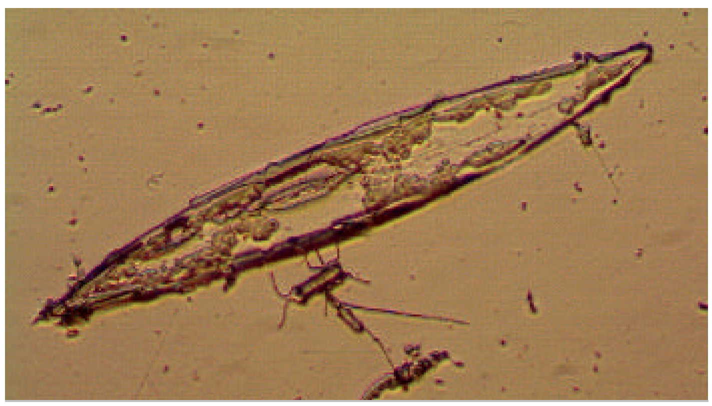


Figure 2. *Phytoplankton derived from the spring, summer and fall blooms over the Bering Sea middle shelf included diatoms, flagellates and coccolithophores. (a) A silicoflagellate is surrounded by scores of 2-mm Emiliania huxleyi coccoliths. (b) A 400-mm diatom Pleurosigma simonsenii overshadows a Chaetoceros spp.*

A high relative number of diatoms in the sediment trap sub-samples (Figure 3) corresponds to phytoplankton blooms over the middle shelf. The late April to mid-May sub-samples represent the end of the spring bloom, comprised mainly of large diatoms (50–600 μm) such as *Coscinodiscus spp.* and *Pleurosigma simonsenii*. Our sediment trap recorded an unusual mid-July bloom, which consisted of a greater number of small diatoms (20–50 μm) such as *Odontella aurita*.

In Figure 3 the $\delta^{15}N$ of each sample reflects bloom dynamics. The initial $\delta^{15}N$ value of 12.2‰ represents plankton utilizing relatively more new NO_3^-. As the nutrient is depleted, the $\delta^{15}N$ of the sub-samples increases, eventually to a maximum of 15.5‰ at nitrate depletion. Over the next two months, fixed nitrogen is returned to the euphotic zone through microbial breakdown of particulate organic matter and wind mixing of the water column. As the midsummer bloom resumes, nutrients are quickly depleted and the $\delta^{15}N$ increases until algae growth slows.

The 9/22–10/13 sub-samples contain the coccolithophorid bloom. Although the bloom was observed over the middle shelf in July (Napp et al., 1998), the trap did not collect numerous coccoliths until autumn. The isotopic signal during these intervals changes less dramatically. The plankton are most likely using more new nitrogen supplied to the euphotic zone, as mixing due to wind events increases in autumn.

In Figure 4 the $\delta^{13}C$ tracks phytoplankton growth rates. As diatoms grow faster they discriminate less between the heavy isotope, ^{13}C, and the lighter one they prefer during CO_2 uptake. The $\delta^{13}C$ increases as diatom biomass increases in the sub-samples and decreases as the number of diatoms decreases.

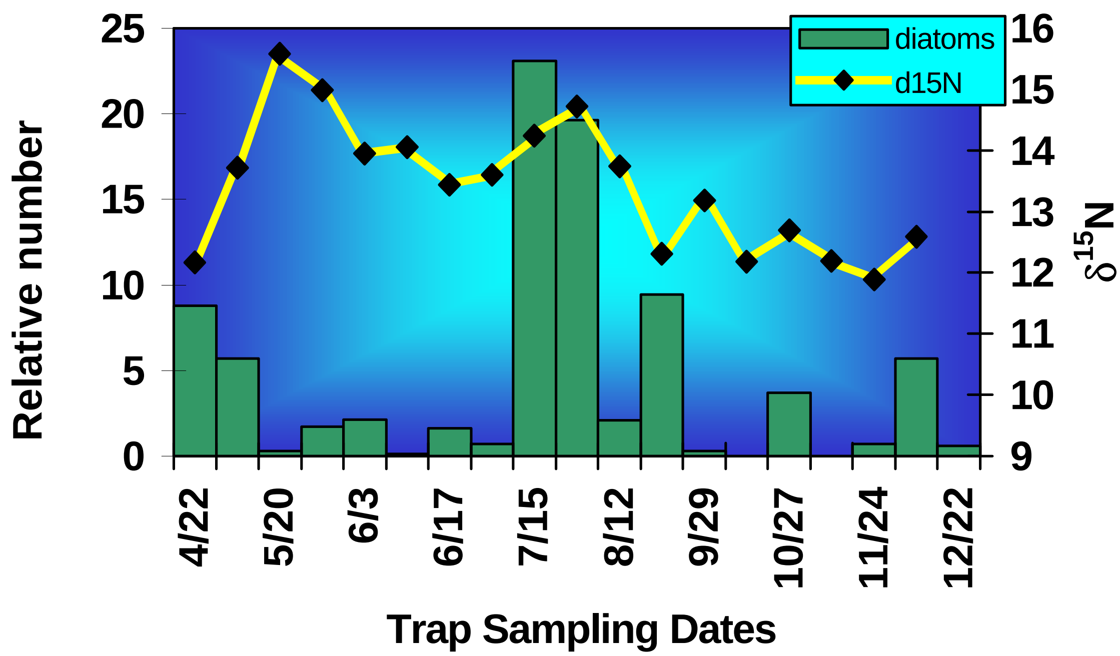


Figure 3. *Temporal change in diatom numbers and d^{15}N of sediment trap samples.*

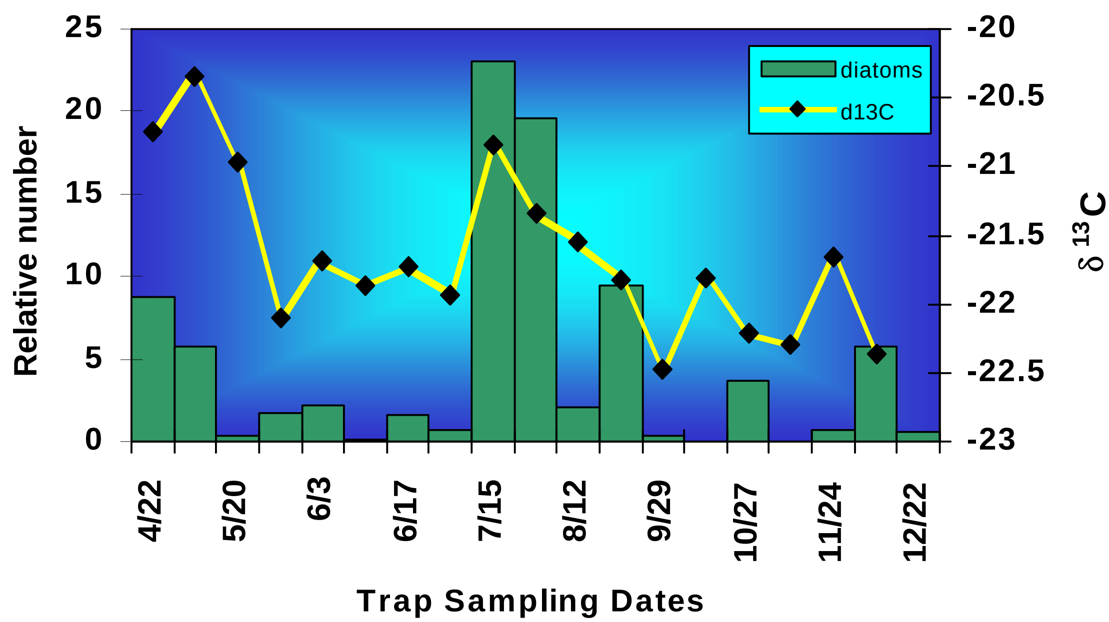


Figure 4. *Temporal change in diatom numbers and d^{13}C of sediment trap samples.*

Conclusions

During 1997, the composition of material collected by the sediment trap over the middle shelf primarily reflected events affecting primary producers. These included spring and summer diatom blooms and the late autumn sinking of the coccolithophorid bloom. The stable C and N isotopic composition of trapped organic matter also apparently reflected phytoplankton growth rates. Heavier $\delta^{15}N$ and $\delta^{13}C$ were associated with nutrient depletion.

References

Napp, J.M., Baier, C.T., Brodeur, R.T., Cullen, J.J., Davis, R.F., Becker, M.B., Goering, J.J., Mills, C.E., Schumacher, J.D., Smith, S.L., Stabeno, P.J., Vance, T.C. and Whitledge, T.E. 1998. The 1997 eastern Bering Sea shelf-wide coccolithophorid bloom: Ecosystem observations and hypothesis. AGU/ASLO Ocean Sciences Meeting,