Mixotrophic Protists in the Arctic - Alternative Nutritional Strategies

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What were the primary questions you were trying to address with this research? (Or, if more appropriate, was there a hypothesis or theory that you were trying to prove or disprove?)

Protists are traditionally described as either phototrophic (function as plants) or heterotrophic (function as predators or grazers), and this defines how they contribute to the generation and use of nutrients and carbon within the microbial food web. Of course, nature is not so black and white, and there are actually groups of phototrophic protists (algae) that can successfully do both, and they are called mixotrophs. Mixotrophy is rare in the macroscopic terrestrial environment, but in the microbial marine environment, and particularly the extreme cold, research indicates that mixotrophy is a successful strategy. This has led us to propose that mixotrophy is an alternative dietary strategy of potential importance in polar marine environments, facilitating survival in long periods of darkness. In this project, we focused on determining whether, and to what extent, mixotrophic protists are present in the Arctic marine environment. Despite numerous studies on microbial communities in Arctic marine environments, none have addressed the issue of mixotrophy.

What have you discovered or learned that you didn't know before you started this work?

The abundance of mixotrophic nanoplankton during the Arctic autumn ranged from 2 to 300 mL^{-1} and comprised the same relative abundances as observed in the Antarctic austral summer when comparisons of total heterotrophic (Arctic 1-22%; Antarctic 2-32%) and total phototrophic (Arctic 2-32%; Antarctic 5-10%) were made. Overall, the mixotrophic community ingested 2X as many bacteria-sized particles as the heterotrophs, indicating that they had an equivalent or greater grazing impact on bacteria as that of the more traditional (heterotrophic) consumer population (Figure 2).

A major difference in our studies of mixotrophs in the Arctic and Southern Oceans was the abundance and impact of the picophytoplankton. We have not observed mixotrophic picophytoplankton in Antarctica.

What is the significance of your findings for others working in this field of inquiry and for the broader scientific community?

The microbial food web is extremely important in the polar regions, and changes to it will have impacts at all the higher trophic levels. This is already being observed in the Bering Sea fisheries. Also, Micromonas-like picoprasinphytes are known to persist through winter darkness in the Arctic and grow exponentially from late winter to early spring. Phagotrophy may contribute importantly to survival during winter darkness and give the organisms a relatively large seed population at the beginning of the spring growth period. This could become especially

important if these picophytoplankton become more abundant in these waters as global climate change freshens the Arctic Ocean.

What were the most unusual or unexpected results and opportunities in this investigation?

The data indicate that a Micromonas-like picoprasinophyte was an important consumer of bacteria in the Arctic during autumn. The large contribution of these minute phytoplankton to overall community bacterivory in the Arctic was previously unknown. We found that only a small proportion of the picoeukaryotes were mixotrophic, but their high abundance frequently made them the major bacterial consumers (Figure 2).

What were the greatest challenges and difficulties?

Shipping hazmat chemicals to Barrow, AK. After several failed attempts, we borrowed these materials from researchers at Barrow and used leftover supplies on the ship.

When and where was this investigation conducted? (For instance, did you conduct new field research, or was this a new analysis of existing data?)

Sampling was conducted at locations within the Beaufort Sea and the Canada Basin of the Arctic Ocean on a cruise of opportunity aboard the icebreaker USCGC Healy in September 2008 (Figure 1).

Is this research part of a larger project or program?

This research has contributed to a larger polar comparison of mixotrophy.

What are your next steps?

We continue to examine mixotrophy in Antarctic protists, through culture work and field studies. We would like to accomplish additional field-work in the Arctic, along with applying our mixotroph species specific molecular assays to field samples, and will pursue funding support through NSF.

Have you published findings or web pages related to this research? Please provide a citation, reprint, and web link (when available).

A manuscript describing the results has been submitted to FEMS Microbiology Ecology, and is under review.

Please provide photographs, illustrations, tables/charts, and web links that can help illustrate your research.

Figure 1. Location of sampling sites within the Beaufort Sea and Canada Basin. North pole is at the upper right corner of the chart.

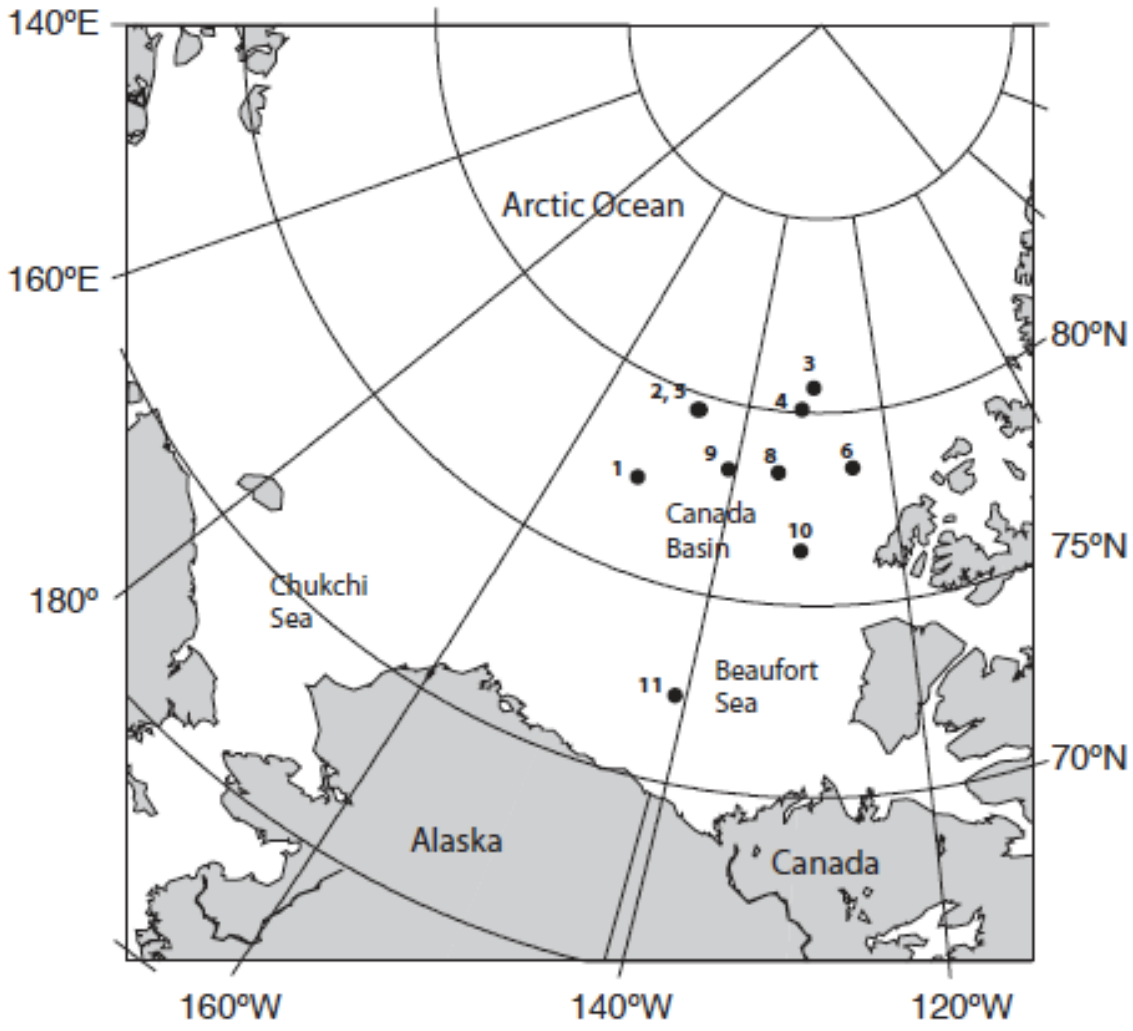

Figure 2. Relative impact of mixotrophic nanoflagellates (MNAN), mixotrophic picoeukaryotes (Mpeuk) and heterotrophic nanoflagellates (HNAN) as grazers of bacterioplankton.