Trophic role of Protozooplankton in northern marine ecosystems

Protozooplankton are the major grazers on phytoplankton in the global ocean, but many questions related to their trophic role remain unanswered in particular for northern marine ecosystems. In the present thesis, protozooplankton communities were evaluated with special emphasis on factors, such as elevated temperature, water column stratification, pH and copepod predation, regulating their biomass, growth- and grazing rates. In addition, it was investigated what role protozooplankton have for the phytoplankton bloom dynamics at present and in a predicted warmer future. The studies were done through a combination of field observations and experiments conducted at four localities within the sub-Arctic and Arctic waters. The Ph.D. thesis is based on 6 scientific papers (Paper I-VI) dispersed on these four localities:

1) In the high Arctic North East Water Polynya, heterotrophic dinoflagellates and ciliates doubled their growth rates when the temperature was increased from -1.7 to 5 °C. Despite this, most protozooplankton were found in association with the highest phytoplankton concentration: i.e. in the marginal ice zones where the temperature was below the freezing point (Paper I).

2) In waters between Iceland and Norway, succession and population dynamics of autotrophic and heterotrophic microbes including protozooplankton were followed prior to the spring bloom in relation to deep ocean convection. A decrease in abundance of small sized phytoplankton relative to larger diatoms was explained by a strong top-down control by protozooplankton. The data further suggests that deep ocean convection control the protozooplankton community prior to the bloom, which may induce or accelerate the onset of the phytoplankton spring bloom (Paper II & III).

3) In the Arctic Disko Bay, pH was documented to increase from 7.5 to 8.5 due to CO2 uptake from phytoplankton as the bloom developed. Microcosm experiments demonstrated that most protists were unaffected by the seasonal changes in pH, even during the massive phytoplankton spring bloom (Paper IV).

4) In a sub-Arctic fjord, field data indicated that the protozooplankton succession was regulated by copepod grazing during most of the productive season and that the protozooplankton provide an essential food source for the copepod populations. In addition the protozooplankton >20 µm were significantly herbivores on the small sized phytoplankton grazing. The importance of protozooplankton as grazers increased over a transect going from open-ocean to the inner part of the fjord (Paper V & VI).

In conclusion, protozooplankton contributed significantly to the area-specific biomass at all investigated sub-Arctic and Arctic localities with a tendency towards high protozooplankton concentrations in the upper water column of stratified waters. Future climate changes are expected to increase water column stratification which will lead to reduced phytoplankton size and increase the importance of protozooplankton as grazers that are especially suited for consuming small cells. This will shift the relative importance of larger metazoan grazers (e.g. copepods) towards protozooplankton.

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