

Interactive comment on “Synergistic effects of iron and temperature on Antarctic plankton assemblages” by J. M. Rose et al.

J. M. Rose et al.

dahutch@usc.edu

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The paper by Rose et al. addresses an important and timely scientific question - synergistic effects of Fe and temperature on Antarctic phytoplankton and microzooplankton assemblages. The title is somewhat misleading in that only <200 micron plankton are included; mesozooplankton are not included. Top-down effects of mesozooplankton grazing/predation on the <200 micron fraction could alter the magnitude of effects of both Fe and temperature in the plankton community.

We agree with the reviewer regarding the potential importance of the mesozooplankton assemblage in structuring the greater plankton community and have changed the title of the manuscript to make it clear that we just looked at the phytoplankton and microzooplankton fractions.

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The paper does present an interesting and potentially important phenomenon that deserves further exploration and documentation. The data set is probably unique and is rich in that it contains in addition to data on phytoplankton abundance and composition, measurements of photosynthetic parameters, indicators of phytoplankton physiological state (Fv/Fm) and changes in the stoichiometry of particulate matter. The significantly lower abundance of microzooplankton in the high Fe and high Fe and high temperature treatments relative to the control and high temperature treatments is striking and unexpected. It would be interesting to see more detailed data on how the microzooplankton communities differed in the treatments. An MDS plot of relative similarities among microzooplankton assemblages is given which indicates that the final microzooplankton assemblages in both treatments with high Fe were fairly similar but quite different from the initial assemblages or the other treatments. However it would help to know how they were different. Did they differ in cell size, feeding type etc? Was the biomass of microzooplankton different?

Unfortunately, we do not have detailed size information on the microzooplankton assemblages and are thus not able to calculate biomass. We did divide the microzooplankton roughly into two size classes while counting (<100 μm and >100 μm), and in general, large microzooplankton declined in all treatments between the initial and final days of the experiment. We used the BEST procedure within PRIMER to identify the microzooplankton taxa that contributed to the patterns observed in the MDS plot. The BEST procedure singled out 6 of the 15 total taxa as being important drivers of the community composition trends. We have added a table detailing the initial and final abundances of all 15 taxa quantified and have highlighted the 6 taxa of importance in bold font (see new Table 2).

The experimental design was clearly presented and methods appropriate and adequately described. Appropriate statistical analyses were employed. In general the interpretations and conclusions are appropriate and supported by the data. However, the conclusion that the negative impact on microzooplankton abundance was “most

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likely a secondary response to changes in phytoplankton community composition" appears hasty. There are data that trace element ion activities and ratios can directly affect the growth of heterotrophic protists from physiological experiments with temperate zone cultures. Some studies suggest that heterotrophic and mixotrophic protists require 2 or 3X more iron than autotrophic protists (cited in Twining et al. 2008, J.

Eukaryot. Microbiol. 55). Thus it seems possible that high Fe could favor larger microzooplankton.

We agree with the reviewer that high Fe could favor large microzooplankton, however, this did not appear to be the case in our experiment. As described above, while we do not have detailed size information for the microzooplankton enumerated, we did record two size classes, $>100\ \mu\text{m}$ and $<100\ \mu\text{m}$. The total microzooplankton in the $>100\ \mu\text{m}$ size fraction actually declined in all treatments between the initial and final days of the experiment.

Unlike the results of Twining et al., in which heterotrophic protists disproportionately benefited from the iron addition in SoFex, we did not observe increased microzooplankton abundance in treatments with added iron. Since the expected direct effect of iron addition would be beneficial to heterotrophic protists, we believe that the observed effects are likely secondary in nature. We have added some text to the Discussion section (page 20) of the manuscript briefly comparing our results to those in the Twining papers, and commenting on the potential direct effects of iron on microzooplankton communities.

Top down control by larger microzooplankton could result in a decrease in smaller microzooplankton and heterotrophic flagellates, reducing over-all microzooplankton numerical abundance. This type of top-down control would be favored by the lack of mesozooplankton predation on large microzooplankton within the experimental incubations. It seems unlikely that changes in phytoplankton composition alone are responsible for the decrease in microzooplankton numbers since abundance of

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nanophytoplankton increased in all the treatments.

We agree with the reviewer that removal of mesozooplankton could result in trophic cascades and significant alterations in community structure within the heterotrophic protistan community. However, as described above, we observed decreased abundance of the largest microzooplankton in all treatments, again suggesting that the main driver of observed changes to the microzooplankton community was likely bottom-up controls from changes in the phytoplankton community. We added the following text to the Discussion section discussing these points:

"The exclusion of mesozooplankton grazers in our bottle incubations would be expected to significantly affect planktonic community structure. Removal of mesozooplankton could reduce top-down controls on larger microzooplankton, which would increase grazing pressure on smaller microzooplankton and heterotrophic flagellates. We do not have detailed information on microzooplankton size distribution in our treatments but did group our counts into $<100\ \mu\text{m}$ and $>100\ \mu\text{m}$ size classes. We observed decreased abundance of large ($>100\ \mu\text{m}$) microzooplankton in all treatments between the initial and final days of the experiment (data not shown), suggesting that removal of mesozooplankton grazers did not result in net benefits to this portion of the community."

Over-all the paper is well written and the results clearly presented. It is an interesting data set. It clearly shows that interactive effects of temperature and Fe should be considered in predicting climate change effects on lower trophic levels in the plankton.

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