Ocean acidification effects on productivity in a coastal Antarctic marine microbial community

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Introduction
The oceans have absorbed approximately 30% of the anthropogenic CO2 released to the atmosphere, of which approximately 40% has been absorbed by the Southern Ocean. Marine microbes (phytoplankton, protozoa and bacteria) are critical drivers of the biological pump and the cycling of carbon in the ocean. Despite their importance, little is known of the effects of increased CO2 on marine microbes in Antarctic waters.

Methods
Minicosms
Six 650 L minicosm tanks were filled with a natural community of Antarctic marine microbes from near-shore waters off Davis Station, Antarctica.
Each tank was acclimated to CO2 concentrations between ambient (343 ppm) and 1641 ppm over 5 days at low light.
Light was increased to saturating intensity between days 5 and 7.
Tanks were incubated until the nutrients were exhausted (day 18).
Samples were obtained every two days.

Primary & Bacterial Productivity
Primary productivity was measured through the uptake of H4C-bicarbonate over 21 light intensities.
P vs. I curves were modelled from productivity data.
Bacterial productivity was measured through the uptake of H4C-Leucine in the dark.

Cell Abundance
Phytoplankton abundance was estimated using Chlorophyll a (Chl a) concentration via High Performance Liquid Chromatography.
Bacterial counts were determined by flow cytometry.

Primary Productivity
- Chl a concentration and gross primary production decreased with increasing CO2 concentration (Fig. 1a-b).
- Chl a-specific primary productivity decreased with high CO2 (Fig. 1c).

Figure 1: a) Chlorophyll a abundance, b) gross primary productivity, and c) Chl a-specific primary productivity in all CO2 treatments. Results for incubation period shown (days 8-18).

Bacterial Productivity
- Bacterial abundance was commonly higher in high CO2 treatments (Fig. 3a).
- Bacterial cell abundance declined through increased bacterivory, however it did not abate the exponential increase in the rate of cell-specific bacterial productivity (Fig. 3b).
- Gross bacterial production differed little amongst CO2 treatments (except at 600 ppm) (Fig. 3c).
- Rates of productivity were highest at 600 ppm CO2.

Figure 3: a) Bacterial abundance, b) cell-specific bacterial productivity, and c) gross bacterial productivity in all CO2 treatments. Results for incubation period shown only (days 8-18).

Conclusions
- Increased pCO2 negatively affected phytoplankton by decreasing phytoplankton biomass and rates of productivity.
- Bacteria appear to tolerate high CO2 conditions.
- The CO2-induced decrease in productivity and cell growth in Antarctic phytoplankton communities are likely to reduce the future CO2 uptake by the Southern Ocean. This decrease will likely exacerbate global warming.

References

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