LONG TERM ADAPTATION BY NEW ZEALAND PHYTOPLANKTON TO CLIMATE CHANGE

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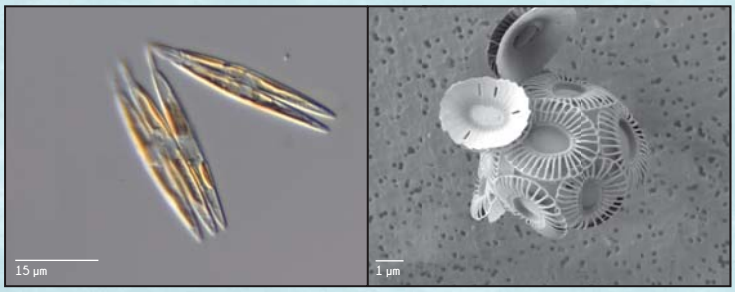
INTRODUCTION

Current research has identified significant changes in growth rate, metabolic processes and nutrient cycling in phytoplankton in response to increasing temperature and CO_2. However, many studies are short term incubations and almost all longer term studies focus on the calcifying coccolithophores which are only one group of the wide diversity of phytoplankton in the ocean.



Pseudonitzschia sp. *E. huxleyi*

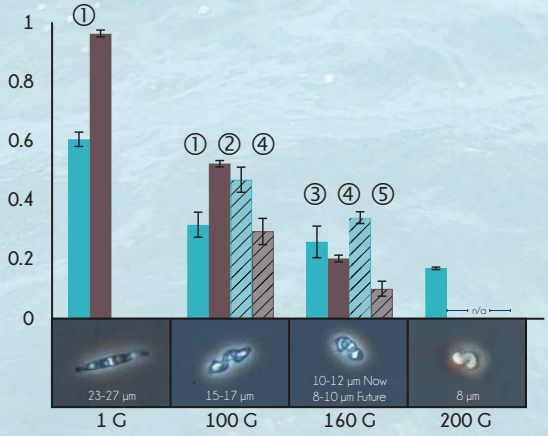
We are investigating the effect of long term changes in temperature and pH on two New Zealand phytoplankton, a *Pseudonitzschia* sp. and an *Emiliania huxleyi* strain, isolated from subantarctic water, by incubating cultures in conditions representing current and future conditions projected for the end of this century (0.3 – 0.4 decrease in pH, 3°C increase in temperature) in the subantarctic.

METHODS

- Diatom and coccolithophore cells were incubated in semi-batch culture, at conditions Now (11°C pH 8.1) and at conditions predicted for the end of this century in subantarctic water (14°C pH 7.8). pH of the Future medium was altered by bubbling with 10% CO_2 prior to cell addition.
- To help maintain the pH of the medium air, 380 ppm and 750 ppm CO_2 for conditions Now and in the Future, respectively, was passed over the surface of the medium.
- At the start of the experiment and after approx. 100 and 160 Generations (G) we measured a range of cellular parameters in each condition.
- After 100 G cross-over experiments were performed. Future cells were transferred into Now conditions and Now cells were transferred into Future conditions.
- Diatoms in Future conditions stopped growing immediately following sampling at 160 G and at 160 G soon after transfer to Now conditions.

DIATOM

Growth rate (per day)



KEY

Now | Now in Future

Future | Future in Now

SIGNIFICANT DIFFERENCES

① Now and Future

② Now and Now in Future

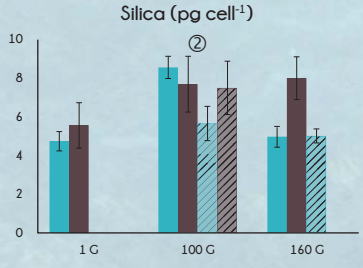
③ Now and Future in Now

④ Future and Future in Now

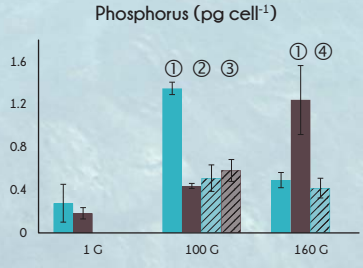
⑤ Future and Now in Future

- Over time growth rate and cell size reduced in both sets of conditions.
- At each time point growth rate increased when cells were moved into Future conditions.
- At each time point growth rate decreased when cells were moved into Now conditions.
- By 160 G there was no longer any difference in growth rate of Now and Future cells.
- At 160 G Future in Now cells grew at a lower rate than Now cells.
- At 160 G Now in Future cells grew at a faster rate than Future cells.

Silica (pg cell^{-1})



Phosphorus (pg cell^{-1})

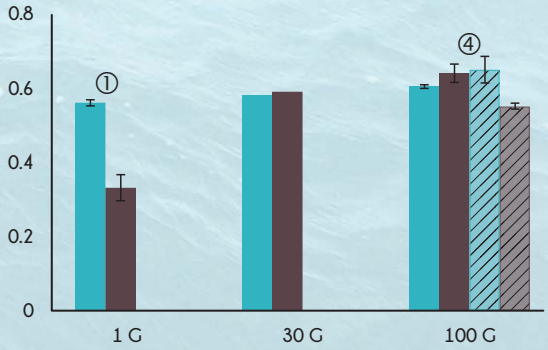


- Cell size decreased over time but there was no corresponding decrease in cell silica content.
- At 100 G silica was significantly lower in Now in Future compared with Now cells which corresponds to a significant difference in their growth rates.
- There were no consistent trends between generations or treatments in cellular phosphate.

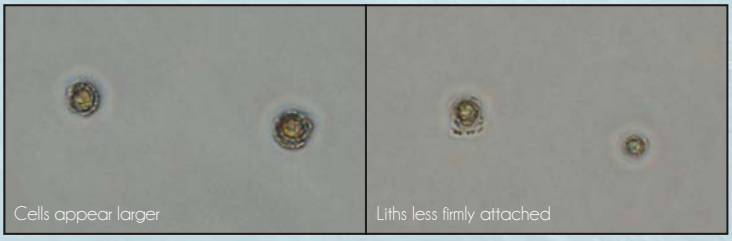
Other results indicate possible differences in elemental ratios at different time points e.g. N:P and C:Si. These should become apparent after all results are analysed.

COCCOLITHOPHORE

Growth rate (per day)



- Growth rate in Future conditions was lower than Now at 1G.
- From 1 G to ca. 30 G Future growth rate increased to that in Now conditions.
- At 100 G growth rates in Now in Future cells recovered to that of Now cells after only 2 generations.
- Cells crossed from Future into Now conditions at 100 G grew at a lower rate.



CONCLUSIONS

- Diatoms and coccolithophores were not affected to 100 G, and may even benefit from, conditions projected for the future in the subantarctic.
- By 160 G the diatom cells growing in Future conditions had adapted to those conditions because when transferred back into Now conditions they had a lower growth rate than Now cells.
- The coccolithophores here demonstrate the conflicts possible with short term experiments; cells transferred from Now into Future conditions did not behave similarly at 1 G and 100 G.

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