Light and Iron Effects on the Ecophysiology of Southern Ocean Phytoplankton

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Introduction

The Southern Ocean is critical in regulating the Earth's climate and serves a major buffer against anthropogenic CO_2. The sea surface readily absorbs CO_2 from the atmosphere where it can be fixed into organic carbon by phytoplankton and sink to deeper depths(Long et al., 2021). The removal of CO_2 from the atmosphere serves as a barrier against climate change as it reduces increases to the greenhouse effect.

Phytoplankton require sunlight and iron for conducting photosynthesis (Lepetit, 2022). Southern Ocean plankton are challenged by highly variable light and limiting iron. Iron and light availability in the Southern Ocean may be affected by climate change. This experiment was designed to predict how phytoplankton might adapt in the future SO environment.

Methods

Cultures of *Thalassiosira antarctica* were grown under two light periods: diel (18:6 light:dark) and constant (24:0 light:dark). Cells were grown under low light (LL) and high light (HL) with nutrient concentrations of 30uM NO_3^-, 2.8uM PO_4^{3-}, and 38uM Si. Cultures were held at 4°C with iron (Fe) concentrations maintained with EDTA at 20nM (deplete, (-)Fe) and 100nM (replete, (+)Fe). Culture densities were measured via flow cytometry (Beckman-Coulter CytoFLEX), and quantum yield (Fv/Fm) was measured concurrently with a

Figure 3: Constant incubation setup for *Thalassiosira Antarctica.* Top row = high light adapted bottles. Bottom row = low light adapted bottles. Light was supplied by a LED light array.

Results

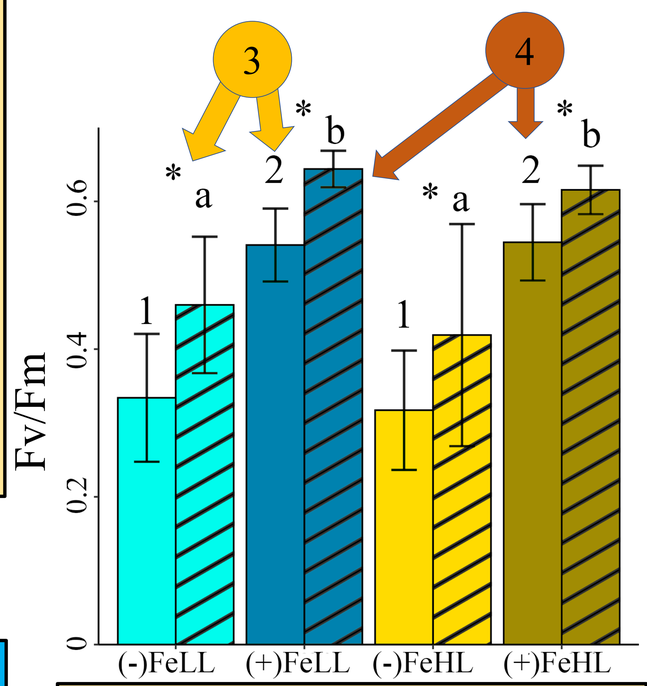


Figure 1: Growth rate data from *Thalassiosira antarctica* experiments. Dashed boxes represent diel treatments and open boxes represent the constant light treatments.

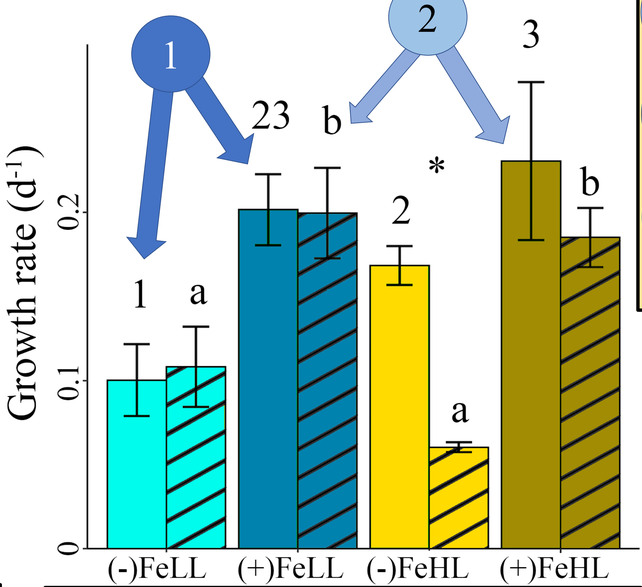
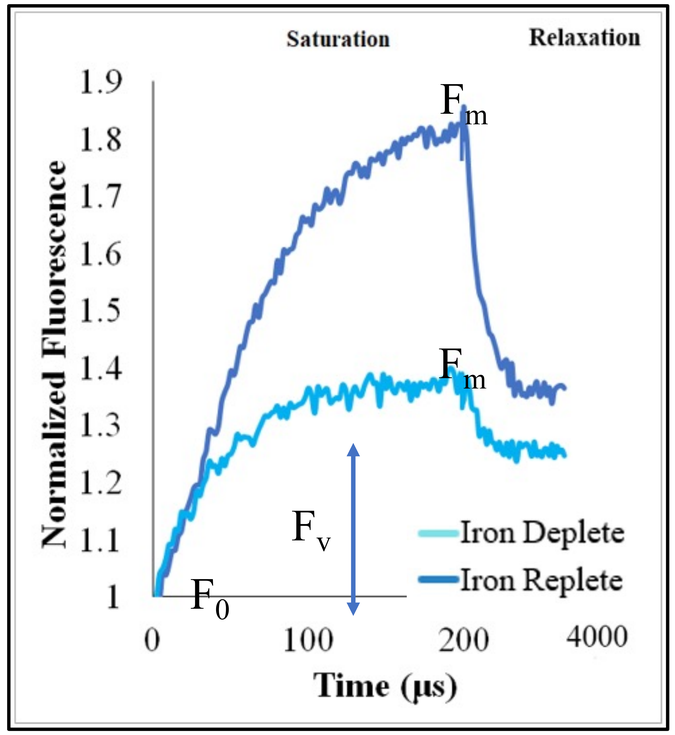


Figure 2: Fv/Fm (photosynthetic efficiency) data from *Thalassiosira antarctica* experiments. Dashed boxes represent diel treatments and open boxes represent the constant light treatments.



F_v/F_m

Figure 4: Normalized fluorescence of iron deplete and iron replete phytoplankton when exposed to a saturating fast pulsing light followed by a slower pulsing relaxing light.

F_0 is the base fluorescence at the first pulse of light and F_m is the maximum fluorescence at the last. F_v is the variable fluorescence given by: F_m-F_o.

The ratio, F_v/F_m reflects the photochemical efficiency of the cell. The greater the F_v, the greater the ability of cells to generate energy by photosynthesis

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Conclusion

1: +Fe conditions resulted in significantly higher growth between all conditions

2: Significant differences in growth due to light were seldom observed.

3: +Fe conditions resulted in significantly higher Fv/Fm between all conditions.

4: Significant differences in Fv/Fm due to light were seldom observed.

Discussion

Our data indicates that elevated Fe conditions resulted in significantly increased growth and Fv/Fm values between all treatments. Conversely, the light intensity or duration had much less of an impact.

These results demonstrate that replete iron conditions support improved photosynthesis by allowing the cells to maintain efficient levels of electron transfer. The lack of differences in growth and Fv/Fm due to the light indicates support that the species is better adapted to light stress compared to iron.

The experiment demonstrates that iron changes in the Southern Ocean may have more of an impact on phytoplankton growth and productivity in the future climate.

References

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