Dynamic Temperature Affects the Response of Phytoplankton Growth and Production to Temperature

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Temperature is a major predictor of growth and physiology of phytoplankton, but despite decades of thermal study, the growth and production of marine phytoplankton under changing temperature has not been described. To address this major knowledge gap, we treated a coastal phytoplankton model, *Heterosigma akashiwo*, with ecologically relevant temperature shifts (2- 4°C), across the reaction norm.

With a symmetric design, we were able to test potential importance of both the direction and total magnitude of temperature change. The smallest temperature shifts and most extreme resulted in immediate specific growth and production consistently lower than acclimated. Temperature changes cumulatively totaling 5-13°C resulted in immediate growth rates which were higher than acclimated. Temperature-size differentiation disproportionately affected production relative to specific growth. Beyond the mean response, with more thermal shifts, the intraspecific variability in growth increased exponentially.

Together, these results, contextualized with *in situ* data from Narragansett Bay, demonstrated how actual production rates could differ from current model assumptions of acclimated rates by -100 to +50 percent.