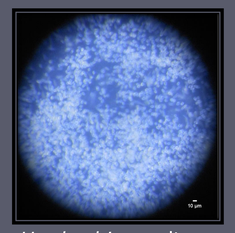
Environmental Conditions Affecting the Halo-tolerance of the Toxic Raphidophyte *Heterosigma akashiwo*

Rachel Hickcox[1], Elizabeth L. Harvey[2], & S. Menden-Deuer[2]
1 Worcester Polytechnic Institute, Worcester, Massachusetts, rhickcox@wpi.edu
2 University of Rhode Island, Graduate School of Oceanography, Narragansett, Rhode Island

Introduction

Harmful Algal Blooms (HABs)

- Accumulated phytoplankton biomass in freshwater or marine environments that has toxic or destructive effects



H. akashiwo culture magnified to 10 x

Heterosigma akashiwo

- Toxic raphidophyte that forms ichtyotoxic blooms
- Halo-tolerant within a range of 5 to 30 psu (Tomas 1978; Haque and Onoue 2002, Strom et al. 2013).
- **Research suggests this broad halo-tolerance may be a mechanism of bloom formation in *H. akashiwo*** (Taylor and Haigh 1993; Rensel et al. 2010; Strom et al. 2013)

Question

Do temperature and light impact the halo-tolerance of *H. akashiwo*?

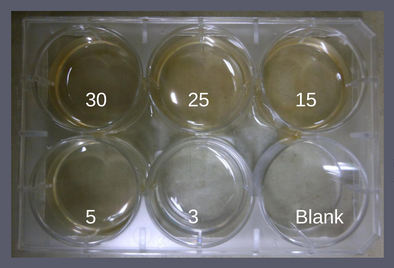
Methods

Two Strains:
- **2809** – collected from Salish Sea in WA, USA, 2006
- **NB** – collected from Narragansett Bay in RI, USA, 2010

1-3. Effect of salinity, temperature, and light on growth rate

Cells were incubated in triplicate well-plates, and daily spectrophotometer fluorescence measurements (RFU) were taken.

Salinity - 3,5,15, 25,30 psu
Temperature - 7, 15, 22 °C
Irradiance - low (10), medium (60), high (100) µmol photon m^{-2} s^{-1}

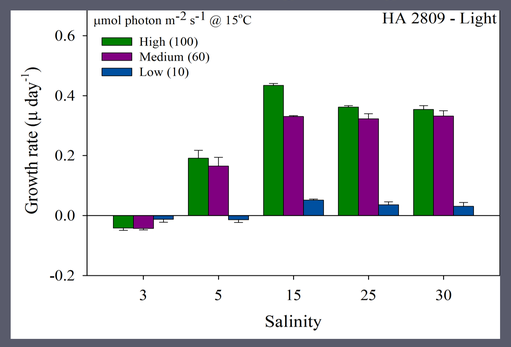


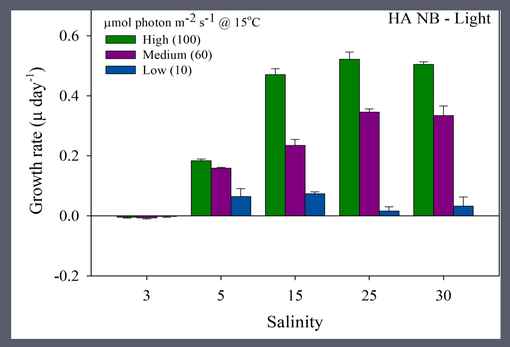
Sample well-plate indicating salinity; wells are discolored proportional to *H. akashiwo* abundance

4. Effect of salinity on photosynthetic efficiency

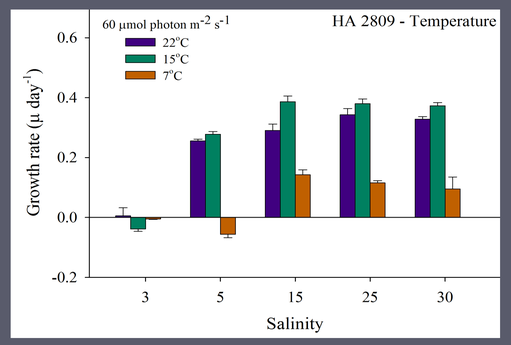
Cells were incubated in triplicate 500 mL bottles at 15°C and 100 µmol photon m^{-2} s^{-1}. Daily photosynthetic efficiency (Fv/Fm) measurements were taken using the FiRe system (Satlantic).

1. Strains had highest growth rates under high light and high salinity





2. Strains had highest growth rates at 15°C; 7°C inhibited growth



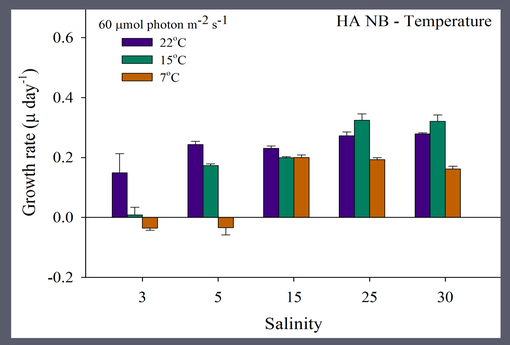
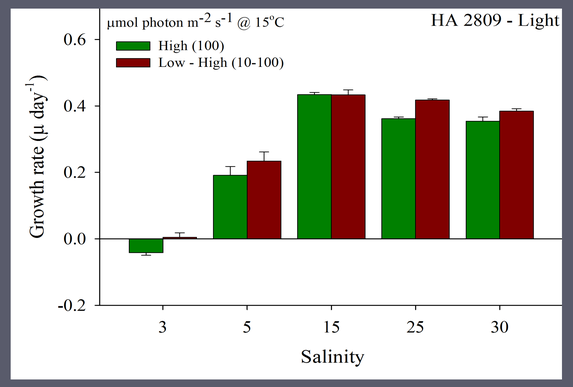


Figure 1: Growth rates of *H. akashiwo* (strain 2809 – left; strain NB – right) across a gradient of salinities in a range of light (top) and temperatures (bottom). **For both strains, fastest growth was observed at high light, and 15° C. Slow growth rates were observed in low light and at 7° C, except for strain NB at high salinities, where growth at 7° C was similar to other temperatures. Overall, no growth was observed in cells at 3 psu, except for when NB was grown at 22° C.**

3. *H. akashiwo* exhibited high growth rates immediately after being transferred from low light to high light; response was strain specific

Transferred after **15** days
Best recovery at **high** salinities



Transferred after **21** days
Best recovery at **low** salinities

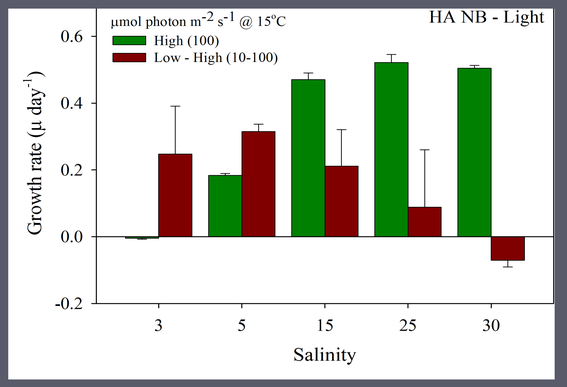
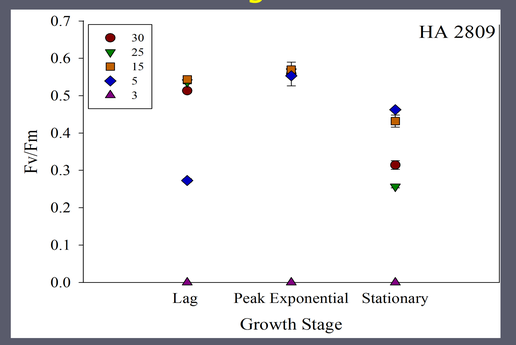


Figure 2: Growth rates of strain 2809 (left) and NB (right) under constant high light conditions (green) and after being transferred from low light to high light (red). Remarkably, growth rates of previously low-light challenged cultures were faster than cultures in constant high light. The response was strain specific with respect to salinity; the best recovery was observed in high salinities in strain 2809, whereas the best recovery was at low salinities in strain NB. **These results suggest that *H. akashiwo* cells can remain viable for a long period of time, and recover quickly to high growth rates when light conditions become favorable.**

4. *H. akashiwo* had high photosynthetic potential even when growth rate was low



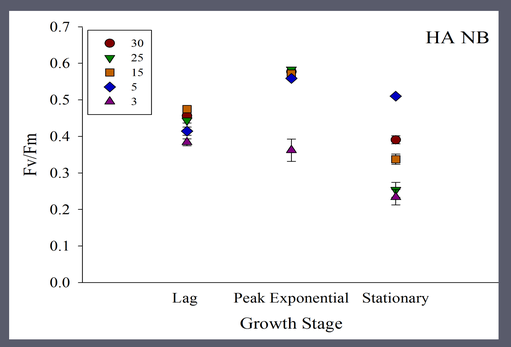


Figure 3: Photosynthetic efficiency (Fv/Fm) of *H. akashiwo*, strain 2809 (top) and strain NB (bottom), in 3 different periods of the growth cycle. Growth conditions were at 15 ° C and high light. **In both strains, *H. akashiwo* maintained high photosynthetic efficiency despite low growth rate (example: 5 psu).**

Conclusions

Halo-tolerance Limits

Population growth rate of *H. akashiwo* was reduced at
- <3 psu (NB) and <5 psu (2809)
- constant, low light intensity
- temperatures <7°C

The ability for *H. akashiwo* to survive and recover after 2-3 weeks of darkness suggests adaptation to environments where light may be sparse due to burial in sediment or advection to great depths.

H. akashiwo exhibits remarkable halo-tolerance under a range of temperatures and light intensities. However, low temperatures and low light intensities reduce growth rates across all salinities. These constraining environmental factors may reduce the success of *H. akashiwo* in late winter/early spring.

Acknowledgements

This research was completed during the 2012 University of Rhode Island Graduate School of Oceanography Summer Undergraduate Research Fellowship in Oceanography. This program is supported by grants from the National Science Foundation – Research Experience for Undergraduates (REU), grants 1156520 and 0851794.