4-2015

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CHEMICAL WARFARE IN NARRAGANSETT BAY: DETERMINING THE ALLELOPATHIC EFFECTS OF *ULVA*

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Introduction

Ulva compressa, *U. rigida* and *U. lactuca* are common species of macroalgae in Narragansett Bay that provide food and shelter for many organisms (Guidone & Thornber 2013). They are fast growing primary producers that also remove excess nutrients from the environment (Sogard & Able 1990). *Ulva* blooms can have detrimental effects on the environment and economy by causing anoxic conditions that lead to decreased species diversity, finfish and shellfish kills, and disruption of recreational activities and fisheries (Teichberg et al. 2009). Previous studies have shown that *U. lactuca* in other systems produce and release allelopathic chemicals that inhibit growth of microalgae (Tang & Gobler 2011). Therefore, it is possible that either *U. compressa*, *U. rigida* or *U. lactuca* may be releasing allelopathic chemicals that have detrimental impacts on macroalgae in the Narragansett Bay ecosystem.

Objectives

Determine if *U. compressa, U. rigida and/or U. lactuca* have allelopathic effects on three species of macroalgae found in Narragansett Bay: *Chondrus crispus*, *Cystoclonium purpureum,* and *Ceramium virgatum* (Figure 1).

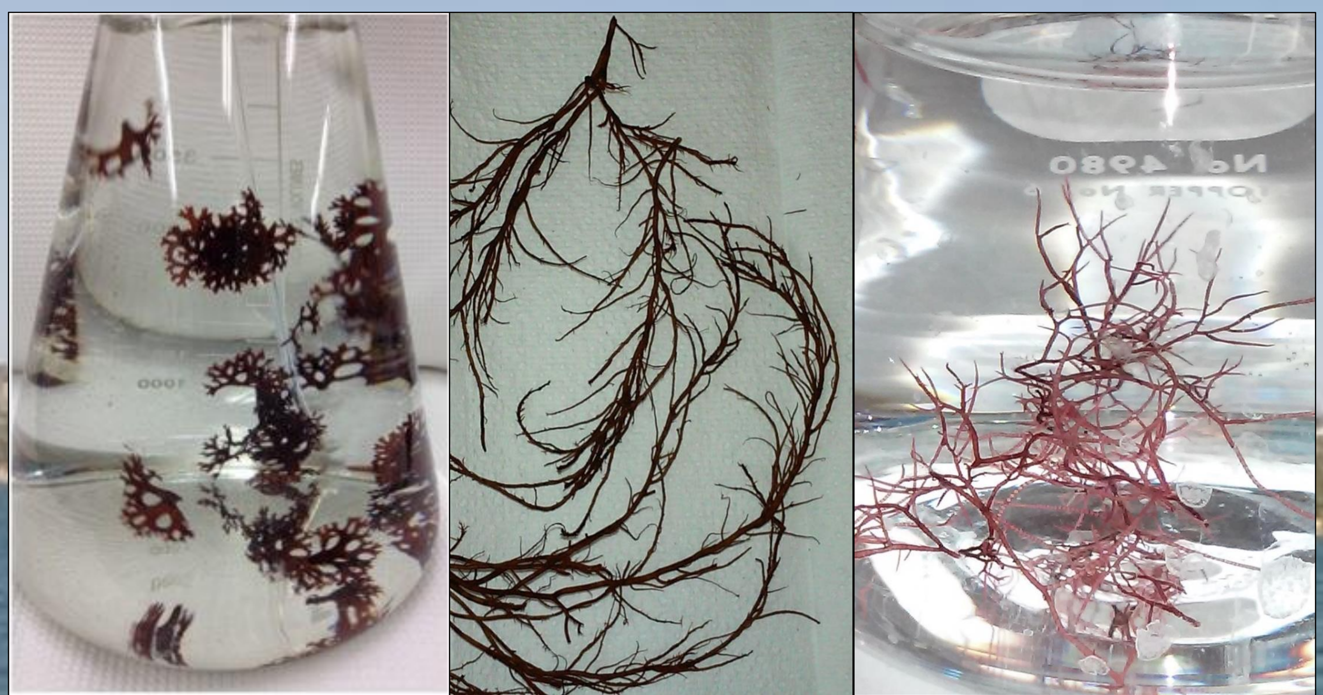

Figure 1. *Chondrus crispus* (left), *Cystoclonium purpureum* (center), *and Ceramium virgatum* (right)

Methods

- Tips of *Chondrus, Cystoclonium,* and *Ceramium* were isolated, cleaned in agar if needed, and grown in sterile seawater before use in experiments.
- Algae were placed in 1 L ball jars separated by mesh to ensure no direct contact between the species (Figure 2). Samples were grown in autoclaved seawater and provided constant filter-sterilized air
- NO_3 levels were tested daily as a proxy for nutrient levels and cultures were re-enriched when necessary (Von Stosch Enrichment, Ott 1966).
- Experiments were conducted at 22˚C, 100 μmol photons m^{-2} $s^{-1}$and 16:8 (Light:Dark)
- Wet mass was recorded on days 0, 2, 4, 6, and 8. Percent growth was calculated as % day^{-1}=100* ln $[(L_2/L_1)/(t_2-t_1)]$, with L_2 and L_1 are the blade wet weights at times t_2 and t_1
- Starting *Ulva* concentration was 1 g/L to reflect concentrations observed during blooms (Thornber, unpublished data).
- Each trial (n=3) contained 7 replicates of 4 “treatments”: *U. rigida*, *U. compressa*, or *U. lactuca* and control (no *Ulva)*
- Results of each trial were analyzed using separate repeated measures ANOVAs with Greenhouse-Geisser corrections for sphericity.

Figure 2. Top view of divided mesocosm (left) and trial set-up with jars of each treatment randomly placed (right)

Results

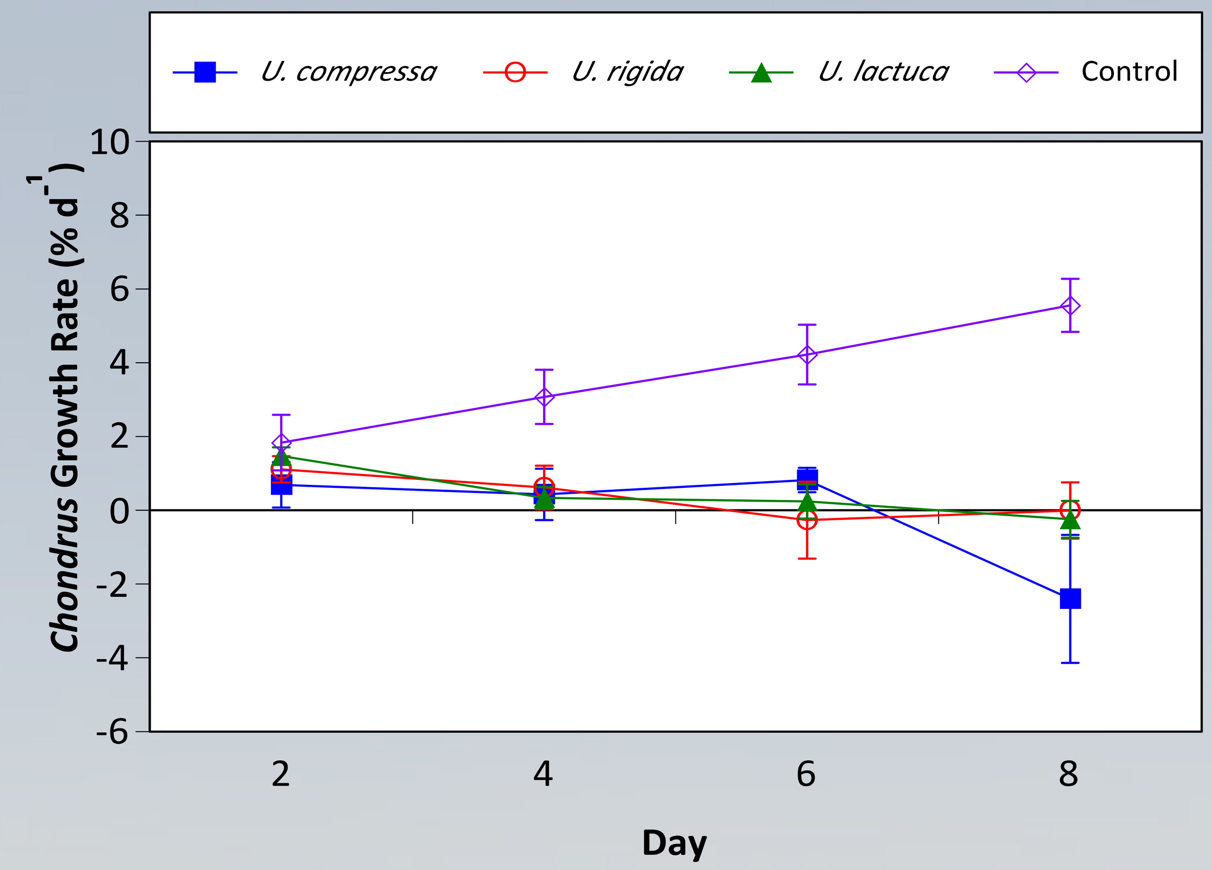

Figure 2. *Chondrus* growth (% day^{-1}; mean ± SE). Treatment had a significant effect on growth, although it was dependent on time (Greenhouse-Geiser $F_{9,72}$=4.6001, p=0.0019)

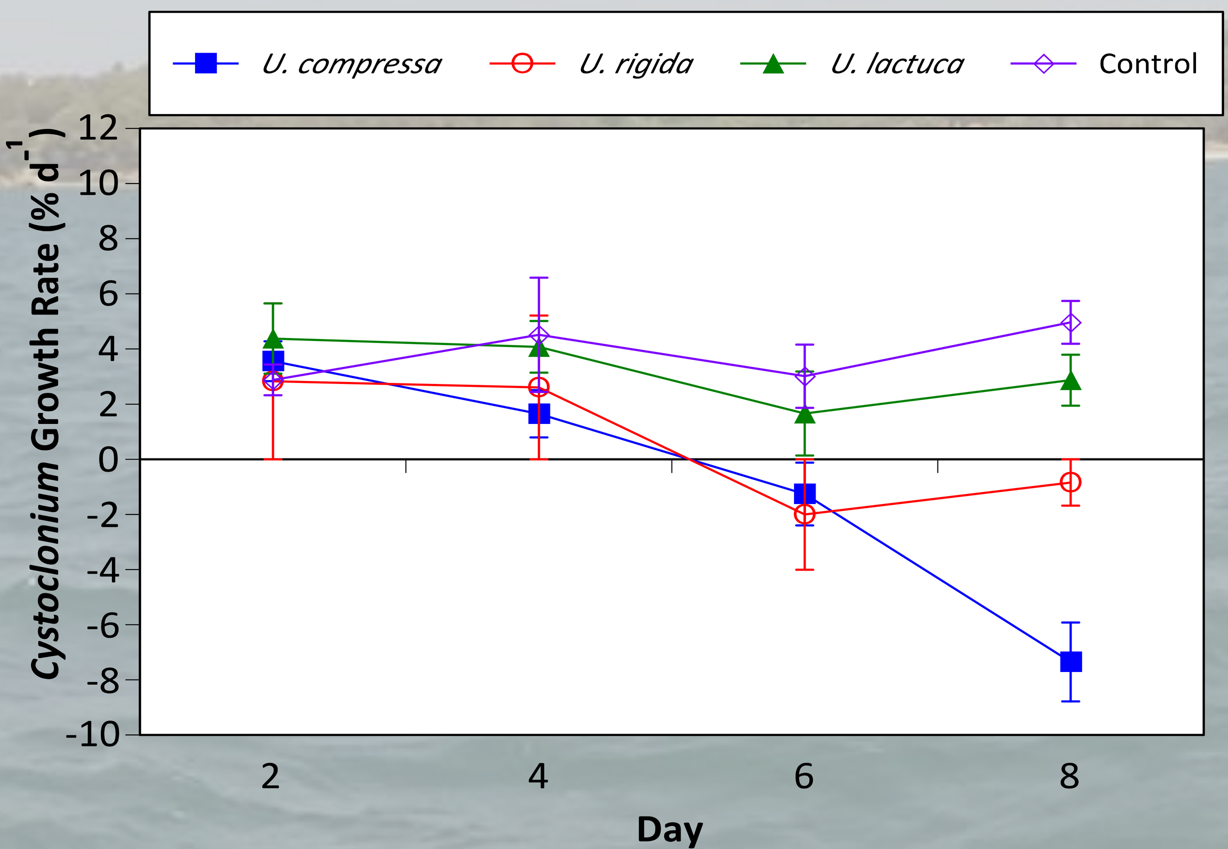

Figure 3. *Cystoclonium* (% day^{-1}; mean ± SE). Treatment had a significant effect on growth, although it was dependent on time (Greenhouse-Geiser $F_{7.3051,58.441}$=2.9068, p=0.0103)

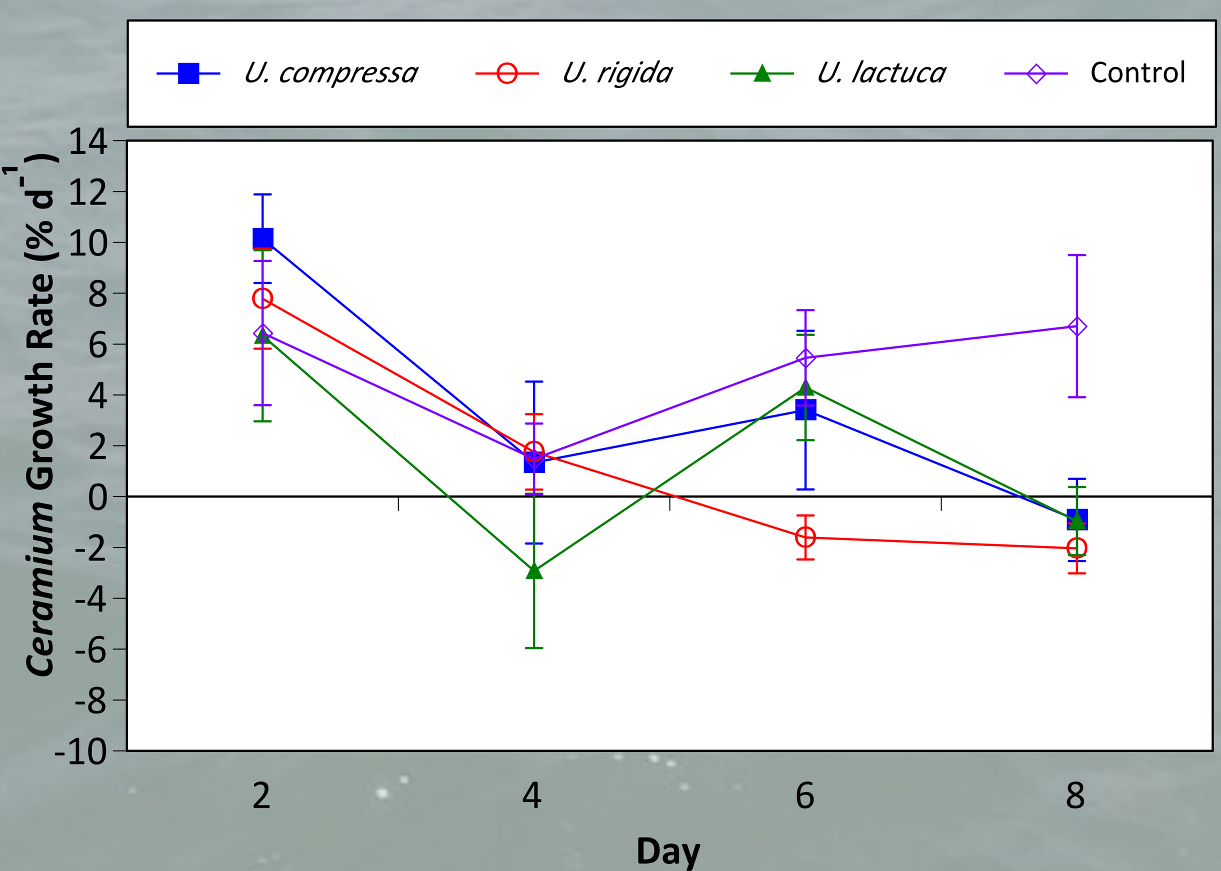

Figure 4. *Ceramium* (% day^{-1}; mean ± SE). Treatment had a significant effect on growth, although it was dependent on time (Greenhouse-Geiser $F_{6.52,52.19}$=3.55, *p*=0.0041)

Discussion

- Overall in two trials *U. compressa* had the most effect on the *Cystoclonium* and *Chondrus*, with both losing mass over time.
- *U. rigida* and *U. lactuca* had less of an effect, with the growth of *Cystoclonium* and *Chondrus* stagnating over the course of the trials, in comparison to the controls which had a significant gain in mass.
- *Ceramium* growth stagnated when grown with the all of *Ulva* species in comparison to the controls, but the effect of each *Ulva* species was not significantly different at the end of the trial
- Even though bloom formations in Greenwich Bay (Figure 3) are not long lived, lasting only 1-2 weeks, based on our results, it is long enough to potentially harm the growth of other species of algae in the area (Granger et al. 2000).
- Algal blooms have been currently noted to reduce the algal diversity in areas where they occur, though this is most frequently attributed to anoxia or reduced light levels during bloom formation and die-off (Teichberg et al. 2009).
- **We propose that there are secondary effects of bloom formations by certain species of *Ulva* that would lead to reductions in diversity based on the chemical effects on other macroalgae.**
- Future directions: implementing field experiments and testing the effects on other life stages of macroalgae.

Figure 3. Beach (left) and quadrat (right) view of a macroalgal bloom in Greenwich Bay

Acknowledgements

This work was funded by the URI Undergraduate Research Initiative, the University of Rhode Island’s Honor Department, and EPSCoR grant #EPS-100405. I would like to thank Ivy Burns, Kyle Carpentier, Emily Bishop, Emily Shopland, and Seanna Grey for all their help during this experiment.

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