Assessing the invasiveness of the non-native kelp *Undaria pinnatifida* in Monterey Harbor

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INTRODUCTION

Undaria from Monterey Harbor

"Invasiveness" is the set of traits which increase the likelihood of a species to invade or overrun new ecosystems (Alpert et al. 2000). Invasive species are detrimental to the dynamics of native communities by out-competing natives for resources such as space, light and nutrients. The annual subtidal alga *Undaria pinnatifida* has been federally declared an invasive species by the National Invasive Species Council (NISC 2008). The ability of this alga to complete its life cycle determines its success in a particular location, and several abiotic factors are important in determining reproductive success in kelps (Dayton 1985). In this study I tested the effects of temperature and nitrate concentration on microscopic sporophyte production (an indicator of reproductive success) in *Undaria* from Monterey Harbor.

METHODS

Laboratory zoospore culture experiments were conducted monthly to test the effects of temperature and nitrate concentration on microscopic sporophyte production from November 2009 to October 2010. *Undaria pinnatifida* sporophylls from Monterey Harbor were brought back to the lab for zoospore release. All cultures were grown in two significantly different temperatures (12, 18ºC). For six months of the study period, cultures were grown with saturating (10 µmol) amounts of nitrate to identify temperature effects on sporophyte production. Additionally, three nitrate concentrations (1,5,10 µmol) within each temperature treatment were used during three months (March, July, September- chosen to be roughly seasonal) to identify nitrate effects. Reproductive individuals were not found in the harbor during the remaining three months of the study (December-February), so experiments were not conducted during that time. Cultures were monitored for sporophyte production weekly under 400x magnification.

Undaria sporophyll

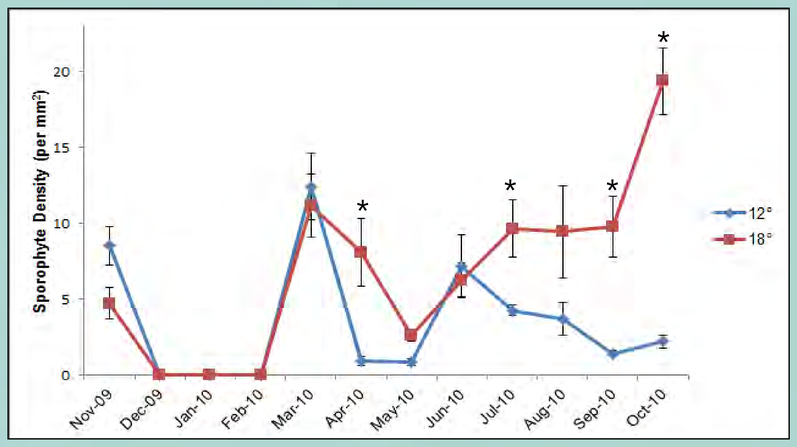
Undaria sporophyte

Statistical Analysis

All data were converted to number of sporophytes per mm². Two-way ANOVAs with Fisher's LSD post hoc comparisons tests were used to test for temperature and nitrate effects on sporophyte production.

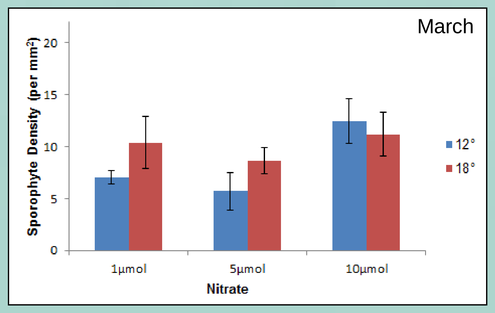
RESULTS

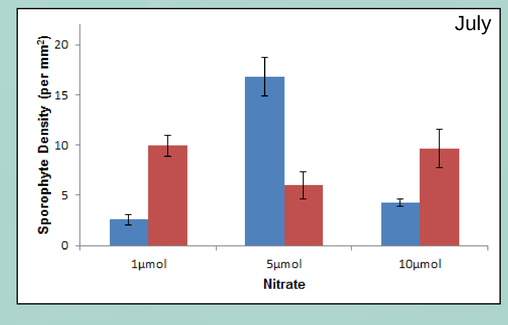
Sporophytes were produced in both temperatures each month they occurred–
the 18ºC treatment produced more sporophytes when there was a difference between temperatures

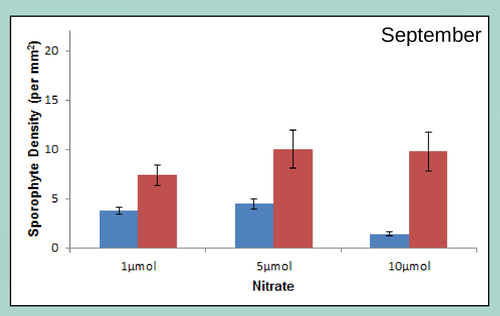


Asterisks indicate a significant difference in sporophyte production between temperature treatments– significant p-values: Apr (p=0.018), Jul (p=0.011), Sep (p<0.001), Oct (p=0.006)

Sporophytes were produced in all temperature-nitrate treatments during each experiment–
nitrate effects were secondary to temperature effects







Month	Temperature Effect	Nitrate Effect
March	**Non-Significant**	**Significant** (0.042) (1-10µmol, 5-10µmol)
July	**Significant** (0.011)	**Significant** (0.026) (1-10µmol)
September	**Significant** (<0.001)	**Non-Significant**

Source of significance indicated for nitrate effect

CONCLUSIONS

These results show that *Undaria pinnatifida* reproductive success is primarily driven by temperature rather than nitrate availability. Similar experiments have been conducted on other native central California kelp species, a majority of which were unable to produce sporophytes in all temperature and nitrate treatments. *Undaria*'s ability to reproduce in a variety of treatments suggests that it is a condition-flexible alga whose reproductive physiology allows it to enter and thrive in new areas. Understanding the requirements of this species is important to inform *Undaria* management, particularly regarding monitoring and removal programs.

References

Alpert P, Bone E, Holzapfel C. 2000. Invasiveness, invasibility and the role of environmental stress in the spread of non-native plants. Perspectives in Plant Ecology, Evolution and Systematics 3(1):52-66, Dayton PK. 1985. Ecology of kelp communities. *Annual Review of Ecology and Systematics 16: 215-245.* [NISC] National Invasive Species Council (US). 2008 Aug. Invasive Species Management Plan 2008-2012. Available from: www.invasivespeciesinfo.gov/council/nmp.shtml.

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