The Effect of Increased Temperature on Inducible Defenses of *Mytilus edulis* (Blue Mussel) Against *Nucella lapillus* (Dog whelk)

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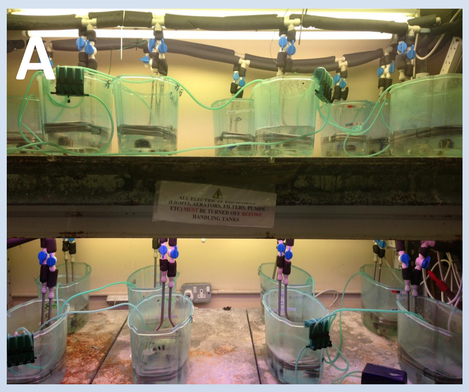
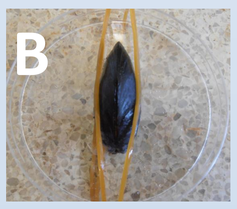
Introduction

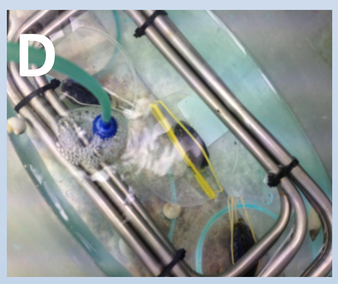
- Global warming is causing worldwide increases in temperature, which can strongly affect many species and ecosystems. It's important to understand how temperature affects interactions between species in order to predict how global warming will change populations and ecosystems.
- Blue mussels and dog whelks are two closely interacting species found in the North Atlantic on the rocky coasts of Europe and North America.
- Dog whelks are predatory gastropods that prey on blue mussels. Blue mussels have been observed to defend themselves by releasing byssus threads to entangle or incapacitate the snail. (Farrell & Crowe, 2007)
- Environmental pressures (salinity, pH, temperature) can affect byssus thread production by mussels. Increased temperature generally leads to an increase in thread production. (Young, 1985)
- The interaction between temperature and predator presence on byssus thread production is less known, and was the focus of this experiment.
- I hypothesize there will be a significant interaction between the effects of temperature and predators on the number of threads produced by blue mussels in the 15°C condition. I hypothesize there will be no significant interactions involving thread length.

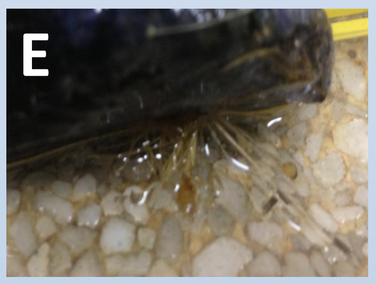
Methods

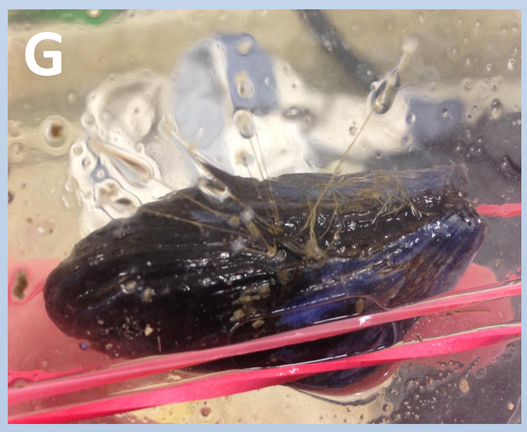
Forty-eight blue mussels and fifty-six dog whelks were collected from Seapoint beach, Dún Laoghaire. Sixteen tanks were filled with 2 liters of artificial seawater at 33 salinity. Eight tanks were assigned to the control condition (10°C), eight were assigned to the warm condition (15°C). Each mussel was placed in a petri dish and secured by rubber bands. Three mussels were placed in each tank and allowed 24 hours to acclimate. Seven dog whelks were placed in 4 of the tanks from both conditions, and allowed to freely move about the tanks for 24 hours. Afterward the threads from all the mussels were cut, counted, and measured for length (cm). The average number and length of threads per tank were averaged, and the data was analyzed in SPSS Statistics using 2 two-way ANOVAs, one comparing the presence of predators and temperature with number of threads, and the other with length of threads.











Photograph Descriptions

A. Experimental setup. Top shelf=15°C, Bottom=10°C
B. Mussel restrained by rubber bands in a petri dish
C. A dog whelk
D. Tank setup with chiller
E. Close up of byssus threads
F. Dog whelks preying on a blue mussel
G. View of byssus threads on underside of petri dish

Results

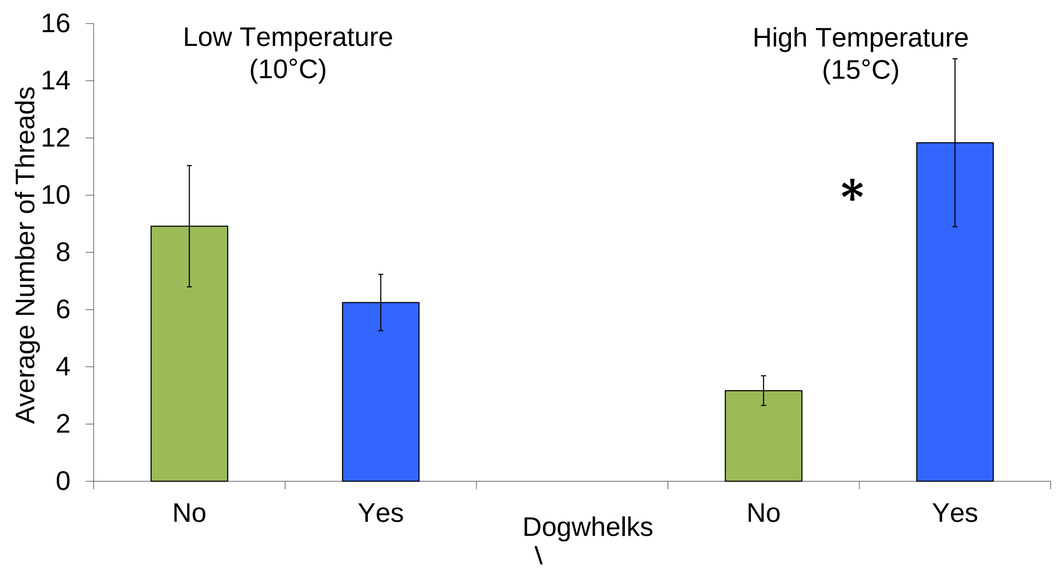


Figure 1. Average number of byssus threads released by blue mussels kept in tanks at 10°C or 15°C, and with predators or without. A significant interaction was found between no predators at 15°C and predators at 15°C. $F(1,12)=8.951$, $p=.011$

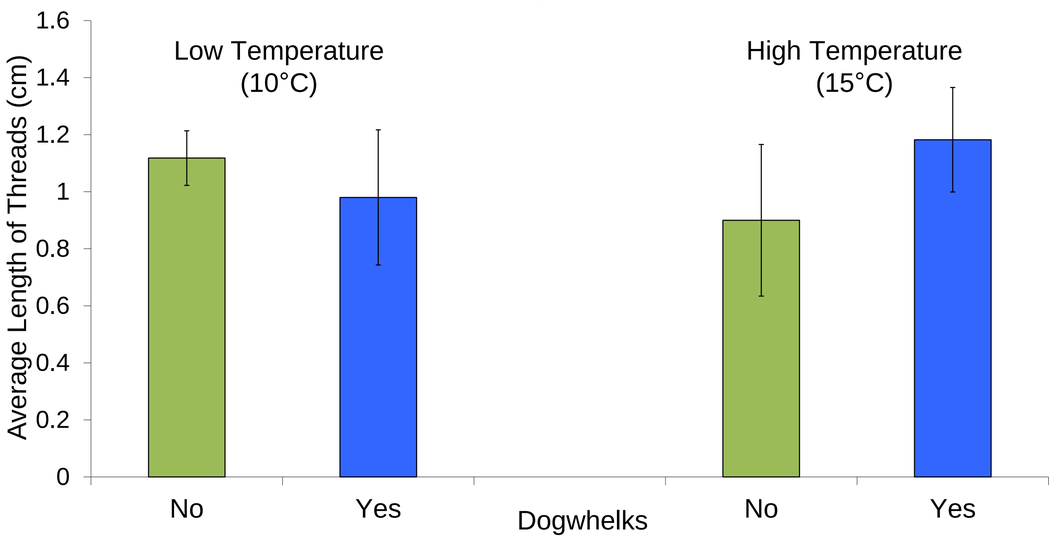


Figure 1. Average length of byssus threads (cm) released by blue mussels kept in tanks at 10°C or 15°C, and with predators or without. No significant interactions were found.

Discussion

A 2-way ANOVA revealed a significant interaction between the effects of temperature and predators on the number of byssus threads produced by blue mussels in the 15°C condition ($p=.011$). No significant interactions were found in the 10°C condition or for length of threads overall. These results suggest that at ambient temperatures (10°C), the mussels do not concern themselves with whether there are predators or not. However, at higher temperatures (15°C) when the metabolism of the mussels are being overworked, if there are no predators the mussels focus less energy on making byssus threads. When predators are introduced though, the mussels appear to overreact to the situation and produce numerous threads. Although these results supported my hypothesis, they still should be taken with some caution. The natural environment of these species has many factors and qualities that cannot be replicated within a laboratory, meaning that results found in the field could be different. However, these findings still help with predicting the changes global warming may lead to in these populations. If mussels in warmer waters exert all their energy producing threads when predators are around, they could have little energy for other processes, and even die of exhaustion. More research in this area will improve predictions of future changes from global warming.

References and Acknowledgements

Edward D. Farrell and Tasman P. Crowe (2007). The use of byssus threads by *Mytilus edulis* as an active defence against *Nucella lapillus*. *Journal of the Marine Biological Association of the United Kingdom*, 87, pp 559-564. doi: 10.1017/S0025315407055622.

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