Survival and adaptation of *Mytilus Californianus* at low pH and high temperatures in seawater

Sarah Cohen, Thousand Oaks High School

Introduction

Mussels are a vital aspect to the fishing and shellfish industries, providing many jobs and enriching the economies of many coastal American fishing towns. The survival of these species is at a risk due to climate and environmental changes resulting in increased temperatures and decreasing pH in our oceans. The potential extinction, or decline in number, of these mussels would be detrimental to the economies surrounding fishing industries.

Methods

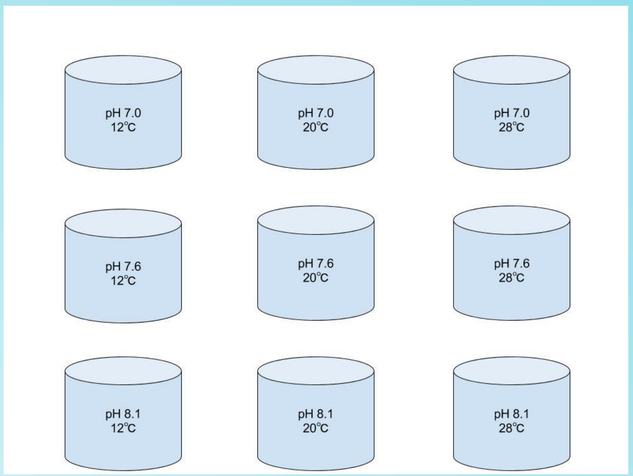
Obtaining and maintaining mussels:
A quantity of 100 live mussels will be obtained from a local fish store and acclimated in an aerated seawater tank at temperature of 12 degrees celsius for one week. The sea tank will be filtered with a salt water filter, and maintained at a particular temperature with a tank heater. Mussels will be fed with microalgae *Isochrysis galbana on a* daily basis as a food source (mg/gm of mussels).
Preparing the solutions for testing:
Seawater was prepared by mixing DI water and seawater kit in a large container. Various solutions were prepared using seawater and adjusting their pH to different levels: pH 7.0 at 12, 20, and 28 degrees celsius, pH 7.6 at 12, 20, and 28 degrees celsius, and pH 8.1 at 12, 20, and 28 degrees celsius. The control conditions for both temperature and pH (i.e., 12 degrees C and 7.6 pH) represent current local marine habitat conditions, and the different incremental test conditions represent environmental projections over the rest of this century. A pH of 8.1 and a temperature of 12 degrees celsius were chosen as the control group because they represent averages based on the mussel's current habitat. These testing variables were chosen based on a previously published study by Durate et al. (2014), and were derived from an analysis of previous data examining appropriate temperatures and CO_2 concentrations variables [2].
Adjusting the pH:
Once each of the nine environmental testing conditions have reached stable levels, testing will begin. To adjust the pH, each beaker of seawater will be kept on a stirring plate, and with a 200 ul pipette, one drop of 1.0 M of HCL solution at a time will be added. This will continue until pH levels of 7.0, 7.6 and 8.1 are reached. If the solution is made too acidic, then pH will be equalized via addition of 1.0 M NaOH solution. Beaker temperatures will be kept constant throughout testing by using three separate water baths, maintaining temperatures of 12, 20, and 28 degrees celsius.

Procedures

Testing:
Twelve day testing period will begin. Five live mussels will be placed into each beaker solution.
Each day the number of living mussel will be recorded. Mussels will be taken out of beaker individually and checked. Mussel is presumed alive if shell in closed. In presence of open shell, lightly tap mussel against surface. Shell closing, indicates life, no movement, presumably dead. Mussel activity will be recorded twice daily. Water pH and total alkalinity will be measured every three days via pH, and recorded. Water temperature will also be measured and maintained daily.
The entire experiment will be run in triplicate. Final mean and standard deviation will than be calculated across all studies.
Following completion, liquid beaker solutions will be discarded down the sink and mussels will be disposed of in waste bins.
.

Results

.



Conclusion

This experiment will test the effects of varied pH levels and temperatures on sea mussel survival, with implications on the adaptability of this species to environmental changes that are occurring naturally in seawater. Results will identify at which temperature and pH level that mussel larvae can no longer thrive. The data can then be translated from pH level into CO_2 concentrations using previously published formulas, and will allow comparison to Duarte's work (2014). I plan to use pre-existing studies that have projected the future ocean temperatures and pH levels to model potential environmental changes on sea mussel survival. The resulting data, together will results from preliminary studies, will be used to predict at which time in the future sea mussels will be unable to grow and develop their calcifying shell. I will also analyze my data to assess the possibility of adaptation, focusing on the mussels' resilience to warming and acidification. This project will adapt materials and methodology from a similar previously published study on mussel survival [2]. I predict that my results will follow in those footsteps. Yet, hopefully, veer from them in the sense that I'm measuring pH rather than CO_2 concentrations.

References

Anthony, K., Maynard, J. A., DIAZ-PULIDO, G. U. I. L. L. E. R. M. O., Mumby, P. J.,
Marshall, P. A., Cao, L., & HOEGH-GULDBERG, O. V. E. (2011). Ocean acidification and warming will lower coral reef resilience.*Global Change Biology*, *17*(5), 1798-1808. [7]
Banks, H., & Wood, R. (2002). Where to look for anthropogenic climate change in the ocean. *Journal of Climate*, *15*(8), 879-891. [4]
Coe, W. R., & Fox, D. L. (1944). Biology of the California sea-mussel (Mytilus californianus). III. Environmental conditions and rate of growth. *The Biological Bulletin*, *87*(1), 59-72. [5]
Cornwall, C. E., & Eddy, T. D. (2015). Effects of near-future ocean acidification, fishing, and