Ocean Acidification in the Pacific Northwest

Effects of Increasing Acidity on the Shell of the Local Clam, *Saxidomus giganteus*

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INTRODUCTION

Ocean Acidification is caused by increased concentrations of carbon dioxide in the atmosphere that dissolve in ocean waters (See Figure 3). This process decreases the pH of oceans, which will immensely alter ecosystems and marine organisms. Surface ocean pH is already 0.1 units lower than preindustrial values. [2] By the end of the century, it is estimated that the pH will drop another 0.3–0.4 units. [3] There is not enough information known about the ecological consequences of increasing acidification.

We studied the implications Ocean Acidification has on the Pacific Northwest's local butter clam, *Saxidomus giganteus*. Our investigation focused on the mass loss of the butter clam's calcium carbonate shell in acidic conditions versus average conditions. We believe these clamshells will lose weight over the duration of the experiment due to calcium carbonate decomposition. This is alarming because clams, corals, plankton and many more life forms will have difficulty adapting to conditions of lower acidity.[4] If these organisms could not survive the pH drop, oceans will have trouble continuing their precarious ecological balance.

METHODS

Collection:

24 butter clam shells were collected from Carkeek Park in Seattle WA.

Preparation:

Shells were cleaned and dried for 2 days in a drying oven at 50ºC and weighed before placing in the pH controlled water. Shells are dried for 2 days before each data collection. (Figures 4 and 5)

Weighing Process:

An analytical scale (0.00001 g) with side covers was used to weigh shells that had been dried for 2 days (Figures 6 and 7).

Lab Setup:

Shells were put into long mesh bags, tied off into sections; labeled then inserted into the tanks where pH and temperature was regulated. Total of 24 shells were used in this experiment; 3 high pH and 3 low pH shells were collected at the same time when creating data to observe average mass loss. A total of 4 collection and drying processes were done for this research (Figures 8 and 9).

	Low pH	High pH
pH	7.34 ± 0.06	8.16 ± 0.06
Temperature	10.2 ± 0.2ºC	11.0 ± 0.4ºC
Salinity	30 ppm	30 ppm

Figure 1: Water Conditions

ABSTRACT

Ocean Acidification is causing negative impacts on a large range of marine organisms by altering their ecosystem.[1] The acidity is causing difficulties in calcium carbonate shelled organisms to maintain their protective covering. This experiment tracks the modeled effects of lowing pH on the shells of Pacific Northwest butter clams, *Saxidomus giganteus*. Artificially bubbling CO_2 into seawater in a closed system and comparing weight over time shows a degradation of shell mass in the acidic tank. Our results validate predictions that an increase of CO_2 negatively impacts calcium carbonate shells. Further research will invariably explore multiple impacts on marine ecosystems, which will further support arguments for CO_2 reduction.

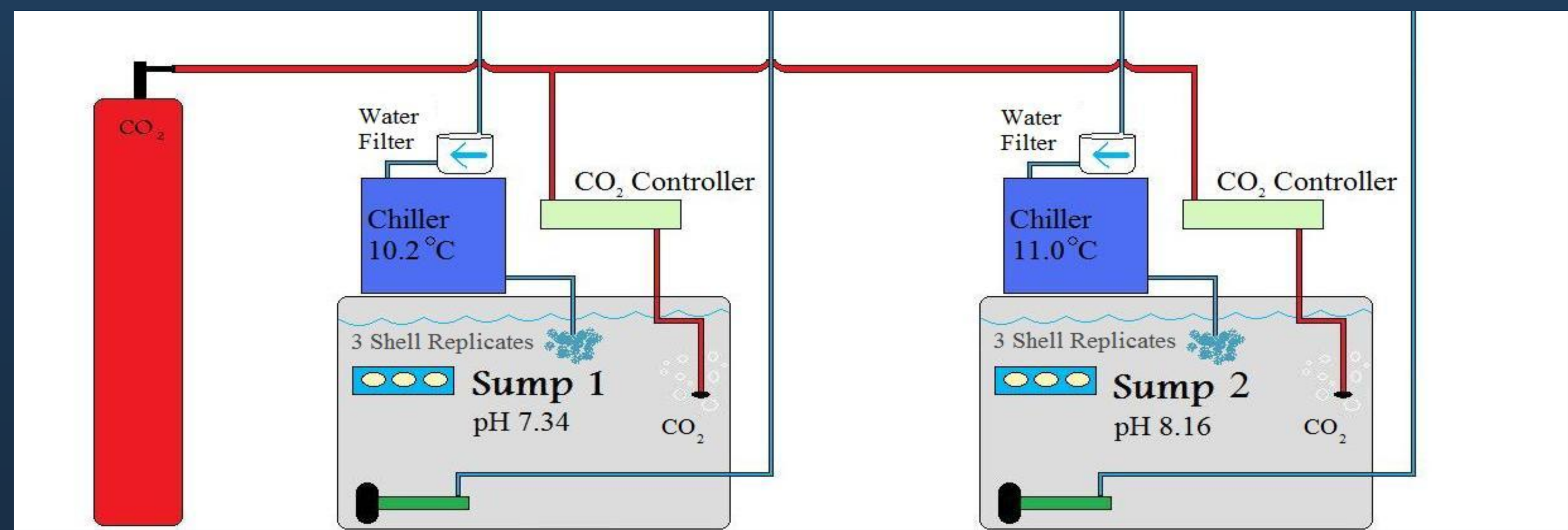

Figure 2: UW Lab Setup
Water is from the Seattle Aquarium and underwent UV and bio-filtration prior to use in experiments. Sump CO_2 diffusion into system is regulated by a solenoid mounted CO_2 tank; solenoid is controlled by a pH meter which continuously monitors the pH of the lower pH system.

Reaction	Description
$CO_2 + H_2O \rightarrow H_2CO_3$	CO_2 dissolves into seawater forming weak carbonic acid
$H_2CO_3 \rightarrow H^+ + HCO_3$	Weak carbonic acid dissociates into bicarbonate and H^+ lowers pH
$H^+ + CO_3 \rightarrow HCO_3$	H^+ ions steal CO_3 (carbonate) secreted by mollusks needing to build $CaCO_3$ (calcium carbonate) shells, rendering CO_3 unavailable to the animal

Figure 3: Ocean Acidification chemical process

Figure 4 (left)
Figure 5 (right):
Preparation

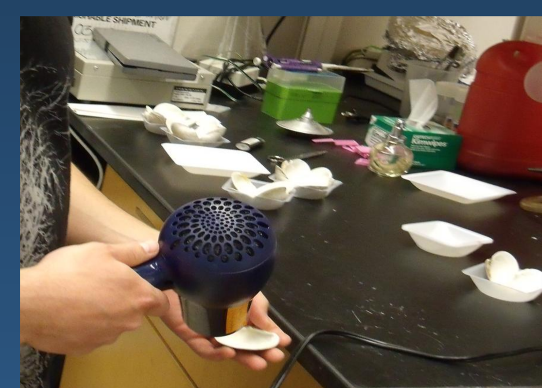

Figure 6 (left)
Figure 7 (right):
Weighing Process

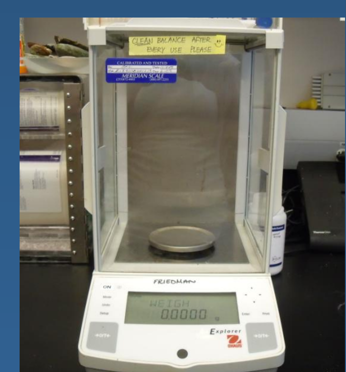

Figure 8 (left)
Figure 9 (right):
Lab Setup

RESULTS

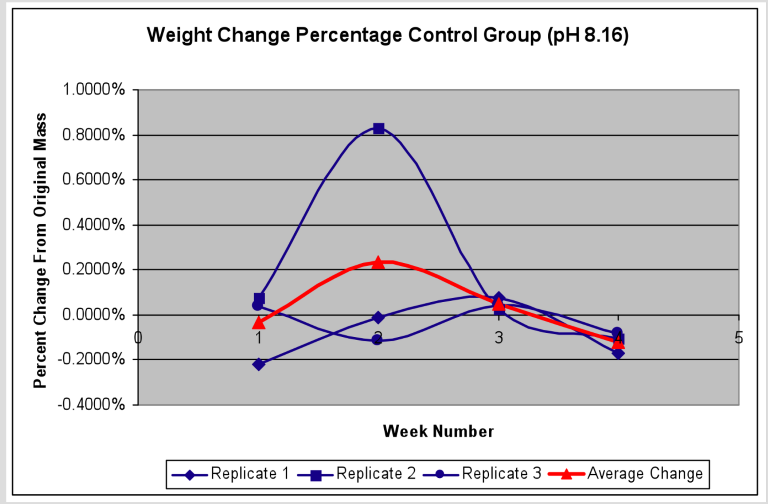

Figure 10: Results from control pH sump. This shows a consistent trend of little to no mass loss, which models the ocean's natural environment.

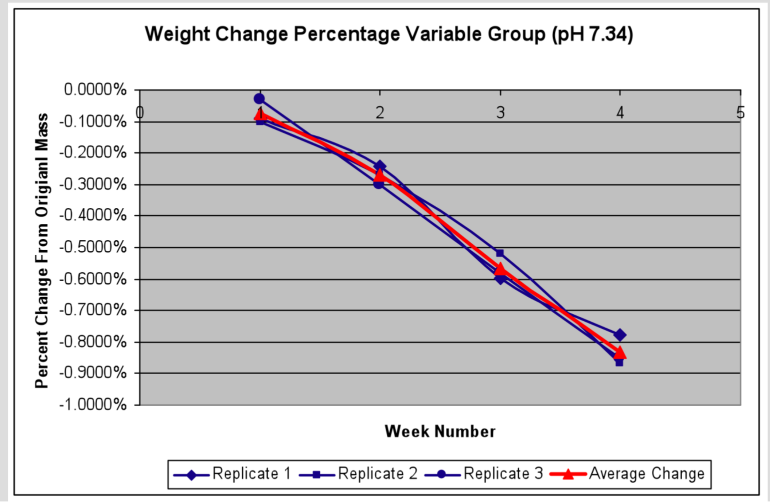

Figure 11: Results from the acidic sump. This graph clearly shows a degradation of mass, which can be explained by Ocean Acidification.

DISCUSSIONS

This experiment was started with the hypothesis that the shells placed in the variable pH water would lose more mass when compared to shells in the environmental modeled pH. Over the four weeks, we saw a significant downward weight loss trend in the acidic water. In the group's opinion, Carbon Dioxide (CO_2) dissolved into the water was the most likely cause of rapid erosion over such a short period of time.

After beginning this experiment, we concluded the time after which the clam actually discarded the shell was an important factor. Shells that had been inhabited for longer periods of time are more susceptible to degradation. If this experiment was conducted another time we would take that into consideration by standardizing the shell selection process.

Another concern we had during the experiment is whether the timeline was of a legitimate length. It would be interesting to document changes over many more weeks under lab conditions to gather more evidence towards the acidification process.

Surprisingly, some of the shells actually gained mass throughout the duration of the experiment. The shells that did so were all in the pH eight tanks. This data was completely unexpected, and should be further investigated.

As expected, reducing the pH by bubbling CO_2 into ocean water negatively impacted the mass of the *Saxidomus giganteus* shells. Human production of CO_2 has consistently risen over recent years without any notion of slowing, so one can extrapolate that ocean water will continually become more acidic. Not only will this greatly affect the mollusk population, as demonstrated by this experiment, but whole ecosystems will be forever altered.

The next step in understanding Ocean Acidification and the implications it carries lies in repeating experiments like this one. Plenty of questions still remain on the effects diverse populations of organisms will undergo. As knowledge strengthens about how humans are impacting the oceans, hopefully humans will begin to make changes that will slow the production of CO_2.

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1. Orr, Fabery, Aumont . Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature. Vol 437. 29 September 2005.
2. Haugan, P. M. & Drange, H. Effects of CO2 on the Ocean Environment. Energy Convers. Mgmt 37, 1019—1022(1996).