Region V, Southeastern MA
Climate Science:

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"The Effect of Ocean Acidification as a Result of Global Warming, on the Viability of Benthic Foraminifera"

ABOUT ME:

Tyler Barron is a 9th grade Earth Science student at Falmouth Academy, MA.

MY PROJECT:

Tyler's interests focus on the effects of global warming and future ramifications of rising CO_2 concentrations in the atmosphere. While researching topics for Science Fair Tyler came across articles discussing ocean acidification as a result of global warming, and its effects on oceanic organisms.

Tyler found that global warming and the constant increase of anthropogenic (human-generated) CO_2 have brought about the consequential effects of ocean acidification. The uptake of carbon dioxide from the atmosphere into the ocean leads to a decrease in oceanic pH levels. Over the past 420,000 years the concentration of carbon dioxide in the atmosphere has fluctuated between 200 and 280 ppm but since the Industrial Revolution this concentration has risen to 375 ppm (Bernhard, 2001). Fossil fuels contain carbon taken from the atmosphere millions of years ago, and when burned, this carbon combines with oxygen to release energy plus the by-produce CO_2; as a result of these use of these fossil fuels, the amount of carbon dioxide has gradually escalated over the last 200 years, forcing the world's oceans to absorb a greater concentration of CO_2.

CO_2 that is released into the air and absorbed by ocean water combines with seawater to form carbonic acid which releases hydrogen ions, some of which bond with carbonate ions to form bicarbonate ions, in the end decreasing the overall pH level ($H_2O + CO_2 <=> HCO_3^- + H^+$). Since many marine organisms use the calcium carbonate in the oceans, the lower pH levels reduce the carbonate saturation of sea water making calcification harder for marine organisms as well as weakening any calcium structures that have previously been formed. As a result, it would imply that reef structures and coral skeletons will weaken significantly with the increase in dissolved CO_2. This could lead to selection of more tolerant species, causing substantial changes in the structure and function of marine ecosystems (Royal Society, 2005). The biological implications are the negative affect on such calcareous marine organisms by affecting their ability to produce an exoskeleton, and consequential negative effects on the ecosystems which they support.

Tyler's interest in this topic took him to the Woods Hole Oceanographic Institution to work with Dr Joan Bernhard, a specialist in the field of ocean acidification affects on the calcareous marine organism foraminifera. Foraminifera are calcareous singled celled protists (micro-organisms with a nucleus, but with no differentiation in their cells) that live in both the benthic (floor) and pelagic (open water) regions of the ocean (Pilson, 1998). Foraminifera build their shell from the calcium carbonate found in seawater. However due to the reduced calcium ion concentrations as a result of increased CO2 absorption foraminifera have been greatly affected (Pilson, 1998). Tyler hypothesized that ocean acidification will decrease the survival rate of foraminifera.

Procedure: The ocean has a basic pH level; estimates are that pre-Industrial Revolution pH was 8.18; while current pH levels are at 8.1. Twelve benthic foraminifera were placed into one of the three pH concentrations, 7.531, 7.771 and 7.917, made prior to the test. After 12 days, the foraminifera were taken from their assigned pH treatment and individually tested for their ATP (Adenosine Triphosphate) level. These ATP concentrations, taken by a luminometer, helped to determine the viability of each benthic foraminifera. Contrary to the hypothesis, which stated that ocean acidification would decrease the viability rate of benthic foraminifera, those foraminifera in pH concentrations closest to ambient seawater had the lowest survival rate. Ten foraminifera were alive at the end of the experiment in pH 7.531, all twelve in pH 7.771 and eight in 7.917, indicating that the hypothesis was not supported. This led to the conclusion that foraminifera might show a preference for pH levels around 7.7 and also that, although the most foraminifera survived in pH 7.771, in general, foraminifera are affected by any changes in pH levels.

Tyler concluded that the foraminifera are sensitive to pH levels, and that therefore, altering of the environment meant that a change in these levels will require these organisms to change or die and as in all marine ecosystems, other organisms must do the same. Tyler warns that the threat of ocean acidification poses serious implications on the viability of aquatic life.

Without the motivation to reduce CO_2 emissions, these ecosystems, along with various economies and communities dependant of fisheries and marine animals for survival will suffer.