Ocean Acidification

By Bonnie McKenna

There is a no more significant group of ocean enthusiasts than scuba divers. As I write this, there are divers out enjoying the bounty and beauty of our oceans underwater; those very people are also seeing reef destruction and diving with floating rubbish. It has happened to me, and I am sure it has happened to you.

We are also concerned with what is referred to as ‘ocean acidification’ and ‘global warming,’ often spoken of as two separate entities. They are different, but inexorability connected like everything is in this world. For example, driving down a highway in any city in the world is related to the strength of the shell of the tiniest mollusk at the bottom of the deepest ocean.

Not everyone believes in ‘ocean acidification,' ‘global warming,' or that we are doomed as a result. This article is not designed to make you believe it or not; this is just a story and the science that makes connections. In fact, most scientists, until this century did not give much credence to these theories and many textbooks, still, have not corrected the science.

The earth has, in millennia past, gone through a period of ocean acidification and global warming. Science knows that this occurred by a natural phenomenon where an excessive amount of CO2 was released into the atmosphere. They do not know what caused it, but they do know the results. It is believed, that plants and animals, both land and sea, underwent massive changes. Not overnight, but over thousands of years; those that could adapt survived and flourished.

The latest study (2017), revealed global emissions from all human activities will reach an all-time record of 45 billion tons of CO2. Even though the ocean is immense, enough CO2 can have a significant impact by dropping the pH of surface waters. A quick change in the chemistry of the ocean does not give marine life, which evolved over millions of years, much time to adapt. Scientists have been tracking the pH of the ocean for many years, but biological studies only started recently.

The term “ocean acidification’ was coined in 2003 by two climate scientists, Ken Calderia and Michael Wickett, working at the Lawrence Livermore National Laboratory in Northern California. Calderia said he chose the term ‘ocean acidification’ for its shock value. Seawater is naturally alkaline.

‘Ocean acidification’ is a consequence of excessive amounts of carbon dioxide (CO2) dissolved in the ocean which, in turn, correlates to the pH of seawater. The pH scale is a measure of the acidity or alkalinity of an aqueous solution. For science nerds, like me, it is approximately the negative of the base 10 logarithms of the molar concentration, measured in units of moles per liter, of hydrogen ions. The pH scale ranges from 0 to 14; 7 is neutral. The higher the pH (1-7), the more acidic; the converse (7-14) is more alkaline. Seawater, normally alkaline, has a pH ranging from 7.8 to 8.5.

Carbon dioxide (CO2) is naturally in the air; plants need it to grow, and animals exhale it when they breathe. Most of the CO2 collects in the atmosphere, but approximately 30 percent of it dissolves in the ocean and then it is released back into the atmosphere. This is known as the Carbonate/Bicarbonate System or the Carbon Cycle; it is the ocean’s process of maintaining equilibrium.

When water (H2O) and CO2 mix, they form carbonic acid (H2CO3) a relatively weak acid – we drink it in carbonated beverages. As with all acids it breaks down to hydrogen (H) and carbonate (CO3) ions. More hydrogen (H) ions are the clue to raising the pH of the water. This causes in fact, for the seawater to become less alkaline not more acidic (pH less than 7).

Marine creatures that require calcium to build shells (mollusks, crabs, lobsters, sea stars, urchins and corals) are especially sensitive to a change in the pH of seawater. The calcium these animals use to make their shells is derived from their environment either from the food they eat or the water they dwell in. The shell is formed, repaired and maintained by a part of the anatomy called the mantle. If the animal encounters harsh conditions that limit its food supply, it can become dormant, or the mantle ceases to produce the shell substance. The hydrogen (H) ions have a greater affinity for the carbonate (CO3) ion than the weaker calcium (Ca) ion. If a hydrogen ion bonds with a carbonate (HCO3) it prevents shell-building organisms from extracting the carbonate (CO3) ion they need to bond with the calcium (Ca) ion. With less calcium carbonate (CaCO3) available the shell becomes less viable, can weaken and even dissolve.

The increased atmospheric CO2 as a result of burning fossil fuels has driven this entire reaction to far to the right (less alkaline). The result: ‘Ocean acidification.’

This brings us back to the example of how driving down the highway with hot gasses, CO2 and other pollutants spewing from the exhaust pipe can affect the strength of shells of not only the tiniest mollusk in the deep ocean but all shell-building animals and corals.

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Deep Future, The Next 100,000 years of Life on Earth, Curt Sager, 2011

Science still does not understand the life histories of most marine animals, much less than their responses to chemical changes in seawater. The challenge is to take a ‘giant step’ from shared knowledge to shared responsibility on a global scale.