Interviews with Report Authors

Scientists are working to better understand how ocean acidification will impact habitats, animals, and people. Here, two ocean scientists – both members of the committee that wrote Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean (2010) *– share insights from their own research.*

James Barry is a senior scientist at the Monterey Bay Aquarium Research Institute. He studies several aspects of the biology and ecology of marine organisms and communities, focusing on factors that influence the structure and function of marine ecosystems.

Q: When did you first begin to consider the impacts of ocean acidification on marine life?

A: My interest in ocean acidification was sparked when I heard scientists suggesting that perhaps we could lessen the impact of climate warming by placing some of the waste carbon dioxide produced by power plants into the deep sea. I couldn't help but wonder if deep sea animals such as crabs, urchins, and fish, would react to the changes in the chemistry of sea water caused by the addition of carbon dioxide to the ocean.

Q:? What are some of the early experiments you carried out to investigate ocean acidification?

A: My research group, in collaboration with other ocean scientists, designed experiments to understand how marine organisms would be affected by increased carbon dioxide. Our plan was to release a small amount of carbon dioxide deep below the ocean's surface, and to analyze the response of ocean animals to the carbon dioxide.

At the high pressures of the deep sea, carbon dioxide is a liquid, not a gas, so we obtained some liquid carbon dioxide from a soda vendor. Using a remotely-operated undersea exploration vehicle, we carried a container of liquid carbon dioxide deep below the ocean's surface and released it onto the seabed. Cameras attached to the vehicle to transmitted images back to the lab, and we watched to see what would happen.

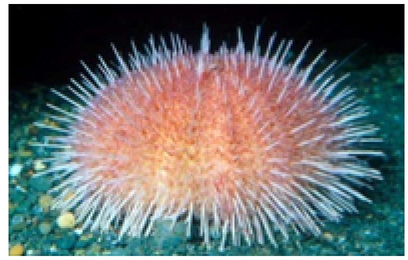
Within a few minutes, a grenadier fish approached the pool of liquid carbon dioxide and swam directly into it, dipping its nose into the fluid. It immediately turned and swam rapidly away – had the carbon dioxide affected the fish in some way? Then a small brittle star – a species related to a sea star – moved close to the pool of carbon dioxide, sensed it, and quickly crawled away. Why?

We knew that as carbon dioxide mixed with seawater, chemical reactions would occur that would make the water more acidic. We concluded that the deep sea animals were probably reacting to the acid produced as the liquid carbon dioxide reacted with sea water.

Q: How did these early experiments direct your later research?

A: Around the time of these initial experiments, there was a "gee whiz" moment for the biological oceanography community as a whole. We'd known for quite a while that the oceans were absorbing carbon dioxide from the atmosphere. But now scientists realized that ocean chemistry was changing rapidly as a result of this absorption, and that it would change marine ecosystems.

As this concept dawned on us, my research shifted. I no longer wondered if carbon dioxide would impact ocean life – it was clear that it already was. Instead, I wanted to know how changes in ocean chemistry would affect different types of marine organisms.



From my laboratory's early experiments, we'd learned that some animals were harmed by exposure to more acidic conditions, while others seemed to be more tolerant. We began to study the differing effects of ocean acidification on animals native to the shallow and deep areas of the ocean, in the hopes of figuring out how ocean acidification would affect different ecosystems.

Q: Why study the Deep Sea?

A: The ecosystems of the deep sea are very different to those of more shallow, coastal waters. In coastal waters, organisms experience dramatic changes in their environment on a regular basis. For example, floods may bring a surge of freshwater, changing the salt content of the water; the temperature of the water can vary with the season, or currents, and rivers can carry nutrients from land run-off that can affect oxygen levels and acidity. In contrast, conditions in the deep sea are cold and dark fairly constantly. As a result, the animals that live in deep-sea ecosystems are generally ill-equipped to respond to environmental change. For this reason, many researchers think that deep sea organisms may be more severely impacted by ocean acidification than their shallow-water counterparts.

Q: What experiments did you carry out to investigate your new research question?

A: One experiment was to investigate the different reactions of a deep water crab and a shallow water crab to ocean acidification. The shallow water crab – a Dungeness crab, the type you often find at restaurants – recovered quickly from carbon dioxide stress, but the deepwater crab did not recover. This showed that animals accustomed to different environments have different capabilities for dealing with environmental stress.

In this laboratory experiment, sea urchins are exposed to high carbon dioxide conditions in sample jars.

We chose to study crabs because they are important members of marine food webs, and thus provide insight into ecosystems will fare in changing conditions. We hope that comparing the performance of various types of animals that are important in shallow and deep water communities will help us develop an understanding of the overall sensitivity of marine ecosystems to ocean acidification.

Q: Why is it important to study different ecosystems?

A: As a society, we need to know how environmental changes like ocean acidification will affect the distribution and abundance of life in the ocean and the function of whole ecosystems. Ultimately, those ecosystems produce marine fisheries, purify our water, and provide other ecological services we depend upon.

But it isn't really possible to perform experiments to measure how ocean acidification will affect whole ocean ecosystems. We can, however, measure how well different animals cope with ocean acidification using a combination of lab experiments and field studies. The species that perform best in our experiments are more likely to continue to survive, grow, and reproduce as the ocean becomes more acidic than those that are less tolerant of experimental acidified conditions.

Combining the findings of many different studies, we hope to be able to predict how ocean acidification may affect the composition and function of marine ecosystems and the services they provide for society. That will help us make informed decisions about how we deal with carbon dioxide.

Joanie Kleypas is a scientist at the Institute for the Study of Science and the Environment. She studies how coral reefs and other marine ecosystems are affected by changes in the Earth's atmosphere and climate.

Q: When did you first begin to consider the impacts of ocean acidification on marine life? What inspired you to look into this research area?

A: Most of my work has involved using simple computer models to simulate how much coral reef growth has changed in the past, and how much it is likely to change in the future. These models use environmental information such as temperature and light to calculate how much calcium carbonate is produced by corals, and how much is removed by erosion and dissolution.

In 1997, a colleague, Dr. Bob Buddemeier, suggested I also look at the carbon chemistry of seawater as another environmental factor, in addition to temperature and light. I did, and it turned out to be a good predictor of reef growth.

Bob had also convinced another colleague, Jean-Pierre Gattuso, to do lab experiments of growing corals under different carbon dioxide conditions. Those results as well as other pieces of evidence convinced us that rising atmospheric carbon dioxide was changing ocean chemistry, and that corals were going to be affected by it.

Q: Please describe an experiment you carried out to figure out how ocean acidification would affect marine life.

A: I've continued to use computer models to predict where and when reefs will continue to grow – the places where more calcium carbonate is produced than is removed – and where and when they will erode away.

Q: Why is it important to study coral? Why does it matter if coral reefs erode or grow?

A: Corals are important both ecologically and geologically. Ecologically, coral reef communities are probably the most diverse on the planet, rivaled only by tropical rainforests. They are not only beautiful and fascinating, which is of course one reason I've chosen to study them, they also support many people around the world because they are important to fisheries and tourism. Geologically, coral reefs have produced a huge amount of rock on the planet. The Great Barrier Reef, for example, is a composite of reefs that have grown layer by layer for thousands of years, into one of the most significant ocean features that can be seen from space. This reef, and many others, act as protective offshore barriers that protect coastlines, provide shelter for many marine organisms, and of course, support their high biodiversity.

Q: Have there been any surprises since you started investigating ocean acidification?

A: This is an interesting question. Scientifically, yes, there have been many exciting surprises. I feel the most fascinating, if disturbing, aspect of this research is that ocean acidification affects not only marine calcifiers, but other organisms that are vitally linked to the major nutrient cycles in the ocean. In the non-scientific world, I have been surprised by the attempts by some to discredit even the most robust scientific findings on ocean acidification.