The Natural Laboratory Podcast Transcript: Acid Ocean: Where will all the seashells go?

Introduction

This is the Natural Laboratory, a podcast exploring science for Bay Area National Parks. I'm Cassandra Brooks.

More than a hundred thousand marine species built their bodies using calcium carbonate, including snails, oysters, sea stars, coral, and plenty of planktonic animals.

This incredible diversity of life evolved over millions of years as animals figured out ways to pull calcium and carbonate ions from the water to build shells and skeletons so robust that they remain intact long after the animals perish.

But all of this is changing. Our addiction to fossil fuels and the billions of tons of carbon dioxide [CO_2] we're pumping into the atmosphere each year may be undoing millions of years of evolution in a geological blink of time.

Ann Russell Interview

Ann Russell: Geochemists and oceanographers have known for a long time that when CO_2 dissolves in water, it forms an acid.

Cassandra Brooks: That's Ann Russell, an ocean geochemist at the University of California, Davis who studies ocean acidification in Tomales Bay, just east of Point Reyes National Seashore.

Almost one third of the world's carbon dioxide is absorbed by the oceans, says Ann. This excess CO_2 reacts with seawater, freeing hydrogen ions, which lowers the pH and makes the water more acidic.

Living in more acidic waters is bad enough for shell-building animals, but CO_2 adds another problem. Animals need both calcium and carbonate to build their skeletons. But the extra hydrogen ions in the high CO_2 water bind carbonate, reducing the amount available for animals to build their shells. So, what might this mean for the future of calcifying organisms?

[somber music and a video of a sand dollar dissolving in acidic water with a pH of 4.7]

AR: Just to bring in some of the geologic perspective on this, 18,000 years ago during the last glacial maximum, atmospheric CO_2 was 200...200 parts per million. Then it rose at the end of the glacial period.

CB: But it only rose to 280, Ann says. And the increase happened over an 8,000-year period.

Since the industrial revolution, atmospheric carbon dioxide has now spiked to more than 390 parts per million. That's an increase of 110 ppm in only 250 years.

AR: So, they're faced with much more rapid change than has ever been seen in the geologic record...ever. We don't have a geologic analogue for the rate of change going on right now.

Terry Swyer Interview

CB: Given how fast the ocean's chemistry is changing, it's no surprise that we're beginning to see widespread effects in many calcifying animals, including those we like to eat. Oyster hatcheries in the Pacific Northwest have recently experienced massive larval die offs. When scientists measured local seawater, they found that during certain times of the year, the waters were corrosive enough to be the culprit.

Terry Sawyer: It's fairly insidious, as far as the effects, if you're talking about degradation of shell because of the lack of ability to bind the calcium carbonate, which is what our bivalves use to build their homes.

CB: That's Terry Sawyer, one of the owners of Hog Island Oyster Company in Marshall, California. Terry said that young oysters are particularly vulnerable to ocean acidification. Their thin shells dissolve much faster and they struggle to make their transition from planktonic larvae to settling out on the sea floor. In general, more acidic waters simply stress the animals out.

Terry Sawyer Interview (continued)

TS: So, what is the...what are we seeing, you ask. Let's say, in the past five years—let's go even ten years—we're seeing disease, a lot of disease issues. Why are they becoming more, uh, susceptible to disease? So, one, maybe there's an introduction of that disease from another shellfish growing region. You know, maybe there's transport going on. Maybe there is stress. And that's where we go into the OA.

CB: OA or ocean acidification.

Hatcheries and oyster growers are actively discussing mitigation strategies, like only pumping in seawater during low CO_2 periods or installing seawater treatment systems.

Andrew Dickson Interview

CB: These strategies might work in the short term, but they would prove ever more difficult as atmospheric CO_2 levels continue to rise. And they're sure to continue rising. Even if we stopped all CO_2 emissions tomorrow, the oceans won't quickly return to pre-industrial levels.

Andrew Dickson: That's one of the biggest concerns—if we add CO_2 to the oceans, and then we just stopped, how long would it take.

CB: That's Andrew Dickson, a chemical oceanographer with the Scripps Institution of Oceanography.

AD: One picture is that it would keep going up a little bit, because the CO_2 in the atmosphere has not all yet dissolved in the ocean. But after a while, it would start coming down. Unfortunately, "after a while" is tens of thousands of years. We're putting it in over a few hundred years, and if we leave it to purely natural processes of our planet to take us back to where it would—I don't like to use the word—perhaps, "prefer" to be, the general chemistry, it's going to take tens of thousands of years.

CB: Do you have any visions in your mind of what the future ocean's going to look like in light of these changes? [pause] Visions, nightmares, dreams…?

AD: Visions, nightmares, dreams, I don't know. [pause] Clearly, it's going to change the possibility for a variety of calcium carbonate organisms in certain environments.

The coral reefs—if they grow more slowly, they are always being hit by waves and broken up. So, you have to keep growing back. If it's harder for them to grow, then they may get to the point that they're not growing fast enough to stay the same and start shrinking. And the coral is a wonderful place, um, the reason it looks so beautiful—with all the fishes and everything—is because it provides so much protection for all these varying different species. It's a whole ecosystem that is kept there, in part, just because there's this reef.

CB: We've touched on, sort of, worst-case scenarios of...of animals dissolving. What's, sort of, what's the best-case scenario of what...what we could expect in the future?

AD: Probably, the best case would be a combination of things happening at once. We could reduce how much CO_2 we were putting in the atmosphere so that we never went to the stage to where it's guaranteed to be bad—just to where it might not be good. We might be lucky. There could be organisms that have within their genetic capacity the ability to adapt to the changed chemistry. That's plausible. Is it likely? We don't know. We really don't know.

In addition, there might be some local things we can do that help. For instance, we were talking here about helping hatcheries for, uh, oyster larvae, where a very simple dealing with it—don't take high CO_2 seawater—that would work. That would work locally. You could almost imagine making changes on a ...on a larger scale, a few square miles even. But I can't imagine making those changes on the whole of the ocean. So, it would be a matter of deciding that there were some parts that were more sensitive or more valuable and...and taking active action to change things.

Conclusion

It's hard to imagine that humans are burning so much fossil fuel that we've altered our atmosphere—and now our oceans—faster than has ever happened in the history of the Earth. And it's easy to feel hopeless. But I walked away from my conversations feeling that our fate—and the fate of our oceans—were not yet sealed.

We live in an ever-connected world, which affords incredible power to educate and be educated. We have the power to learn about the world around us and to listen to the scientists who are continuously deciphering our impact on it. We have the power to teach our children, to inspire change in our communities, and to support policies that are in favor of a healthy planet. We have the power to make a choice—every day—about how we live our lives.

With the Pacific Coast Science and Learning Center, I'm Cassandra Brooks.