The Glow of Discovery

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Edith Widder has spent a lot of her career underwater—deep underwater. In diving suits and submersibles, she has collected, measured, and studied bioluminescent creatures of the deep ocean. Working with engineers, Widder has also developed innovate instruments that allow scientists to see the deep ocean in new ways. Her camera systems Eye-in-the-Sea and Medusa have captured video not only of new species, but also of the giant squid in its natural habitat. In 2006, Widder was named a MacArthur Fellow for her work with ORCA, an organization dedicated to conserving the oceans—the setting of what she calls an "absolutely amazing, dream career."

Action potential

In my high school yearbook, I said I wanted to be a marine biologist. But when I got to college, I started to realize that not many people get to become sea-going marine biologists; there just wasn't a lot of funding for that kind of work. At that point I was getting really interested in neurobiology, and as it turned out, a lot of my undergraduate neurophysiology work was on marine organisms.

I did my Ph.D. in neurobiology in James Case's lab at UC Santa Barbara. When I started, Jim and Beatrice Sweeney, a major authority on bioluminescence, were planning an experiment in which an electrode would be inserted into a bioluminescent dinoflagellate to record the action potential that triggers the flash of light. Bioluminescence was a cool topic, and to be working at the edge of human knowledge about it was thrilling to me.

Drawn to the light

With a grant from the Navy, Jim acquired the latest and greatest spectrometer that could measure really, really low light levels. It was key for being able to measure the emission spectra of bioluminescent organisms. It was a complicated piece of gear, but I've always been a gadget freak, and over time I became the lab expert on it. At that point, Jim decided that we needed to start measuring all these animals in the ocean that make light. Suddenly, I was a sea-going marine biologist.

The first time I went to sea, the researchers were doing trawls with special nets that could bring animals up alive, and they were bringing up unbelievable creatures. I couldn't believe these things even existed—I'd never even seen a picture of anything like this anglerfish, this dragonfish—and they had light organs all over them. I was beside myself.

On another cruise, they were testing a diving suit called the WASP as a tool for ocean exploration. I was out there to measure any of the animals they were able to collect, but I'd talk on the headset to whoever was down in the suit. I'd ask them to turn out the lights and tell me what they saw, because I knew they'd see bioluminescence. They would say, "Oh, wow, that is so cool!" It was driving me nuts. I trained as a pilot over the next year so I could go down and see for myself.

An explosion of curiosity

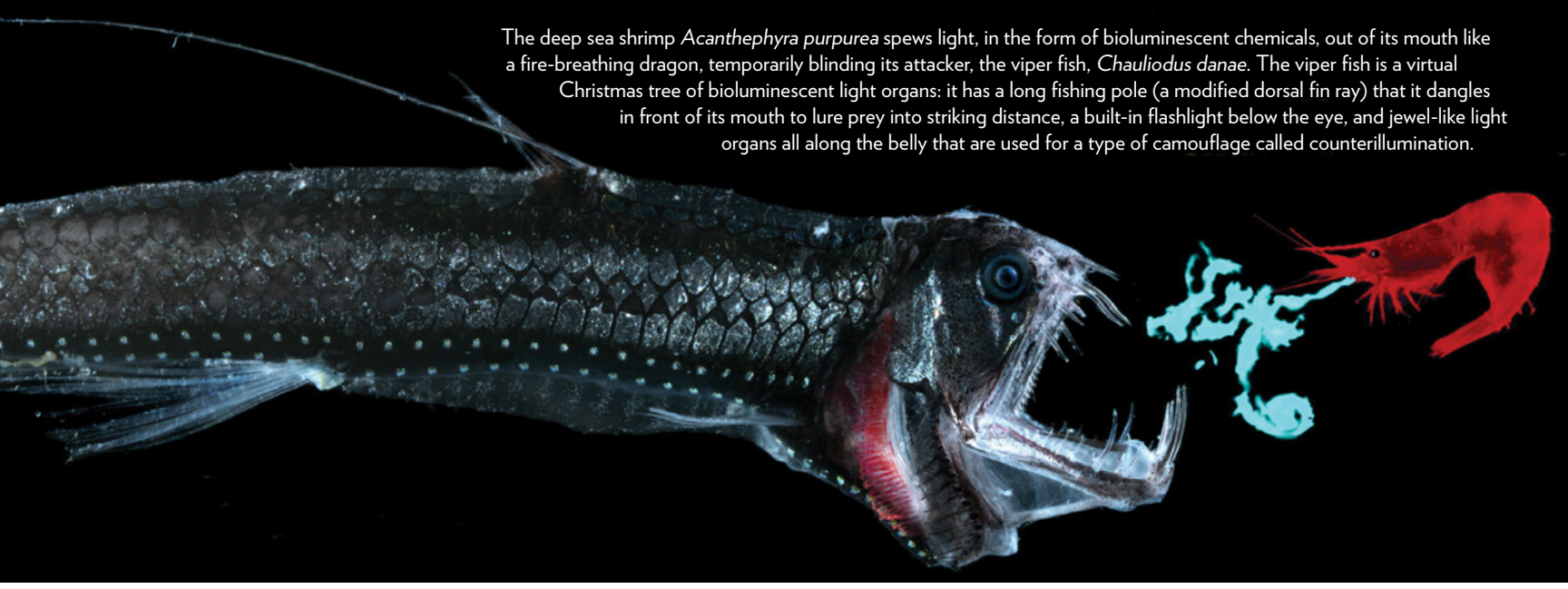
My first dive was an evening dive in the Santa Barbara Channel. I went down to 880 feet, and I turned out the lights. I was blown away, just absolutely blown away. There is no statistic that can prepare you for seeing that kind of a living light show. I knew that this was what I wanted to see for the rest of my life.

I was suddenly filled with questions. Why were all these animals making light? A single photon of blue light is energetically equivalent to the hydrolysis of six ATP molecules, and one of these flashes of light can produce 10^{11} photons. It's a staggering amount of energy for an animal to use, so what were the driving forces? I wanted to know the evolutionary pressures that led to this. I wanted to know how it all worked. I wanted to know which animals were communicating with which animals and what they were saying.

Mission: Imperceptible

When I was diving in the WASP, I wanted to talk to the animals. I created a blue LED light stick that I could flick on and off, thinking that the animals would respond. They didn't. It was very frustrating for me, but then I realized that I wasn't exactly unobtrusive, bouncing up and down in a big bulbous yellow suit. I knew we'd been scaring a lot of animals away with motion and noise.

So we set out to develop a camera system that could sit inconspicuously on the ocean floor and record animals without disturbing them. After a lot of development and testing, we finally had a system that we took on an expedition to the Gulf of Mexico. We put the camera down next to a brine pool—an amazing underwater oasis



The deep sea shrimp *Acanthephyra purpurea* spews light, in the form of bioluminescent chemicals, out of its mouth like a fire-breathing dragon, temporarily blinding its attacker, the viper fish, *Chauliodus danae*. The viper fish is a virtual Christmas tree of bioluminescent light organs: it has a long fishing pole (a modified dorsal fin ray) that it dangles in front of its mouth to lure prey into striking distance, a built-in flashlight below the eye, and jewel-like light organs all along the belly that are used for a type of camouflage called counterillumination.

where I thought large predators might patrol. For the first four hours of its deployment, it just sat there filming with the red lights on, and then an optical lure was programmed to turn on. This was the electronic jellyfish, or e-jelly, I'd developed to imitate a type of bioluminescent display that I thought might be attractive to large predators.

Deep discoveries

When we got the camera back and reviewed the video, I saw fish swimming around, straight toward the camera and the lights, clearly not disturbed. I was over the moon because I had a window into the deep sea.

And then the e-jelly came on. Eighty-six seconds later, a squid over six feet long was attacking my electronic jellyfish. It was unbelievable. I shared the video with experts at the Smithsonian, and they told me it was a squid so new to science it couldn't be placed in any known scientific family.

We then started developing a version of this camera system that could be deployed without requiring the use of either a submersible or ROV. That yielded the Medusa, which could just be dropped off the back of the ship. That's what I took with me to Japan on the hunt for the giant squid. Incredibly, the Medusa recorded the first images ever of a giant squid—which can grow to over 40 feet long and has an eye the size of your head—in its natural habitat. It was an experience I wouldn't have imagined in a million years.

On board with ORCA

In 2004, the U.S. Commission on Ocean Policy released a report that detailed the deteriorating state of the ocean and the fact that we had little time to act if we were going to save it. I'd had this absolutely amazing, dream career, and I realized that it was time to give something back.

I started the non-profit Ocean Research and Conservation Association to focus on developing technological solutions to conservation challenges. What I like best about science is solving problems, and discoveries can come on any front. Learning to figure out new ways to track pollution in the ocean, for example, turns out to be just as exciting for me as getting those first images of the giant squid. Well, almost as exciting.

The power of optimism

I'm not being overly dramatic when I say that conserving the oceans is about human survival. They are a critical part of our planet's life-support system, and they are in collapse. The idea that we could actually be changing the chemistry of the ocean is mind boggling, but what's even more mind boggling to me is that we have every tool we need to solve these problems. What we lack is the will.

It gives me hope when I see kids who are willing to take on the challenge. One of the most important tools—maybe *the* most important tool—they need is optimism. It's the optimists who are going to find solutions.

So to future explorers I say, "Don't let anyone tell you there's nothing left to explore. We have explored less than five percent of the ocean." And to present explorers I say, "Share the excitement any way you can. People only protect what they love, and they only love what they understand." My hope is that we can teach people about all the amazing things there are to love in the ocean before it's too late. ■

Learn more about Dr. Widder's work at www.teamorca.org.