Exploring the amazing life and lights of the ocean depths

January 9 2023, by Anna Miller

Edie Widder in the WASP atmospheric diving suit. "I went down to 800 feet and turned out the lights, and I was just blown away," says Widder. Credit: Courtesy of Edie Widder

Edie Widder is one of the few people in the world who has been to the bottom of the ocean. She's a deep-sea ocean explorer, and among many discoveries, was the first person to ever capture a giant squid on camera.

Widder, the CEO and senior scientist at the Ocean Research and Conservation Association, has spent most of her career as a deep-sea biologist and is a pioneer in the field of bioluminescence research—studying how and why deep-sea creatures make their own light.

Over the years, she has created groundbreaking technology to capture never-before-seen behaviors and discovered new species in the oceans. She's written a book about her life's work, "Below the Edge of Darkness: A Memoir of Exploring Light and Life in the Deep Sea."

"When you enter the ocean in a submersible, the first thing you notice is how the colors change dramatically," says Widder, recipient of a 2006 MacArthur fellowship.

"They go from blue-green near the surface, to richer and richer blues, until you're down to indigo blue, and then down into blackness," she says. "You start seeing these sparks of blue-green flashes all around you. And that's the magic for me—all of this bioluminescence that is so much a part of life on Earth, because it's so much a part of our ocean and that so few people know anything about."

Tufts Now spoke with her about her life's work, and what it's like being

face-to-face with teeming life far underwater, and how she remains optimistic in the face of climate catastrophe.

Tufts Now: What were your first experiences with deep-sea diving and seeing light in deep water.

My first dive in a submersible was in a diving suit called WASP, an evening dive in the Santa Barbara channel. I went down to 800 feet and turned out the lights, and I was just blown away. Later when I was asked what it was like down there, I blurted out, "It's like the Fourth of July," which got quoted in a local newspaper, and for which I took a considerable amount of ribbing from my colleagues.

In fact, it's better than the Fourth of July, because you're not just observing this fireworks display from a distance, you're right in the center of it. That's because every move you make triggers these flashes and glows, with sparks that look just like when you throw a log on a campfire. Only these are icy blue embers. It's breathtaking, and it's a lot of energy. And there are so many animals doing this.

What kinds of animals are capable of bioluminescence? In your book, you talk about this wide array of species that are capable of making light.

On my first expedition on a ship, we were bringing up deep-sea animals, because we had a net that kept the animals cold. If you can keep them cold, you can sometimes keep them alive for short periods of time.

It seemed like just about everything we brought up made light. This is true in all of the oceans of the world. About 75% of the animals that you bring up in a net—the fish, the squid, the shrimp, the worms, the jellyfish—make light, and they do it to help them survive in a dark

world.

It helps them find food, either with built-in flashlights or a glowing lure like that scary-looking fish from Finding Nemo. They also use it to attract mates with special flash patterns or specially shaped light organs, and for defense. For example, when a squid or an octopus squirts an ink cloud into the face of a predator, they can squirt bioluminescent chemicals, which are called luciferins and luciferases, into the face of a predator, temporarily blinding the predator while they swim away in the dark.

A lot of them use bioluminescence for camouflage, producing light from their bellies that exactly matches the color and intensity of down-only sunlight. So they obliterate the shadow, the silhouette that they create that is the search image for most predators in the open ocean environment. It's a perfect camouflage. If a cloud goes over the sun and dims the sunlight, they dim their bioluminescence. They just disappear.

What's one of your favorite creatures that you've seen on your dives over the years?

It was a deep-sea octopus that we discovered had glowing suckers. That was a major discovery in and of itself, but the thing that made it especially cool was when we examined those suckers' light organs, we discovered that the suckers were turning into light organs. We could see the vestigial muscle rings around the sucker. It was an example of evolution caught in the act.

For whatever reason, it got pushed out in the open deep-water environments, where its suckers were no longer useful for hanging onto things, but they were useful for mating. They will throw their arms up over their heads to attract a mate. "Hey, look what I've got." And they

developed this ability to make light.

People think of the deep ocean as just being vast and empty and dark, but you're saying it's far from being that.

There are animals in every cubic meter of the ocean and every cubic meter of the ocean contains bioluminescence as well. The argument could be made that bioluminescence could be the most common form of communication on the planet. There are people that would argue with me about that, but still, it's pretty huge.

When you were about 18 and a student at Tufts, you went in for back surgery and ended up in the ICU, near death. Can you do talk about how that changed your view of not only life, but also did you apply any of what you learned to your life's work?

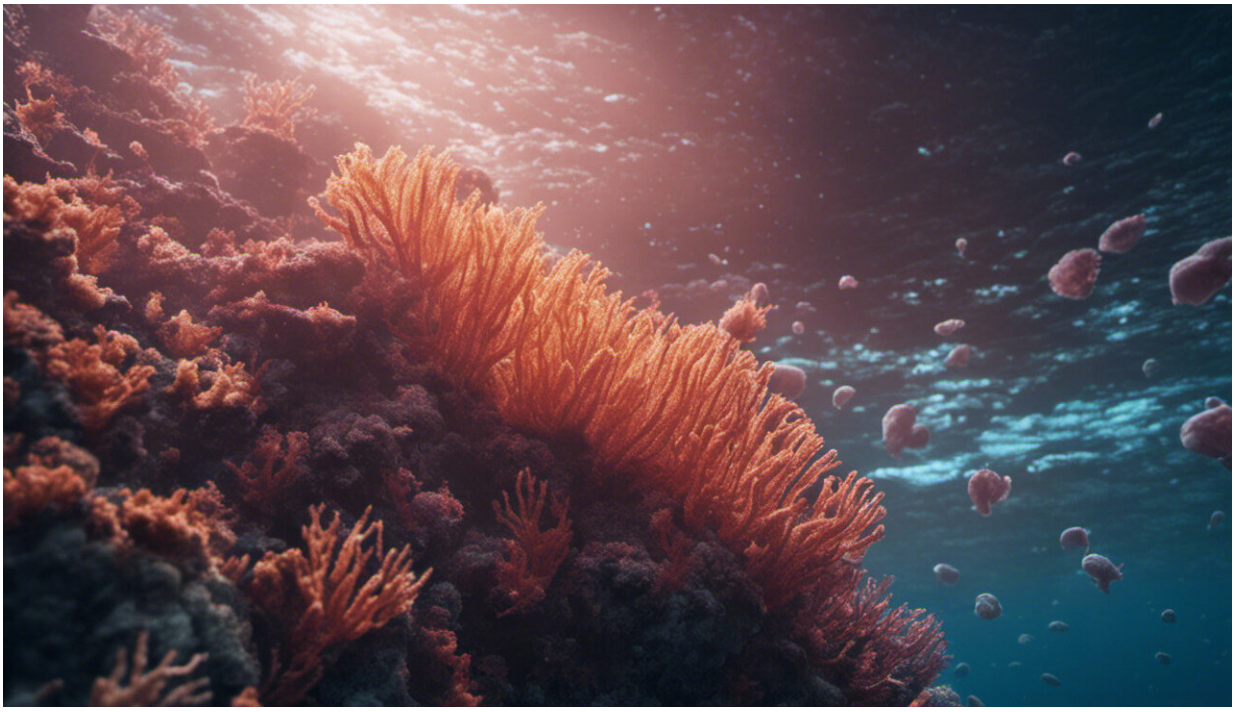
My freshman year at Tufts was tough. During my college physical, they discovered my back was broken. I thought everybody had lower back pain. I apparently jumped out of one too many trees when I was a kid, which I did a lot.

The pain had gotten so bad, I went in for surgery for a spinal fusion. It went horribly wrong, and I got disseminated intravascular coagulation, which made it appear like I was hemorrhaging everywhere. Some of the bleeding was in my eyes, so I was blind when I came to, and only gradually got vision back. It was a huge struggle.

I came out of the experience having lost that optimism of youth that anything is possible. Anything could be bad as well as good, I realized,

and I started always looking for a plan B. What was the alternative if this doesn't go right? That has ended up benefiting me enormously during my career. I also learned how to handle panic pretty well, and that served me in some of my submersible experiences.

I'm just imagining being in this teeny little submersible, hundreds if not thousands of feet down, how would you not panic? How do you not get super claustrophobic?



Credit: AI-generated image (disclaimer)

One of the things that being in the hospital taught me was how to refocus and to just make myself think about something else. It's essential to be

able to have that kind of control. That was one of the concerns when I did my first dive down 800 feet.

It was a very short dive, because the whole point of it was a psychological test. They wanted to find out who was going to panic, because it is very common to have a claustrophobic response, especially in a little diving suit.

How much do we know about the deep oceans? How much of the ocean has been explored?

If you ask people how much of the ocean we've explored, they usually give you the number of 5%, based on remote sonar mapping. That's when a ship at the surface puts down a swath of sonar and maps the shape of the bottom of the ocean, but only with a resolution of about 100 meters, which is about a football field.

Of course, doing that you're not seeing any of the life. We've in fact increased that number from 5% to past 20% now, and the goal is to get it up even further. But in terms of visiting the deep ocean to see what's there, the number is closer to 0.05%. So hardly at all.

You've made other major discoveries with deep-sea creatures. I've seen your work in the news with the giant deep-sea squid that you filmed for the first time.

The giant squid was this creature of legend for a long time known as the kraken. We knew they really existed because they float when they die. It became kind of the holy grail of natural history cinematography to film one in its natural habitat.

If this giant squid had its tentacles intact, fully extended, it would've

been as tall as a two-story building—and they can grow as tall as a four-story building. It would shift its color from bronze to brushed aluminum. It was just so spectacular and awe-inspiring. Here was this creature—it was that enormous and had never been seen in its natural habitat. What better example could you have of how poorly we have done at exploring our own planet?

The primary way we know about life in the ocean is we either drag nets behind ships—and I defy you to name any other branch of science so dependent on thousands-of-years-old technology—or we go down with submersibles and remote operated vehicles, which have bright lights and noisy thrusters.

How did you come up with a new way to film in the deep sea?

All the time I spent in submersibles, I kept thinking about how many animals are out there just beyond the range of my lights that can see me, but I can't see them.

I developed a camera system called the Eye-in-the-Sea, that was meant to be a stealth system that could view the animals without disturbing them. I was experimenting with different colors of red light, which is absorbed very quickly in sea water. I found inspiration from another one of my favorite deep-sea animals, the stoplight fish, which has very unusual bioluminescence.

A lot of animals have these built-in flashlights under their eyes that are blue. And most animals only see blue light in the deep sea, because that's mostly all there is to see. But stoplight fish have also a red-light organ under the eye, and they can see red light. It has to be within fairly close range, but they can sneak up on animals that can't see it.

When I was first studying the stoplight fish, I discovered it had this unusual filter over the light organ that cut out all of the shorter wavelengths. I copied that filter on the illumination system I was using on the Eye-in-the-Sea, and that proved to be the key to be able to see without being seen.

I also developed an electronic jellyfish that imitated certain kinds of bioluminescent displays, which turned out to be highly attractive to squid. I first tested it on an expedition in the Gulf of Mexico in 2004. Only 86 seconds after I turned that lure on for the very first time, we recorded a squid over six feet long. It was completely new to science—couldn't even be placed in any known scientific family.

That's why I ended up getting invited on this major giant squid hunt off Japan in 2012, and it was my camera system that captured the first images of a giant squid in its natural habitat.

Why is studying the life in the oceans important?

We live on an ocean planet. We hear that all the time, but I don't think people really grasp the extent of it. If you look from space, 71% of the surface of the area of the Earth is covered by water. That's just surface area.

If you think in terms of the living space on the planet, what's called the biosphere, the terrestrial living space extends into the tallest trees and several feet below the surface, but it's an absurdly thin layer compared to the volume of the ocean, which is on average 2.3 miles deep. So the living space on our planet, 99.5% of it is ocean.

We just live on these little dry islands we call continents, and have a very, very poor idea of how the machinery of life works. We have to, for our own sake, realize that the most precious resource on this planet is not

oil or ore; it's life. And we're destroying it at our own potential expense. And we need to start learning more about how the planet works.

We're changing it before we understand it. This is happening in ecosystems all over the world. Very often science doesn't get funding to study any kind of ecosystem until it collapses. At which point the public is up in arms saying, "Fix it, put it back the way it was." And how can we ever do that if we never dedicated the funding to figuring out how it works when it's healthy?

Despite so many depressing statistics about plastic in our oceans, climate change, warming waters—how do you remain optimistic?

I will confess that it is sometimes a challenge to remain optimistic, but I think it's essential that we do so. One of the reasons I love the movie The Martian is because of the gestalt of being an explorer means having to deal with problems, life-threatening problems, over and over again. You don't give up. You keep working the problem and trying to find the solution. And if you find enough solutions, you survive.

That's the situation we're in. It's always been the situation that humans have been in. We are by nature explorers—that's who we are, and I think we need to tap into that. The doom and gloom is just turning people off.

We need to focus on our strengths rather than our weaknesses. Our strength has always been exploration: figuring out how the world works; where we can find shelter; what food was safe to eat; what animals were dangerous; and then sharing that with each other. That's been key to our survival, always. We have to continue that tradition, but in a much bigger way.