Q&A INTERVIEW WITH A RESEARCHER

Let's Talk With Melanie Stiassny About the Oceans

DENIS FINNIN / AMNH

What's so special about the world's oceans?

Ours truly is a water planet. When humans first saw pictures of Earth taken from space, we realized that what we had understood to be separate oceans, seas, and coastal waters centered on landmasses, were in fact part of a much bigger, interconnected whole. This whole is known today as the World Ocean. It covers more than 70 percent of the Earth's surface, and is one of our planet's last great frontiers.

From the deepest ocean trench to the sun-drenched waters of the open ocean the largest living space on the planet to the habitat-rich coastal waters that bathe the continental shelf, the ocean brims with life. But as terrestrial creatures, we tend to think of life on our planet as essentially consisting of life on land, as if everything started a little over 350 million years ago when the early vertebrates crawled out onto land. But this couldn't be further from the truth. The ocean, where life appeared about 3.5 billion years ago, was the cradle of life on Earth. And instead of everything leaving the cradle, most things stayed there.

Furthermore, it's the ocean that makes our planet habitable. Without it, rivers would cease to flow, lakes would dry up, and desert would engulf the land. No matter how far from the sea you may live, your life, and all life around you, depends upon it absolutely. Ocean health is absolutely critical to the health of all life on Earth. Yet in many ways the oceans are the least-known part of the planet.

Can you give us an idea of the scale of the oceans?

There are just so many superlatives. Saltwater covers more than 70 percent of the planet's surface 362 million square kilometers. Ours really is the blue planet; it's blue because there's so much water. The ocean's expanse is difficult to comprehend: It contains over 1,347,000,000 cubic kilometers of aquatic living space and is home to some of the most spectacular physical structures on Earth.

The tallest mountain, the deepest trench, the broadest plain, and the longest mountain range are all found in the ocean. The average depth of the ocean is

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3,795 meters, while the average height of land on the dry part of our planet is only 840 meters. Mount Everest is about 8,847 meters above sea level, and that's a long way up. But the tallest mountain on our planet is Mauna Kea, in the Hawaiian archipelago. It rises 10,200 meters from the ocean bottom, 4,000 meters of which are above sea level, so it's actually considerably taller than Mount Everest. The longest mountain range on the planet is actually under the ocean. It's the mid-ocean ridge, which runs all the way around the planet and is four times the length of the Andes, the Rockies, and the Himalayas combined.

MORE ON MELANIE STIASSNY	
FIELD OF STUDY	Ichthyology (the study of fishes)
HOME COUNTRY	"I'm an American citizen but of English origin—so I still speak funny ..."
FAVORITE MIDDLE/ HIGH SCHOOL SUBJECTS	"I was very, very interested in all aspects of biology and was particularly fascinated by the idea of evolution."
LEAST FAVORITE MIDDLE/ HIGH SCHOOL SUBJECTS	Mathematics
THOUGHTS ON MIDDLE SCHOOL	"It's a tough time in many ways, but it's also a time of great opportunity. You can really explore ideas and learn about all sorts of stuff before you begin to specialize."
INTERESTS IN MIDDLE SCHOOL	Horses and chemistry
INTERESTS TODAY	"Where to begin ... "
LIFE LESSONS FROM THE FIELD	"Be flexible and patient. And be nice to everyone."
RECOMMENDED READING	"Anything and everything—most of all just read!"
MAJOR INFLUENCES	"My mother was a huge influence. Her love of nature was infectious."

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AMNH: I think most people are surprised by the diversity of life under the water and the sheer quantity of life in water. Can you address that a little bit?

MELANIE: It comes as a bit of a surprise to many people to realize that we really don't know that much about life on our planet. We can't even say how many species exist in the oceans, so everything has to be an estimate. Some scientists believe that the deep sea alone may contain millions of undescribed species. The numbers keep going up and up just for fishes, the animals I study. Every year, more than 200 new species of fish are described by scientists, and there seems to be no end in sight. But whatever the final count turns out to be, what's most impressive is not just the quantity of stuff in the oceans, but its diversity. At the higher levels of classification (the phyla, classes, and orders), the ocean is much richer in life than the land. For example, 20 of the 33 or so animal phyla are either exclusively or predominantly marine; many are not represented on land at all.

AMNH: What major types of ecosystems can be found in the ocean?

MELANIE: As land-dwelling creatures, we tend to think that all the action takes place on land. After all, on land we have deserts, temperate forests, tropical forests, tundra, marshlands, mountains, savannas, and grasslands. But the ocean is so much more diverse in terms of living spaces. In the Hall of Ocean Life we highlight eight of those major ocean ecosystems: kelp forests, coral reefs, mangrove forests, the deep sea, the ocean floor, the polar seas, the great estuaries of the world, and the continental shelf. Each of these provides a completely different living space, populated by a tremendous diversity of ecological communities of organisms

AMNH: What does it mean to live in water? How is it different from living on land?

MELANIE: Life in water is very different from life on land. Water is about 800 times more dense than air, and 50 times more thick and viscous. Although the chemical formula of water is H20, it actually contains about 95 percent less available oxygen than air does. All the organisms that live in water have to deal with those chemical and physical properties in some way. Breathing, moving, eating, and reproducing the fundamental activities of life are all different underwater. For example, imagine being able to suck in your food from a distance. In air you can't really do that (unless you're eating spaghetti), but in water you can. Suction feeding is a very important means of obtaining food if you are a fish; it basically allows you to take in just about anything that fits inside your mouth. This could be why many fishes can take advantage of different food sources around them. Another way of feeding in water that is very uncommon on land is filter feeding. Many invertebrates and a good number of fishes are able to collect the tiny food particles that are suspended in water. Spiders do it using a web, but very few other land dwellers can manage it.

AMNH: You've observed that there's no fish the size of a whale. Why do you think that's the case?

MELANIE: I've got an idea, but I can't prove I'm right. My idea relates to the fact that water doesn't carry as much free oxygen as air does. The largest fish is the whale shark, which has to extract oxygen from the water. Like all fish, it uses its gills to extract that oxygen. Gills are very efficient and extract about 75 percent of the oxygen passing over them (that's twice the percentage of oxygen our lungs remove from a breath of air), but water doesn't contain enough free oxygen to power a really massive body. The largest vertebrate, the blue whale, is a mammal that must come to the surface to breathe atmospheric oxygen. In this way it escapes the constraints of having to extract oxygen from water, and because its bulk is buoyed up in water, it can support a much larger body mass. Sounds like a reasonable idea to me. (Is this last sentence actually the lead-in to the interviewer's next question below? Should it be in next section, in itals? Would make more sense …)

AMNH: What's the most important thing you'd like people to understand about the oceans?

MELANIE: I'd like them to understand the importance of the ocean, how much life it contains, how diverse it is, and perhaps most importantly, how precious it is. I have described the World Ocean as being the last great frontier on the planet, and in many ways that is true. For example, less than 5 percent of the deep ocean has been explored. At the same time, it's very clear that humans have already had a profound effect on just about every ocean ecosystem.

It's hard to comprehend that something as huge as the ocean can be fragile. But marine species have been driven to the edge of extinction by overfishing and hunting. Global climate change threatens fragile ocean ecosystems. Development encroaches on our coastlines. And pollution stretches from shore to shore. The complex web of ocean ecosystems could unravel very, very quickly. So I also want people to be empowered, to understand how each individual's behavior can affect the ocean, or reduce the impact of other people's activities.

AMNH: Which marine ecosystems are especially vulnerable?

MELANIE: People are increasingly hearing about how global climate change is beginning to affect the planet. Well, those effects are already being felt in the polar seas. The Arctic and Antarctic ice sheets are beginning to break up and shrink. Studies have found that a hole in the atmosphere's ozone layer above Antarctica lets a harmful form of ultraviolet light shine on the ice and kill the ice algae that are the foundation of the Antarctic food web. In addition to global warming, unregulated fishing and pollution from tainted rivers are major threats. What happens in the polar regions will have cascading effects throughout the globe.

Other systems at risk are the world's coral reefs, the rain forests of the seas. Many people are aware of a phenomenon called coral bleaching, and how we're losing coral reefs at a horrifying rate. Similar stories could be told about the loss of the world's mangrove forests primarily to clearing for shrimp farms and shoreline development which are disappearing as fast, or faster, than inland rain forests. Mangrove forests are a poorly known ocean ecosystem, but they are critically important nurseries for many kinds of commercial shellfish and finfish. These changes, too, are going to have cascading effects throughout the ocean.

People should be aware of this, not to be bummed out and depressed, but to realize that we do have a responsibility for the oceans of the world. The health of the oceans and the full impact of our interactions with them: what we eat, how we dispose of our wastes, where we build, and how we modify coastlines can no longer be "out of sight, out of mind."

AMNH: What are some of your favorite ocean animals?

MELANIE: I'm an ichthyologist, so it's got to be a fish, you know? One of my favorites is called an oarfish. It's essentially a midwater open-ocean animal, so we seldom encounter it except when it comes up to the surface, which usually happens when something's wrong with it. The oarfish is the longest rayfin fish on the planet. It can grow to be about 30 feet long, and is a very weird-looking animal. It has an extraordinary head that has this great bizarre mane, almost like a coxcomb. The only thing I can liken it to are the sea monsters drawn on the early navigational charts by the Portuguese and Spanish explorers. Well, this is one of those sea monsters; there's no question about it. These early sailors must have come across these animals floating moribund on the surface.

Another favorite animal is the deep-sea anglerfish, which lives in pitch-darkness in the deep ocean. Now imagine a female fish about the size of my fist, down there in the darkness, in an area the size of a football field, with maybe one male somewhere down there, too. How is she ever going to find him? Actually, he finds her. The female anglerfish looks like a small football. The male is a tiny, streamlined little thing and has a huge nose–well, strictly speaking, huge olfactory organs. He sniffs her out. Once he finds her, he bites into her side and actually grows into her; she starts feeding him through her bloodstream. His nose disappears. His fins disappear. Just about everything disappears, and he becomes a giant testis. And there he is, stuck on to her for the rest of her life. She never has to worry about finding a mate again.

Male parasitism is one of the more bizarre vertebrate reproductive strategies, but in that deep ocean environment it makes sense. Many other fish down there don't have parasitic males, but they're hermaphroditic, and synchronous hermaphrodites at that: They're both male and female at the same time. They can't mate with themselves, but in an environment where your chances of finding a mate are few and far between, if you're a synchronous hermaphrodite and you meet another individual, you know you can mate with it, so that strategy really makes sense, too.

AMNH: How did you become interested in ichthyology?

MELANIE: I've always been interested in animals, all sorts of animals. As a young girl I wanted to be a veterinarian. I was particularly interested in evolution and natural history. I was enthralled by questions like: Why is the world like it is? Why are there so many beetles? There are tens of thousands of fish species, more than all other vertebrates added together why?

In England, when it comes to getting a Ph.D. you learn your trade by going straight into an apprenticeship with a research scientist. In my case, that scientist could have studied frogs. It could have been snails. I didn't care. I was interested in evolutionary biology and systematics. There was a chap at the British Museum who was willing to take on a student and who worked with fish, so that's how I started. I never looked back.

AMNH: What does your fieldwork usually entail? And what are you looking at in your research?

MELANIE: My research has many different aspects, but a theme that runs through it is basically how little we know about life on the planet, particularly about its aquatic life. The task of describing new species doesn't always relate directly to my research interests, but I think it's a very important focus in a day and age when we're losing habitats and species at a horrifying rate, particularly in freshwater habitats.

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This means that a lot of my fieldwork is basic survey work. It involves going to places that we know virtually nothing about, and finding out what fishes live there. That fundamental information can lead to all sorts of interesting evolutionary questions. It also provides information that's really necessary for conserving life on the planet. We need to know what's there before we can develop a strategy for saving it. An example would be the survey work I've been doing with colleagues in Gabon, in Central Africa. In this study we are finding many new species of fishes; recently we found one which doesn't "fit" into existing classifications. So now we are revising our ideas about fish relationships to be able to place this strange animal into a new scheme. There are many surprises out there underwater. We're also finding that human activities, particularly the cutting down of rain forests, are having a really devastating impact on health of life in the waters.

AMNH: Where do you usually go?

MELANIE: I do most of my work in the Old World tropics, so a lot in Africa. Madagascar has been my primary focus for the last 20 years.

AMNH: What projects are you working on at the moment?

MELANIE: Many of them have to do with conservation biology. But I'm also in the process of pulling together a summary of what we know about the evolutionary relationships of fishes. We're trying to compile a state-of-the-art Tree of Life for summarizing what we know about all the different kinds of organisms on the planet. And I'm leading a group that's working on the fishes.

AMNH: One of the favorite attractions in the Milstein Family Hall of Ocean Life is the blue whale that hangs from the ceiling. Can you think of something about it that people may not know yet?

MELANIE: There's a great deal that people don't know about the blue whale and a tremendous amount that scientists don't know either, which is more surprising. Our model of the blue whale was made in the late 1960s, when the hall opened for the second time. And at that time, believe it or not, we'd walked on the moon, but no one had been able to study a blue whale swimming in its natural habitat. To me, that's amazing.

Our model was based on a dead specimen caught in the 1920s at a whaling station. By the time Museum scientists got to it to make their drawings and measurements, the animal had started to decay. Our blue whale had huge goggly eyes, almost on stalks, but these were actually an artifact of decay. So the whale had to have a complete face-lift. It's had its eyes shaved down, and they're now in the right proportion. We also added a belly button; after all, whales are mammals and they do have umbilical cords. When our model was first made, we didn't have an accurate idea of the color of live blue whales either, so it's been completely repainted. The model is now a very accurate depiction of the largest animal that's ever lived. It's a massive creature, the equivalent of 400 rhinoceroses. A small child could squeeze through its main blood vessel, the aorta. Even though we now know a lot more about these wonderful animals, there are still many mysteries about them. There's still so much to learn about the oceans and the myriad of creatures living there.