Ask a Biologist vol 036   Topic: Coral Reefs Guest: Diana Lipscomb

Mystery of the Dying Coral Reefs -

Dr. Biology and his guest, taxonomist Diana Lipscomb, dive into the mystery of why coral reefs around the world are dying. With no untouched reefs left today the possibility of losing this important marine life and habitat is real. Learn how taxonomy is being used to solve the mystery and possibly save these beautiful and important ecosystems.

Transcript

Dr. Biology: This is Ask-a-Biologist, a program about the living world and I am Dr. Biology.

Our guest today is not only a scientist; she is also a detective working on a mystery occurring around the world; a mystery that involves all the coral reefs in the ocean. It also turns out that this year, 2008, has been declared the year of the coral reef. This may sound like a good thing and it may turn out to be, but unfortunately coral reefs at the moment are in trouble worldwide.

Some appear to be dying from disease and others actually might be the victim of a pack of marauding hunters, but not the kind of hunters you might be thinking about. The good new is help might be on the way from scientists like our guest, Dr. Diana Lipscomb, who is involved with the study and classification of all living things. That is call taxonomy.

Taxonomists, as they like to be called, want to be sure that each unique living species has its own name and are placed in groups, actually what they call ranks, of similar plants and animals.

Now you might think, "What is so important about a name?" If you listen in you will soon learn how living things are named is key to understanding how they relate to one another. And in the case of coral reefs it might be the difference between life and death.

Dr. Lipscomb, thank you for joining me on Ask-a-Biologist.

Dr. Diana Lipscomb: Oh, I am very happy to be here.

Dr. Biology: You gave just a stunning lecture for the opening of the new institute. It is the International Institute for Species Exploration at Arizona State University, and I had to have you on the show.

Diana: Well thank you very much.

Dr. Biology: A lot of people might be familiar with coral reefs. They see them in movies, they see them in pictures. Some people actually have coral in their aquariums, if able to get a hold of it. Why are coral reefs so important to us?

Diana: Well coral reefs, when you see a reef itself it is actually a huge structure. It is made by little tiny animals, each one looks like a small sea anemone. The coral animals are related to sea anemones and they secrete this big large calcium carbonate skeleton.

Now calcium carbonate is a hard material, snail shells are made out of it, chalk is a type of calcium carbonate. In the ocean you might think of the plants and animals trying to live, it's hard to find a place where you can sit down and rest; a place where you can just take it easy, where you can find food. If you stopped in the middle of the ocean you might just sink to the bottom. If you stopped where it was sandy you might get covered up by the sand.

Coral reefs, these big heavy-duty mountains under the oceans supply a place for all sorts of plants and animals to make their home. And there are very-very diverse numbers of plants and animals that live there.

Dr. Biology: You actually said something about; they're the rain forest of the ocean.

Diana: Well, the rain forest, and everyone knows the rain forests around the tropics are places where a lot of different plants and animals live. There is a lot of food there, there are a lot of resources for them and it promotes a very healthy and intricate lifestyle for these animals.

The same thing happens under the ocean. Of course there's not trees under the ocean, what we have instead are these corals and they provide that same sort of environment for plants and animals to live in.

Dr. Biology: Right, and even protection, a place to hide.

Diana: Absolutely. Oh, or a place to hide if what you want to do is jump out and pounce and eat somebody else. So, yes, absolutely.

Dr. Biology: OK, I brought in, because we can't be on location unfortunately at the coral reef, I brought in a picture of a coral reef. As I look at it the abundance of life is just obviously.

There are at least three or four different species of fish and they are in giant schools. And there is this wonderful abundance of color even. Are coral reefs found everywhere in the ocean?

Diana: No there not, they are pretty much restricted between the Tropic of Cancer and the Tropic of Capricorn. That means they are pretty much restricted right around the equator. Corals need to have warm shallow water to live in. Coral animals, the little animals have algae that live inside of them. These algae, in the sunlight, photosynthesize and produce sugars and other foods; just like the plants you eat produce sugars and foods for you.

Dr. Biology: Oh.

Diana: And the little coral animal lives off of these algae. So the corals have to live in warm shallow water so that their algae inside of them are happy.

Dr. Biology: So they are actually two kinds of living organisms?

Diana: They live together, we call that a symbiosis, when two organisms live together.

Dr. Biology: Oh, yes, symbiotic relationship.

Diana: That's it.

Dr. Biology: Perfect. Well, what are the functions of coral reefs, besides... well we talked about the abundance of life, do they do anything else for the oceans?

Diana: Well of course they do. Where corals are around the world, they provide protection for coastlines. When you have a storm surge, a big storm coming through, the waves can come up very high and swamp the land. If there is a coral reef there it absorbs that energy and keeps the water from surging up onto land. That is one major protection that they have for us.

That abundance of life is also important. Fishes, and crustacean that we use as food, use the coral reef as a place to live or as a place to have their nursery. And if that coral reef wasn't there a lot of species would be in trouble, a lot of the species that we depend on as food sources.

And then third, scientists that have been looking at corals have been discovering very interesting chemical compounds inside the sponges and corals themselves. Some of these may have very interesting pharmaceutical, or in other words, medical like proprieties that we can use.

Dr. Biology: Oh, so drug companies are interested in them because they might be good for treatment.

Diana: That's right.

Dr. Biology: Oh, OK. Well we have talked a little bit about this in the rain forest, a similar thing occurs and it also brings up the importance of, which we will get into a little bit later, how we really need to know what is out there before its gone.

Diana: Absolutely. We use the natural world for clothing, for food, for pharmaceuticals. Imagine that is our big warehouse for people, the world around us. Now imagine having a warehouse and not knowing, but maybe ten percent of what's in it. We're not running our warehouse very well.

Dr. Biology: Right, and so something is escaping out the back or it's just disappearing.

Diana: Exactly.

Dr. Biology: Oh, OK. Well, I don't like the sound of that.

Let's talk a little bit more about the, just a little bit about the physiology or the anatomy of coral. You talked a little bit about symbiotic relationship and you also talked about that they are engaged in photosynthesis with the algae.

Diana: Yes.

Dr. Biology: Do they do the exact same thing as green plants or is it a little bit different?

Diana: It's just a little bit different. For practical purposes the same thing results, but green grass has chlorophyll A and chlorophyll B. Those are just two different types of chlorophyll. In the zooxanthellae algae that live inside the coral reef, its chlorophyll A and chlorophyll C.

It functions just a little bit differently and it makes these corals a sort of yellowy brown color instead of the grassy green color that you are familiar with.

Dr. Biology: So do they still do things where they need gas exchange as well?

Diana: Yes.

Dr. Biology: In an earlier show, it was called "Oceans Breath", we had one of our facility members, Suzanne Neuer, and we were talking about the fact that when we are looking at the oceans they don't just supply a way of getting food, for example. They also have a real important function in the sense that they also do this gas exchange.

A lot of people understand that if a tree is cut down that's a problem because they are actually doing the opposite of what we're doing as far as this gas exchange and we have this nice relationship. Oceans are very important, and the corals, evidently, with their algae, are very important.

Diana: The same thing is happening inside the coral organism. All animals breathe out carbon dioxide and breathe in oxygen, and plants, when they photosynthesize, take up that carbon dioxide, the waste gas that we breathe off, and they use it to build sugars. So in that way they're clearing out the carbon dioxide out of the coral animal, and sort of cleaning it up and getting rid of some of the waste.

One of the things that's important there is, by getting the carbon dioxide out of the coral animal, they make the environment around the coral basic, the opposite of acidic. And this allows the coral to secrete that calcium carbonate skeleton. Calcium carbonate will dissolve in acid conditions, so we need to get that CO_2 out of there, and the algae supply that.

Dr. Biology: Oh. OK. Now, pH, which is a scale that scientists use to measure how acid or how alkaline, we also say basic, that something is, and the scale is usually set up as 0 to 14, and we take seven as the neutral area. It's neither acidic nor basic. And the oceans are typically, what are they? Are they neutral?

Diana: It depends on where you are in the oceans, actually, as to whether or not they are acidic or basic or neutral, and it varies quite a bit. Around coral reefs, it needs to be more alkaline or more basic, or the coral skeleton will dissolve.

Dr. Biology: OK.

Well, at the beginning of the show I mentioned that coral reefs are in trouble. What would you say is the overall health of the coral reefs in the world?

Diana: Well, there are no pristine, undamaged reefs left on the planet now. And they vary quite a bit as to how damaged they are. Right now we estimate that about 11 percent of the reefs are lost, and about 16 percent we would classify as being severely damaged. As much as 60 percent is under serious threat. None of them are completely untouched by some sort of damage.

Dr. Biology: None of them.

Diana: None of them.

Dr. Biology: Why are they dying?

Diana: Well, it's a complex question, and there seem to be many factors that are coming into play here. We have actual physical damage that's happening to some of the corals, you know, they get damaged by boats, they get damaged by anchors, they get damaged naturally by storms. So we have physical damage.

We also have pollution and problems with water quality. And these poor corals are very sensitive to pollution and murky water. If water becomes filled with some sort of pollutant and it's not clear and clean anymore, that affects the photosynthesis, and that damages the corals.

Global warming is probably playing a role, and as the temperature rises, this affects the corals. They're very sensitive to just one or two degrees' difference in temperature, and if the temperature goes up or down too much, then they will actually kick the algae that live inside of them out of their bodies and stop the photosynthesis. This makes them, of course, not as healthy as they were before; it also stops this nice symbiotic relationship. So the temperature is very important to them.

One of the other things that seems to be happening is we have an increased report of coral diseases. And it's not that we're just simply discovering new diseases, we are fairly sure that coral diseases are on the rise worldwide.

Dr. Biology: So if there are these diseases, can't we just treat them? We'll just give them some medicine, right, and fix them up.

Diana: Well, that means that we need to understand actually what is causing the disease. And what is this disease? Diseases in humans can be caused by a number of different things, and this has been studied for years and years. And if you have pneumonia, we know it's caused by this particular bacteria.

We know those things because we've been studying it for a long time. We don't know what is causing many of these diseases in corals.

Dr. Biology: Oh, I could see that. I've gone to the doctor and they've tried to treat me, and I don't get any better, and so I go back, and they give me yet another medicine. All right.

Well, where does taxonomy fit into this?

Diana: Well, taxonomy is the branch of science where you discover and describe new species, or re-describe old species that have been poorly known before. And you place them into a group, so that we know who their closest relatives are and can therefore understand them better.

Dr. Biology: Well, you're a taxonomist, and I mentioned, you're involved in a real mystery right now.

Diana: Yes. We're looking at some of these coral diseases that seemed to be caused or associated with some very interesting single-celled organisms. They're not bacteria; they're what we call protista.

And these protista, in particular the ones that I'm interested in, are ciliates. Now, ciliated protists are single cells. They're covered all over with little tiny hairs that help them swim.

A common one you might have seen in a classroom is paramecium. They're very common, they live all around you. They're just mostly microscopic. I have to say mostly, because when you've been studying them as long as I do, I get to the point where I can see a lot of them with my naked eye, but most people would just think it was a piece of dust floating in the water.

Dr. Biology: Have you started dreaming about them too?

Diana: Oh, all the time!

[laughter]

Diana: I have protista dreams very frequently, yes.

But these little organisms are mostly not causing diseases and not causing problems. In fact, most ciliates are very important for the environment. They eat huge numbers of algae; they eat huge numbers of bacteria. Bacteria would probably overgrow everything in the natural world if these ciliates weren't out there sort of scrubbing them up, eating them as their food.

And then they, in turn, tend to be the food choice for a lot of baby fish. So we wouldn't have food for all of the little baby fish trying to grow up in the oceans and in the ponds and streams if it weren't for these ciliates.

Dr. Biology: So most of them are good, but I'm guessing there are some bad ones out there.

Diana: There are a few bad ones. There are very few of them that cause problems for people. There's one whose name is Balantidium that make you have to go to the bathroom quite a lot. There are a few others like that. There are a few that cause diseases of fish. And there's one in particular that if you have a fish tank at home with freshwater fish, every now and then there's a ciliate that cause a disease there.

Dr. Biology: What about corals? What's going on with them?

Diana: What we've discovered is that there are some coral diseases, and maybe disease isn't even the right term here, but there's some things happening in corals where it appears that ciliates are playing a role in the corals' dying off. And it seems to be very complex, it's not just that the ciliate is attacking the coral, but there are some complex interactions going on between the corals and the ciliates.

Dr. Biology: So as a taxonomist, the story goes, someone sends you a sample of this particular protista, right?

Diana: Right.

Dr. Biology: And you could've very easily just given them the name and sent them on their merry way. But it's not just the name, it's knowing what they do and how they do it, right?

Diana: Absolutely. You know, when people ask about taxonomy, or if you just pick up a very simple textbook or you go and you say, well, what's a scientific name? At first it looks like, well, someone has just put a label on these things. Nothing could be further from the truth, because the name is a handle.

The name actually means information about that organism, and when taxonomists work, the most fun thing that we do is we're exploring the natural world, we're finding something new, and we need to describe its basic biology. What does it eat? How does it live? What kind of structures make up its body? How does it reproduce? How fast does it reproduce?

All of those things are part of the job of a taxonomist. We are actually the ones that are describing the natural world, and when we get all done with that explanation or that description, we put a name on the organism, a unique name that goes just with that organism. And that allows any scientist or anybody in the world to use the name of that organism, and instantly everybody can get access to that information.

So if I said to you, while we're sitting here in your studio, that I just saw a little paramiscus run across the back of the room. Well, if you knew what paramiscus was, you would know what I meant was a little tiny brown rodent with a white fur on its chest that had, as I said, fur, was warm-blooded, had a four-chambered heart, had three different kinds of teeth in its mouth, and gave birth to live young that drank milk from the mother.

And what's more, you would say, "Paramiscus? They normally live outdoors in the woods, they're not house mice." That name would've given you all that information with just that name. And that's what we're doing.

Dr. Biology: All right. Well, with the coral, what have you been able to help out with this decline in their numbers?

Diana: One of the things that we looked at was a sample of coral that came from the Red Sea, and then later got a similar sample from the Great Barrier Reef. Living on this organism was a ciliate.

And we knew right away it was a ciliate, but a ciliate is not very specific descriptive term. I could've just said, "OK, this is something new," and put a new name on it, but that's really not enough. It's my job to find out, how does this thing live? Is it really damaging the coral?

It sure looked like it. This ciliate lived in huge numbers all around the coral, and it formed a black band, because the ciliate itself live inside a little shell it had secreted that was dark grey, so it looked like dark speckles of grey all along the coral.

Every day that band would move a little bit further along the coral. Behind the band where it had been before, there was no living coral left. Ahead is the living little coral animals, and this band is just slowly moving over them.

Well, what's it doing? How's it living? How's it reproducing? What we discovered is that this particular ciliate didn't actually attack the coral animals directly. Instead, what it was eating were the algae that come out of the coral, those algae that are normally symbiotic inside the coral.

Something was affecting the coral. Maybe it was something people did. Maybe it was, the water had gotten a little polluted, or maybe there was a storm, but when the corals released the algae because they were stressed, they throw them out through their mouth, the ciliate was so happy, because that's what it eats. So it ate a bunch of them.

Well, once it had eaten, it split into two, which is, this simple splitting the cell is the way most of these things reproduce, because it had lots of food it could split. One of these little daughter cells, as we call it, one of these new little ciliates, then swam away and secreted a new shell, and started to live.

But when it's secreting the shell, it's secreting sort of an acidy shell. And this shell eats into the coral, because it causes that coral skeleton to dissolve. And that made the coral weaker. And so now the coral is even more stressed, so it throws out more algae, so the ciliate eats more algae and it grows some more. So you see, it's not a disease the way we normally think of a disease, but it's still having an effect.

So we put a name on this organism, hallofuliculina corrallasia, so that everyone could access all this information about how this organism lived. We've since discovered a similar species in the Caribbean.

Dr. Biology: In the Caribbean?

Diana: Yes.

Dr. Biology: Well, that means it's moving, or is it just something that occurred on its own?

Diana: We think it's occurred on its own. This is actually something I'm still working on.

Another thing that taxonomists do is they not only describe life, they describe where it lives, and whether or not it can be moved around the planet. And right now, to me, it looks like, with our preliminary studies of the Caribbean reefs, like this is a new species. It means that whatever triggered this organism to become high numbers on the Great Barrier Reef is also, the same thing is happening in the Caribbean.

I haven't proven that yet. It may be that something from the Red Sea or the Great Barrier Reef got transported into the Caribbean. You know, boats, when they pull into docks, especially the big, big ships, they suck up seawater when they unload their cargo so that they don't float too high up in the water, they settle down in.

Then when they sail across the ocean and they're ready to pick up cargo again, they dump that seawater out. I don't think that that transported this organism into the Caribbean; right now I'm not absolutely positive. It's still part of the mystery that I'm working on.

Dr. Biology: Right. So it could be naturally occurring, or it could be what we call an invasive species. Another example of that would be the fire ants that came up to the United States in around, what, the early 50s, somewhere in there, and just spread across the United States.

All right. So we know about the protist and what might be happening. What about this pack of marauding hunters? This was really intriguing to me.

Diana: Well, this is a project that we've really just started working on. There are several places where coral ecologists are trying to understand how corals establish themselves, how new little coral animals can set down when they're babies and grow and build a whole new reef. This is important because it will help us understand how corals might recover from damage and repair themselves.

An experiment like this is going on in the Caribbean very close to Puerto Rico. And some scientists there noticed that the little coral animals were settling down, and then promptly vanishing. When they looked at it more closely, they noticed that there was a protist that might be involved.

So we are looking at this now, they sent a sample to my laboratory, and what is happening is these little corals are settling down, and again, it's a ciliate. It's not just one ciliate, but they tend to swim in packs. Now, that's really cool, because we're talking about an organism that's just a single cell, and it's swimming in a pack.

Now one interesting thing about ciliates is they have mouths. Now the cells in your body don't have mouths on them, but ciliates have a mouth. It's a permanent opening that they can chomp down on food with. These ciliates swimming along in a little group zero in on these baby coral polyps, and they just attack it, eat it up.

Dr. Biology: How fast?

Diana: It takes them just a few minutes to eat an entire coral polyp.

Dr. Biology: A few minutes?

Diana: Just a few minutes.

Dr. Biology: Wow.

Diana: And they just go in for the kill. It's very, very interesting.

Now, what's more interesting to me about these things is that I know they're ciliates, but they have a very, very strange anatomy. When I look at them through the microscope, they have some structures in them that I've never seen before in the 25 years I've been working on ciliates, so I'm pretty sure this is, oh I'm positive this is a new species, but I'm pretty sure it's a new genus, might even be a new family.

Dr. Biology: Wow. That's pretty impressive, and for a taxonomist, that's pretty cool, right?

Diana: It's exciting, yes.

Dr. Biology: And as you mentioned, you're an explorer. It's as if you've gone off to another planet, but the other planet's right here, right?

Diana: That's right. I mean, we all love to look at these science fiction movies where they show all these wonderful, wild things that live on other planets, but remember, we don't know probably 90 percent of the life on this planet. We have a wonderful time exploring this planet and finding out just how other organisms live, how other plants, animals, protists and bacteria live is still a big mystery.

Dr. Biology: So what do you think the future holds for coral reefs around the world?

Diana: I tend to be an optimist. I'm hopeful. I'm cautiously optimistic. So many people are worried about them and so many people are concerned about them that I'm hopeful that we will be able to get to the bottom of some of these mysteries, and those will hold the keys to allow us to save some of the coral reefs.

I'm sure that some are going to go extinct. The damage is too severe and they are very sensitive organisms, but I'm hopeful that the people of the planet will get together and try and save some of these major important habitats.

Dr. Biology: Well, I can only hope that there is some young scientist out there that'll take up the call to duty sort of things and study coral reefs and other living things, maybe become taxonomists.

A lot of people might think that that's a dry and maybe even boring world, because a lot of times they're in museums, or they're back in the labs, you don't see them, they're not out on the frontier, when in fact, it's very exciting, and they're either out in the frontier literally traipsing through the Amazon jungles or down in the oceans looking at coral, or in your case, you're a microscopist, and so am I.

Microscopists are the people that use microscopes. And we actually get to explore inner space rather than outer space, and I'm always a fan of that, and I believe you're a big fan of that as well.

Diana: I love my microscopes, I have several of them. When I look through the microscope, it's just so beautiful. It's like looking into the night sky, when you see all of these different creatures that live and can live in a drop of water, all the different things they do.

Some of them are predators, moving around, hunting for other things. Others are just going along like little scrubbers scrubbing up bacteria. And others are sitting there just creating water currents and filter-feeding. So there's a beautiful world through the microscope.

Dr. Biology: This leads us into these questions, three that I always ask. And the first one is, where was the spark? When did you first know you were going to be a biologist?

Diana: I think I first knew I was going to be a biologist in second grade. And in second grade, we were allowed to look through these small student microscopes, and I thought of all the things I was seeing. It was just so interesting.

I got, then, interested in insect collecting and I also got interested in working in the laboratory and doing laboratory experiments. In fact, when I got to college, I knew I wanted to be a scientist, I just wasn't sure what kind of scientist I wanted to be, because I liked working in the lab, I liked working with the microscope, but I liked going outdoors.

That's why taxonomy is the perfect science for me, because since what I do is describe new species, that means I have to go out and collect them, and go out and find them, so I get to go out in the field and go on expeditions.

Then I bring them back in the lab, and I get to look at them with the microscope, and I sequence their DNA. And then I get to do experiments on them, so I get to do all aspects of biology by being a taxonomist. It's the most fun.

Dr. Biology: What if I took that all away from you? This is a challenging question for some of my scientists. You can't be a biologist, you can't be a scientist. If you were going to do something else with your life, what would you do?

Diana: Well, if I couldn't be a scientist, that would be really, really hard for me. And I'm going to fudge on that question a little bit, because I actually, as a college student, had two wonderful jobs, and I think that either one of those would be what I would want to do.

One is, I worked in a kindergarten with children. And I loved it. I really enjoy teaching. After all, I am a college professor, most scientists are. I still love teaching, and I think I would have liked to have been a teacher.

The other thing I did is I worked at a zoo, in the nursery. And I have to say, being a zookeeper and working with animals was a lot of fun too. So I think that I would probably either be a teacher or be a zookeeper.

Dr. Biology: Marvelous.

OK, now the last question. What advice would you have for a young scientist or someone that's shifting careers to science?

Diana: I think the main thing to remember is that science is such a huge field, and so many different things that go on in science. Sometimes it seems overwhelming to read all of these facts and all sorts of new terminology that you have to learn whenever you learn a new field of science, and that can seem so dry and so boring.

I just recommend that you read, and you read in a light sort of way. Don't worry about the terminology. Once you begin to get into it, the terms just start to stick in your brain. Don't try to memorize things, read the stories that go behind science.

And the other thing is be observant. I'm always very surprised at how unobservant most people are. There's a lot of science going on around you all of the time. I work in Washington, D.C. and I was very surprised not very long ago to be walking across one of the big, open, grassy areas, when right in front of me, down out of the sky comes a sharp-shinned hawk, picks up a pigeon, and flies away.

I thought that was just amazing; here in the middle of one of the biggest cities in our country is this wonderful, wild creature. Around me are all sorts of people talking, picnicking, none of them seem to notice it at all. So if you want to be a scientist, one of the first things you have to do is open up your eyes and look around. It's all around you.

Dr. Biology: I did a show in Washington, D.C., and it's actually called Science is for Everyone, and in this case, we'll add Science is Everywhere.

Diana: That's right.

Dr. Biology: Diana Lipscomb, thank you for visiting with us today. I hope your detective work is able to help us save the coral reefs.

Diana: Thank you for having me. This has been a lot of fun.

Dr. Biology: You've been listening to Ask A Biologist, and my guest has been Professor Diana Lipscomb from George Washington University Department of Biological Sciences. The Ask A Biologist podcast is produced on the campus of Arizona State University.

Our show is recorded in the Grassroots Studio, which is in the School of Life Sciences, and the School of Life Sciences is a division of the College of Liberal Arts and Sciences. And even though our program is not broadcast live, you can still send us your questions about biology using our companion website. The address is askabiologist.asu.edu, or you can just Google the words "ask a biologist". I'm Dr. Biology.