Video Transcript: A Century of Discovery of Sea Urchins and Relatives

Maggy Benson: Wow.

Maggy Benson: Welcome everyone. We're so happy to have you here at Smithsonian Science How. We're kicking off the first show of the brand new season with an invertebrate zoologist from the Smithsonian's National Museum of Natural History, Dr. Dave Pawson. Dave, thank you so much for joining us here today.

Dave Pawson: Thanks for having me.

Maggy Benson: Dave, you're an invertebrate zoologist. You brought along some of the collections that you study, like sea stars, I see sea urchins. These are just fabulous. Can you tell us what they're called?

Dave Pawson: Well, as a group, they're called echinoderms, which comes from two Greek words meaning spiny skins. Most of them, as you can see, have spiny skins indeed.

Maggy Benson: You can see some of them on the screen here. They come in all different shapes, sizes, and colors.

Dave Pawson: Yes. Yeah, there's a great variety of them. There are about 7,000 different kinds alive today in the world's oceans.

Maggy Benson: I wonder what beyond having spiny skins unite this entire group. There's clearly a lot of diversity here.

Dave Pawson: Most echinoderms have a hard skeleton, bony skeletons, hence their name. But one group of echinoderms called sea cucumbers have squishy bodies. They have squishy bodies because ... They do have skeletons, but the skeletons are reduced to little tiny microscopic bones in the skin. It's hard to believe that this animal is related to a starfish, but it is.

Maggy Benson: What are the other characteristics? What are some of the other traits that unite echinoderms?

Dave Pawson: One of the obvious ones is that they usually have five parts to their bodies, five so-called arms. Even a sea cucumber doesn't often look as though it doesn't have five parts to its body, but if you look inside, you'll find five of various things. It's not so obvious in some of these animals, but it's certainly obvious in the starfish and in these so-called brittle stars, which have five arms coming from their mouth. The sea cucumbers, the little bones in the skin, as I mentioned, are microscopic. They're very beautiful. They're fun to watch. These animals are fun to study under the microscope at least.

Dave Pawson: Another characteristic of echinoderms is that they can grow new parts when a part of their body goes missing. If you cut a starfish in half, it will grow into two starfish. Some of these animals can lose body parts very easily. Another characteristic of echinoderms is that they have so-called tube feet, which are hollow organs filled with fluid. At the end of the tube feet is a disk-like termination there. They use these feet to help them in getting around, locomotion, and feeding. They're also used for breathing too. Some tube feet are used as lungs.

Maggy Benson: Here, what's happening in this picture?

Dave Pawson: Oh, that last picture, a starfish is feeding on a coral in the deep sea.

Maggy Benson: Interesting. Echinoderms have been referred to sometimes as stars of the deep sea. Why is that?

Dave Pawson: Mainly because there are so many of them down there. Echinoderms live all over the world in all the world's oceans from the sea shore down to the greatest depths. When you get into the deep sea, they really come into their own. In fact, on the deep sea floor where it's dark, totally dark, sea cucumbers can make up more than 90 percent of the total weight of animals on the deep sea floor.

Maggy Benson: Do they have a specific role on the sea floor?

Dave Pawson: Sea cucumbers do. They feed on mud, most of them. They're like earthworms. They pass mud through their bodies. As it passes through, they add oxygen to the mud. They make the mud more livable for lots of other kinds of animals that can then settle in like worms and little shrimps and so forth.

Maggy Benson: A critical role indeed. But so fascinating is that not that long ago, over a hundred years ago, scientists didn't even think anything lived in the deep sea. Isn't that right?

Dave Pawson: Yeah, up until the early 1860s, most scientists believed that the deep sea was essentially a desert below a depth of about 1,800 feet. But in 1868, a Norwegian scientist called Dr. Sars, Michael Sars, took a dredge hole in a very deep part of a fjord inlet in Norway, and he pulled up this strange animal, which is called a sea lily. He made two famous discoveries in collecting this little animal. One was that he was able to prove that these sea lilies, still living in today's oceans, they were only known as fossils until that time.

Maggy Benson: We can actually credit echinoderms for helping us discover life in the deep sea.

Dave Pawson: In the deep sea, yeah. He also proved that there was life in the deep sea. A lot of scientists became very excited about these discoveries because they speculated that maybe the deep sea was a place where a lot of living fossils were hiding.

Later work has proven that this isn't so, but there are still lots of weird animals living down there.

Maggy Benson: This is very incredible. It does look a little weird as well to think of that as an animal. Tell me, the discovery of these sea lilies in the deep sea, did that kick off a frenzy of deep-sea exploration?

Dave Pawson: Yes, it certainly did. Many countries, especially in Europe and also the U.S., decided that exploring the deep sea was a good thing to do. Many very large purpose built research ships were constructed. Among them, a very famous American ship called the Albatross, which was launched in 1883.

Maggy Benson: Which we see here.

Dave Pawson: It was a steamer, but she also could sail when she needed to. She worked for almost 40 years in the Atlantic and Pacific Oceans. Sailed about a million miles. Collected tons and tons and tons of animals.

Maggy Benson: Which are now here in the Smithsonian in our invertebrate zoology collection, correct?

Dave Pawson: Yeah, we have enormous numbers of them in our collections.

Maggy Benson: There was one scientist in particular that looked at echinoderms and collected a lot of them aboard the Albatross. Who was that?

Dave Pawson: He was a man called Austin Hobart Clark. He was invited as a naturalist to participate in the 1906 cruise of the Albatross, which went from San Francisco, to Alaska, and around Japan, and back to San Francisco. The entire trip took seven months. Austin had just been married to his wife, Mary, for one month before he took off on this long trip.

Maggy Benson: It's a very kind wife.

Dave Pawson: Yeah, their families were not too happy about this, deserting his spouse after one month. But they decided it was probably a good career move to take this job for seven months, and so he did it. While he was on the ship, he wrote long and very affectionate letters to his wife, Mary. There were hundreds of these letters. He wrote them pretty much every day.

Maggy Benson: We have a whole folder of them here.

Dave Pawson: We have great folders full of them. My wife, Doris, has transcribed them now, and they're about to be published. They're not just affectionate love letters.

Maggy Benson: I can see it at the top, dearest, dearest, dearest, sweetheart.

Dave Pawson: Sweetheart, yeah. They are great diaries about life on board the ship, day to day life, describing all kinds of events that happened. Also, describing the ways in which they collected animals, what the animals looked like when they came up in the nets and so forth. It's a wonderful detailed diary. We're very glad to have this record of life on board a ship 110 years ago.

Maggy Benson: This record of life aboard a ship, as you say, is providing you more information about the animals that were collected and life on board the Albatross at that time.

Dave Pawson: Yes, yeah, that's right.

Maggy Benson: Can you tell us a little bit about what life on board that Albatross was like?

Dave Pawson: Well, it was in many ways, it was a rough life. It was a very lively ship in rough weather. Clark told a bunch of stories about how they collected animals in all parts of the ocean from the surface, such as shown here, down to very great depths. They would tow these enormous nets around the bottom in great depths and pull up literally tons of animals, which would be sorted and carefully preserved.

Maggy Benson: Now in addition to the scientific value of these love letters essentially that you've been able to find, is there any anecdotal information that's within these letters that provides what life was like? Maybe the daily, the relationships among the people on the ship?

Dave Pawson: Yeah, some of the stories are just amazing. One of the very exciting aspects that Clark dealt with a lot was a mascot on board the ship called Buck. Buck was a very large goat. In those days, ships tended to have mascots, dogs, and cats and monkeys and so forth.

Maggy Benson: It's a big goat.

Dave Pawson: But Buck was very large, and he was on the ship for at least 12 years that we know of. He was sort of a nasty animal in the sense that if you were to tease him, he would get you later. He was vindictive. There was a story about a cabin boy carrying a very large tray full of meals from one part of the ship to another. Apparently, he had teased Buck earlier that day or earlier that week. Buck saw his opportunity and came and hit this young man from behind. He went sprawling and the meals went flying everywhere.

Maggy Benson: Oh dear. In addition to providing some humor about what life was like aboard the Albatross, Austin really provided context for the objects that are here at the Smithsonian now that are still being studied. What did Austin go on to do after he got off the Albatross?

Dave Pawson: He started his life as a collector of birds. He was a fanatical collector of birds. But as he became more and more involved with deep sea trawling, he became interested in these particular animals, the echinoderms. Here's one of his early ... I think he was about 12 years old when he did that painting.

Maggy Benson: A great illustrator.

Dave Pawson: Yeah. When he came back after the cruise to Washington, he studied echinoderms for a year working for the National Fishery Service. Then he was hired here at the museum in 1908 and became a scientist. He was here for the rest of his life until he retired in 1950.

Maggy Benson: Here you are side by side with Austin.

Dave Pawson: Yes, I feel as old as he does right now. But yeah, we're holding exactly the same animal there. It's extraordinary.

Maggy Benson: He left behind not only his letters to provide context with what happened during this very specific research trip, but he left behind his research to science and a lot of collections for you to study as the echinoderms curator here at the Smithsonian.

Dave Pawson: Yes, that's right. He was a great scientist. He described about 500 new species of echinoderms and published hundreds and hundreds of scientific papers, and hundreds of popular magazine articles as well.

Maggy Benson: How wonderful.

Dave Pawson: He was a great communicator.

Maggy Benson: Thank you for introducing us to these echinoderms. Let's get to some of our student questions. This first one comes from Wallenpaupack Area School District. Thanks for coming, an alma mater of mine actually. So, how many feet does a starfish have?

Dave Pawson: How many feet? Well, some of them have thousands of feet. The feet ... If I can lift this up for a moment?

Maggy Benson: Absolutely.

Dave Pawson: This animal, for example, has the remains of the feet are dried here. He has hundreds of feet underneath each of these arms. He uses them for holding onto very hard areas on rocky shores, rocky coasts, and also for feeding on mussels and clams, using the feet to pull apart the shells of mussels and clams.

Maggy Benson: Great question. This one's from Gabe. Are there any sea stars that are endangered?

Dave Pawson: Yes, and it happens that some of these sea stars, including this particularly large type, is endangered in California and to the north of California because of suffering from some disease, which is called a wasting disease. It pretty much has died out. The disease has died out pretty much by now. But for a few years, literally thousands of these starfish were being killed by this strange malady.

Maggy Benson: It's unfortunate. Our next question comes in by video, so let's take a look at the screen.

Sydney: Hi, I'm Sydney.

Diamond: Hi, I'm Diamond. Why do you call these sand dollars?

Sydney: Yeah, why do they call these sand dollars?

Dave Pawson: They were interesting. Those sand dollars are either from New England somewhere up north or somewhere off Washington State or Oregon State. I think they were called sand dollars because small ones would wash shore, and they looked probably a little like a one dollar coin when they washed up. There are a couple of very large sand dollars from down off of the coast of Florida.

Maggy Benson: Wonderful. So students, keep your questions coming. We'll get to more of them as ... But first, we're going to learn a little bit more about the history of deep-sea research and Dave, your work here at the Smithsonian. Tell us, when Austin and the other scientists were collecting specimens from the deep sea using big nets, where there any major limitations to that methodology?

Dave Pawson: Yes, I think the largest limitation was the fact that a lot of deep-sea animals are very fragile because they have a lot of water in their bodies. When they were collected in nets along with rocks and all kinds of hard things, they'd become mangled as the net would come up to the surface. So when these animals were dropped onto the deck of a ship and then put into bottles and preserved, it was often difficult to determine what they looked like when they were alive. Austin, in some of his letters for example, tried to reconstruct what these animals might have looked like. He was pretty good at it. But there were a lot of things that we didn't know until we were able to do more in the way of sampling these animals.

Maggy Benson: What came after trawling these huge nets along the ocean floor?

Dave Pawson: Well, the next big development was the introduction of cameras into the deep sea. Dropping a camera on a line from another ship to the sea floor.

Maggy Benson: Which we see here.

Dave Pawson: When the camera would hit the sea floor with the motion of the ship on the surface, an electronic flash would go off, and the camera would take a picture.

Over the course of two hours, the camera could take 800 pictures. Millions of these photographs were taken. At last, we were able to see how these animals are making their living, what they're doing, how many of them there were. We tried to interpret their behavior, often completely incorrectly. Millions and millions of these pictures were taken. I've probably looked at more than a million of them over the years. It's very exciting.

Maggy Benson: Wow, it's a first look at the deep sea. What came after this camera apparatus?

Dave Pawson: The next development was, especially during the 1960s and beyond, that was a manned little submarine, submersibles so-called, which could take between one and five people down to great depths. Here was the chance to go down to where the animals are and see them doing their thing, and videotape them, and photograph them, and pick them up if you needed to, to study them more in the laboratory. This shows my wife on the left and Dr. Carole Baldwin on the right about to descend on a submersible in Curaçao.

Maggy Benson: Dave, how many sub dives have you done?

Dave Pawson: I think I've made a few more than 200 dives over the past many years, 40 years.

Maggy Benson: That is amazing.

Dave Pawson: Yeah, that's very lucky.

Maggy Benson: Now that means that you've seen parts of the ocean that nobody else has seen before. What does that feel like?

Dave Pawson: Oh, it's always exciting. There's always something new to see when the submersible gets to the bottom and the pilot turns the lights on. Suddenly things are illuminated. There's always something new to see.

Maggy Benson: How fabulous.

Dave Pawson: Incredibly exciting.

Maggy Benson: Now after the submersibles, there was another development in deep sea. What was it?

Dave Pawson: Well, it's going down in the submersible can be dangerous. It's not as dangerous as riding in an automobile. But the trend has been over the past several years was to send submarines down that don't have people in them. These are called remotely operated vehicles. In an ROV, you can sit on board the mothership or you can sit on land and watch what the ROV is finding. The ROV can videotape animals. It can photograph them. It can also collect them.

Maggy Benson: Just like this animal here. What are we seeing?

Dave Pawson: Yes, I wished we'd collected this one. This was a photo taken down in the Gulf of Mexico. It's a sea cucumber, which has decorated itself with dozens of little triangular shaped shells from a little mollusk, which is about an inch long, related to clams and oysters and snails. This little animal swims vertically in the ocean, swims upwards all the time. They're all over the world. When they die, they drop to the bottom, drop to the sea floor, and the soft parts rot away leaving the beautiful clean white shell. The sea cucumber picks these shells up and attaches them to its body, holding on with its tube feet.

Maggy Benson: How fascinating that it can sift through find those of everything down there.

Dave Pawson: We have no idea why they're doing it, the decoration. It's totally dark down there. This sort of white shells if there's any light down there would tend to reveal the body of the animal rather than conceal it.

Maggy Benson: I'm sure you have a lot of other hypotheses as to why they would do this because as a scientist, I think you have discovered why some shallow water species that are related. So sea urchins, their cousins, sea cucumber's cousins, they also cover themselves in tide pools. You do know why that happens, correct?

Dave Pawson: Yes, they do. Other scientists have discovered why these animals cover themselves. Mainly the sea urchins in shallow water cover themselves with debris to reduce the ultraviolet light from sunlight that's hitting their bodies and it could damage their bodies.

Maggy Benson: So you told us that it may not be for camouflage because they live on the bottom of the sea in really deep water.

Dave Pawson: Yeah, the deep water ones. Another thing the shallow ones do that's fairly common is they hoard food. Drifting pieces of seaweed, they'll grab them and hold onto them and then pass them down to their mouths when they feel like a snack. We were amazed to find that in the deep sea, in the Bahamas, and southeast of Florida, there are 33 species of sea urchins there that we were studying. Three of them cover themselves. They pile debris on tops of their bodies. We don't know why. There's no sunlight down there. There's no ultraviolet radiation. The debris that they're using to cover themselves is not material that they would use as food. It's a mystery. It's something we haven't been able to ... We've brought live animals back from the deep and tried to get them to cover themselves, but they won't cooperate.

Dave Pawson: We have no idea. We think that possibly the animal himself doesn't know why he's doing it, or she. It maybe that the covering activity is genetically linked to something more important that the animal must do. We don't know what that might be.

Maggy Benson: So this is still a mystery out there.

Dave Pawson: It's still a mystery. There are a lot of mysteries in the deep sea for sure.

Maggy Benson: So Dave, you're a modern scientist, but we have a lot of historic collections here on the table. Is there any scientific value in the objects that came to the museum a hundred years ago from expeditions like the USS Albatross?

Dave Pawson: Yeah, these collections that are quite old are still very scientifically valuable. Scientists come from all over the world to study them. In this particular case of that sea urchin there in front of the table, that sort of pancake-like object, we looked inside some of those and found that their intestines, their stomachs and intestines were full of pieces what's called turtle grass. Here's the same animal alive in a depth of about half a mile down off the coast of Florida. We were amazed to discover that this animal, this particular species, which can be present in very large numbers, feeds on turtle grass, and essentially nothing else. Turtle grass is its preferred food.

Dave Pawson: Turtle grass grows only in very shallow water around the coast of Florida and the Gulf of Mexico. It's like a coarse lawn grass, and it can be found in water that ranges from one foot to about 30 feet deep, very shallow. With wave action and storms, pieces of turtle grass are broken off, and they float out to sea, and they become water logged, and they eventually sink down to the deep sea floor, where these urchins are waiting to feed on them, and also other kinds of animals too. Because food is always scarce in the deep sea.

Dave Pawson: The problem for these urchins is that the turtle grass beds are disappearing mainly because of human activity, sort of development building and marinas and so forth, but mainly fertilizers and other chemicals that are brought down in the river and streams onto the shallow depths are killing off turtle grass beds. We've learned that over the past 40 years or so, the beds have decreased in size by about 70 percent.

Maggy Benson: That's devastating.

Dave Pawson: Which means that the food available for these guys that are living in very deep water, these urchins, has decreased by 70 percent also. Eventually, they're going to have to change over to another diet. We don't know what that might be.

Dave Pawson: I've always been struck by this connection because here is something that we are affecting in water that is one foot deep and right there where you're wading. What's happening out there a mile out to sea and a mile down, you're directly affecting these sea urchins by killing off turtle grass. It's this direct connection that's always impressed me greatly.

Maggy Benson: Absolutely. How closely and connected we actually are on land and the shallow sea too, these deep-water specimens.

Dave Pawson: Yeah, we are indeed.

Maggy Benson: We have a lot of questions coming in. But before we get to them, Dave, can you tell us about some of the recent discoveries you've made. You've shared a couple mysteries out there for now.

Dave Pawson: Well, we have here is an example of a sea lily related to that one that Dr. Sars found in 1868.

Maggy Benson: How beautiful.

Dave Pawson: It's a dried one. We have discovered a new one, and it's not nearly as pretty when it's dead. There it is. But it's very beautiful when it's alive. I hope we'll show a picture of it soon. There it is there, a gorgeous animal. It's only about this high when it's fully-grown. A Russian colleague and I described that. Here is a polka dotted little worm-like sea cucumber that we described from some methane seeps so-called; they're holes in the sea floor where methane gas is coming up in the Gulf of Mexico. Here's another kind of sea lily that's about two inches high that we described some years ago.

Dave Pawson: Our latest little find is this guy, which is a brittle star. It looks rather like a starfish, but it's a brittle star. It's a female. It has 10 masses of eggs there that you can see. It's about half an inch across. It was first discovered off Curaçao; this reddish animal was attached to a bright green beer bottle lying on the sea floor.

Maggy Benson: It wanted to be discovered.

Dave Pawson: Yeah, it was.

Maggy Benson: Dave, thank you so much for being here and sharing all of this wonderful information about sea stars and urchins and all their relatives.

Dave Pawson: Well, thanks. It's been an honor to be here.

Maggy Benson: Where can our viewers learn a little bit more about echinoderms?

Dave Pawson: Well, I'd recommend the first place they go is a blog run by one of our resident scientists, Dr. Chris Mah. It's called the Echinoblog. E-C-H-I-N-O-B-L-O-G. That has some wonderful information about echinoderms in it.

Maggy Benson: Wonderful. Thank you so much, Dave.

Dave Pawson: Thank you.

Maggy Benson: If you want to learn more about the history of deep-sea research and the ocean in general, you can go to our Smithsonian Ocean Portal. We also have teaching

resources related to Dave's work on our Q?rius website at qrius.si.edu, which is the same place where this program will be archived later this evening. Thanks again for joining us today on Smithsonian Science How. We hope to see you next time.