But Why: A Podcast For Curious Kids

Why Is The Sea Salty?

September 30, 2016

[Zach] Some fish are really neat.

My favorite fish of them all are called alewives. We call them anadromous.

[Jane] There's your vocabulary word for the day: anadromous. This is *But Why: A Podcast for Curious Kids* from Vermont Public Radio.

You ask the questions and we help find the answers. I'm Jane Lindholm.

In this episode we're taking the podcast to see we're heading to the coast of Maine to learn a little bit about why the sea is salty, how muscles get their shells and why a lobster with no claws no antenna and no eyes will probably still come out OK. And we'll find out what the heck and anadromous actually means.

[Zach] My name is Zach Whitener and I'm a research associate at the Gulf of Maine Research Institute in Portland, Maine.

Today we're down at Kettle Cove in Cape Elizabeth with lots of pretty lobster boats in the distance and the wonderful place by the ocean.

[Jane] Cape Elizabeth is near Portland, Maine and Kettle Cove is a sheltered little area with tide pools and a rocky beach. Zach and I met there on a bright September morning not long after low tide. At high tide a lot of the rocks are covered with water, but when the water recedes it exposes those rocks and some of the little creatures that live in the shallow water.

[Zach] I think one of the most exciting parts about coming down to the side of the ocean is it's not just about the water, it's about the birds and the people that are here too. As you can see on the rocks here we have a lot of what we call rock weed or bladder rack. Every place you go you hear a different name for it. Lots of little animals underneath it. You'll find lots of crabs sometimes even baby lobsters. We've got periwinkles and many, many, many different types of snails. We've got sea stars and sometimes sea anemones you can find in the tide pools sometimes little fish. There's a lot of neat things you can find here.

[Jane] If you've ever been to the ocean you've probably discovered that the water in the sea is different from the water that comes out of your sink or even the water in lakes and streams. If you taste it it's salty. But why?

[Chase] Hi, I'm Chase. I'm 9-years-old and from Enfield, New Hampshire, and I want to know why the sea is salty?

[Zach] Hi, Chase! I think that's a great question to ask. What it really comes down to is that the ocean is, for lack of a better word, the bottom of the food chain. Every stream and brook next to your house in Enfield, New Hampshire eventually gets to the ocean. And so not only do things like salt and mud but also your pollution goes all the way downstream. I have to put in my plug for pollution. But the most important thing is that rainwater is actually slightly acidic which surprises a lot of people but it's because of a reaction between carbon dioxide and water. It creates carbonic acid. And so when it rains the rain weathers rocks and pulls some of the ions or elements out of it. Different minerals. And so it's not just salt but lots of different things but salt's the most common one. So the salt actually comes in the rocks and it washes into the streams and then washes into the rivers and then down into the ocean. So since the ocean is the bottom of the line, excuse the pun, there's nowhere else for the salt to go. And so it builds up in concentration. Interestingly it's not just the ocean that salty the Great Salt Lake which is a famous lake in Utah, in the western United States, that's very salty because of the fact that there's no outlet. There's no river that goes from the salt lake to the ocean. So all the salts from the rains out west they go into the salt lake. So to get back to the ocean, the ocean is about 35 parts per thousand salt. Which means about three and a half percent. You can actually evaporate seawater to get salt.

[Jane] So some of the salt that we eat actually comes from ocean.

[Zach] Yup, the exact same salt. Unfortunately because of pollution you have to be careful which seawater you use to make salt now.

[Jane] And when you're in the ocean, if you swim in the ocean you might realize that you can float easier in the ocean than you can in a lake. And that's also because of the salt?

[Zach] That's right because of the salt in the water, the water is more dense. It doesn't feel like it if you just touch it, but when you get your body in you float much better in salt water than freshwater because the salt makes the water heavier so you don't have to displace as much of the salt water to float, which is why in some places with greater salt concentrations like the Great Salt Lake or the Dead Sea in Israel you float like a cork because there's so much salt in it.

[Jane] Animals that live in the ocean are specially suited to surviving in this salty environment. But not every animal can do that.

[Zach] So for example if you took a freshwater fish and put it in the ocean it's not going to live because what’s going to happen is its body is more fresh than salty for lack of a better explanation. And so its body is going to soak up a bunch of salt. So since they can't get rid of that salt it actually poisons them and they die. Whereas if you took a salt water fish and put it in the lake, what would happen is the lake being freshwater, fresher than the salty body of the fish, would suck all of the salt out of the fish which would also cause it to die. And so fish have evolved for different areas to regulate salt. A great example of salt regulation is actually with seagulls. The herring gulls that we have on the coast of Maine they have salt ducts on the top of their beak and so their bodies are constantly extruding salt so that they can survive in the harsh salty environment.

[Jane] That's pretty cool. Those seagulls have a special adaptation that allows them to spend so much time floating and fishing in the salty water. But seagulls aren't the only animals who have special adaptations that allow them to go between salty and not so salty environments. Zach's special area of focus as a marine scientist is with fish that live in both salty and freshwater environments.

[Zach] Some fish are really neat. My favorite fish of them all are called alewives. We call them anadromous which means that they live in the ocean but spawn in freshwater. Just like a famous example that I hate to use is salmon. I hope someday everybody knows about alewives I can use alewives for the example. But alewives live in the ocean until they're ready to breed. They swim up rivers and they go back to the ponds where they themselves were hatched. They spawn in the ponds and the juvenile fish after a few months swim back down the rivers to live in the ocean for a few years and then they complete the cycle. They go back up the rivers. What's really interesting about going back and forth between salt water freshwater is first of all physiologically it's really strenuous on the fish. It's impressive that their bodies have found a way to go back and forth between fresh and salt water.

[Jane] If it's so hard on their bodies why would fish evolved to do this to live in salt water, but go lay eggs and be born in freshwater?

[Zach] The ocean is a big scary place for a fish many, many, many things can eat you. So the alewives and other fish like that have learned that freshwater is a safer place to have your babies. But the problem is eventually you have so many babies. There's not too much to eat in a little lake. So the juvenile fish know that it's in their best interest to swim downstream to go out to the ocean, the buffet of the world. By then they're big enough that it's not quite so big and scary and everything is trying to eat them.

Everything is still trying to eat them but they do a better job as they get bigger in the ocean.

[Jane] Before we move on do you remember what Zach said fish like alewives that live in salt water but spawn or lay their eggs in freshwater are called? Anadromous. Anadromous is a Greek word meaning “running upward,” which makes sense. I mean fish don't have feet of course, so they can't exactly run upward but fish like alewives and salmon swim upstream against the current to lay their eggs in fresh water. So it makes sense if anadromous means running upward and fish are swimming upstream.

Let's go back to the beach. Can we look in a couple of the little pools here and see what we can find? Can you show me a couple of things?

[Zach] Sure.

[Jane] So this is not really a tide pool but kind of. It's almost a tide pool, right?

[Zach] Yeah it's a little one but we can see what we find here. We've got a few different periwinkles here.

Periwinkles, an interesting fact. These are actually invasive here.

[Jane] And these [periwinkles] are tiny little snails.

[Zach] They are little brown snails that everyone sees as “ubiquitous” which means they're everywhere on the coast here in New England. These are actually a non-native species that came from Europe many many, many years ago but now we see them as commonly as all the seaweed and we think nothing of it, that they're supposed to be here.

[Jane] And something like a periwinkle, a little snail.

When you say “came over from Europe” that could have come on the ships, right? It sort of sucks to the side of a ship and comes over that way.

[Zach] Yeah. They're probably stuck to the sides of ships that came from Europe and they got over here and they stayed.

[Jane] There's something that I used to call a lady slipper as a kid. What is that?

[Zach] Monoplacophora. I don't know how to describe them.

[Jane] It kind of looks like half a clamshell, but then it has a little shelf inside of it so you could sort of scoot something underneath it.

[Zach] Yeah. They are closely related to the clams and mussels. It's basically a snail with a cave for a shell instead of being able to go up inside. So they stick themselves to rocks and they're very, very difficult to pry off of you or a fish or anything else trying to eat them were coming on.

[Jane] And then there's some other kinds of snails and I'm guessing you don't have an answer for this because nobody seems to have an answer for this. But when I was a kid we were always told if you hum at a snail it will come out of its shell. And from my experience it works but nobody knows why.

[Zach] I think there was recently a scientific study looking at this and their conclusion was basically if you hold a snail in your hand and hum at it, eventually come out of its shell or if you just hold on your hand long enough it eventually come out of its shell. But what's the fun in that? Of course you should hum at it.

[Jane] Can we do it see if it works?

[Zach] Sure.

[Jane] I have, is mine a periwinkle? A big, large periwinkle. And what are you holding?

[Zach] This is also a periwinkle.

[Jane] All right.

So are you ready to ready. OK. See who wins here.

[Zach] Yours is already coming out. Quick, hum.

[Jane] Mine is coming way out.

[Zach] Mine has a bigger shell to try to move.

[Jane] Mine's going back in. Uh oh, I'm not singing well enough.

[Jane] I don't know, Zach is yours coming out?

[Zach] It was starting to and then I picked it up.

[Jane] All right so here I see a little mussel shell and people may be familiar with these. Right, they're sort of the bluey black ones. This one has a barnacle attached to it. It feels pretty light. I think this one does not have anybody inside of it.

But we did get a question from Lauren.

[Lauren] How do mussels get their shells? My name is Lauren, and I live in Washington, NH.

[Zach] Well when mussel eggs first hatch, the larvae mussel drifts around in the ocean for four to six weeks until it finds a suitable habitat, which means basically it's looking for a place where it can stick itself to the bottom and hopefully not get eaten, at least not too soon. So as soon as they attach to the bottom the muscles actually already have the very beginnings of their shells. And just like how when we eat food we can use the nutrients in our body to grow our fingernails and our toenails, they grow their shells by taking nutrients out of the water. Interestingly where a muscle lives will have an effect on how thick its shell is.

In a place like this, an inner tide pool where we have lots of predators like crabs and sea stars, the shells will be very thick. The muscles will put a lot of energy and effort into making big thick hard shells protect themselves. However people have found that with mussel farms offshore or ones that are up in the water column and not on the bottom. Well what we found was that when the muscles aren’t around predators they put very little energy into producing shells. So although they still have shells but they're very, very brittle. What scientists believe is that the mussels can smell their predators. They're called pheromones. They're chemicals in the water.

Just like how we smell by chemicals in the air, mussels smell by chemicals in the water. If they can't smell any predators they have no clue. They have no instruction to build big thick strong shells.

[Jane] Zach says the size of a shell depends on the type or species of mussels but it also depends on the age of the muscle as the animals get older their shells get bigger. Since we were looking around in the tide pools, Zach wanted to see if we could find a little lobster. Sometimes young lobsters hide under rocks and the tide pools.

[Zach] This could be lobstery. See how it’s dug out right there. When lobsters get under rocks they’ll excavate it more to make a bigger home for themselves. So you can see where somebody has been digging under this rock.

I don’t know if I can move it.

[Jane] Good muscles, of the human variety.

[Zach] Anybody home? Oh, there's one.

Here's a baby, a juvenile lobster. I'm not sure the size but he's probably a few years old at least. A lobster isn't legal size until it's about seven years old in this area.

[Jane] When he says “legal size” Zach means legal to eat. Lobsters are big business on the coast of Maine. In 2015, more than 120 million pounds of lobster was caught. When a lobster man or woman pulls a lobster out of a trap he has to measure from the lobsters eye socket to the edge of its body. If it's not at least three and a quarter inches long the lobster has to be thrown back into the ocean so it can keep growing. Lobsters that are too big have to be put back too, by the way. So any lobster you see on someone's plate or in a tank at the grocery store that comes from Maine is at least about seven years old. The lobster we found could fit in the palm of Zach's hand. But as he said it was already a couple of years old. When he looked a little closer, Zach noticed something really weird about this guy.

[Zach] This guy actually doesn't have any eyes.

[Jane] Somebody has been preying on him you think?

[Zach] Yeah. He lost his eyes and his claws. But he can still eat and he's still alive, quite alive. No antenna. I bet another lobster clamped right on the front of him. Poor guy. Actually, yeah. This is a male.

[Jane] So will he survive?

[Zach] He could clearly he's been living for a while because these aren't recent injuries you can tell just from the way that there's kind of scar tissue over the missing appendages over the missing claws and over the missing antenna. He's clearly still living. He’s find things to eat hiding under this rock. I'll put him right back under it to keep him safe. Lobsters can regrow their limbs. So eventually his claws will grow back and his antenna. I've got no idea about their eyes though. It's really interesting. I wish him the best of luck.

[Jane] If the only lobster you've ever seen has been cooked you might be surprised to find out that lobsters aren't red, at least not when they're alive. Their shells turn in orangey red color when they're cooked. But lobsters are naturally a sort of dark bluey green color. If you'd like to see the lobster we were talking about, we have a video of it on the But Why Kids Facebook page. You can have an adult help you see it.

Before he became a scientist, Zach actually grew up in a family of lobsterman. That's what got him interested in the first place in becoming a marine researcher.

[Zach] I grew up lobstering in Long Island, Maine which is in Casco Bay off of Portland. And so I saw lobstering when I was 10 years old and I was wondering why are there more lobsters here in this channel or there behind that island beyond just the migrations that the lobsterman have to have figured out. In June they go here, in July they go there. I was very interested in what attracts the lobsters to different places. I first got involved in research when I was I believe 16 years old. I got a temperature sensor from a scientist at the Woods Hole Oceanographic Institute and it logs the temperature once an hour. And so I put it one of our lobster traps for him and kept a record of what I caught. And so he did this with I think 10 lobsterman up and down the coast of Maine.

[Jane] The study showed that the temperature of the water on the sea floor where lobsters crawl around changes a lot even from hour to hour and that can affect where lobsters go. Being part of scientific research as a teenager got Zach interested in becoming a scientist himself. So he went to school to become a researcher and now he says he's doing what he loves.

All this talk of the sea has us feeling quite nautical. And as you listen to those waves roll in and out maybe you are thinking of big sailing ships on the sea. Some people like to capture that feeling and put it in a bottle. Have you ever been to a museum or someone's house and seen a glass bottle lying on its side with the model of a ship inside of it?

Well, I'm not the only one who's wondered how did that ship get through that bottle's tiny opening?

[Nico] My name is Nico, from Nashville, Tennessee. I am seven years old and I want to know how people put a ship in a glass bottle.

[Daniel] My name is Daniel Siemens and I'm a ship and bottle builder here out here in Colorado. I got into building ships in bottles because I watched Pirates Of The Caribbean actually and the fourth movie Blackbeard has all those ships and bottles in the cabinet and stuff and I thought at the time I was like how do they get ships in bottles? And so I went online and I started looking around and I figured it out. And after you do a couple you just get hooked. It's just too much fun.

The first step is finding the bottle. The bottle is pretty important as far as building the ship goes because you build the ship to fit the bottle. What you're looking for is the clarity to make sure you're able to see the ship pretty well through the bottle. Some bottles are just not clear enough. So then it's a matter of sizing out the plans. Some people draw them out. Some people, like I will find plans and print them off. I'll set my printer up to print bigger pictures or smaller pictures and kind of size it out and I'll put those pictures in the bottle and see does this fit? And pull them back out and try different things. So sizing the plans to the bottle is the next step. Then you start building the ship and the entire ship is built outside the bottle before it ever goes in. Everything the masts, the rigging, all of it is all built outside the bottle.

I use Basswood for the wood it's pretty easy to carve and bamboo skewers work great for the mast because they're really strong and you can whittle them down really really thin or fly tying thread for the thread for the rigging and the rope side of it and paper actually for a lot of different things. I use paper for windows or different really fine details. A lot of ship and bottle builders actually will go out and find all sorts of crazy materials. Like I've used the black wire in a cell phone charger cable to do canons because it's nice and round in and it's already black and or have to paint it.

The model is built so that the masts fold down. Typically the most common method is to put some hinges at the very base of the mast into the hole and the masts will fold back on those hinges. And when they're folded back against the deck the entire ship is a lot shorter and it will fit through the bottle neck. And so you slide the whole ship through the bottleneck and in the bottle and then you have what's called the forestays it's the lines that run out from the top of the mast to the bow and then out the bottle. You pull on those forestay lines and it'll hold the masts back up into position and then that's the hard part of gluing them down and cutting them off while they're in the bottle. And then the ships in.

Everything that you've done up to this point is make or break at that moment. And I've had models that I get them to that point and I'm pulling the masts up and something snags or something goes wrong and you got to pull the entire thing out and start over and redo all this rigging. And yes it is a little bit tense and a little bit exciting because you know everything's coming together at that point. And when it comes together and it everything pulls up correctly you get all the snags out of the way.

It's amazing like it you just look at it and go I did this.

[Jane] So now we know how to get a ship into the glass bottle. But some of you might still be asking why? Why would you want to do this? Sure it's fun and it's cool to look at. But is there a purpose? Daniel says there is.

[Daniel] You always have to ask the question how did it get in there? And that's kind of the fun part even for me when I build them and I show them off to people and they just look at them stunned and go how did that get in there? And you know and then you explain the process. Partly I think especially for sailors back in the day. It provides a good protection for these little tiny models.

[Jane] Daniel has built over 50 model ships in the past four years. He says a really simple ship can be built and finished in a couple of hours, more complicated set ups can take months. It depends on how detailed you want your ship to be. And he says it's not just something adults can do. Daniel makes ships and bottles with his kids and he's done workshops on it at his local library. If you want to try it have an adult go to our Web site: butwhykids.org. We have a link to Daniel's blog which has plans and instructions on how you can build a simple ship in a bottle. If you're successful send us a picture and we'll post it on our Facebook page.

That's it for this episode. Thanks for listening and for sending us your great questions. We have been getting intriguing questions from all over the world. You are an impressive and interesting bunch. You can always send us a question by having an adult help you record it using the memo function on a smartphone. Then send the recording to questions@butwhykids.org Be sure to tell us your first name, where you're from, and how old you are.

Thanks this week to Zachary Whitener at the Gulf of Maine Research Institute for checking out the tide pools with me and Daniel Siemens the ship in a bottle builder in Colorado. *But Why* is produced by Melody Bodette and me, Jane Lindholm, for Vermont Public Radio. We'll be back in two weeks with an all new episode.

Until then, stay curious!