

Hey to all you fish enthusiasts out there. Whether you're an avid angler or just curious about fish, we'd like to welcome you to fish of the week. It's Monday, May 10 2021. We're excited to talk about all the fish. I'm Katrina Liebich with the US Fish and Wildlife Service in Alaska.

And I'm Guy Eroh and aspiring micro fisherman. And the fish that we have today is one that I've really been looking forward to covering. We're talking about the stickleback and in particular, the three spined stickleback.

This is a fish that I grew up in Utah, and we read about them and their interesting behaviors in you know, AP Biology textbooks, but it seemed like this kind of mythical creature that I would never get to see because we don't have them out there. Midway through my time in high school, our family moved out to Oregon. And so one day I was out on a stream along the coast, and I was looking in and seeing the fish and see a bunch of sculpin, those are easy to identify. And then there's all these other little fish swimming around, I didn't know what they were, I was walking around waiting. And I actually I kind of pinched my heels together in the stream. And these fish would dart into my feet and get stuck in my feet, I'd reach down and grab them. And I looked at it and I you can see the distinctive face and these distinctive spines in front of the dorsal fin. And I knew immediately what it was from the pictures I've seen, but it's almost like finding a creature from another planet. Since then, you know, it's I've seen a lot of them. But that's kind of my personal connection to the sticklebacks. And I'm sure that the guest that we have on today has a lot of cool stories to tell about so. Katrina, would you like to introduce our special guest?

I would Guy. Okay, so our very special guest today is Dr. Frank von Hippel, who's Alaska born and raised and worked for a number of years at the University of Alaska Anchorage, before recently becoming a professor at the University of Arizona. And we wanted to thank you for joining us, Frank!

Happy to be here.

So for the folks listening to give them a visual, can you describe what a stickleback looks like in general, and how many species are there in Alaska?

Sure. So we have two species of stickleback and Alaska, but they're actually both species complexes with many species within them. So one is the three spined stickleback species complex. The other is the nine spined stickleback species complex. The Nine spined stickleback is an Arctic species. So it's throughout the Arctic and all of the Arctic countries. It's freshwater fish, but also in the marine environment. And it extends down to about the Aleutian Islands is the southern extent of its range. The three spined stickleback gets into the Arctic, but it's really more centered in the sub Arctic and temperate zone. And its distribution goes all the way down to the subtropics. So in the Americas, you can find them down in Baja, California and Mexico. And on the east coast of North America, they go down to about Boston. In Europe, they go all the way down to the Mediterranean, and in Asia, they go down to about Korea, so they have a massive distribution in the marine environment. And then in coastal freshwater environments, including rivers, wetlands and lakes. The three spined stickleback that we're talking about today it has typically three dorsal spines on its back. Two are large one is small.

It also has an anal spine and it has two pelvic spines. It also has dermal bones that we call lateral plates. So it's a well-armored fish when it locks together the provides this rigid structure that spiny and most of the predators are dealing with or other fish. Fish are gape limited predators. And so by making itself bigger and spiny, it makes it much harder for other fish to eat them. The males are really beautiful. So in most animals in the world, it's the male that's beautiful and the female that's dull because of sexual selection. So the male during breeding has a bright red throat, an iridescent green back and bright blue eyes and the female is silver in color. But the three spined stickleback also has many different shapes and many different coloration patterns around there are little sub species that you really are separate species with totally different coloration patterns, totally different behaviors. Like there's a white three spined stickleback in Nova Scotia that's distinct from all the rest. There are many species pairs around the northern hemisphere. There's at least six different types of species pairs of three spined stickleback. So their evolutionary dynamics are really remarkable and interesting and pretty complicated,

Cool and size wise, very small. What's the you know, largest, or I guess the average size and the largest

So the oceanic version, the one the ones you find in the ocean, as well as the anadromous ones they, in in adult stage, they tend to be about 65 to 75 millimeters long in standard length, and the freshwater ones tend to be more like 40 to 55 millimeters long. Nine spined stickleback are a little bit smaller and there are also thinner than a three spine.

So I was shocking some fish when I was working with fish Wildlife Service out on Kodiak Island, and we got of course plenty of sticklebacks. Got some pictures of some of the nice beautiful males red bellies and everything. One came up that was like a whitish blue looking thing. I wasn't sure if it was a color morph, or if it was just sickly. And I wanted to get your diagnose. I actually have a picture of it if I could share my screen. I don't know if you need that or if you're good enough with my description, but what was up with that fish that I saw?

Yeah, I don't think I need to see a picture you most likely found a stickleback infested with *Schistocephalus* which is a tapeworm that's specific to stickleback. What happens is that these fish the fish eat copepods that are infected with the *Schistocephalus* worm. The worm then grows up in the stickleback, which is the terminal host for the worm and the worm its next phase of its life history is in fish eating birds, so it has to get itself into a fish eating bird. And the way that it does that is it turns the stickleback into a blotchy white color to make it more conspicuous. And it changes the stickleback's behavior so that it swims at the surface of the water slowly and doesn't effectively run away from predators. And in fact, if your listeners try to go out and catch stickleback, they're pretty likely to catch *Schistocephalus*-infected stickleback because they're the easiest ones to catch, because they're trying to get caught. Not at their own volition, but the parasite has changed their behavior.

Evolution is crazy in that way.

And so then then the bird eats the stickleback. And then the bird defecates out the eggs of the *Schistocephalus* which are then eaten by the copepod, which is then eaten by the stickleback.

Oh my gosh.

Well that's a good thing. I didn't eat that one then.

It wouldn't hurt you to eat it, it won't. It won't infect a person so if you want to eat the *Schistocephalus* tapeworm of the stickleback, you can.

I'm just really curious. So of the 30 plus 1000 species of fish out there what makes this one such an ideal model organism for these behavioral ecology ecotoxicological questions?

We know more about the stickleback than we do any other fish in the world. And it allows us to get it very sophisticated questions of biology using this little fish. Part of it is that they have an oceanic ancestral stock that continually invades freshwater and gives rise to these freshwater species very rapidly. And it's based on what's called scanning genetic variation. And we've learned a tremendous amount about how evolution works by studying this process, and the stickleback

I was reading some of the papers that you and others have written. And it's just like a huge array of really interesting behaviors. Can you just describe a few of them?

Sure. So probably the one that is the most important to describe would be the parental care behavior. You know, most fish don't have parental care, but have fish that have parental care. The vast majority have paternal parental care. It's a father that takes care of the offspring, not the mother. So it's the opposite of mammals. And that's the case with stickleback as well. So the stickleback male, he defends a territory about one meter square in size. And in that territory, he gathers up little pieces of vegetation and sand and he builds a nest, which he constructs with a glue called spigen that he produces from his kidney. And so the stickleback actually converts the kidney - the male converts a kidney from an osmoregulatory organ into a glue producing organ during the breeding season. Builds his nest and then he courts a female she lays her eggs in the nest. When she's in the nest II and they go through an elaborate courtship dance on the way. When she's in the nest, he grabs onto her caudal peduncle and quivers. That stimulates her to spawn the eggs. And then he swims through and fertilizes the eggs. And then he provides about three weeks of extensive parental care. He fans the eggs - the embryos - with water to bring in oxygen and remove carbon dioxide. He defends them from predators, which includes the female stickleback, because they raid nests. There are females who will pretend to court male to get into a nest to eat his eggs.

So if there's all kinds of behaviors involved in this, but it turns out that they're really tractable to study and, and really easy to work with both in the field and in the lab. So for example, if you look at diseases that are genetic diseases in humans, you can find that 82% of them have unambiguous genes that are the same genes in teleost fishes, that means that if there's a human genetic disease, we can study that in fish about 80% of the time, and look at the same effects in fish that we would see in humans. So they're remarkably powerful for looking at human health. And they're much easier to work with than mammals. So I'd much rather do a study with the stickleback to look at the effects of pollution on humans than a mouse or rat. Part of it is that stickleback are quite hardy. In fact, there's some classic

pictures where in Europe they would take stickleback out of one area, shovel them into a back of a pickup truck, drive half an hour somewhere else and release them to seed that lake with stickleback. They evolve really fast. We've looked at this in earthquake uplift islands in the Gulf of Alaska in Prince William Sound where the 1964 earthquake uplifted oceanic areas which then became freshwater almost instantaneously. And we find that you get the evolution of a freshwater fish in just a few generations. We've also done experiments where we've introduced anadromous stickleback to lakes in Alaska that were extirpated of their fish, by rotenone. And we introduced the anadromous fish we get freshwater fish in a few generations, and everything evolves fast, the genomics evolves really fast, the physiology, the behavior, the morphology, all of it. So they're just an incredibly hardy fish. And they just allow you to work on these really interesting problems and behavior and genomics and developmental biology and so on. In an animal that's quite easy to work with.

Man that actually makes me feel kind of embarrassed because all the ones I put my aquarium died and are now in formalin.

Hey there everyone. One thing that we want you to always keep in mind, regardless of what it is or where it is that you're fishing is safety. Every week, we're going to give you a tip or two that you can use to stay safe while you're fishing. On this show, we've discussed fishes with big teeth and others with dorsal spines, so I figured it was about time that we talked about how to keep yourself safe while handling fish. As a general rule, if you catch a species of fish that you're unfamiliar with, especially a large one, keep your hands out of its mouth. Keep a pair of fine nose pliers or hemostats handy to remove any hooks. As a side note, you can use these tools to fit into tight spaces and get leverage on hooks. I use them on all species all the time, regardless of their teeth, just so I can get them back in the water faster. The other piece of officious anatomy that can put people off on the spines. Most often these are found on the forward most dorsal fin and on the anal fin, but they fold down backwards. Make sure that as you grab fish, you move your hand from the face backwards, laying the spines down as you go. Additionally, I'll just throw this out there. I've been spined before and I can tell you that the pain is so small compared to the joy of handling the fish.

What is eating sticklebacks? How important are they to the ecology of Alaska?

So they're not important to the direct consumption of fish because we don't have any people eating stickleback directly. We used to. Like Ship Creek and Anchorage the indigenous name for it means "where the stickleback run" because the Alaskan Natives who live in that region used to eat stickleback in soup when there weren't salmon around as a subsistence food source. So parts of year they would eat stickleback. But really, they're quite important to the ecology and also to the economy of Alaska's fisheries because other fish eat the stickleback. And the stickleback is the most abundant fish in the lakes and streams of most of Alaska. They're out there by the millions. And they're also a very important food source for fish eating birds. Like if you're in Southcentral Alaska, and you find a lake that has breeding loons on it. That means you're stickleback in the lake. So they're critically important to the overall ecology the system and indirectly to the fishing industry because they are a food source for so many fish that we do fish for.

As a researcher, I presume that when you're trying to collect fish in the wild, you use nets or traps, maybe even a little bit of electricity. But you got any tips for amateurs going out to try to actually maybe get one of these fish on a hook in line so you can just add it to your life list.

Well, that's interesting. I didn't even know that anglers have a life list and I do enjoy fishing. So that's a new one for me. But the easiest way to catch them is actually with a dip net or minnow trap or any kind of a fine mesh seine net. And it's quite easy even for a little kid to catch a stickleback. If you have a small dipnet, if you want to angle for them, you would have to have an incredibly small hook. And as far as bait, any kind of benthic macroinvertebrate that's small enough to fit in their mouth would work so they eat anything they can get into their mouth in the benthos, so little worms, little aquatic insects. They'll eat the larvae of flies like mosquitoes, all of those kinds of things. So I would just try to get the smallest one you could possibly get to put on your line and that movement, would that attract it. But have you never tried this nor have ever even thought of trying this. I can't really give you much more advice beyond that.

All right. Hey, the other day I was down in the Okefenokee Swamp. I caught a one and a half inch mosquito fish on a mosquito that I slapped on my arm, threw it on a tiny hook and got myself one of them. So I think if I put my mind to it, I might just be able to get one of these sticklebacks.

if somebody wanted to go out to their local lake or stream. Do you have any tips on how to look for stickleback, you know, do they prefer certain types of habitats over others just what are your tips for just seeing these fish in the wild?

So I think the best way to watch stickleback in the wild is to go up to a shallow part of the lake or shallow part of a stream with slow running water and find a male that's guarding his nest because that male is not going to go more than about a meter from his nest. And you can watch all of this complicated behavior and real action, which is really difficult to do with other fish. So if you just sit down, sit still the stickleback will go back to its normal activities right away, you'll be able to see it build a nest, glue it together, the nest will be ready when the male swims through the nest which is called "creeping through". You'll be able to see when the female comes he does a zigzag dance towards her to attract her to the nest. If she's receptive. She puts her head up and shows her swollen belly full of eggs. He then sometimes for some populations, so bite her, sometimes he won't, but he'll swim back to the nest in what's called leading. she'll follow if she's receptive, maintaining her head up, and then she'll poke her head into the nest, she'll swim into it, he'll grab onto her tail start quivering, that causes her to spawn her eggs, he swims through spawns his sperm, he chases her away. And then he starts his elaborate parental care of fanning the nest and keeping a tightly clustered together, defending it from other fish. When the embryos get to be about five or six days old, they'll hatch and you'll see them start to the fry start to swim away from the nest, he'll chase them down, grab him in his mouth, bring them back to the nest, spit them out. He loosens up his nest into a nursery, and he gets a little more space for the fry and he'll defend them until he can't catch him anymore, which is about three weeks after their, their spawn. So you can watch all of that occur with the stickleback which is just an amazing thing to see in nature. Not too many animals can you do that with.

Sticklebacks feat. Frank von Hippel

I've heard folks mention that they've seen like very large kind of mass groups of sticklebacks moving. Do you have any insights on when and where to see kind of those those large movements kind of those wildlife spectacles?

so the way to see that is go to any kind of a relatively small width slough that's coming off of the ocean. So for example, if you go out to Palmer and you look in Rabbit Slough this coming off of Cook Inlet during the early part of June, you can see them swimming up in vast numbers coming up to all the lakes and streams that that system.

I'm gonna go take my GoPro there and see if I can see that this year. That sounds awesome.

Right on I've had so much fun here.

Thank you, Frank, so much for joining us. This was very, very fascinating stuff.

Happy to do so I enjoy talking about it. And as you might have guessed, the stickleback is my favorite fish.

So I guess we'll wrap by saying that we hope you all get out and enjoy all the fish and please appreciate the stickleback because they are super cool. Thanks for listening to fish of the week. My name is Katrina Liebich. And my co host is Guy Eroh, our production partner for the series is Citizen Racecar. The show is produced by David Hoffman, co-produced and story edited by Charlotte Moore, post production by Garrett Tiedemann. Fish of the Week! is a production of the US Fish and Wildlife Service, Alaska Region Office of External Affairs. As the Service reflects on 150 years of fisheries conservation, we honor things and celebrate the whole community, individuals tribes, the state of Alaska, our sister agencies, fish enthusiasts, scientists and others who have elevated our understanding and love as people and professionals of all the fish.