

Getting Curious with Jonathan Van Ness & Professor Kelly Zamudio

JVN [00:00:00] Welcome to Getting Curious. I'm Jonathan Van Ness and every week I sit down for a gorgeous conversation with a brilliant expert to learn all about something that makes me curious. On today's episode, honey, I'm joined by Professor Kelly R. Zamudio, where I ask her: What is the story on frogs? Welcome to Getting Curious, this is Jonathan Van Ness, and I am so excited about today's topic, I'm so excited about today's guest. Without any further ado, let's jump right in. Welcome to the show Kelly R. Zamudio, who is a professor in the Department of Integrative Biology at the University of Texas at Austin. Go Austin! And an endowed fellow of the Doherty Regents chair in molecular biology, honey. Her research focuses on the origin and maintenance of vertebrate biodiversity, especially reptiles and amphibians. How are you, Kelly?

KELLY ZAMUDIO [00:00:55] I'm great. Thank you for having me. Very excited to be here, too.

JVN [00:01:00] Me too! Because you are a literal professor and a literal reptile and amphibian expert, I want to tell you how the origin of this episode came up. Well, we can't be here for six hours, so I guess I'll just start with the beginning and the end. There's a lot of frog interest in the middle. One. Poison Dart Frogs when I was little. I was, like, "Why are they poisonous?" "Why do they have bright colors?" One. Then most recently, there was this random frog in our backyard, and then my puppy ran up to it, and then was trying to like, lick it. And I was, like, "Oh my God, you're going to, like, get high! You're going to hallucinate off the toad!" So before we go any further? Is it true that if you lick a frog or a toad or whatever, you get high?

KELLY ZAMUDIO [00:01:45] Ha! Well, you don't want to go around licking any frog just randomly because there are some that could actually hurt you. Frogs and toads, depends on the frog. Depends on the toad. They vary in terms of how much they have, but they do have secretions in their skin that they use for protection. And in fact, some of them can be quite toxic. So the poison arrow frogs that you were attracted to as a child, those just have bright coloration. That's actually an evolved strategy, which is the bright coloration warns, right, "I'm toxic! I'm toxic!" And then, of course, the toxins in the skin are there to back it up, so keep them from getting eaten.

JVN [00:02:24] Oh, OK, but now we're really going to, like, just rewind into all things frogs. First of all, frog basics, Frog 101, because I need to be there. What's the difference between reptiles and amphibians?

KELLY ZAMUDIO [00:02:38] They're two different complete groups evolutionarily. Right. So frogs are part of a group called the amphibia, the amphibious vertebrates, and then reptiles are in a completely different group, which is the reptilia. So they evolutionarily had an ancestor in the past that was in common, but they diverged and became very different. So that's, that's why we have reptiles and amphibians. They're sort of put together in this field called

herpetology. So oftentimes we refer to ourselves as herpetologists. They're put together that way in an odd way just because, you know, they're not actually not a common group, a normal group. There are two very different evolved groups.

JVN [00:03:20] Is it just cause, like, all their skin is kind of, like, wet? So the scientists in the late 1800s was, like, "We're going to really like the wet, slimy skinned animals together!"

KELLY ZAMUDIO [00:03:30] Yeah. Interestingly enough, many reptiles with their scales are actually not slimy skinned at all. So I don't know if you've held a snake. They're actually quite dry. I mean, there are some that live in the water as well, but the skin is actually dry. They really got lumped together because they're sort of in the same kind of environments. So you find them, they're, like, referred to as, like, "the creepy crawlies." Right? So the ones that are under the rocks under the logs creeping along on the ground. And that's why they got lumped together into herpetology.

JVN [00:04:03] We did interview a herpetologist who is a snake expert this one time on Getting Curious. I'm not as scared of a frog as much as I am a—, because frogs seem so. This is not a psychology episode, Jonathan. Get it together. We are going back into where we belong. So frogs belong to the amphibians, right? Yes. You just said that. So what are some, like, defining features of frogs?

KELLY ZAMUDIO [00:04:30] So frogs are incredible if you think about it. The amphibians include three very different kinds of moist-skinned vertebrates. One of them, a large group, is called frogs, by far the most diverse group. We also have the newts and the salamanders, which are four-legged and have tails, right? And then there's a group that's, that's fairly less known, but also very diverse, especially in the tropics, which are called the Sicilians. And they're sort of elongated sort of eel-like, snake-like shaped amphibians. So those three groups include the amphibians. Frogs are kind of special inside of the amphibians because they basically turn themselves evolutionarily into these jumping machines. Now, not every frog is an expert jumper, but frogs ancestrally back at the beginning of frog diversity. Evolutionarily sort of modified their body plan to become jumpers, right? And a bunch of things happened at that point. One. you know how you think about a frog sitting down and it's sort of angled like this and its little legs are tucked under, that very typical frog posture? That is part of this body plan alteration. They basically made their vertebral column relatively short, very sturdy, and sort of fused, so all their vertebral elements are fused. They made this these hip bones where the legs attach to the to the vertebral column. They elongated those hip bones forward so that when they sit, they have that little crooked back part of the bone. [CROSSTALK] Yeah. And then all of that evolved so that when they push off their legs from that sitting posture, poof! They just launch themselves forward. So their little rocket, you know, jumping machines.

JVN [00:06:24] So how many species of frogs are there, like, in the world?

KELLY ZAMUDIO [00:06:28] There is a database where all the frogs of the world are listed. [CROSSTALK] Yes. And not only that, but it has distributions and maps and everything else.

JVN [00:06:40] What's that website called! Do you have to be, like, a certified herpetologist to go there?

KELLY ZAMUDIO [00:06:46] No, you don't. It's open to everybody. There's two, actually. One is called Amphibia Web. And then there's another one called Amphibian Species of the World. And they basically keep up-to-date with the literature and make sure that every species that is described gets logged in there so that we have a record of all frogs. We're just at about 7400, seven thousand four hundred species of frogs right now.

JVN [00:07:10] Wow. I kind of thought you were going to say, like, fifty thousand or something.

KELLY ZAMUDIO [00:07:21] No, no, not quite that many!

JVN [00:07:18] But maybe someday! How often is, like, a new frog discovered?

KELLY ZAMUDIO [00:07:24] Oh, every month in the journals of herpetology, we have descriptions of new species, so there are quite a lot of frogs still to be discovered out there.

JVN [00:07:32] And then how do, like, the sizes differ? How do the colors differ? Like, what's the smallest one and what's the most gigantic?

KELLY ZAMUDIO [00:07:40] So the largest frog is called the Goliath Frog. It's fairly large, like, larger than a football. The smallest frog, there's some debate, but one of the smallest frogs is only about seven millimeters long, so less than a centimeter. And there's one species in Brazil that I know that exists on the Atlantic coastal forest that is only about that big. And then there's another small species that competes for smallest frog of the world in Papua New Guinea. So those two are the tiniest and there are about seven to eight millimeters long as adults, so not as juveniles. So imagine the juveniles even smaller.

JVN [00:08:20] So is there a difference between a toad and a frog?

KELLY ZAMUDIO [00:08:25] Yeah. So a lot of people ask this. We use the term frog more generally for everybody who's inside of this group of jumping organisms, jumping amphibians, right. Now generally, if you asked people what kinds of frogs exist, people will say, "Well, there's the general pond frog," the kind that you see at the edge of a pond, right? So that's an aquatic amphibious frog and spends time moving between the edge of the pond and into the pond. There are tree frogs, which I'm sure you've seen right with the long legs, and they tend to be arboreal and those are. Then they're the ground dwelling frogs, sort of the toad-

like frogs. So generally, people, there's much more diversity than that. But generally those are the kinds of habitats where frogs exist.

JVN [00:09:11] Oh, so toads are just frogs that don't live on a lake!

KELLY ZAMUDIO [00:09:16] They tend to be more terrestrial. A little more dry-skinned. They tend to have the warty skin. Yes, they're, they're a little less amphibious than the typical pond frog.

JVN [00:09:27] Ah! So but are toads and then tree frogs, like, born in water, though?

KELLY ZAMUDIO [00:09:34] It depends. There's a lot of diversity in terms of where eggs of frogs are actually laid. But yes, most frogs, pond frogs and also most toads, lay their eggs in water. And then the tadpoles, of course, develop in there. And then they go through this process called metamorphosis, and at that point, they become adults.

JVN [00:09:55] Ohmigod, we're not there yet. Oh my gosh. I have to wait. I'm so sorry. I'm not ready. I'm so sorry. I'm freaking out. OK, wait. So when it comes to, like, toads, frogs, and tree frogs, what was that Goliath?

KELLY ZAMUDIO [00:10:08] It's an aquatic species. It just happens to be very large. Yeah.

JVN [00:10:13] And then is the littlest one a, like, frog species, like, a more aquatic one, too?

KELLY ZAMUDIO [00:10:19] Oh, the littlest one is going to be special. So the one from Brazil, and I don't know if you're ready to go here yet, but the one from Brazil, that tiny little frog from the Atlantic coastal forest is actually one of the frog species that has evolved something special, which is what we call direct development. They do not put their eggs in water. Their eggs get put on land in moist environments under the leaf litter, and out of that egg hatches a tiny little frog directly. There is no tadpole stage.

JVN [00:10:56] Oh, is it, do they usually only have one baby at a time?

KELLY ZAMUDIO [00:10:59] No, they actually can lay a clutch, so they have, like, five, six eggs, but every one of those eggs hatches out a little froglet directly instead of a tadpole. So it's really, it's really, really cool. Mm hmm.

JVN [00:11:13] Aww, I love that. So then, like, do toads, like, what's the diversity, like, within the three main groups, like as far as size goes, like do toads tend to be like any bigger or smaller? Or do they really range in size? The same with tree frogs, same with, like, frog frogs?

KELLY ZAMUDIO [00:11:27] Yeah, that's a really good question. So toads have quite a lot of variation in size. You know, if you think about the cane toad, which is an invasive species, and

it's from South America originally, but it's an invasive species in Florida. If you've spent time in Florida, you've probably seen a cane toad. They can get fairly large. Well, they'd be, like, 10, 12 centimeters from snout to vent, right, from length of the body. And there are also some very small toads, a couple of centimeters. So that's a lot of diversity. There used to be a toad. We know of a fossil toad that was almost as big as the Goliath frog. It's, it's genus name. The paleontologists love doing this, right, they called it Beelzebufo. "Bufo" is the genus of a lot of toads. It's one of the genera, right, that, that we assign toad species to. And so this fossil is called Beelzebufo.

JVN [00:12:24] Cute! And then what about colors? Like, I feel like I've definitely seen, like, dark green frogs a lot. And then the poison dart frogs, like, I only have seen in magazines, but I think those have a fairly bright blue, some bright red, some bright yellow, like, with black. And then I see pictures like bright green tree frogs. Like, what is there, what is there, any other, like, cool colors that we need to know about?

KELLY ZAMUDIO [00:12:51] Well, there are some beautiful blues in the frog world. In poison arrow frogs, actually, there are a couple of species that have, like, these vibrant blue colors that are really beautiful. Generally, the tendency is that arboreal frogs are going to be sort of more on the green spectrum. Not always. It's not an absolute rule, but a lot of the tree frogs tend to be green. Of course, they're matching their environment, up in the canopy of trees. Ground frogs often will take on sort of a greenish hue or a brown kind of hue, depends. And then you have these vibrantly colored things, like the poison arrow frogs, right? Or the mantella. And those are the ones that, as we mentioned before, often have, like, some, toxin in the skin. So that's a warning coloration.

JVN [00:13:40] What's, like, the most messed up thing that, like, a toxic, like, coloring can do to you, like, if you ate it or touched it, like, can any frog kill a human?

KELLY ZAMUDIO [00:13:51] Probably. Yes, there are some poison arrow frogs that are highly toxic in the Amazon. Yeah.

JVN [00:13:58] And what would it do to you?

KELLY ZAMUDIO [00:14:00] Umm.... you would die.

JVN [00:14:03] Even though they're so cute?!

KELLY ZAMUDIO [00:14:06] Yes. You don't want to be, you don't want to be licking and eating and eating frogs. And in fact, it's not just frogs. You know, salamanders can be fairly toxic, too, in terms of their skin secretions. Newts and salamanders are also amphibians, they're just not frogs, right? But they're related to frogs. There's a newt out west that is highly, highly toxic. And I remember there would always be stories in the news of some guy who got

drunk and on a dare basically swallowed a newt and then would end up dead. So you, you definitely don't want to be eating amphibians.

JVN [00:14:43] Oh, no, not the newt! I just always remember that one from Matilda. I think about, like my hometown, I definitely think I saw, like, toads that weren't really close to water, or maybe they were, like, on their way to a lake, but I didn't really live that close to a lake, so there must, it must have been a toad. But then I've also seen, like, lake frogs. What do they do when it's, like, cold as hell? Do they hibernate or what do they do in the winter?

KELLY ZAMUDIO [00:15:06] So generally, there's quite a lot of diversity in frogs, both in the temperate zone and in the tropics. There's what we call a gradient, meaning there's more species diversity in the tropics, just like there are in lots of groups of organisms. But there's, there are a lot of species up here as well. In the extreme, there are species that go all the way up into Canada, right? So in the extreme environments, frogs will actually hibernate during the winter, just like bears, so they lower their metabolism. They sort of shut down. They go into a burrow or they go underground and they just stay there until it warms up. So that's a very common strategy of what they do in the cold. They basically spend six months out of the year sleeping through the winter. In the tropics, of course, you don't have to hibernate, right. And so there is more activity year round, but that's what they do is basically spend some time out of the cold, avoiding it.

JVN [00:16:06] Will the frogs that had to hibernate and toads and stuff, do they build their own burrows or do they go get ants, like, an ex-snake burrow? Like, how do they make a burrow?

KELLY ZAMUDIO [00:16:15] Oftentimes, they're using burrows that are already there, that were created by some other organism. So, you know, if you walk in the woods, rodents and other organisms have basically created quite a lot of space underground, around the roots of vegetation and so forth. As long as you're below the frost line, so you can avoid getting frozen, that's all they need. And in fact, some species have evolved the capacity to avoid getting frozen by having a circulating agent in their blood that keeps their cells from actually getting frozen.

JVN [00:16:49] Like what?

KELLY ZAMUDIO [00:16:50] Yeah, it's, it's basically a circulating agent, like a peptide or a protein that basically keeps them from, you know, kind of like an antifreeze that you put in your car.

JVN [00:17:01] Will scientists ever, like, find that, like, frogs that, like, didn't, like, burrow deep enough and then they did freeze to death?

KELLY ZAMUDIO [00:17:08] I'm sure it happens. I don't know that we find them a lot because, you know, what's the chance of actually finding that, but I'm sure it does happen.

JVN [00:17:17] Poor things and so literal hype just do newts and salamanders. Well, I guess this isn't about them, but they're happening to some of them in the cold places?

KELLY ZAMUDIO [00:17:26] Yes, absolutely.

JVN [00:17:29] Oh, OK. So then how old? And oh, and what about like, do they exist on every continent except for Antarctica?

KELLY ZAMUDIO [00:17:39] Exactly.

JVN [00:17:40] So everywhere, except for Antarctica, that's where frogs, toads, and tree frogs are. So what's, like, the life cycle for most frogs and, and is the life expectancy of all of them, like, super different?

KELLY ZAMUDIO [00:17:52] Yeah, there's some variation there. Typically, a frog will live a couple of years, you know, two or three years. But we do know of some frogs that actually have lived longer than that, especially some of the larger species. So this gets into an area that I am, this is what I'm really interested in, which is sort of the life cycle of a frog, right? And oftentimes we refer to this as, as sort of their reproductive strategies, like, how is it that they go about one, living; two, reproducing. And this is where frogs shine. There's, like, so much diversity here. And to me, that's just fascinating. So reproductive strategies are sort of everything like where you put your eggs, how you find a mate, but where the eggs hatch and whether there's a tadpole or not. We already talked about the fact that there are some frogs that skip the tadpole stage, right? And there's huge diversity there.

So most frogs, if we think back in the history of frogs, back all the way to the ancestor of all frogs, the ancestor of all frogs we know from looking at the diversity now was an aquatic breeder, meaning they put their eggs in a body of water, a pond or a lake, and then the eggs hatch into a tadpole. The tadpole swims around and eats, and then the tadpole goes through this process called metamorphosis, where the tail – they lose their tail. They develop, they sprout out these little legs and then they hop out of the water as a juvenile. So that's what we call the ancestral frog lifestyle. That's how frogs started, right. Now from there, though, they've gone crazy. So there are frogs that put their tadpoles or put their eggs in bodies of water that are up in the trees, like bromeliads, for example.

JVN [00:19:49] Oh my god, wait, will you just stand by for one sec. I have to switch positions, and I have to pay attention. But my little back was just, like, "Girl, this wood floor, honey!" I just have to, I'm in a different set-up than usual, I'm so sorry, gotta lay on my stomach. OK, because I just, I'm taking this in so hard core and I'm so here for everything. So what did you

just say? Some of them put their tadpoles in water, but then they go up in the tree? What was that last piece?

KELLY ZAMUDIO [00:20:14] So some species, especially arboreal species, instead of going down to the pond and putting their eggs in the pond or in the stream, actually put their eggs into some body of water that is out of a pond or a stream. So, you know, in the tropics, there are these bromeliads, these plants that are arboreal, and they have these, they have these beautiful leaves that sort of point outward? Those leaves create little, little cups of water at their base. And some frogs actually use those kinds of environments to put their eggs. And so the tadpoles will develop inside of this plant before they turn into juvenile froglets. So that's one group. They just do it in all sorts of different ways. There are species of frogs that actually retain their eggs on their own body.

JVN [00:21:02] I was gonna you ask about this, I was going to ask you about this! This has been living with me rent free for a long time, and it was really traumatizing to me. So this one time I was watching the Discovery Channel when I was, like, 10, and I'm pretty sure that this frog had the eggs in its back. And then the, and then the baby frogs, like, punched their way out of the back of the mom frog or dad frog, and which I was. I almost died. It looked like it, like, these, like, little, anyway, these, like, little hexagonal holes on your back and like the image of the frog is laying around with all the holes punched out at us. That was, like, so fucking gross looking, no offense to that frog, but I was just like, the back and, like, this little skin was flailing, I jumped out.

KELLY ZAMUDIO [00:21:58] Yeah, so that's true. It's true.

JVN [00:21:59] It was, like, a figment of my imagination and I didn't really see.

KELLY ZAMUDIO [00:22:03] Yeah, it's true. It's true.

JVN [00:22:04] What's that poor frog's story?

KELLY ZAMUDIO [00:22:06] Well, actually, it's mom being really good, mom being a good mom and taking care of her froglets. So that whole group, that's a highly aquatic group of frogs there in the family called pipids. And what they do is when they when they actually mate, they have this little ritual, which is actually quite beautiful. And it might change your mind about that, about that female frog. But they, when they mate, the male, you know, grabs the female from the dorsum, from the back, and then they do this little upside down swim, like this. And right, as are going upside down, the female releases, the eggs and the male fertilizes them, right out in the environment. And but by being upside down, it sort of helps the egg slide on to the female's back. And the female goes through this physiological process that you can think of it as, like, a frog pregnancy in a way, in which she, you know, hormonally and everything physiologically basically grows up that skin on her back so that the skin grows over these eggs. It's quite an investment, and so that female is basically taking care of those eggs

by keeping them out of the water and keeping them on her body. And then, of course, they have to hatch out, and that's the part that sort of gave you the willies. A lot of people have that reaction.

JVN [00:23:25] Does it hurt her?

KELLY ZAMUDIO [00:23:26] I don't. Well, probably anybody does that. [CROSSTALK] I don't think anybody's asked the frog as to whether there's pain involved or not, but I don't know. I don't know. But it certainly does keep those eggs from getting predated and eaten in the pond.

JVN [00:23:53] And then do the moms die or do they live? Can they do it again?

KELLY ZAMUDIO [00:23:46] They do it again. Yeah, they live. They have their life span. Yeah. And you know, keeping eggs and babies in the body or on the body of frogs actually happens quite a lot, and it evolved multiple times. So it's not a single front that does this. The one you saw, I'm pretty sure on Discovery Channel is pipid. It's one of the more famous examples, but there are frogs where the female has a pouch on the back so she doesn't grow over the skin. She actually has a slit with a little pouch, and the eggs get put inside of their pouch and then the frog legs come out of that slit so that that seems very different, right, than putting your tadpoles in the water. There's one species. Unfortunately, it is thought to be extinct, but there are a couple of species where the female would actually swallow the eggs, shut down her stomach, like, actually shut down the production of gastric juices in her stomach, go without eating, and then develop the tadpoles inside of the digestive system. Those were called gastric brooding frogs, and then she would basically regurgitate her froglets.

JVN [00:24:58] Was that ever, like, on tape?

KELLY ZAMUDIO [00:25:02] No. There are some photos, but I don't, I've never seen a video of that. There's another species, actually, where it's the male who does this. So you know how frogs, when they call, they have this pouch in place. It's called their vocal sac. They make noise with it, and there's a species which is not extinct. This one does still exist, and there is a video of this where the male basically swallows the eggs, keeps them in his vocal sac and then the frog legs once they develop in there, basically come out of his vocal sac into the environment.

JVN [00:25:34] Baby little frogs?

KELLY ZAMUDIO [00:25:36] Mm hmm. Yeah.

JVN [00:25:38] What's the most amount of, like, froglets or tadpoles that, like, a mom, normally would have? Or is there just so much diversity.

KELLY ZAMUDIO [00:25:48] So I'm here in Austin and there are toads where they can put a string of eggs in a pond that is, like, 10,000 eggs. And so that's a huge amount of babies and all of those hatch. And if they all get fertilized, they all hatch, and they turn into tadpoles.

JVN [00:26:03] So those eggs don't get fertilized, like, the toad mom and dad don't have sex. The mom just lays the eggs and then a boy toad has to come find a big sack of eggs and frog ejaculate on them?

KELLY ZAMUDIO [00:26:13] No, the, the eggs, the eggs get fertilized as they're being deposited. But you're right, fertilization is external, meaning there's no copulation, right? So the male frog grabs on to the back of the female frog. And this is a position that we call amplexus. It's basically their mating position, amplexus. And so the male grabs on to the back of the frog. And there, there's, you know, courtship and there are some, some stimulation of some sort, right? Because the female has to accept that male. And then if she accepts that male, she will start depositing her eggs. And as they come out, the male fertilizes the eggs.

Then on the other side of the spectrum, there are frogs that have a very small number of eggs, and a lot of these tend to be these specialized breeders. So so for example, the terrestrial breeders, the direct developers that I told you about where the where the frog skips the tadpole stage, those, those species tend to have smaller clutches, so they'll have, like, six, seven, eight eggs, and each egg is actually supplied with a lot of yolk, right? So a toad that puts 10,000 eggs in a pond is counting on the fact that those little tadpoles are going to hatch out of those eggs and they're immediately going to start eating the algae at the bottom of the pond? Right? So that's that strategy. If you're keeping your eggs on land and you're skipping the tadpole stage, you've got to feed that developing froglet, right? And so that's why they have fewer eggs and each one is supplied with this really nutritious yolk that the embryo uses to turn into a little froglet.

JVN [00:27:56] Is there any, like, bigger frogs who do the direct breeding? Or is that so far only been the teeny tiny ones?

KELLY ZAMUDIO [00:28:03] No, there's, there's some good-sized frogs. There's a whole family of frog that's direct-developing in the tropics, in the near tropics, and some of them, some of them get, you know, six to seven centimeters. So there's some variance there.

JVN [00:28:17] And then obviously, this is a question that I just can't help but ask, it happens every time. Any evidence of gays frogs? Like, any, do, is there any, like, just, like, gay best friend frogs? Are these? Well, there probably be. They, they do it. They do that, that word you just said—

KELLY ZAMUDIO [00:28:36] Amplexus, amplexus. So you know, there is there is quite a lot, and all of animal diversity, right has same-sex behavior. This isn't anything unusual. You will find cases where, especially with pond-breeding frogs that tend to be mating at the same time, I

don't know if you've been to a pond where it's, like, peak of the breeding season and the males are all calling in, the females are coming in and there's all this scrambling to try to get the females. Sometimes you will see males that are amplexing other males. Of course, there's no fertilization of eggs because there's no eggs in that case. But you do see, you do see amplexus. And I've even seen amplexus of males with other species.

JVN [00:29:20] What happens with that?! If there's more than, like, one species in a pond, can other species have, like, frog babies with a different species?

KELLY ZAMUDIO [00:29:28] It depends on, probably it's going to depend on how distantly related they are. So if they're closely related, it's possible that you could end up having what we call hybridization, right? Meaning cross-species fertilization of eggs, but mostly, mostly reproduction is best within species.

JVN [00:29:47] And then what about, like, like, maternal-ness with frogs, like, do any of the moms ever, like, hang out with the babies for longer? Or are they all just, like, "Get the fuck out!" Like, "You punched holes in my back! I can't stand you anymore!" "I need to go exfoliate and get back to my old back!"

KELLY ZAMUDIO [00:30:07] Yeah, there's probably—, exfoliate! That's perfect. That's a great idea. A great analogy. There's quite a lot of diversity and both paternal and maternal care.

JVN [00:30:17] Oh, yeah, don't write the dads off!

KELLY ZAMUDIO [00:30:18] Yeah. No, they do some, too. And there are some groups of frogs where it's all about the dad and the dad care. I don't know if you've heard of glass frogs? They're these beautiful neotropical frogs that are sort of semi-transparent, so you can sort of see their organs inside. There's a whole family of them.

JVN [00:30:37] You've said it twice now, and I shook my head and was, like, "Yes, of course, the neotropics. I've been there multiple times, myself, actually. It's a beautiful place." Is the neotropics, just, like, the right outside the tropics. Like, almost there, but not quite?

KELLY ZAMUDIO [00:30:53] No, it just means the new world tropics.

JVN [00:30:56] So what's that mean?

KELLY ZAMUDIO [00:30:57] There's tropics all over the world, right? So if you take the globe and you just make a band around it, that, that's going to be the tropics. And so there's tropics in Africa, there's tropics and Asia, and there's tropics in South America. It goes all the way around the globe, right at the equator. The neotropics are just the tropics that are in the Americas.

JVN [00:31:18] Ah! Okay, got it.

KELLY ZAMUDIO [00:31:21] Not the African tropics, not the Asian tropics, the South American tropics.

JVN [00:31:26] Got it.

KELLY ZAMUDIO [00:31:27] That happens to be an area where I do a lot of my frog research. In terms of where the tropics extends, this is actually a really good question. And you know, there's all sorts of distributions of organisms that are tropical, meaning their origin is tropical, but they extend up north and south, right, from the equator. So for example, Austin, we are up here in the US, right? There are a few groups of organisms that actually extend *just* into Texas that are actually tropical in origin. So, for example, this is not a frog, but there is a green jay that is, occurs here in Texas, and the green jays are from a tropical group of birds. And this one just barely makes it up into Texas. Same with frogs. We have species of frogs here, even in Austin. If you go to the Greenbelt, there is, there are species of frogs here that actually belong to families that are 99 percent tropical in origin, tropical and origin, and these species just happen to have extended up this far. So sometimes you get people saying, "Oh, you know, there's the tropics, and then there's the subtropics," like, Florida's subtropical.

JVN [00:32:39] Yes. So but that's not what the neotropics are, OK. That makes sense. I'm so happy I asked because I like, I was like, "Uhh, I got to ask, and I don't know what it means!" So what? And so going back to Austin because I lived there and I did in a separate, totally different incident by the gigantic tarantula that was dead in my front doorway. What is the most, like, tarantula-ish frog? Meaning I never would have thought moving to Austin, I was going to see, like, scorpions or tarantulas. I didn't know that they were there until I got there. Well, I think the most surprising, like, pretty surprising frog species that Austin. Is there any ones who think that weird color or, like, got a cool story that, like, I wouldn't think was there?

KELLY ZAMUDIO [00:33:23] Mm. Yeah. Well, this might be a little. I think I'm going to go back to this tropical species that reach up here. I mean, I was taking a hike, actually, on the Greenbelt with some of the students here from the university, and one of them actually managed to catch this one species that's in a genus called *eleutherodactylus*. And having worked in the neotropics a lot, right, that's one of the big families down there. It occurs everywhere. And they're very typical. Like when you catch one of these, you sort of know what, what family it belongs to. And it was pretty amazing to see this frog hidden in these holes in these, you know, beautiful rock walls that we have around here, right? These, these limestone cliffs. And in those holes, if you shine your light in there, you see these little frogs hidden in there. There are completely tropical radiation that has just gotten up this, this far north.

JVN [00:34:23] That's cool! And then you were saying earlier about, like, the translucent, the translucent skin frog when I interrupted you about the neotropics, what are you going to say about that frog?

KELLY ZAMUDIO [00:34:34] Oh, we were talking about paternal care, remember? So in glass frogs, there's a lot of, there's maternal care, but there's also paternal care. And so what happens is that a male will set up. He finds a leaf, like, on the edge of a stream. And basically calls and advertises to the females. If the female chooses that particular male, what what? Amplexus happens and she deposits her eggs and he fertilized them and he stays with the clutches. So and he guards the clutches. You've actually studied some of the species that do this and, you know, basically figure out what's going on in terms of, you know, how many, how many eggs, how many different mothers. They can guard up to, like, six clutches at a time. So every night, he might get a different female and then he takes care of all the, all the clutches on his leaf.

JVN [00:35:21] What is he, like, defending or protecting the clutches from? Like, who might want to come eat a bunch of frog eggs?

KELLY ZAMUDIO [00:35:27] Oh, all sorts of things. Insects and snakes, crickets.

JVN [00:35:35] So his hands are full because there's, like, all sorts of people vying for his eggs.

KELLY ZAMUDIO [00:35:36] Mmhmm. Mostly predators, yeah.

JVN [00:35:39] Nooo! So before it's the point, like if she's going to accept him or not, what's the courtship look like? So, like, that's like when we are hearing, like, the classic, like, "ribbit." Is that what we're hearing? Are they calling to each other to diddle?

KELLY ZAMUDIO [00:35:52] Yeah. So we call those advertisement calls, right? They're basically courtship calls. There's a lot of information, it turns out, in a frog song. You know, people have studied this a lot. There's actually even advertisement about how good a mate you are going to be or how good a father you're going to be, or how good of a caretaker of the eggs you're going to be, if it's a species where the father takes care of eggs. So, yeah, that's the advertisement call. Once females come into a breeding situation, once they're ready to breed, right, they have eggs that they're ready to deposit, then, then there has to be some sort of courtship so that the female then makes a decision as to who she's going to breed with. And now again, frogs you're already learning are all over the spectrum in terms of what they do. Some species, it's just like the pond species. Remember, we were talking about that. It's just, like, all simultaneously calling, and it's deafening, sometimes, when you're out there at the pond. All the males calling, and there's, like, a lot of scramble, males trying to get females when females come in and so on. So that's one way.

But in other species, it's like almost you could think of it as almost monogamous, right, like, there's a lot of choice and a lot of effort going into the courtship. So there are some species of tree frogs that have been studied in Brazil, where the courtship takes hours and the male is touching the female and, you know, sort of rubbing her. I'm sure there's transfer of pheromones, you know, like, transfer of not only tactile stimuli, but maybe even chemical stimuli. And then the female finally makes the decision. They come down from the tree together, and then the male has a chamber at the base of the tree that he's dug. And then they go into that little chamber and do amplexus in there. That takes hours. So there's a lot of variation in terms of what females are responding to, and it's, of course, very species-specific.

JVN [00:37:56] And then will they, like, stay together until she, like, has the tadpoles?

KELLY ZAMUDIO [00:38:01] Not in the case of that particular frog and. In the case of that particular frog that I just described, the tree frog that goes into the chamber, they lay their eggs and then the eggs basically develop terrestrially. This is at the edge of a stream, right? So the tadpoles at some point when the rains come basically get washed out of that chamber and into the stream. However, there are species where the female frog actually tends to her tadpoles. So these are, you know, tadpoles that are in a stream in a pond or they could be in these bromeliads, and the female will come by and feed them every once in a while by using unfertilized eggs that she herself has as a source of nourishment for her babies. So there's a lot of variation in terms of maternal care as well.

JVN [00:38:48] So, and then, will a girl frog ever like praying mantis a boy frog and, like, kill his ass because she doesn't want to do it? And he won't leave her alone?

KELLY ZAMUDIO [00:38:58] I don't know of any praying mantis frogs like that. Females will definitely reject the males. I mean, there's no question.

JVN [00:39:04] And will they just, like, run away when that happens? Or what do they do?

KELLY ZAMUDIO [00:39:08] Yeah, they just move away. There are particular posture, actually, the females use to signal that they are not in a breeding, they're not in a breeding situation .

JVN [00:39:18] And would that be because they're too, like, they already have had a bunch of babies that year? They just don't like you?

KELLY ZAMUDIO [00:39:24] Maybe they don't like you. Or maybe you're not the male that they wanted. Or maybe they already, you know, made it to somebody else and their eggs are already deposited in the environment somewhere.

JVN [00:39:36] Hmm. Mm hmm. And then is there any, like, frog, mom or dads who stay with the babies till they're, like, full, frogs?

KELLY ZAMUDIO [00:39:46] Usually, they say, if there's maternal or paternal care, it usually ends at some point, either when the tadpoles are in the environment now and able to feed themselves or when they become juveniles. So there are a lot of frogs where, especially the ones that carry their babies on their back, right, they actually will still continue to carry their babies until they're little juveniles. The whole point is to get them to a place where they can provide for themselves, right? While still, you know, reducing predation during those early, early life history stages where the, where the babies are really vulnerable. I mean, frogs are little snacks, right? Like, anything can eat them, especially the little ones. And so taking care of your babies until they get to some point of being able to provide for themselves is what, what's going on here.

JVN [00:40:38] Do we ever see a mom or dad frog get mad and just, like, eat one of the babies?

KELLY ZAMUDIO [00:40:42] Oh, cannibalism. I don't know that. I mean, it's sort of human to say, "Oh, she got mad and ate her baby." I think that there's more to it.

JVN [00:40:53] I'm sorry, I didn't mean to say it! I'm sorry! Well maybe he did it, too! Maybe she needed the nutrients because she hadn't eaten away from a predator!

KELLY ZAMUDIO [00:41:02] It's possible! There is evidence of cannibalism in frogs. It tends to be among clutchmates. So tadpoles eating other tadpoles, not so much parental cannibalism. But yeah, it's, it does happen.

JVN [00:41:14] So there's sibling rivalry, cannibalism.

KELLY ZAMUDIO [00:41:18] If we want to call it that.

JVN [00:41:20] I think I just read this article about, like, snake moms eating one of their snake babies, and they studied all these different snakes, so only like one of their own species and there was like 10 and there was like one other mom snakes ate one of the babies in the end. And they even said in the study that, like the snake was because they were talking about how some of the moms snakes will eat the dead babies. But then this one snake ate one of her life babies, and I was like, I like her, she said. But these snake kind of like, "Your ass made me feel bad. You hurt me. I am eating you." Yeah, I just thought she was kind of fierce. I just didn't know if that ever happened in frogs.

JVN [00:42:00] What's your favorite frog?

KELLY ZAMUDIO [00:42:02] Oh, my goodness, there's so many. I like frogs that are stream breeders. There's a whole genus that I study in Brazil, there are a number of species, just, like, I don't know, 20 species in this genus, and they all live on these beautiful streams that run down mountainsides. So they tend to be, you know, nice waterfalls. And this particular genus

has a terrestrial tadpole, which I'm just fascinated by. So the tadpole, you know, tadpoles swim in ponds or rivers or whatever. They have a tail, that's what they use to propel themselves through the water. In this particular genus, all the species have tadpoles that live on the sprays zones and waterfalls. So, you know, when a waterfall comes down off of rocks, there's this wet rock surface that's called the spray zone. This particular genus specializes in that its tadpoles crawl out of the water and onto this spray zone, and they forage there. They eat the algae that's in the spray zone. And the way they get around is by using their very muscular tail to flick themselves forward. So they're like these little tadpoles that are sort of jumping on the wall of, of the waterfall, you know, in the spray zone. The genus that's called cyclo rameses. And I just, I've studied with, I and my students have studied, a lot of aspects about it, including their mating behavior and so on.

JVN [00:43:31] That is so cool. So you mentioned those one frogs that are, like, almost, like, monogamous, like does that type of frog tend to only have like one partner its whole life or like maybe two if the one dies or something?

KELLY ZAMUDIO [00:43:43] Yeah. So there are long term associations between frogs. There are species that stay together where the male and the female basically collaborate in terms of provisioning and taking care of young. So there are, there is definitely documented monogamy in a number of species of frogs. Most frogs are, don't have these long term associations. So a lot of pond breeding frogs, for example, will get together. Of course there's calling and there's courtship and there's amplexus. But once the eggs are in the water, they're, they're done, until, you know, the next breeding season. So again, frogs span that gamut, and there actually, we discovered recently, there's even frogs that are in the middle where a male has a number of females that he courts and stays with and allows there on his territory. And they have a long term association, so he breeds with those same females over a number of different months during the breeding season.

JVN [00:44:45] When is the breeding season?

KELLY ZAMUDIO [00:44:47] It depends on where you are. So up here, in more northern latitudes, it tends to be spring and summer, although we do have some fall-breeding frogs, you know, here in Texas. In the tropics, it tends to coincide mostly with rainy seasons, right? I mean, frogs are still amphibians. They need water. Even the ones that lay their eggs on land still need moist habitats. There are frogs that exist in deserts and very dry environments, and they have to seek out particular areas to put their eggs.

JVN [00:45:19] Hmm. What are the desert frogs like?

KELLY ZAMUDIO [00:45:23] Oh, so fascinating, right? I mean, imagine being a frog, frogs just have this moist skin, and they lose so much of their, you know, humidity through their skin, and they have to stay moist to capture oxygen through their skin. So desert frogs have to, have to either choose a micro-habitat, like a place that's really moist, like a spring, or they can avoid it

altogether by taking off, just like our frogs up here hibernate during the winter. There are some desert frogs that estivate, meaning they just take the hottest months off and go underground, protect themselves.

JVN [00:45:59] Estivate! Hibernate but estivate! Interest! So what, what's, like, the differences between, like, frogs and, like, humans or like other mammals? Like, is there any, like, like, so they, they get their oxygen through their skin from the water?

KELLY ZAMUDIO [00:46:22] They also have lungs, so like us, they breathe, but they do supplement their oxygen intake through their skin. And that's why keeping moist is so important, right? So the difference between us and actually the difference between amphibians and reptiles is that we basically have put a barrier in our skin, which is, you know, either scales or keratin or whatever in the skin. And that keeps us from losing all our water through our through our skin. Right? I mean, we lose plenty of water through, you know, our noses and our mouth and so on. So it's We're. Also, everybody's losing water to the environment. And but frogs are especially susceptible that way.

JVN [00:47:06] Hmm. OK. Obsessed with that. And then what? So currently, what's going on with frog biodiversity like what's the state of it? Obviously, climate change, I know, is an issue. Like how are frogs doing, in the world?

KELLY ZAMUDIO [00:47:24] Yeah, that's a great question. And it's something that a lot of herpetologists are working on actively. So there are a couple of threats just to frogs that are big. And like you mentioned, there's climate. And so there are issues of, you know, how we see these extreme weather events, for example. There are issues in terms of frogs that tend to breed seasonally and they need particular environments that if, if that kind of change gets too extreme, we basically are, you know, could be possibly threatening entire species. We have also destroyed a lot of our environment and this is true up here, as well as ongoing destruction in the tropics. And so, you know, that's something to really worry about because some of these species have relatively small ranges. And if you destroy too much of it, they could just blink out. And then, of course, there's disease. I don't know if you've heard about the frog pandemic. Yeah, there is. There is a chytrid fungus, a fungus out there. It's a pathogen and it actually infects amphibians and especially infects frogs. And there are some species that are very, very susceptible. And so they they have actually been threatened. So there are a number of threats out there.

JVN [00:48:38] What is that thing! And how do they get it! And how, is there anything that people can do to help prevent it?

KELLY ZAMUDIO [00:48:43] We're working on it. There's a lot going on. So it's a, it's a fungus. And you know how fungi make spores? That's part of their lifecycle. And these spores are actually the kinds of things like if you have mold in your house, mold is a fungus, right? If you have mold in your house, those spores is what gives people allergies, because your body is

reacting to all those spores. So this fungus transmits from frog to frog through the water. And of course, frogs are in the water and the, the the fungus basically gets into the skin, reproduces in the skin, and then all these spores come out of the skin, and then they go in the water and infect the next frog. So it's pretty insidious, especially if you live in the water, right, because you can't escape this pathogen. Now there are a lot of people trying to figure out what to do about this. So there are people working on sort of, like, a vaccine for frogs. There are people looking at how other things like bacteria on the skin might be beneficial. They're actually good bacteria that are part of our whole system. And so there are people studying that. There are people trying to eliminate the fungus from the environment, you know, sort of cleaning out the environment. So there's a lot of efforts going in, in terms of the frog pandemic itself.

JVN [00:49:57] How big of a deal is it? Sounds bad. Are they going to, are we going to, ah! Are they going to be OK, the frogs?

KELLY ZAMUDIO [00:50:08] I think. I think so. I mean, some species we think have already gone extinct because of this, and that's really unfortunate. There's a lot of variation among species in terms of how susceptible they are and just like anything else having to do with biodiversity and conservation, the rarer you are, meaning maybe a species only occurs on one mountaintop, or maybe it has a really limited distribution or something like that. So the rarer you are, the more vulnerable you are, because the chances of you blinking out as a species, so to speak, is higher. But there is also hope, like, people, for example, there are some species in Panama that we thought were extinct and people have now rediscovered populations. So they survived in some sort of, sort of protected area for some reason. And so that gives us a lot of hope that it's not going to kill all of them, so to speak.

JVN [00:51:04] How does, like, frog welfare and the wellness of frogs affect like other animals in other environments? Because like, if you I would imagine if, like, frogs are able to thrive, isn't that going to impact other animals, too?

KELLY ZAMUDIO [00:51:17] Yeah, it does. And we can already see this. It's like it's already measurable. So if you think about it, you know, have you heard about food chains? And how, you know, energy moves through the environment because organisms consume other organisms and then you know that energy gets moved up the food chain? So at the base of it all, there's plant material, right? And plant material gets eaten by little things. Insects, also big things, giraffes, you know, anyway, that's, that's movement of energy from plants into animal tissue. Frogs play a very important role because they tend to be adults. Frogs tend to be insectivores. They eat insects a lot, and insects often are deriving their energy from plants. And so what frogs are doing is moving the energy from the tiny packages to themselves, and they then themselves get eaten by larger animals. So frogs get preyed upon by snakes and by birds and and small mammals and even large mammals. They're an important sort of link between the tiny amount of energy that's in insect that came from plants to the larger members of the food chain. So we already know, this isn't my work, but it's work by a

colleague of mine: we already know that snake communities in the tropics are actually already showing signatures of declines. And that's because the frogs have been hit hard by this frog pandemic and their food source for the snakes is actually now lowered.

JVN [00:52:51] Hmm. So if a frog is doing it, then you mentioned this before. Like Panama, we rediscovered some frogs. How do you and other labs discover species that were thought to be extinct? You just got to go searching?

KELLY ZAMUDIO [00:53:05] Yeah, there's manuals. We know where the species used to exist, right? We have records of their distributions in the past. And so we do a lot of sort of manual, I mean, just observational searching, mostly at night and with flashlights. We also use some new technologies, which has been really, really fun to work with. One of them is called environmental DNA, and that is, instead of searching for the frog itself, you're searching for DNA in the habitat that came from that frog. So, you know, we shed DNA all the time, right? And as do frog. So flecks of cells come off of your skin and you know, you sneeze and then you know, you pee and you poop. And all of that has cells, remnants of cells that include your signature, which is your DNA. So we can actually go to a stream and pump a bunch of water through a filter, isolate the DNA off of that filter and try to find the DNA that's characteristic of that particular species that you're looking for. So, yeah, it's really cool. So we did this for a bunch of frogs that have gone missing in Brazil or that have shown pretty abrupt declines in population numbers. And sure enough, we didn't find all of them, but we found seven of the species that we thought were lost.

JVN [00:54:30] So maybe they are, like, a little bit, OK?!

KELLY ZAMUDIO [00:54:34] Maybe there's somebody there. It doesn't mean that the species is thriving, but it means that at least there's a presence, right?

JVN [00:54:40] Okay, that's exciting!

KELLY ZAMUDIO [00:54:41] Yeah, it's one more piece of data, because then it allows you to say, "OK, now we've got to do something because we know the species is here."

JVN [00:54:48] So there is a lot to understand about frogs, amphibians. Do you feel like the scientific community of herpetologists and, like, bio, like, biology, all the experts in your field? Do you, I mean, do you feel like we've learned all there is to know about frogs?

KELLY ZAMUDIO [00:55:05] Oh, no. There's always good surprises still around the corner, right? There's— it's so great. This is why, this is why I love them so much. It's, like, unending the amount of stuff that you can learn, especially if you start probing into things like that, things that we weren't able to study before. So, you know, I use a lot of genetics in my work, and one of the ways that genetics is so useful is not only for, you know, using eDNA to discover frogs that are missing in the wild, but also because it allows us to ask questions about how frogs are

functioning. So I use DNA a lot in studies of mating systems. So, you know, kind of like people do paternity tests to figure out whether a kid is theirs or not. We can do that with tadpoles and we can ask, you know, "What males were successful here in this population and why were they successful? Were the males with the best calls? Were they the largest ones or are they the best dads?" You know, so we can ask a lot of questions, and I always every time I do something like that to study sort of reproduction and paternity and maternity in terms of outcomes, I always discover something interesting. So I think there's a lot there, like, this essence of being a frog and you know how you behave and we're getting, like, an eye into their existence through using these genetic techniques. So I think there's still a lot, a lot to learn.

JVN [00:56:32] And then with Austin, because you're in Austin now as well. What frogs are like local to the area? What should we try to explore? Like, what should we try to go, like, frog spelunking for?

KELLY ZAMUDIO [00:56:42] There are a lot of wonderful frogs here, including these tropical relics that I was telling you about, like the species of *eleutherodactylus*. When we caught that frog in that limestone bluffs on the Greenbelt, I was, like, "Wow, I feel like I'm in Panama."

JVN [00:56:56] Was it green or, like, what color was it?

KELLY ZAMUDIO [00:56:58] It was a, it's a pretty greenish. It's got a greenish hue, but it's sort of a brown green. Really beautiful. There's some really cool, narrowmouth toads and toads around here. If we go a little bit south from Austin, like down towards the Rio Grande Valley, there are some really amazing species that just barely make it into Texas, from some, primarily from Mexico. But there's there's I'm still learning. There's a lot to explore still here.

JVN [00:57:27] So what's next for you in your lab?

KELLY ZAMUDIO [00:57:30] Well, we're here now in Austin, so all sorts of fun things to explore. And we're going to continue working, I think, on this mating system stuff, which fascinates me, it's sort of my, it's my eye into sort of what it means to be a frog. And I've been working a lot with the conservation side of things that we talked about, especially this disease and this fungus. And so using the tools that we have here are genetics to actually be able to study things like, you know, what species is susceptible and what species is not really important towards looking to the future of who's, who's going to be endangered or not.

JVN [00:58:11] So some species are way more prone to this fungus than other ones?

KELLY ZAMUDIO [00:58:16] Absolutely.

JVN [00:58:18] And then what happens? They just, once they get it, they just die real quick?

KELLY ZAMUDIO [00:58:21] Oh, it's terrible. Yeah, well, it invades the skin, right? And frogs are very sensitive because they need their skin, as we already mentioned, and invades the skin and it disrupts the skin. And so people have actually shown what they end up dying of is cardiac arrest like they just can't. It breaks down their, you know, the body function. It's kind of like if you were, you know, a victim of, a burn victim, for example, right? Like, your skin is disrupted and that's what holds together everything that goes on metabolically. So that's what happens to them.

JVN [00:58:57] So and then, this is just another is, as someone who studies frogs here, an expert, you're a professor. What're, like, the biggest misconceptions about frogs?

KELLY ZAMUDIO [00:59:06] Huh. That's a good question. I think a lot of people without knowing think that they're without thinking much about it, think that they're sort of, they're cute, they're there, but they don't really have a role. And when I was telling you before about sort of the importance of frogs in the food chain, it's a real thing like there are, you know, they are. Think about it. They have two parts to their lifecycle. They have the tadpole and then the terrestrial part. So they're actually critical in terms of moving energy between aquatic and terrestrial environments. The tadpoles are often eating algae, which contributes to, you know, the water, the aquatic ecosystem and then the and then the adults are moving that energy onto the onto land. So I think people don't realize how critical they are. Plus, they eat insects, right? So we have to have control of insects, right, as well. That's part of the food chain is making sure that everything is in balance. So I think, I think that's one big misconception. Another big misconception is that maybe they're gross or, you know, warty, or people are afraid to touch them. And, and you know, there are a few that have toxins in their skin, but they're actually really quite fascinating creatures.

JVN [01:00:27] So we're not going to get a wart from picking up a toad?

KELLY ZAMUDIO [01:00:30] No, no.

JVN [01:00:32] They're not transferable to humans.

KELLY ZAMUDIO [01:00:34] No toad warts that are transmissible.

JVN [01:00:38] OK, I'm obsessed with that story. And then I also notice that like. If there's anyone who's listening to this and they are just, like, "I am obsessed with frogs, I cannot live my life the way I was, I must get involved with knowing about frogs, studying frogs." Where would you direct people to go to? And also just could you give us a little bit of an idea about, like, what jobs are out there for people who want to really make frogs part of their life?

KELLY ZAMUDIO [01:01:09] Mm-Hmm. Oh, I'll answer this last question first, which is the jobs question. A lot of frog biologists and organismal biologists more generally, right, it doesn't just have to be frogs, whatever group you're interested in. A lot of folks end up doing really

important work that has to do with conservation. And though that kind of employment has to do, it happens at all levels, it can happen on the level of the state of the city and even nationally. So basically working towards preservation. So I don't know if you know this, but the city of Austin has this wonderful salamander, right, that occurs in Barton Springs and all these springs that we have around here in central Texas. And there is actually a state facility that hires a full-time herpetologist to actually make decisions about preserving environments, breeding the salamanders in captivity, studying them and so forth. Same for the state, the state has Texas, you know, Parks and Wildlife. And then nationally we have the Fish and Wildlife Agency, right? So there's a lot of opportunities that come there.

There's also opportunities in terms of working in the field, right? So a lot of habitats that are owned by the state or federally or by the city needs to be managed. And there's, that's on-the-ground work that needs to be done. Some of that has to do with restoration, restoring habitats so that they go back to, you know, being, being good for the species to actually inhabit. So, so that's where a lot of opportunities exist in terms of if you want to get involved, where do you go? There are a lot of opportunities, especially in cities where there are universities. So, for example, there is a field station that UT owns here. One of a few field stations in the field station network that's called the Brackenridge Field Lab. You've probably seen it. It's right along the river. It's a riverfront property, and they have wonderful talks that are hosted by the university called Science Under The Stars, where people come from the university and give an evening talk to the community. And it's— you should get on their listserv. There's some really interesting things that one can learn there and get involved in. Texas has a herpetological society called the Texas Fair Logical Society. They have an annual meeting, they run field trips there. There are some academics there, but also people who are in these other professions that I mentioned, you know, Texas Parks and Wildlife, a number of folks working in, you know, federal co-ops and cities and so on. So there are a lot of ways for people to get involved!

JVN [01:03:50] So there's more space for people to get involved. There's enough to go around.

KELLY ZAMUDIO [01:03:54] Oh, yes, there's definitely stuff. I mean, especially if people wanted to, you know, not only learn but also volunteer. There's all sorts of opportunities.

JVN [01:04:04] Kelly R. Zamudio, thank you so much for coming on and giving us the full 4-1-1 on all things frogs. You're probably going to have to come back. We got to learn so much more about Brexit, like our jumping off point. I'm so grateful for you and your time. Thank you so much for coming on Getting Curious.

KELLY ZAMUDIO [01:04:18] Yes. Thank you.

JVN [01:04:20] You're so welcome. You've been listening to Getting Curious with me, Jonathan Van Ness. My guest this week was Professor Kelly R. Zamudio. You'll find links to her

work in the episode description of whatever you're listening to the show on. Our theme music is "Freak" by Quiñ - thanks to her for letting us use it. If you enjoyed our show, introduce a friend and please show them how to subscribe. Follow us on Instagram & Twitter @CuriousWithJVN. Our socials are run and curated by Middle Seat Digital. Our editor is Andrew Carson. Getting Curious is produced by me, Erica Getto, and Zahra Crim.