

## **Transcript**

**Speaker 1:** You're tuned in to 90.7 FM, k a l x Berkeley. My name is Tesla Munson, and this is the graduates, the interview talk show where I speak with UC Berkeley graduate students about their work here on campus and around the world. Now, please let me introduce our guests for this week. Claire Willing in the Department of Environmental Science Policy and management. I wanted to say integrative biology because I know you sit there, uh, occasionally, but you're actually in SBM. Yes, I'm in SPM. Um, and I work with Todd Dawson in who's [00:00:30] in Esto manned in IB. Um, and I also work with Tom Bruns, who's a fungal ecologist. Um, and he's also an SPM and plant and microbial biology. So what is SBM, can you get? What's the difference between SBM and integrative biology? So SVM stands for environmental science policy and management, and basically it's a really interdisciplinary group of scientists. Um, and we work on lots of different issues ranging from society and the environment all the way through, um, some basic biology.

**Speaker 1:** Okay. [00:01:00] Ecosystem Sciences. So it's a little different in than integrated biology in that you are, you do have those words policy and management in there as well. So you're thinking about the environment in different terms, maybe then some classic organismal biologist and integral. Exactly. Yup. So it's a very broad department and lots of different things going on, but it's fun to be a part of. But you are technically a botanist, right? Or what do you call yourself? What do I call myself? I think I'd call myself an eco physiologist [00:01:30] to play eco physiologist. Um, and I also call myself a fungal biologist or I study fungal community ecology as well. So I'm sort of at an interface of a couple of different fields right now, but, okay. So we're going to do some definitions. First thing that the audience might not know is that plants and fungus are not the same thing.

**Speaker 1:** No. So fungi are actually more closely related to animals than to plants. Um, so they are two different lineages of, uh, tax, if you will. And [00:02:00] so I study basically how these interactions between plants and fungi influence plant physiology. Okay. And then physiology might be another one we should key them in on. Uh, but that's basically like how your body works. Yeah. So it's basically looking at like the function and like how like a plant is living in an environment and what, what's going on with like how it's able to photosynthesize in different environments and things like that. Okay. Okay. So [00:02:30] plants and fungi, uh, interacting, that would be much like thinking about how humans and plants interact. Right? Or how we interact with fungi in that they're two different groups, as you said, with a lot of distance between them evolutionarily. But they do interact.

**Speaker 1:** Yeah, definitely. And there's been a lot of focus, um, on like the human microbiome lately. And so they're also fungi in that, um, in the system, things sort of similar. So I look

at basically like the plant, I call it the micro biome, um, like the fungal [00:03:00] biome of the Pam. Why CEO? Exactly. Nice. Okay. Yeah. But, um, people also study the, the total micro microbiome, so like the bacteria, the fungi like procure attic and you carry odic life as well. Um, but most of my focus is on the fungi is those are pretty understudied. Okay. So we'll take it back to the beginning. Is you just like eat a lot of mushrooms growing up and that was what brought you here or? Um, yeah, so I grew up in southern Oregon, um, and my parents have a lot of property [00:03:30] in the woods down there.

**Speaker 1:** And so I always grew up, uh, wandering around the forest and playing lots of games outside. And, um, so I've always had a special place in my heart for, for plants. And then when I went to college, I, I studied at Occidental College in Los Angeles. Um, and I was sort of lost for a few years. I knew I liked biology, I knew I like science. Um, and then once I started working in a plant ECO physiology lab, that's when I sort of realized like, oh, this is a great place for me. [00:04:00] And I was able to kind of think about a lot of the cool questions that I was wanting to ask. And then I also took a class on microbiology as well and I realized that I really like this, um, field work and lab work combined. Um, so I think using both field work and lab work, I'm able to kind of ask questions on a different scale and I really liked integrating both of those together.

**Speaker 1:** Okay. So you mentioned that you as an undergraduate, you actually got involved in some research in a lab. Can you tell us [00:04:30] a little bit about what you were doing? Yeah, so I started out, um, working in a, a totally different lab and I was doing some thin sectioning of the venom deck of cone snails. Um, yeah, so that was sort of my first introduction to like what it is to be in a lab. Um, and the research itself wasn't something that was like quite my own interest. Um, but I really enjoyed being in a lab and it was a great lab environment. And so that was sort of my first introduction into lab work. Um, and then as [00:05:00] I sort of finished that first semester of work, I moved into a plant ECO physiology lab. And so we were looking at, um, a Gavi species, a few different species of a Gavi and looking at fine root development with drought conditions and that sort of the thing that introduced me into studying plants basically.

**Speaker 1:** And then I also took a seminar or like a senior seminar that we had to take and the focus of that was on microbial interactions. Um, and so that's where I was able to [00:05:30] sort of introduce this like microbiology component and think about how microbes might be influencing some of those plant traits that I thought were really cool. So you are actually a product of your education because it sounds like you were just introduced to these topics one after another that's, you know, spurred your interest and then you integrated them through your own path. Yeah. So basically I would find things in college and then I realized that I could kind of use all of those tools. And actually I took a year off before I started [00:06:00] graduate school and I worked at the University of Colorado at the medical school there. And so I was in a lab at that facility and the focus of that lab was actually using stable isotopes to look at zinc and iron deficiency in developing countries.

**Speaker 1:** Um, so zinc and iron are both really important cofactors for proteins. And so basically as you're growing as a child, um, there can be an, a deficit of some of those net micronutrients that are really important for growth and development. Okay. So you've done work on humans. [00:06:30] Yeah. And that was before you even came to Grad School? Yeah. And so now I'm linking all of those things together. So I used stable isotopes in my research. I use a lot of microbiology, um, mostly fungi. Um, and then I'm also looking at plants, other redwoods. Okay. The redwoods. That's, that's what you said. So that is your plant species of interest, the redwoods. Yeah. So my dissertation work is predominantly on coast redwood. Um, so there are three different main types of redwoods. So there's [00:07:00] Metta, sequoia coast, redwood and giants quota. And so coast redwood must, many of us are probably familiar with that one.

**Speaker 1:** That's the focal species of my dissertation work. And our redwoods only found in California? No. So, um, giant sequoia and coast redwood are, I guess technically only found in California coast. Redwood barely crosses the Oregon border and then met us. Korea is actually in China and those are the three existing, uh, attacks of, of redwoods at this point. But historically, redwoods [00:07:30] ranged all over the southwest of the United States and then their relatives are all over the globe. So what changed that made their, their range so much smaller. So shifting climate was really important to that. So some of the earliest fossils of redwoods that we know are approximately 200 million years old and those are mostly found in the southwest u s and so there was a huge shift in climate at that point that basically caused a real contraction of the range. And so now they have these very limited ranges [00:08:00] and the coast redwood is really limited to this, um, coast fog belt.

**Speaker 1:** Um, and so we've actually found that 25 to 37% of their water intake is actually from fog water, um, in different parts of the year. So how do you study something like that? How'd you guys find that out? Yeah, so one of the fun things I've gotten to do is we have a fog chamber. And so you're able to basically fog plants, um, and seal off their roots or their like below ground portions [00:08:30] and then see how much of the tracer they had to take up from the fog water. And so both through condensation of the fog on leaves. Um, and then also through fog drip, we have found that the fog water in this system is really an important resource. So I'm just trying to picture this. You're doing that on like a John, like a huge redwood tree. Most of that is actually been done on seedlings or saplings.

**Speaker 1:** Yeah. But we've also been able to use stable isotopes in the field to look at fog, water [00:09:00] absorption. And so fog has a really unique stable isotope signatures. So the water that those trees are taking up through the fog looks really different than the water that they would take up through rainfall. And that's through a series of different evaporative processes and state changes. Okay. And, uh, so I'm just trying to imagine, do all redwood trees, these three different types, like pretty much look the same and that we would recognize as you know, being gigantic and having a really broad [00:09:30]

diameter of the trunk. Yeah. So one of the characteristics of what we call redwoods is the red bark. Um, and part of the reason it's so red is because of tannins. And so we've probably heard about tannins through wine, I imagine. Um, and those are the things that give you a headache in wine, but they also, for these trees are really important or Beveri deterrent and also pathogen deterrent.

**Speaker 1:** So they deter a lot of fungal pathogens. And redwoods have a really high concentration of these tannins, which causes their [00:10:00] red coloring of the bark as far as their stature. The coast redwood is the tallest tree, so it's somewhere around I think 380 feet tall. Um, which I think is approximately like 37 37 story building in height. And then the giant sequoia is not quite as tall, but they're much wider and so they're considered more massive as a whole. And then the Metis Aquaria do get quite large, but they're not quite as big as either of the, the coast railroad or the giant sequoia. But one of the cool things [00:10:30] about them is that they're deciduous, which is really different for this group. So they actually dropped their leaves, um, and then regrow them in the spring, which is kind of cool. Okay. So you said you study coast, the coastal redwoods.

**Speaker 1:** I was going to say coast live oak, but [inaudible] hang out with other people too much. So Redwood and I've seen pictures of you climbing them. Yeah, so for my own research, it's mostly been on the soil and the root systems, but for our labs work as a whole. [00:11:00] Um, these are really tall trees. And so some of the typical methods that you'd use to study plant physiology are, are kind of limited with this species. And so to be able to understand what's going on with the trees in terms of their water status and relation to drought, what's happening in the canopy and some of the life that's going on up there, you really do have to climb the trees to be able to get at some of those, those questions. And so we use a system called the Texas style system, and that's basically where [00:11:30] you rig the tree with a rope and then you, you climb the rope using ascenders or a Grigory as a descender to come back down.

**Speaker 1:** And how far up have you gone? I'm not totally sure. Probably in feet, like 200 250 feet, something like that. That's awesome. Yeah, so they're, they're huge trees and it's, it's a really crazy process getting up there. And then it's very humbling seeing how big those [00:12:00] trees are and then also realizing how old they are too. So some of them are, you know, 2000 year old trees, which is a pretty impressive thing. That's really impressive. Yeah, man. So if you're tuning in, you're listening to the graduates here on calyx. My name is Tesla, and today I'm joined by ECO physiologist Claire Willing from the Department of Environmental Science Policy and management, uh, and also hanging out in integrative biology. And I'm speaking with Claire about her work, uh, on plants. [00:12:30] We haven't talked about the fungus yet, but we will. Uh, but she's been telling us how she climbs redwood trees and it's just, I just can't even imagine what, give us a sense.

**Speaker 1:** What is it like when you're up there? Um, well you're really high up obviously, um, and you don't quite realize from the ground. So the branches of redwoods actually start

really high up and some of the trees and so you don't really realize how much actual life is up there. Um, and so there's a whole body of research looking at canopy [00:13:00] biology and in the redwoods it's a pretty interesting system. So a lot of canopy biology has done in tropical forests and we know those canopies are full of life. Um, but also the redwoods have a lot of life up there as well. So there's canopy soils that form their unique plants that live up there. Um, lots of animals and salamanders and things like that. I've seen some owls, so it's a, it's a pretty lively place up there and you don't really have a sense of that from the ground necessarily.

**Speaker 1:** [00:13:30] So cool man. It's experience. It's like talking to Grad students and hearing about experiences like these always makes me think, Dang, it's good to be in science. But did I choose the right uh, subject? Uh, no. I mean I've done plenty of cool things, but uh, that sounds really amazing. So, um, but you said your work mostly deals with the soil, so tell us about that. Yeah, so I studied plant fungal interactions and plants interact with fungi and in many different levels. So there are fungi and leaves like Fungal endophytes [00:14:00] and leaves that basically live inside of leaves and on leaves they are fungi in stems. And then there are fungi also associated with plant roots. And so most of my phd is actually been focused on plant associations with microrisal fungi. So myco means fungus and rhizome means root. And so these are root associated fungi in there, a bunch of different types of these micro [inaudible] and they're sort of categorized based on anatomy and how they live in a route.

**Speaker 1:** [00:14:30] And then also their phylogeny. And so their ecto micro [inaudible] which associate with pines and oaks and things like that. But most of my work has been on our basilar microwave Z, which is a different kind of a fungal interaction. Um, and they're really cool. They basically formed these really intimate associations with plant roots. And so somewhere around 70% of plant species form associations with our best color maker IC. So they're really, really prevalent interactions and they're really important for plants, [00:15:00] access to a lot of micronutrients like phosphorus as well as macronutrients like nitrogen. So when you say associate, that's what's happening, they're passing new nutrients? Yes. So the exchange that happens is basically that the plant supplies the fungus with photosynth theatre carbon. So when the plant is fixing carbon, some of that gets passed on the sugar to the fungus. The fungus is enabled to fix its own sugars, just like us.

**Speaker 1:** It's dependent on plants for some of those carbon inputs. And so [00:15:30] an exchange, the idea is that the fungus provides the plant with some of these nutrients. In reality, this is, we talk about this as sort of this, uh, mutualistic process. So both are benefiting, but in reality it's actually along a spectrum. So there's some times more parasitic interactions depending on environmental context or plant species, fungal species, uh, identities. And then it can also be more commensal where maybe the fungus is getting sugar from the plant, but it's not necessarily providing [00:16:00] the same amount of, in return of some of those micronutrients that the plant might need. Okay. And you said a few words in there, but they all sort of fall into this category the

audience might've heard of, of symbiosis, right? Yeah. Yep. So I study basically symbiosis and symbiosis just means that two things are intimately associated, but as symbiosis actually does range along this, this gradient of mutualism are both partners benefiting to Paris tourism where one partner benefits and the other is harmed.

**Speaker 1:** [00:16:30] And sort of the intermediate of that is commensalism where one member of that association might benefit and the other isn't really harmed. And so just like most symbiosis, a micro rises also fall on these spectrums. And so that's something that I've been really interested in in my phd. And this is not something that just like happened last week. Right. These, these species have been evolving together for a very long, super long time. Yeah. So the earliest land plants are thought to have been able to colonize [00:17:00] land because of these associations with arbuscular mycorrhizae, he actually, um, so the specific micro fuzzy that I'm working with and then as plants have evolved over time and as fungi evolved over time, there have been many more types of, uh, microorganisms that have evolved. So the ECTO, the air quad, my Gracie, which associated with the air KCA family plants.

**Speaker 1:** So, um, like vaccinium or some blueberries, things like that, as well as the work and my crazy, which was a shade just with orchid plants. [00:17:30] Oh yeah. And maybe you can clear something up for us because I said phone guy at the beginning of the show. But you're saying fungi, I never know. Is there one that's right. Uh, so this is something that I've been thinking about for a while now and, uh, actually I, I didn't really know it was correct when I first started Grad school. People say both. My understanding is that a fungi is actually sort of the more British pronunciation and fun jazz, the Latin pronunciation. So I always say fungi, but [00:18:00] I don't think either is necessarily correct or incorrect. Right. I just figured since I have an expert here, ask now and then I'll [inaudible] I think the Latin pronunciation is fungi.

**Speaker 1:** Fungi. Okay. I'm going to go with that one. Um, so I also saw that you do a lot of outreach. Yeah. Yeah. So I've been involved in outreach at many different scales, I guess. Um, I think that education is really important to me and so I've been involved in a number of different, [00:18:30] uh, outreach activities related to that. And so basis bay area science in schools is one that I've worked with. Um, and that's basically where a team would get together and we would teach a fourth grade classroom about microbes and what they're doing. Basically. I've also worked with expanding your horizons. Um, it's a really cool conference that UC Berkeley puts on to basically encourage women to get into stem. And so this conference is focused on middle school girls and getting some [00:19:00] of those girls into stem fields and having them participate in lots of workshops.

**Speaker 1:** Some of them build robots or learn how to code. Lots of cool stuff. And for that I've actually been on the parent workshops committee. And so we've also started having these parent workshops during the, well the girls are in their own workshops and that's basically to help parents kinda get the resources they might need to keep their

daughters encouraged in stem fields because there are a lot of different ways where we lose women in stem. And so [00:19:30] it's good to have parental support in that. Yeah, absolutely. And do you have advice for students who are interested in science or research? Yes. So one of the things that, it depends on what level you're at, but one of the things that I've been really advocating for in my phd is hiring students through work study. So I really encourage students who are maybe freshman, sophomore, even juniors or seniors in college to go to labs, see if they can get in [00:20:00] some lab experience, but don't forget that there's also ways to get paid for that.

**Speaker 1:** And so one of the things that I think is really important is that people are always looking for volunteers in lab. There's always help needed, but I think it's really important to, to encourage diversity in stem by allowing people to have some of those positions when they might not be able to, if they have to have a job or something like that instead. Oh, that's a really good thought. I actually hadn't thought about it from that perspective, but you're absolutely right. Not everyone has the [00:20:30] free time, right. To volunteer. Yeah. And I was lucky enough to be able to do a little bit of that when I was an Undergrad. But I recognize that some students, especially at cal and I had been teaching, I've noticed that students really end up working a lot often. And so if they can spend some of the time working actually getting some skills in the lab and understanding what lab work is, both of us benefit.

**Speaker 1:** Yeah. Oh, and you did, you mentioned you also do lab work along with your fieldwork. I should've, I should've asked earlier, but do you have any [00:21:00] big results from your dissertation or from your work here? I didn't ask. Yeah. So, um, the paper that I'm working on right now, one of the things that's mind boggling to me is that this study that I'm working on is the first one to look at fungal diversity and the redwoods. And so that's never been looked at before. And so that chapter is in the works. Um, and one of the things that I've been finding is that fungal association with the roots is actually really specific in the redwoods. And so the soil community changes a ton [00:21:30] throughout their coast redwood range. But the s the root community actually kind of converges on this core microbiome that I like to call it.

**Speaker 1:** Um, so there's like a core set of fungi that are associating with redwood roots throughout the range. And these could be really, really important for redwood function. And so some of my later chapters are looking at those interactions and what are the consequences of these fungal interactions with plants. And I found that they're really important for the architecture of these seedlings. So [00:22:00] when seedlings have mycorrhizal fungi, they grow really differently than when they don't, not just in terms of like their a nutrient content, but also in terms of their architecture. And this can be really important for seedlings growing in an understory. So one of the things that I've found is basically that ceilings that have [inaudible] have more shoot branch length. And so they're basically growing out more like little umbrellas as opposed to the ones that don't have micro ric, which are the same height, [00:22:30] but basically aren't putting out that branch area.

**Speaker 1:** And that can act like a solar panel. Right? And so these little seedlings need all of the sunlight they can get in that understory. And then it could also be important for uptake of fog water and fog drip. Very cool. And what about, I mean, obviously people talk about climate change all the time. And you know, I've just noticed in my time it seems a little less foggier these last few years. So how do you think that will impact the redwoods here in California? Yeah, so some of my advisor's [00:23:00] work has shown that there's been a decline in, uh, fog occurrence in the redwoods. So there's been a 33% decline in occurrence of fog and the redwoods over the past 60 years. And we've shown that fog is really important for these trees in terms of a water SimCity. And so as you have declining fog water, these trees are not the best at dealing with drought always.

**Speaker 1:** They have done it for many, many years, but we might be pushing them past a threshold and that, so that's something that we need to be kind of [00:23:30] mindful of. And even beyond that, the trees aren't acting totally in solid, like in isolation. So they, they have these interactions with fungi, other plants, lots of other animals and things like that in the redwood forest. And so my first chapter, my dissertation is basically looking at how those climate factors influenced the swale community and the root community. The root community has to be a subset of what's available in this soil. And so if that soil community is changing a lot, that means [00:24:00] that they're potentially less associates that might be available to a plant from those swales. Yeah. And uh, so we're definitely coming to the last little bit of the program, but I need to ask, where should people go to see redwoods especially we're worried about bog and all this stuff.

**Speaker 1:** We, we want to see them as much as we can. Where should we go? Yeah. So the redwoods exist along this really crazy precipitation gradient. And so one of the cool things is that we're sort of in the middle of that gradient and the bay area. [00:24:30] And so if you go north at all, you can see some really awesome temporary [inaudible], um, really wet forests. Or if he goes south, you can see sort of the end of their range where it's really dry. There is also a redwoods just east of us. I'm in the East Bay hills, so that's like the closest place she could go see some redwoods. The botanical garden has a really awesome little redwood grove as well. And then if you're wanting to explore a little bit and see some of the diversity of that range, my favorite place up north is prairie creek redwoods.

**Speaker 1:** [00:25:00] And so that's just kinda north, uh, or just south of the Oregon border. And then if he goes south at all, you can go to big basin, which is a really awesome spot in the Santa Cruz nuns. And then a little bit closer, not quite as far of a drive up north is Montgomery woods. Um, and I really liked that state reserve. It's kind of a unique spot because it doesn't get a ton of precipitation within like the range that crossroads might, but because of some tree falls and some of the topography, [00:25:30] it's actually a really moist site. Um, and so you get this really entrace interesting forest type there. Um, that's a little bit more resembling some of the, the northern forests. He said Montgomery, Montgomery Woods. Yeah. Emory woods. Prairie Creek, big basin. Yeah.

So those are kind of my, my three favorite sites to give you like the whole range of what redwoods might be experiencing.

**Speaker 1:** Wow. I'd definitely put those in my list. Uh, well any last words before we wrap up here? No, I mean I think if people are interested in [00:26:00] learning more about fungi, fungi are always under studied. Um, and that's one of the big things that I have been trying to focus on. So I was teaching the biology of fungi, uh, this past year. And there just so many things that are just unknown about fungi and their interactions with lots of different things. And so if you're interested, there are places you can go to learn more about them. I'm Sonoma County mycological society is one place that is close to the bay area and then there's also a monthly meeting [00:26:30] through the bay area and mycological society on campus. If anyone's interested in attending that, it's a cool way to kind of learn about something that is not always accessible.

**Speaker 1:** Cool. So fungi don't just eat them, study them. [inaudible] yeah, exactly. Awesome. Well Claire, thanks so much for joining us on the graduates here today. Yeah, thanks for having me. Of course. And that's right. You've been tuned into the graduates here on KLX 90.7 FM. My name is Tesla Monson and today I've been joined by ECO physiologists, clear willing from the Department of Environmental Science Policy [00:27:00] and management. She's been telling us about her work, looking at microrisal interactions between redwood trees here in California and the fungi that live in their roots and in the soil. And she's also telling us about how she climbed redwoods and how awesome they are and all the places we can go to see them. So it's been a very quintessentially California episode. Thank you, Claire. Thanks for having me. Of course. We'll be back in another two weeks with another episode of the graduate. Stay tuned. This is 90.7 FM Berkeley.