Tesla Monson: You're tuned in to 90.7 FM, KALX Berkeley. My name is Tesla Monson 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. Today I'm joined by botanists Roxy Cruz from the Department of Integrative Biology. Welcome.

Roxy Cruz: Hi. Thank you for having me.

Tesla Monson: Of course, my pleasure. We actually had one of your labmates on not too long ago, Claire.

Roxy Cruz: That's right. I loved the interview you did with her. I think she did great justice to the redwoods and all of those fungi she studies.

Tesla Monson: Yeah, and she told us a little bit about climbing redwoods here in California, but you climb a different kind of tree, don't you?

Roxy Cruz: Actually, I do help climb those same redwoods she studies, but I spend most of my time climbing tropical trees in the Andes and in the Costa Rican tropical forests.

Tesla Monson: We know that redwoods are really tall. But are those tropical trees, are they pretty tall as well?

Roxy Cruz: Yes. Tropical trees generally are not as tall as redwoods. I mean, redwoods can get to be tremendously tall, like 37 foot building, I think. But tropical trees and I'm climbing are no bigger than, let's say, 100, 120 feet or so. So they kind of Pale in comparison to redwoods, but I still get reactions like, that's pretty tall when I tell other people about it.

Tesla Monson: Yeah, it's definitely tall enough that you need to strap yourself to something, right?

Roxy Cruz: Oh, absolutely. If you're going to climb a tree, you have to take a lot of safety precautions and harness yourself into some ropes very securely and make sure you're climbing properly.

Tesla Monson: Are you interested in the trees themselves? Or what aspect are you studying up there?

Roxy Cruz: Yes. I study tropical trees in general along tropical montane gradients.

Tesla Monson: What does that mean?

Roxy Cruz: That means in tropical areas, we typically have mountainous zones, and I like to study the trees along these gradients because there's multiple habitats and multiple ecosystem changes that happens along the mountain gradients. So if you're in California listening to this and you've ever seen the Sierras, you know that if you start at the bottom of the Sierras, the trees and the climate and the ecosystem looks a lot different than when you make it to the very top where it's likely snowy. Basically, I study trees along this gradient and I studied their survival strategies. More specifically, I study how they respond to drought and a changing climate.

Tesla Monson: Interesting. For people who are less familiar with these areas of the world, I guess when I think of mountains in Central and South America, I think of the Andes. But are you working in that area or is it a different montane area?

Roxy Cruz: No, I do definitely work in the Andes. In South America, I work in the Peruvian Andes. I work where Andes the meet the Amazon, so on the eastern flank. Most people are familiar with a national park there known as Manu, and it's right where the Andes dramatically drop down into the Amazon basin. I work more specifically in tropical cloud forests. Tropical cloud forests are basically forests that receive a lot of cloud cover on a daily basis, and it kind of shapes the way that the plants and life that grow their can live and the types of plants and animals that live there.

Tesla Monson: That brings us to my next question because you mentioned drought. I guess I wouldn't necessarily... It wouldn't be the first thing I think of when I think of tropical forests and cloud forests, is that drought is playing a role in there. Can you explain that?

Roxy Cruz: Yeah, actually, I've had multiple people laugh when I tell them I studied drought in tropical rainforests. They're like, what drought? Especially when we're actually standing there in the forest and we're soaking wet in cloud water. But it's a real thing. Basically, to simplify it, the scenario with climate change is that rising temperatures are causing cloud cover to rise. So what does that mean? That means that in the Amazon, let's say, you have moisture evaporating from the Amazon basin and rising up. Not to give us a huge weather lesson here, but that basically results in cloud cover being pushed against the forest up in the mountains. And so what's happening is, is these rising temperatures are causing clouds in these cloud forests to either rise or disappear altogether. So we're essentially seeing a deprivation of clouds from cloud forests.

So why do clouds matter in these forests? Well, they're a really important source of water. You might think, well, what if they get rain? Isn't rain just water is water is water? Well, there's a big difference between cloud water and rainwater

and the types of inputs that forests get. Anyways, we're basically seeing increasing drought scenarios happen in our tropical montane forests, not just in Peru in the Andes, but in other cloud forests, other mountainous areas as well. Which is also why I study this in Costa Rica as well.

Tesla Monson: I'm not ashamed to say that I've done some zip lining in Monte Verde in Costa Rica, the classic cloud forest recreational activity. Man, I mean, there are days where you can't even see any trees, you're just totally engulfed in clouds. Is that the type of cloud forest you're talking about and working in?

Roxy Cruz: Yeah, absolutely. I actually do work in Monte Verde in Costa Rica, and you do get this really insane, heavy cloud cover. I think Monte Verde's a nice place to talk about because a lot of people have visited there, and so a lot of people actually have experienced cloud forests in that way. You basically have these daily inputs of clouds coming out and hanging on these trees, and trees act as this really... Trees and all the plants growing on them, so mosses and epiphytes and all these other plants basically act as this intermediary net, and they basically catch this cloud water. It's a really important function, not just to water the trees and the plants and the life there itself, but it basically regulates water flowing downstream.

Just to jump back to the Andes for a moment, you have millions of people living in the Amazon. You have a tremendous amount of life supported by water that flows down from the Andes into the Amazon. A big part of the regulation of that water is cloud forests that catch that water and act as a slow, steady drip down into the Amazon basin. Without that, you would basically just have massive amount of floods and erosion happening. You would see tremendous floods just causing chaos and havoc on all the people and life that depends on the water coming from upstream. So cloud forest can be a really important ecosystem service for people.

Tesla Monson: That's a really good point, because it's easy to talk about the effects that climate change has on plants and animals, but it's always really important, I think, especially for our audience, to tie it back into things that affect us as humans, for better or for worse.

Roxy Cruz: Definitely. The amount of water that's regulated for all sorts of services, everything from growing the food that people eat to the water that they can drink heavily depends on this water regulation going on up in the mountains. So in the tropics, this is a really important scenario.

Tesla Monson: How long have the tropical forests been around in Central and South America? Is that a relatively recent thing? Or is this as long as the continents had been there?

Roxy Cruz: That's a really great question, and it's a big question. I'm not a geologist, but I'm going to do my best here to simplify this for us. At least in what we call the neotropics, which are the tropical forests in South America, Central America, and the Caribbean, we have forest that essentially have... Well, actually, worldwide, the present day flora and fauna that exist have basically been shaped most dramatically in its present day form over the last 20 million years or so. But let's break it down from 20 million years. We have tropics being basically the source of most of the life that we see today on earth. So most of the plants, most of the animals that we see, their lineages evolved from the tropics. So the tropics are a really ancient place. They are a really ancient source of biodiversity for our planet. The things that we see today on the planet are either derived from these ancient lineages coming out of the tropics or present day ones.

Certainly, if we're going to talk at all about the tropics, you really have to consider two pieces of the story. There are plate tectonics of geology and also climate. It's really the story of those two that bring about how we see the tropics today. For instance, let's take South America and let's take the Amazon. The Amazon, before the Andes were there, was just basically this big giant basin of rivers and drainage and wetlands. This big, giant area of water, and it was very poor in nutrients. Why do we hear about nutrients? Nutrients are basically like the resources for life upon which a lot of the biodiversity we think of today in tropical forests can grow.

Then you have, over the last 60 to 10 million years ago, you have the Andes rising up and forming. This was really important to the formation of the Amazon, because you have these massive mountains that are basically a storage unit of nutrients that are all inside of this bedrock, and you have these mountains rising. Over time, you get all the nutrients that are tied up in that bedrock basically eroding and being deposited down into the Amazon basin as this nutrient rich sediment, this food for life. It basically flows down into the Amazon basin as we know it today and creates this really rich area for life for the tropics.

Central America's a more complicated story in just that it involves a lot of plate tectonics and a lot of movement. Even though Central America was separated from South America, you basically have, 3 million or so years ago, you have those two plates crashing into each other. You have Central America and South America finally touching, and then you have all this interchange of life between the two continents. Basically, it's the movement of continents, the movement of these plates, and climate. If you've ever been to a tropical forest or if you think about a tropical forest, you know that it's hot, there's a lot of water, it rains a lot. And so you basically have this climate that's very specific to that type of life happening there. Does that answer the question?

Tesla Monson: Yeah.

Roxy Cruz: Okay.

Tesla Monson: Okay, and to step it back just for a second. You mentioned that a lot of life has come out of the tropics. This, of course, applies to humans as well, right? Because we evolved in the equatorial region of Africa. But why is it that there's so much diversity in the tropics? What is it about the tropics that fuels life?

Roxy Cruz: This is a fantastic question, actually. If we think about it, this is a question that's been central to science and the study of biology since Darwin, since Wallace. This is a question central to understanding the origins of life. Essentially, the short answer is, it's complicated. The longer answer is, is that there's a lot of different hypotheses. There's lot of different theories that people have been trying to throw at this question for a long time to try and figure out, well, what exactly is it about the tropics that creates so much biodiversity?

Of all these different hypotheses, there's a number of themes that come up. We have energy, meaning lots of sunlight, lots of heat and radiation coming into the tropics. You have time, the tropics are ancient. You have area, there's a big area of historically... In the history of the earth over different times in our earth's history, we have these warm periods on earth where much of the earth is in this tropical climate. There's all sorts of different things that people cite. The interactions between organisms. There's competition for life, so things evolve more quickly because they're in this arms race to evolve. There's all sorts of theories and hypotheses.

One of my favorites is the idea of climatic stability. This doesn't sound as exciting as some of the other ones, but it integrates a lot of these ideas that we have, where basically we're saying that because the tropics is less seasonal than, say, North America, the temperate zones, we're not getting periods of freezing, we're basically staying year-round with a more stable climate as compared to more temperate zones further north you go towards North America and Europe. We have this stable climate where we're basically allowing... The idea is that we're allowing for speciation that happens, so the evolution of species to happen continue uninterrupted. Whereas in more northern areas, like in the US and in Europe and in the Arctic, we have these massive glaciation events. Glaciation, if you can think about it, basically freezes and rips up entire areas and causes a high number of extinctions. Now, certainly, some things can survive glacial events. But I like this theory because it basically posits that things in the tropics have time to continue to evolve uninterrupted, as compared to areas that experiences freezing and glacial events. Does that make sense?

Tesla Monson: Yeah, absolutely. Absolutely. If you're just tuning in, you're listening to The Graduates here on KALX. My name is Tesla, today I'm joined by Roxy who is a plant ecophysiologist in the Department of Integrative Biology. She's been telling us all about tropical diversity of plants and animals, too, in Central and South America. You mentioned that you climb trees and you do it down there, but have you always been really interested in that part of the world? I saw that you've also worked in other parts of the world as well. Maybe if you want to just tell us a little bit about some of your undergraduate research experiences.

Roxy Cruz: Sure, yeah. I'll just start at the beginning. I'm from East LA and Southern California, and that's where I went to college. I went to one of the Claremont Colleges, Pitzer College. I was always really interested in environmental science and really interested in plants. They had a field station down there, which is at the foothills of the San Gabriel Mountains. It's coastal sage scrub environment, coastal sage scrub habitat down there. I basically got interested in doing research on plants in California there. It was really fun, because I was able to test out different projects and experiments going on down there. I studied what now seems wildly different than what I study now, but we all have to start somewhere. So basically started studying plants there, and I've basically bounced back and forth between California and the tropics and Asia, I guess. Wow, I've really bounced around a lot since then. So in college, studied California plants, but then I also studied abroad. First in Nepal, which I'll get to in a second, but also in Costa Rica, where I'm doing research now.

Costa Rico was my first time ever exposed to tropical ecology, and really fell in love with the tropics there. As I mentioned, I studied abroad in Nepal and fell madly in love with Asia and the subcontinent and the Himalayas. After I graduated from college, I got a Fulbright Fellowship to go do research in Nepal. It's, again, very different than what I'm doing now, but I essentially was researching the interface between subsistence agriculture and subsistence livelihoods and forest management. For me as a scientist, I had this very strong passion for the biological sciences and for the natural sciences in general. But I also found Nepal to be this very special place where I felt you couldn't disentangle the natural world from the human world. I liked to think that to make myself a good biologist, I had to study both the interface between human ecology and ecology as we think about it in a historical biological sense.

Oh, man. So I spent all this time in Nepal doing all this research and I was very inspired by the Himalayas. I think everyone should go there. I think it's a really special place where you can witness so many different life forms happening in such a short distance. I'll never forget standing in the low elevation plains of Nepal where there's tropical forests, and staring at an elephant and an alligator, and the backdrop is literally Mount Everest, the highest point in the world. In

just such a short distance, you can go up such dramatic elevation. Along this elevation, as I would hike up through the Himalayas to get to my different research sites, I would just see the forest change and turn over so quickly. I was really inspired by that.

In thinking about my PhD research, I really liked the idea of looking at the quick turnover and the quick change in mountains, because I think it's a nice natural laboratory to study climate change and what's happening today on our planet. It's a perfect place to study where multiple ecosystems meet and you can see what's happening.

Tesla Monson: But it still had plants in it, so it wasn't that different in terms of a general person.

Roxy Cruz: Yeah. I studied farm plants and I studied tree management, and we don't have to get into all of that, but basically I would hop back and forth between Nepal and the US. I was in Nepal over the course of six, seven years. But I would hop back into the US, and I also worked in California and Southern Oregon as a tree climber for some bit, surveying for nests of red [trebles 00:00:18:55], which is where I learned how to climb trees originally. That's where I first got my experience climbing trees, and then it just took off from there and I'm still climbing trees today.

Tesla Monson: It's really cool to see all the different parts of your research coming together through your progression through the education system and your different passions and the boat. So what ended up bringing you to Berkeley in particular?

Roxy Cruz: Honestly, my advisor, who studies redwoods, just really inspired me, not only with his tree climbing, but his passion for understanding how trees function and how they interface with our ecosystems. Understanding the impacts that climate change have on our ecosystems really seemed like a right fit for me. I never in a million years thought I would make it to Berkeley, but they let me in, so here I am.

Tesla Monson: They let you in because you deserve to be here.

Roxy Cruz: Thank you.

Tesla Monson: Of course. Give us a sense... I can't let this interview go without asking you, what is it like to climb those trees? Can you give us a sense of what it's like out in the field?

Roxy Cruz: The best part about climbing the tree, not some cliche, but is getting to the top. It's the view. I really mean it, because it's an entirely different world in the canopy. In the tropics, it's so much more pronounced. Sometimes you'll be

standing at the top of a tree, it's so dense at the top of the canopy you can't even see the forest floor, and you suddenly realize you're experiencing a whole other level of the forest. You are in an an entirely unique forest itself. There's a lot of life in the canopy that we don't know about. Sometimes you have to be careful for monkeys and careful for other rodents. But besides that, it's just the most amazing place to be.

Tesla Monson: What are you doing while you're up there? You must be sampling things, or you're just looking around, doing a little drawing.

Roxy Cruz: Having this time of my life. I'm definitely taking samples of the trees. So leaves, stems, sometimes I have to take entire branches, really, really big branches. A lot of my work involves getting up at 2:00 or 3:00 in the morning, making it out to the trees in the dark, climbing them in a race against time to go cut some branches before the sunlight comes up, because that's when they start photosynthesizing and transpiring and losing water. Since I study how trees respond to drought, I essentially have to study their water status, and I basically have to make it out there before the sun starts on some days. So I'm taking lots of samples while I'm up there.

Tesla Monson: I've heard from Andrew, my partner, that he's done some pre-dawns, and he doesn't even have to climb the trees. But my goodness, it sounds like an exercise and energy and staying awake and love... It shows your love for science when you get up at 2:00 in the morning to climb a tree in the dark.

Roxy Cruz: Yeah. It's no fun until you get up there, and then everything is fine. Then you get the added benefit of watching the sunrise from a tree, and there's nothing like it.

Tesla Monson: Can you give us a little sense of some of the similarities or differences between your sites in Costa Rica and maybe down in the Amazon? Do you see a lot of difference between those sites?

Roxy Cruz: I have noticed a lot of differences between cloud forests. I've learned they're not all created equal. Costa Rica has a lot more topographical variations, meaning it's just not as cut and dry as the Andes, where I literally can stand at 10,000 feet and look down and see almost what looks like a straight drop to the Amazon Basin. In Costa Rica where I work, it's inland, so there's not a steep, dramatic gradient the way that there is in the Andes.

Tesla Monson: If you had to give us a sense, what are your favorite parts of your research and the most interesting parts of your research? What are those?

Roxy Cruz: Good question. Most interesting part of my research, well, I love not just studying how trees work, not just the physiology of trees, not just how they function and how they deal with water stress, but seeing also how they interact with their environment. One of my favorite questions is in Peru where I look at trees that can take up cloud water directly through their leaves. We call this foliar water uptake. It's a phenomenon we see also in redwoods where they can take up cloud water directly through the leaves, as opposed to how we typically think about plants taking up water, which is through their roots. It's cool to see these processes and interactions with the environment.

Aside from climbing trees, I love the idea that all this work that I'm doing can be translated back to the classroom and to other budding researchers. I love outreach, I love to share what I do with my research with other people. Where I'm from, I didn't know any other biologists or plant ecologists or anyone like that growing up, I didn't know any scientists growing up. It's really fun to go back to my eight younger brothers and sisters and show them photos and tell them all about what it's like in the tropics and what it's like out in forests, and basically just to share this knowledge with where I'm from, but also just the public in general, because it's like tremendous privilege I have to be out in the forest and to be out doing this work.

So yeah, my favorite part is being out there, seeing these trees interact with their environment, and taking that back and sharing these stories.

Tesla Monson: You touched on this already, but obviously, outreach is a really important part of biology, especially today. It's getting a lot more awareness from younger scientists and early career scientists. Do you want to talk a little bit about some of the outreach you do or why you think outreach is important?

Roxy Cruz: Well, I was really fortunate along the way along my journey to meet people who were willing to mentor me and willing to share their stories with me and show me the way. I just feel like I really want to give back to that and inspire other people to pursue their passions, and if it happens to be in tree ecology, then I'm really happy to do that. I see outreach taking on a lot of forms. I try and do outreach within my research by not just employing but mentoring local students.

In Peru, for instance, the closest city to my field site is Cusco. I basically take undergraduates who are interested in biology under my wing and pay them and they help me do my field work. I also help them design their own thesis projects and their own research and try and share some of these really advanced physiological techniques I spent all this time here at Berkeley learning, I try and

share that with them. So I try and do outreach just at the very small scale with the people I work with and who I mentor.

I also like to participate in events on campus or in public. UC Berkeley has this really amazing conference called Empowering Women of Color Conference. It's been running for over 30 years, it's the longest running conference aimed at empowering women of color in the US. I like to participate in designing and running this conference and organizing workshops. So it doesn't necessarily just have to be related to science, but I think showing up as a scientist in multiple spaces can be really important for outreach in a lot of ways. I like to volunteer and give lessons to high schoolers and all sorts of things like that to spread awareness about tree ecology and ecosystems and the natural world.

Tesla Monson: Do you have any advice for students who might be interested in getting in into research?

Roxy Cruz: I think a big thing that nobody tells you is that you just have to show up and ask. If you're interested in doing research, let's say you're in high school listening to this. If you're interested in doing research, you got to get yourself to college, step one. If you're in college listening to this, you got to get yourself to a lab. You got to go introduce yourself to your TAs, to your professors, and you have to say, hi, I'm really interested in doing research. I don't know about what, or I'm generally interested in X, Y, or Z. Show up and say, how do I do this? Where can I find opportunities? Half the battle is just asking, and half the battle is just showing up for it. People will help you along the way.

It unfortunately feels like this exclusive club that you have to know to go ask for. I always try and encourage people just to reach out and see where they can find opportunities. So if in a university setting, reaching out to a lab, someone in a lab can be really helpful that way. And trying to design their own research project, try and find a mentor or try and find programs that'll mentor you to do research.

Tesla Monson: That's great advice. We're basically out of time here on The Graduates, but I do want to give you a chance to tell us if you have anything on your mind. What I call the Soapbox Segment. If there's anything you really wanted to tell the public about science or about your research, we have this forum here.

Roxy Cruz: I think my graduate education, especially in this last year since the Trump administration has happened to all of us, my graduate education has really felt under attack. It's not just my education, it's science in general. I'd say that if we'd like to continue to study some of the most biodiverse regions of the world, some of the most understudied regions of the world, I think that we need to keep funding sources open and we need to have support from our government.

We need to have support in multiple forms. I think having an assault on the recognition that climate change is actually happening is really hard for us and supporting science is really important.

I think it shouldn't go without saying that we need to support science through policy, through legislation, and by contacting our legislators and saying these are things that matter. The National Science Foundation, I feel like, is just having things cut left and right from their budgets, and that affects us as researchers because we need that funding to do work. It's not just to fund my research, but this is stuff that contributes to not just the state of knowledge in general but to the wellbeing of our planet. So stay involved, stay active, stay aware, watch out for science. It matters to... It's not just about what it affects in our textbooks, but what it affects in our communities and as the state of our planet as a whole.

Tesla Monson: Excellent. Well, we are out of time here on The Graduates. My name is Tesla Monson, and you have been listening to, that's right, The Graduates here on KALX Berkeley. Today I've been joined by Roxy Cruz, who is a botanist or a plant ecophysiologist in the Department of Integrated Biology. She's been telling us all about her work in the tropics and climbing trees throughout Central and South America, and looking at how they interact with water resources, and just telling us about how important science is and how amazing your work is. It's really interesting, and I wish... I don't know if I'm going to ever climb a tree like that, but I'll put it on my bucket list as something to do.

Roxy Cruz: I'll take you out there.

Tesla Monson: Sounds good. We'll be back in two weeks with another episode, but until then, stay tuned. You're listening to 90.7 FM KALX Berkeley.