

Indigenous Pedology with Dr. Lydia Jennings

Ologies Podcast

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Oh hey, it's the leg that's asleep and waking it up is only going to feel worse, Alie Ward, and we're deep into autumn. A few weeks ago, we talked trash, and today, we're dishing dirt. We've got a soil episode. So, what is soil made of, why it's different colors, what it smells like, if you should rub it on yourself, what happens after you mine stuff out of soil? Do you need a PhD to be a dirt expert? What is dirt versus soil? Is mud soil? Is clay? And how long does it take a soil scientist to go for a jog?

So, this Indigenous pedologist is someone I've wanted to chat with for years and is so deeply revered and respected in her field, in her actual field, doing fieldwork. They have an associate's degree in biology, an undergrad degree in environmental science technology and policy, and a minor in chemistry from California State University Monterey Bay, and just got a PhD from the University of Arizona in soil microbiology with a minor in American Indian policy. So, this ologist is now doing a postdoc in community, environment, and policy at the University of Arizona in Tucson. And the most grutable coincidence is that after all these years waiting and waiting and finally just recording remotely, I'll be in Tucson this week, visiting Jarrett's Grandma Sue. So, Tucson people, get at me.

Also, thank you to everyone who submitted questions for this via [Patreon.com/Ologies](https://patreon.com/Ologies), a dollar a month gets you in that club. Thank you also to everyone who tells friends, and subscribes, and rates, and leaves reviews. That has helped *Ologies* stay at the top of the science charts and I appreciate it so much that I read all the reviews and then I pick one to whisper at you, like this fresh one, from the zebra emoji reviewer who wrote:

I feel like if I randomly ran into Alie at a sketchy gas station, I would recognize her immediately and she would probably give me some of her Cheetos she just bought.

And those are facts, I would. So, thank you for those.

Let's get into the episode. Indigenous comes from the Latin meaning 'sprung from the land', or 'native'. And pedology comes from the Greek word for ground or earth. And this particular ologist is a perfect fit for this episode which, coincidentally, it is coming out during November, which is Native American Heritage Month. So yes, let's listen, let's learn, celebrate, and let's get dirty, with soil microbiologist, researcher, data scientist, runner, filmmaker, and Indigenous pedologist, Lydia Jennings, PhD.

Lydia: Hi everyone, my name is Lydia Jennings and I go by she/her pronouns. I am a citizen of Pascua Yaqui and Huichol Nations, my dog is Salchicha, she's right here at my feet because she's my partner in crime.

Alie: When I first met you, you were Lydia Jennings. You're now Dr. Jennings! Very exciting.

Lydia: I'm Dr. Jennings now, it's been a journey and it's finally happened.

Alie: December 2020, right?

Lydia: Yeah, December 2020. It was supposed to be May 2020 but the pandemic, you know, it kind of took its toll.

Alie: Oh, you know what? I can't believe that I didn't have this teed up, but there is an ology for soil. Are you aware of this?

Lydia: Oh yeah.

Alie: Pedology.

Lydia: Yes, yes. So, a lot of people and soil science are pedologists. So, soil science is an interesting fact, right, because soils, like people, are very diverse, very ubiquitous. Like besides water, soil and air, soil is the most common thing you're going to interact with. Humans have constructed all kinds of surfaces to not interact with soil, but soil still makes its way in through dust; it transports.

I'm saying all this because I think, as you talk about pedology as this over-encompassing field, there are a lot of different ways that people and scientists interact with soils. It's really interesting to see and identify as a soil scientist because it's encompassed in so many other types of environmental fields. And pedology is one of those fields that soil science... that's really the root of how we talk about soil science today. But what I studied in my PhD work is much more around soil health, and environmental contamination, environmental justice work, and it really took a process of, "Am I a soil scientist?" Most of the analysis that I do is soils, but I also could be seen as a microbiologist who studies microbes in the soils.

It took me a long time to actually identify as a soil scientist; it's something I wear really proudly today. But it was actually on – and I hope we talk about this – this 135-mile run that I did with two other women soil scientists. One is a soil ecologist, one is a pedologist, and they were able to identify the different layers of the soils, and they do a whole thing called soil judging, which is something my university didn't have a team in. And I remember, even though I have a PhD, getting anxious or having imposter syndrome about being a soil scientist, and it led to this really beautiful conversation about who we are as soil scientists is so diverse because soils are so diverse and we have to be more inclusive in how we talk about soils because they are a big part of climate science, and contaminate science, of agricultural science. Soils are embedded in so many different fields and really important in powerful ways.

Aside: We will indeed talk about that 135-mile run because, how could we not? My first question about it is: Does she still have legs, or did she wear them down to nubs, like pieces of chalk? Because 135 is so many miles. But the best part about that run is that she made it into a film! And it's called, *Will Run for Soil*, and it features two other soil scientists and it's not out yet as of November 2022. Again, more on all of this in a bit. But for now, let's get some questions out of the way that are either brilliant or very, very not smart, but I love this next answer.

Alie: And what is the difference between soil and dirt?

Lydia: So, it depends on who you ask. But the way I like to think about it is... So, dirt is displaced soil. Soil is naturally occurring in ecosystem, it's really full of life and microbes and helps filter water. Dirt has kind of been removed from its home, and I think often it gets degraded as being called dirt as opposed to recognizing the life force it is, in part because of the removal from its home.

Alie: Augh, that's such a good answer. I wasn't sure if it was like, "it's got to have a certain percentage of rock, or certain percentage of dust," but it's really more philosophical, from what it sounds like.

Lydia: Yeah, just moving it from its surface. I think the easiest place is to call it is removed dirt, soil. I think there are so many of soil microbiologists will also think about the microbes associated with soil. You often hear people say soil is alive, dirt is dead, which I don't think is really true, especially as someone who studied mining issues. There's a lot of questions about if a reclaimed soil system or a mined soil is full of life. So, I think dirt is displaced soil.

Alie: What about mud? Is mud just wet soil?

Lydia: That's... but it's also, mud is often displaced as well but it's highly saturated soil. So, I'm in Sonoran Desert, our soils typically have like 3% saturation of water. Like, they're really, really dry soils. And then I went to North Carolina, and to me, the soils there are like mud; [Alie laughs] they have like 45% saturation of water and I'm like, "Oh my god!" But also, those soils, they hold so much more humidity and so much more organic matter, decomposition, so I think it's always kind of ecosystem dependent.

Alie: Well, let's talk about what is in a handful of soil. What is in soil?

Lydia: So, within soil... You often talk about in a single teaspoon of soil there's like over 10,000 microbes in there, and there's all these nutrients in there that help make the soil that really speaks to the parent material and the climate. So, parent material being like, rocks, right?

Aside: For more on that parent material, you can see the recent two-part Geology episode about rocks with Schmitt Thompson, who is a treasure and a gem themselves.

Lydia: And the climates that help make that soil color and texture and also the nutrients that are breaking down the soil. We often can't see the sort of soil particles themselves, but they have macropores, or different microbes, or chemical interactions can happen. So, soils are so diverse, in part because our landscapes are so diverse, and soils are affected by the climate, and the temperature, and the moisture regime. Even the slopes and angles when you go on a mountain, you can see on one side of the area it has really dry soil and on the other side it has really wet soil because of the important things of slope and different aspects that can affect a soil system.

And then you have all the biological activity that's happening, so think of the different plants and animals that are interacting with that soil to help make it what it is. So, it really is this embodiment of our ecosystems and all the things that interact with our ecosystems, including humans.

Alie: What was it about soil that drove you to get a PhD in it, run 135 miles with other soil scientists? Obviously, you have a passion for this. Where did that come from?

Lydia: Yeah, I think in talking about my love for soils today, it's really been a meandering river. I started at a community college as a biology major and I thought at one point in time I wanted to be a marine biologist. My undergrad degree was environmental science technology and policy with a minor in chemistry, so I really liked the first soils class I took. I thought it was so cool to learn about the cation exchange capacity, and just all these chemical reactions that are happening within soils themselves, and also just their ability to hold moisture, let go of it. I just thought that was really cool.

Aside: Augh, if I had a dollar for every time I've thought about cation exchange capacity, I could get an Arizona Iced Tea because I was like, "What the fuck is that?" But I looked it up. Let's break it down because it's cool and soil is all about it.

So, a cation has fewer electrons than it has protons, so it's an ion with a positive charge. So, think of a happy, positive cat that you're keeping an eye on. But what is an ion, even? It's an atom or a molecule with some kind of electrical charge because either it's gained or lost an electron. So, a cation is a positive one, a negative ion is an anion. But not all atoms are ions, some are just neutral; they're not positive or negative, they're just sitting there knitting, minding their beeswax. But yes, a cation is a positively charged ion. Cool.

Now, the cation exchange capacity, CEC, is great for soil science, which is probably something you never thought you'd think about because that cation exchange capacity is a metric of how many cations, positive ions, like calcium and magnesium and potassium, that plants need, can stay in the soil. So, clay and organic matter tend to be negatively charged, which means that they'll attract those cations, like magnesium and calcium and potassium, which you now know are positively charged. So, the cation exchange capacity is a measure of the negative charge in the soil to figure out how much good cation action can stick around without leaching from the soil and getting washed away before the plant can use it. Kind of like if you needed to transport a bunch of weasels, you've got to figure out how big is your purse to calculate how many weasels you can fit in your bag.

So yes, Lydia was learning about this while getting her associate's in biology at Cabrillo Community College and in undergrad, but still, soil didn't have her whole heart... yet.

Lydia: I was much more interested in marine systems. And then I worked for about three years before going to grad school as an environmental toxicologist. I thought I'd be doing a lot of water testing, which I did, but I also did a lot of sediment testing for toxicity, and I began to think a lot more about texture. Like we would go and sample these river systems, we sampled all the major rivers in California, and we would look at trying to get the fine-grained sediment versus sandy sediment. So, the fine-grained sediment can hold onto toxins, in this case, a lot of pesticides and also oils that were being sprayed. [*"Gross."*] And it was there, understanding how small particles can hold onto so much toxins that have all these impacts to ecosystems and to different marine organisms that are growing. So, I thought that part of it was really interesting, just the complexity and power of such small materials, right, the small grains and fine sediment.

And I think as I came and pursued my graduate degree, I wanted to use my love for science in a way that really served my own cultural heritage and my tribal nation. Environmental injustices are really prevalent in Native communities for a variety of structural racism reasons, but as I was studying all this environmental toxicology and sampling all these major riverways in California, it was really clear to me, just in that three-year time period, of seeing how the areas most polluted with pesticides were often in close proximity to poor income and predominantly brown communities. And then also just seeing the difference between northern California and southern California, how they talked about the environment so differently, was really interesting. And those are all big scale things but it kind of comes down also to how we concentrate environmental pollution. Again, those low-income areas really having a lot more environmental contamination near them.

So, I wanted to understand, how can we learn about the soil systems in a way, and work with the biggest polluters, to actually not just mark that these areas are contaminated but actually develop solutions. So, as I pursued my PhD program, it was one of the biggest contaminators in Arizona, mining companies, some of the biggest ones. And there is so much mining in close proximity to my tribal nation and other tribal nations in Arizona, so

how can I use this love of science and understanding of soil systems to be able to work and address those environmental contaminations?

Aside: So, though Dr. Lydia Jennings grew up in Sante Fe, New Mexico, which are Tiwa lands, she is a citizen of the Pascua Yaqui and Huichol nations, and zoom into those lands and you'll find tiny, tiny, itty bitty bits of land and minerals, and chemicals, and animals, and tiny plants.

Lydia: It's interesting because I love soils, I love their complexity, they're really complex; dependent on the soil systems and how they hold contaminants and all their chemistry. But also, I think bringing in an Indigenous perspective and recognizing that relationship and reciprocity that we have with our environmental ecosystems, and in a lot of ways, understanding what do the soils tell us about their health that we can understand using both Indigenous epistemologies and our typical soil science metrics, to help improve these ecosystem's health long-term, and thus helping humans and animals long term health as well. So, that's kind of where I see the work that I love to do today.

Alie: When you were doing these samples in northern and southern California, how did you even emotionally prepare to try and get a sample from the LA River? How did that go? From someone who lives very close to the LA River... *[laughs]* The LA River for people who've never seen it is... wow.

Aside: So, for those who haven't ever seen it, quick description. The LA River is a 51-mile trickle of runoff that was concreted into a big, massive grate ditch by the Army Corps of Engineers. And though there are parts, like there's this 11-mile stretch of Glendale Narrows kind of near Silver Lake, that have crumbled on the bottom and allowed for plants and animals to return, amid the shopping carts and discarded Gatorade bottles and such. But before it became the saddest waterway in the west, one which the *LA Times* reported was, "Mostly industrial and residential discharge," the LA River used to be this thriving wetland and the Tongva land that we now call Los Angeles was this giant waffle of ponds and swamps. If you've ever been in LA, have you ever taken La Cienega? La Cienega means "the swamp." But now, it's just a big mall on dry asphalt. But yes, the LA river, the aquatic underdog we're all rooting for.

Lydia: So, I went to college in Santa Cruz, so it's really easy to be an environmentalist there because it's, like, redwood trees and the ocean and it's really easy to be a tree hugger when you get to sample in beautiful places. So, I kind of didn't know what to expect when I went down sampling in the LA River or the Tijuana River where I had to like, triple layer of protection because it smelled toxic, or when I had to collect samples next to meat rendering plants, you know, [*"Delicious."*] and it just smelled like death. Those are all really tough experiences that I didn't know how to mentally prepare. I think that being an endurance runner where you just put your head down and get through it is how I processed that.

One of my favorite experiences sampling in the LA River... So, I think it's really interesting how in southern California, particular rivers are named after the streets that go over them while in northern California, streets are named after the rivers that they are over.

Alie: Whaaat?

Lydia: Right, and just how the naming of river systems kind of also shapes how people interact with the environment, which I found super fascinating.

Alie: I had no idea.

Lydia: So, the LA County, all the rivers are highly channelized. If you didn't know to look for a river, you might miss it because there's so much concrete built around it. We had to tie a rope on the side pole or whatever, in waders and big backpacks that carried a four-gallon glass jar, basically slowly lower ourselves down on a rope to get to the LA River channels, and then collect soil sediments there. And it was amazing when you get down there. A lot of times, it was cool to see how sediment had built up and there are trees and riparian areas growing. There are other times where there are huge homeless encampments that we had to navigate around. I mean, it was definitely always on your toes. *[laughs]* But I think to me, those experiences of being in the heart of the city but also seeing how nature and natural ecosystems were also trying to reconquer the concrete was really beautiful.

Alie: And I imagine if you've got a glass jar, that's because you don't want to use plastics which could maybe contaminate your samples? How do you even go about figuring out what's in them?

Lydia: Yeah, so in that time we were looking particularly for any presence of heavy metals and pesticides. And so, with plastics there is potential for some of those compounds in the soils to react with the plastic surfaces, so it's better for long-term preservation to keep it in glass and then keep it in a controlled environment. The type of vessels in which you collect samples are really dependent on what you're sampling for and also, just thinking about potential volatiles that might be happening in plastics versus glass, right?

Alie: When you're doing the soil analysis, what things are you looking for? The metals? How much rock is there? How much moisture is there? Is there a histogram of what's in each thing?

Lydia: Depends on the project. With that project that I did in these gap years between my undergrad and PhD, that project was a stream pollution transmonitoring project, and so we were sampling all the major riverways in California and looking for, kind of, areas of more concentrated pollution or not, then particularly looking at pesticides, heavy metals and any kinds of oils or other types of waste streams that might be in those systems. And then we were able to look at, "okay we sampled 100 spots throughout California, these are the areas that are more concentrated in terms of pollution," and we were able to give that to the California EPA, which then was able to talk to the regional EPAs, Environmental Protection Agencies, and start to make some management decisions about how to address those hotspots of pollution.

I keep on talking about pesticides because that was one of the biggest ones, also insecticides. We would go out and sample some agricultural fields near Sacramento area after they had sprayed different types of insecticides to address mosquito populations. And so, that was really interesting because we would go out before they sprayed, and then an hour after they sprayed, 12 hours after they sprayed, 24 hours after they sprayed, and 7 days after they sprayed to really see how those levels were decreasing. That was a really interesting example of how, as humans, we're using our science and chemistry to address one type of irritant, but we're also potentially creating others, and so that's why we have to be monitoring that to make sure that we're keeping people healthy from both the insects but also the insecticides and pesticides that we use to address those insects.

Aside: So, that was an undergrad project. But her PhD research focused on looking at microbial critters in soil to figure out how much mining waste was left in the soil. Asking the soil, "Hey, who's in here? What's the vibe?"

Lydia: But now, my PhD work, I measured very different things. That was less about the chemistry and the environmental toxicology work, and this in my PhD where I'm looking at soil health, then I would measure the soil texture, the soil pH, the soil electroconductivity, I would collect samples and have to collect clean samples to get microbes and then do a variety of analyses when I got back right away because you don't want your microbes to die, they're very sensitive. [*Well you hang on in there, bud.*]

Alie: You mentioned also that we are so concentrated on making barriers to soil and how important are all of the minerals, and microbes, and funguses, and all the things that live in dirt? Should we be breathing more of that, should we be getting that under our fingernails and into our ears? Are we not dirty enough? I feel like we're not dirty enough and maybe that's me just not wanting to wash my hair.

Lydia: Yeah, I mean I think it's an interesting question about what is dirty enough? COVID-19 introduced a lot of increased sanitation that I think is necessary in that respect. But conversely, there's been a number of interesting studies looking at what is happening to us, if you think about the One Health, which is this idea that we recognize that we live within an ecosystem and so when you change one factor of that ecosystem, we have potential to impact a lot of other factors in that ecosystem. And us humans, being part of that ecosystem or our bodies being an ecosystem and recognizing that. The reason why I bring that up is that there have been some interesting studies that looked at how gardeners, in particular, have lower levels of depression, in part because you're digging into the soil and you're inoculating yourself constantly with those soils, which have microbes that actually are really good for elevating your mood.

Aside: So, for more on this you can just do some light reading of the neuroscience paper titled, "Identification of an immune-responsive mesolimbocortical serotonergic system: Potential role in regulation of emotional behavior," which describes findings linking this one soil bacterium, *Mycobacterium vaccae*, to lowered stress, and better focus, immune modulation that could lead to less brain inflammation and more serotonin.

Lydia: There's been another study that looks at how your pets, I'm sitting next to my dog called Salchicha, how your pets are really good inoculators of microbes of the soils that they're rolling in outside, and they come rub up on you, and they inoculate you with microbes that help boost your mood. So, I think that there are really interesting ways in which we as humans have coevolved to want to be closer to natural ecosystems. And more recently, and definitely Western colonization and industrialization have really built up means to keep us separate.

Today, we increasingly have more issues associated with depression and anxiety and there's a lot of factors why. And there have been studies that show more time in nature helps decrease some of that depression. So, I think there are interesting associations that have not been correlated but I hope more people are interested in investigating that in the future. I'm a trail runner, so I try to get outside as much as possible. I have a dog who I'm trying to get to constantly inoculate me, even if she doesn't want to snuggle. [*Alie laughs*] So, I think there are really interesting ways that we can take that matter into our own hands.

Aside: So, being outside and near alive stuff and green things are good for you and we cover some of this in the Awesomology episode with Neil Pasricha, and also in the Dendrology episode about trees. But you can also talk to a doctor about it or just go out, huff some bark. You can also ask the US Forest Service, which has a whole webpage

dedicated to facts like, “Studies also show that being outside in nature is relaxing, reducing our stress, cortisol levels, muscle tension, and heart rates.” So, even the US Forest Service wants you to be happy and is like, “Get your keister in the outta doors,” which reminds me, I would like to start jogging again.

Alie: I was going to ask, as a runner, how hard is it for you to actually stay on task and get your run done without just pulling over and being like, “Look at this! Look at this soil, look at that! This one is so loamy and this one has peat in it, and this one’s red, and this one’s brown”? How do you even keep running?!

Lydia: Yeah, we call that a soil scientist pace. *[both laugh]* No, but I mean, you have runs for different intentions and sometimes it’s like, “I just need to get out there to escape looking at my computer screen,” and I get pulled away and distracted and that’s okay. Sometimes I want to go and run really hard and feel my lungs burn, and that’s okay, I have those times too. I think it’s giving myself the permission to, as long as I’m getting out, to experience whatever that’s going to be. When I was training for the Boston Marathon, I didn’t run on trails very much because I was very workout focused. But today, I went out with my boyfriend, and we just wanted to get out and have a good time, look at the Saguaro cactuses blossoming, and be together and so it’s just like, we walked, we ran, we talked. There are different reasons to go out, but each time is enjoyable. *[laughs]*

Alie: What about questions that you get... Do you have a lot of people with gardens and houseplants who are like, “Dr. Jennings, what am I doing wrong?” Was there ever a time when Styrofoam balls were necessary in houseplants? Did they do that, or did I imagine that?

Lydia: So, I mean, I think it’s really important to highlight that I am not a master gardener or horticulturist. I study contaminated soils, but some of that knowledge around soils and soil health apply to other fields. But my dad is definitely much more of a master gardener than I will ever be. He doesn’t have a degree but it’s one of the ways that I feel like he’s a lived experience expert and has a PhD through trial and error because community engagement and education redistribution is really important to me. So, it’s really important for me to do different workshops with, particularly, tribal members.

Last summer I was helping out with some friends, they have a community farm in northern New Mexico. It’s called the Three Sisters Collective and they have this community-engaged farm to create place-based space for young, Indigenous people. So, they had a workshop talking about soil health and they asked me to come talk about it. And it was really cool because it was a space only for Indigenous growers and beginning, those who are plant enthusiasts. And so, some of the questions I got were like, “Okay, so if we’re trying to think about different fertilizers or nutrients, I’ve seen people give hot Cheetos to their plants, is that okay?” And it was really funny to talk about and they’re like, “I would never ask someone normally, but you are part of my community and I feel comfortable to ask this.” And I’m like, “Well, there’s no real documentation of it, but Cheetos have these different chemicals, so maybe, but it’s not something I would recommend.” There’s a curiosity, we always want to help spark that.

Aside: And for more on sharing traditional knowledge when it comes to food, you can see the Indigenous Cuisinology episode with Mariah Gladstone of Indigikitchen and I’ll link that in the show notes. I also looked up the benefits of hot Cheetos for plants and I found a viral TikTok by SweetNothingsTV [*“So, I’m gonna teach you how to grow your own hot Cheetos.”*] 10 out of 10, convincing as hell, but no, not real. To obtain Cheetos, you have to

meet me at a sketchy gas station, and I will give you one, like you are my special raccoon friend.

Also, why is there Styrofoam in potting soil? I asked the Google and sometimes, those little white nuggets you see in potting soil, sometimes those are just added mineral blobs called perlite, which is this lightweight volcanic glass. It degrades naturally over time, because it's a natural thing, but sometimes those little white beads in potting soil are just Styrofoam, just lurking in potting soil to help with drainage and aeration. But yeah, it's just like adding tiny confetti litter into the soil. And the next generation of humans on Earth are like, "We are asking you from the future to not Styrofoam the soil."

Alie: When you were going down the path to a PhD, did you talk to elders, or did you get any resources from the tribal community in terms of what questions you were asking or what data you were collecting?

Lydia: Yeah. So, it's interesting because I didn't grow up in my community, I grew up around other tribal nations. A big reason why I chose to come to the University of Arizona was it's in close proximity to my... the tribe that I'm enrolled in. I knew mining had been a big issue and it was something I reached out to. So, the important part was like, as I began my PhD project, I knew I wanted to work on mining issues, in that first year, I really just spent time going and becoming part of community and talking about what I was interested in. The project I was hired in on was not really community engaged at all, it was more working with mining companies on reclaiming the land. But by the presence of who I am, it was really important for me to ensure that there was a cultural component and engaging with tribal nations. How we teach soil education and environmental science education in general is predominantly not centering Native knowledge or expertise.

Aside: So, Lydia said that she began by doing science outreach to kids and then building trust within the community to get insight into mining practices for her research on the importance of traditional ecological knowledge in mining consultation. So, building that trust was a really key aspect of her research and she says it's tough if you don't have faculty or advisors that can guide you in that. So, engaging properly, centering community knowledge, all of that is a skill that she developed, and she now tries to mentor students in a way that she wasn't trained to do.

Lydia: So, I think right now in general in science we see a lot more emphasis and highlighting the importance of traditional ecological knowledge or Indigenous knowledge systems, but we have to recognize that that's pretty recent. Even in my PhD time, I felt like I was really dissuaded from pursuing those and was much more encouraged to get the technical science down. And so, now I've done both and I feel good about that.

Aside: So, we'll get back to soil, but this topic was really interesting to me and important, especially during Native American Heritage month... and also every month.

Alie: Do you have any advice for any Indigenous students that you wish you had known when you started your PhD?

Lydia: Yeah, I mean I definitely think that finding Indigenous mentorship is critical. I think getting involved with different Native science organizations, whether that's the American Indian Science and Engineering Society, or SACNAS, the Society for the Advancement of Chicanos and Native Americans in Sciences, there's Native American Fish and Wildlife group. I think it's really important that you have a network of mentors, not just one person too, because each of us have different communities that we have been mentored by and that we can

speak with. But there are 576 different tribal nations in the United States, so each community operates differently, and there is power in that, but it also means knowing the proper protocols of the nations in which you come from and in which you choose to engage with.

I'm not an expert, I have some trained knowledge in some things but there are many people who I would say have PhDs in our community without the formal letters and those are... I see my role as an Indigenous scientist is to amplify their expertise. I can never speak on behalf of them, I can only amplify the expertise that has been shared with me.

Aside: So, you don't have to have a PhD to be an expert, or to be on this podcast, even though Dr. Jennings has one.

Alie: And getting back a little bit to the work that you did with mining and contamination, tell me straight, how fucked is the soil after mining and what happens to get it back to a healthy place? What can you do? Is it like unringing a bell?

Lydia: Yeah, so the work that I did prior to my PhD was the heavy metal measurement, but in my PhD, it was kind of understanding what the soil can tell us about its health after it's been mined. And in Arizona they use a strategy called "cap and plant." So, let's say a mountain, you have a mining pit and that's been dynamited out and then it goes through a series of chemical and physical treatments to get out the metal of interest, which in our case is copper.

Aside: So, Arizona, I didn't know this, supplies over 60% of the nation's copper. I always pictured it like gold mining, where people just look for nuggets of copper, or veins in rock, but copper. However, according to too many weird old mining documentaries I just watched a little too late at night on YouTube, what happens is they blast these big, gaping holes in the Earth, and then they drag out a bunch of grayish, brownish dirt, and then they take that into a factory and crush it into this sandy texture, and then it's kind of boiled with sulfuric acid to nab the metal into this copper sulfate solution. So great, so that's how they get it out. Boom, boom, boom, then they make that into shiny, pretty copper that we use in all kinds of applications. I skipped a bunch of steps, but you get the point.

So, what's left over? Just a bunch of extra rock and 6 of the top 10 environmental toxins, according to the World Health Organization. Which ones? I'll tell you. Mercury, lead, arsenic, particulate air pollution, asbestos, and cadmium. It's delicious.

Lydia: And then, all of that waste material from the chemical and physical treatments gets put into what they call a tailings pond, so it's kind of like this gray slurry. [*"Nice, nice, nice."*] And so that gets stacked up into an area and it's really, really moist because you don't want it to get into the local dust transport systems, but you have to figure out how to get that to be stabilized and then try to get things to grow on there. And so, often what they do in the Sonoran Desert, is they take soil from an offsite desert area, and they put it on top of the mine tailings themselves.

Aside: Like if your hair looks a mess, just pop on a little hat on top, but it's a cap made of soil, and your hair is byproducts from mining, tee-hee-hee.

Lydia: And mine tailings, I should say, they're about the size and consistency of cooking flour, so they're really small and it's really wet and that's why it can be an environmental contaminate issue, even just because of the small particulate which can get deeply embedded in your lungs. And so, the main strategy is cap and plant, and it's taking the soil from the desert area, and oftentimes it's surface soil, and putting it on top of the mine

tailings which creates what they call a soil cap. And then on top of that they will then seed plants to try to establish what they call a vegetative cap on top of the mine tailings itself.

So, that's what I studied, was looking at an area that had been seeded, the land was leased from a tribal nation in the area, basically look at that strategy of how has the area been recovering after it's been seeded, and what can the soil tell us about how the seed mix is working? So, that's where we were able to study all these below-ground metrics on the biological, chemical, and physical parameters, but then also what's happening above ground in terms of plant coverage and species diversity.

So, what was interesting was the tribe chose to invest a lot more seeds than are normally planted. Most mining companies will choose maybe 10, but the tribe chose to invest in about 37. Part of that is informed by traditional ecological knowledge and what's commercially available but also, just what kind of plants they want that ecosystem to look like into the future. So, I think that's what was really interesting and then seeing how it changed over six years in terms of vegetation and recovering.

Aside: For more on this you can see Lydia's dissertation entitled, "Evaluating the Biotic Potential of Degraded Soil Development on Reclaimed Mine Tailings in Southern Arizona," which has a section on page 44 titled, "Indigenous Perspectives on Reclamation" and she writes that:

For Indigenous people's ethics of reclamation is as much about redressing inequities of power, capacity, agency as it is "cleaning up the environment" in the traditional context of things like restoration, remediation, revegetation, and rehabilitation. This belief contrasts with the settler-colonial tradition of viewing land as an object one can own.

And then she cites the research of Dr. Robin Wall Kimmerer, who is the author of *Braiding Sweetgrass*, and was last week's Bryology guest about moss. But yes, Lydia studied this land for more than half a decade.

Lydia: So, six years is relatively long for a field study. We found some really cool trends. Of course, there's always more things I wish I would have done. I wish I would have done more molecular work and fungal work but that's part of being a researcher, you feel like there are always more questions to ask. *[both laugh]*

Alie: And as a scientist you kind of get to keep asking those in your continued work, right?

Lydia: Yeah, it's like, you have a little bit of information but then you have more questions, which I think is exciting. I think it's also made me think a lot about how we think about how we do science moving forward. I talked a little bit about my work and the tribal consultation piece and thinking about how we value traditional ecological knowledge in trying to develop the seed mix to revegetate this area, but we don't value it when it comes to tribal consultation for new mines. Why is that? So, it's kind of left me to shift my research questions a little bit now and I'm actually looking at data mining in addition to heavy metal mining *[laughs]* but I think they're interrelated, and similar systems operate within very similar patterns.

Alie: Yeah, that's something that I'm sure would get overlooked so much. Having someone asking those questions and being there to understand the many, many nuances is so, so important.

Anything that people think about soil that they get wrong? Anything that you just want to stand on a soapbox and be like, “No! It’s this!”?

Lydia: Well, I think a big part is that we’re not on the soil, we’re with the soil. We’re part of the ecosystems, we’re not above it. And I think this notion of we’re above, is very settler-colonial narrative. But recognizing our interdependence on soils, on the water that filters through soils, on the foods that grow on the soils, on us who gain happiness, running and recreating on those soils, and just recognizing that they’re not just something that we step on. No matter where you’re at, you’re going to be interacting with soils. Even if you’re in a city, that city is built on urban soils. Just recognizing all of those ways that we are part of ecosystem, so we have to care about it if we care about our own health. But also, them existing for the sole purpose that they are is also important. I guess I’m just asking your audience to reframe how they think about soils as something that’s not just to be studied or to be extracted from, but as something that we have a responsibility to care for, for our health, for our planet health, and for our future health.

Alie: And we become soil, pretty much.

Lydia: We become soil! Yes! It’s so amazing. And all the microbes that we’re talking about that help make us happy, help break us down so that we’re not covered with crap, worm poop. [*both laugh*] So, that part is so exciting. Soils really are everything.

Aside: How much do you love her? We love her.

Alie: We have one billion questions from listeners who know that you’re coming on. [*laughs*] Can we lob some at you, we’ll do like a lightning round?

Lydia: Sure.

Aside: But before we cut to the break, Lydia and I talked for a little bit about a film that she just finished shooting called *Will Run for Soil*.

Lydia: So, myself and two other women soil scientists, we ran 135 miles last September, running the farthest any of us have ever ran before in attempts to really increase public awareness about soils. Most college students don’t get training in thinking about soils, despite being this ubiquitous medium that we all interact with. So, we are all three, women soil scientists and literature will tell you the average soil scientist is a 65-year-old white guy named Robert, like statistically speaking. But we’re three very different women who all study soil science but also love to run. So, we combined forces to run this really remote trail in the desert, starting in Nucla, Colorado and ending in Moab, Utah, and just looking at soils all along the way and talking about them and why these soils are beautiful, both color-wise but also, culturally recognizing the many Indigenous people who have run through those areas prior to us, but also talking about the language and what it means to be a soil scientist.

Aside: And they are still working on postproduction so if any listeners who work in programming for SXSW, or you know someone, find Lydia Jennings and the *Will Run for Soil* people, because they’re interested in screening it at SXSW when it’s done. And if you need me to intro the panel, hi just holler! So, that *Run to be Visible* film is already made but she’s making the new one, *Will Run for Soil*, and you can donate to that if you’d like. I’m going to put a link on my website.

But for her donation for this episode, she chose Rising Hearts, which was founded by Jordan Daniel who also directed Lydia’s first film. And RisingHearts.org is an Indigenous-

led organization, elevating Indigenous voices and fostering intersectional growth through organizing and programming. You can go to RisingHearts.org to learn more about their wellness classes, advocacy, community jobs, running with a purpose, and running on native lands programs. So, to find out more go to RisingHearts.org. And then for fun, we made a second donation toward editing Lydia's current film, *Will Run for Soil*, and we'll include a link on our website to both. So, those donations were made possible by sponsors of *Ologies*.

[Ad Break]

All right, finally, your questions, patrons. And if you want to submit questions, you too can join for a dollar a month at Patreon.com/Ologies, but you don't have to. But yes, patron questions.

Alie: Okay, I am going to lob some questions at you. A lot of folks want to know about the spectra of dirt, Jennasis, Ray Holloman, Jess Loeffler, Ally T want to know: Why does dirt come in different colors? Why is it rust colored? Why is it brown? So yes, what exactly, what's in there?

Lydia: Yeah, so the different colors of soil really come from the variety of nutrients that are broken down to— or, I say nutrients but really the rock materials that are broken down, that's one source of color. But then there's also a source of color from the chemical reactions. You're talking about those red and rust colors, that can come from an iron oxidation. Here in the Sonoran Desert, there are areas that have blue soils and it's from different copper oxides, so those are another component of that. And then also, just the weathering process, so thinking about how those are not only exposed to oxygen or to other forces, but then also how they get transported, that can often cause different soil colors.

Aside: So, to recap, reddish soils tend to have more iron oxides and whiter soils tend to contain more salt, or silicates, or calcite. Black soil has more decomposing organic matter stuff, and there are even greenish soils that have glauconite, which is an iron potassium phyllosilicate, but I mean, you knew that.

Also, if you're wondering how pedologists agreed on color swatches, it's not with a Pantone wheel but it's with something called a Munsell chart that helps them compare the hue, like reddish, blueish, or yellowish; the value, which is light to dark; and the chroma, or like, the saturation of color. But even without the charts, there is long-held knowledge about how fertile a soil is based on a look.

Lydia: There's different language translations for black soil being good soil, and white soil being poor soil. We can look at how that translates to actual organic matter levels or actual salinity levels in the soil. There are all these different ways our cultures have evolved with soils and somehow we've gotten separated and lost from that, but they're part of us, we're part of them.

I also want to really give a shoutout to my friend, Karen Vaughn, who has the ART of SOIL website, and she actually sells custom-made soil pigment kits that are amazing. And so, she is kind of who I would say is like a soil colors expert and has these amazing kits and recipes that she's made to help amplify the colors of the soils.

Aside: So, ART of SOIL is a great small company that makes watercolor art supplies out of different soils! And you can just gawk over these refillable cherry wood pallets with little discs of earth-toned pigments with names like Sprout, and Bluebird, and Basalt. And I

can see why they have 82,000 followers on Instagram, I feel like my heart rate goes down just looking at their page. So, ART of SOIL, for anyone shopping small businesses this holiday. Who knew being gifted a lump of coal is actually tight as hell. Okay, onward.

Alie: Kelly King, Ashley Oki, first-time question-asker, Clara Pfundt, first-time question-asker Kylie Tschida, so many folks want to know: Clay versus soil? Kelly King is a beginner potter here and is wondering if clay is technically dirt or if it's something else?

Lydia: Yeah, I would say clay is not dirt. And I might get some pushback on this [*Alie laughs*] but again, going back to this initial definition of dirt being displaced soil, well clay is really more in that place. It does get transported and clay is one of those finer particulates, but I don't think that it's dirt.

Alie: Okay, that's good to know. I think stand by...

Lydia: [*laughs*] That's my final answer... [*Alie laughs*] I'm like, "Oh man, am I going to get some pushback!" [*laughs*]

Alie: You know, it could be a matter of opinion here.

Aside: So, everyone who asked if clay was soil; clay is an element of soil but by itself, it is very, very, very, *very* small rocks surrounded by this molecular film of water which is why it is squishy and moldable.

Now, for more on clay, you can see the Geology episode on rocks with Schmitt Thompson but honestly, I want to do a whole episode on clay, and pottery, and kilns, and all that. I don't know what the ology is, but I want to do it. But in that Geology episode, with Schmitt Thompson we also discuss licking rocks. So, what about sniffing the soil? So many of you, such as first-time question-askers Professor Koshka, Meg Getzinger, and Amelia McCardle, as well as Alphabet, Lindsay Deal, Rhona Taylor, Aleksandra Romanowicz, *Ologies* editor Mercedes Maitland, and aforementioned Geology guest Schmitt Thompson as well as...

Alie: First-time question-asker, Anuja Joshi as well as other people want to know: Does soil smell different in different regions and why?

Lydia: Yes. Part of it is the amount of moisture, and again, the material that has been breaking down in those regions. So again, I was in North Carolina in the Lumbee and there are just certain plants that are there that make the soil smell so much more uniquely, versus being in California last weekend. A lot of the soil there smelled like eucalyptus to me because of the eucalyptus trees that are around there that are breaking down.

Aside: For more on why California has so many non-native eucalyptus trees grown from Australian seeds, you can listen to the recent Xylology episode, which is all about wood. We'll make you laugh, and cry, and eucalyptus has hopefully never felt so seen, so we get into it. But in other parts of the continent...

Lydia: North Carolina has these tannins in the soil, and you can see it. In fact, the Indigenous people there call themselves People of the Dark Waters from the tannins. So, I think there are definitely different elements of the soil or of the ecosystem that influence the soil feel and smell in really beautiful ways.

Aside: Shoutout to the People of the Dark Waters, the Lumbee Tribe of Northern Carolina. But why are those waters dark? Well, the tannins are plant compounds that evolved to deter herbivores who would come along and munch it. And your dark tea, that's

tannins. So, some rivers are just big streams of tea, if you want to think about it, and you can just dunk your body like a little biscuit. But back to arid lands...

Alie: You're in the desert, which is the most, best smelling [*played back in slow motion, "Most best smelling"*] dirt place, I feel like, ever. I have never smelled anything like driving through the Arizona desert when it rains. And Rhona Taylor, Jessica Janssen, Meghan McLean, Ariel Vanzandt, Francesca Huggins, Alicen Meysing, Hannah Gargrave, Liv Bruce, first-time question-askers Apollonia Piña, Meghan Matthews-Adair, Emily Krieger, I mean, we have a lot of people want to know essentially about petrichor. Why does soil smell so good after a rain? Is it true that big drops release some kind of volatile oils? Compounds?

Lydia: I'm in the Sonoran Desert, and the smell of a desert after it rains is really the smell of creosote, which is this plant that does have certain oils on it, and I feel like that's what gets activated. In part, I think the desert has baked for so long that that moisture just activates so many microorganisms who start breaking down those materials in really powerful ways. I think that's a general smell that we have is that breakdown material process. But in the Sonoran Desert in particular, it's the creosote that gets activated and the oils on there that get released and create those aromatics that are just so incredible. You actually can see people who take branches of it and put it in their shower so that they can smell it on a more regular basis.

Alie: We were just replanting our hillside with native plants, and it's been a process this year, but one of the plants that we put in is a native coyote brush which smells... it's like that smell of the desert. It's a baby right now and it's growing and I'm just... I can't wait to just put my whole face in it because it smells so goood!

Lydia: [*laughs*] Yeah, it's an amazing, really unique smell and it's funny, like after it rains in the desert, I like to go on runs and check it out because the desert feels so alive, but I swear you can hear the soil absorbing the moisture and it just sounds... everything in the desert is so happy and you can just hear that soil so thankful for the moisture, and it's one of my favorite— And it's a really subtle weird sound, people are like, "Lydia, you're imagining things," but I swear you can hear it. [*both laugh*]

Aside: I looked everywhere for an example of this, and it is not a sound that has been caught on tape a lot, so I'm just going to have to sit in the desert and wait for some kind of monsoon.

And as for the sweet, sweet smell of rain... So, petrichor means the godly blood of a stone, but scientists call it "Argillaceous odor," which I learned from the 1964 publication in the journal *Nature*, which was titled, "The nature of argillaceous odour" which says that yes, oils that are produced by plants sink into dry clay soils and then when rain falls, that oil becomes an aerosol and it's mixed with something called geosmin, which is a byproduct of little bacteria, little rod-shaped ones called actinomyces, which are everywhere in soil and in us. The human nose is so attuned to finding water that we can detect the smell of geosmin in concentrations as low as 0.04 parts per billion, which is not a lot of parts.

But what about the types of rainfall? Well, in this other paper, 2014's "Aerosol generation by raindrop impact on soil," researchers figured out that the way the scent hits our faces via aerosol is that the rain hits the ground and bubbles form in the raindrop, and then the bubbles burst along the surface of the raindrop, kind of like a fizzy beverage. So, slower raindrops produce more bubbles, thus the smell, which is why light rains, particularly on

really dry soil, that's the most bang for your buck when it comes to petrichor, or I guess, argillaceous odor.

But what does argillaceous even mean? I just looked it up, it means, "Of or relating to clay." And when I saw that, my throat closed, my palms got sticky and I was like, "No, is it possible?" And I googled "argillology." [*voice quivers*] Yes! It's the study of clay. Shut up, this is happening. I found the ology for clay, what a same-episode payoff! That never happens. But yes, petrichor, thank you plant oils and thank you for that sweet musky earth whiff that we all love, you geosmin-making actinomyces bacteria, just... kisses on your tiny microbe butts.

Alie: Have you heard any other soil scientists looking for antibiotics from soil? Tara McNee, Lauren Cooper, and Anne wanted to know: Are there microbes in soil that maybe might be used medicinally?

Lydia: Yeah, definitely. There are a fair amount of research projects that look at different antibiotics and microbes that can have healing processes. I think a lot of that work has traditionally been done more in Latin America than here in the Southwest, although I believe some research has also focused on microbes in extreme environments for medicinal purposes. I think there is something to be said, particularly as we think about climate change and how our environments are changing, that people are looking at extreme environments for potential solutions both environmentally but also pharmaceutically based.

Aside: Okay, so one tiny gram of soil contains up to 3 billion bacteria and 1 million fungi, and there's soil everywhere. This was news to me, but the vast majority of antibiotics come from soil, including penicillin and streptomycin. And researchers are looking at an anti-cancer drug that was found in a hot spring in New Mexico. Plus, there's this whole slew of antibiotics called malacidins, derived from soil. There may literally be a cure for cancer in your garden, and I'm looking at you, patrons Chris Brewer, Harper Thomas, Marisa Holzman, Alesa Weiss, Sikwani Dana, Rachel Adams, Shannon Foster, and Karlie V who asked why people say, "Rub some dirt in it," when they are wounded. Maybe though, before you do that you should wait for more research, or maybe, perhaps you could become a soil scientist. You know what, let us help you.

Alie: First-time question-asker Natalie Gomez said: I've never asked a question before, but I've got a freaking soil science final coming up, don't let me down, JK. [*Lydia laughs*] But they wanted to know: What is the most important mineral, or element, or ion found in soil. They just watched a video that said we're going to run out of phosphorous fertilizer in 40 or 50 years. So, is there anything that we're seeing as a trend of, "Oh no, we're really screwed when it comes to farming because we're depleting this stuff?"

Lydia: Mm-hm, I mean phosphate continues to be one of the more depleted nutrients. So, phosphorus continues to be one, and that's something that was attributed a lot to big dustbowl types of processes, is having- I would say anything that's like nitrogen, phosphate, and potassium are the big three, NPK.

But I also think you're continuing to see more of the topsoil being eroded away, and also with building construction, a lot of the topsoil being lost, which has the majority of nutrients in it to have self-fulfilling ecosystems. And so, actually you see in the UK, they started to make soil health metrics, recognizing that we're losing topsoil at an alarming

rate that can't be replenished. And I would love to see other countries in the world also fulfill some kind of plan in thinking about topsoil long term.

I think this kind of goes into again that there are multiple ways to think about and see soil. Many people think about it only as a growth medium as opposed to an ecosystem that we can appreciate, or how to repair an impacted and contaminated ecosystem. So, for the purpose of the question, I would say NPK are the primary ones that we want to focus and worry about, but it also depends on your ecosystem.

Aside: There are many, many ways to see soil. But what soil would Lydia stare at moonily? Many folks including patrons Danielle Soloman, Nicole Kleinman, Steve Hansen, Charlotte Fjelkegård, Argiope17, first-time question-askers Meghan Matthews-Adair, and Lidiya Beida, and another Lydia, Lydia Lambe, all wanted to know what, in *this* Lydia's opinion is the best soil? Does she have a favorite?

Lydia: So, favorite soil... It's hard. [*Alie laughs softly*] I mean, there's a texture, it's like a sandy loam, I like those a lot. But if it's a specific one, there's one where I grew up in New Mexico, it's one of the places I love to go running and it's this yellow sandstone and it's called Chupadera series, and it makes a really beautiful color pigment, this bright yellow. But also, I love, it's on an ancestral pueblo at the Galisteo Basin and I really love that it's called Chupadera because, so in Spanish that means like, sucked, sucker or sucked. And I guess it's just this integration of language, and it's right next to another soil series called the Zia soil series, which is like this bright red color.

So, it's this integration of language and ancestral knowledge in the names of the soil series themselves but then also, Chupadera is weathered away sandstone, so it's sucked of its sandstone material and weathered away, and I think that name correlates so well with what the soil is and embodies, and just knowing that the caretaking ethics of those particular soils in this ancestral pueblo that has made all this beautiful pottery is all embedded within that soil itself. And I think that part is just really beautiful. So, those are probably two of my favorites.

Alie: Augh, that's awesome. And first-time question-asker Ingrid Zaragoza, wanted to know if we can make a difference to our planet via carbon sequestration and changing our farming practices? And also, if you have an opinion, Kaitlin Garofano wants to know on regenerative agriculture and trapping carbon. Is that something we can do with soil?

Lydia: I would say the evidence suggests yes, that investing in soil health and building up soil carbon and being able to sequester it, is a really important factor to addressing climate change and there's a really great TED Talk on YouTube by Asmeret Berhe, where she really talks about soil being the climate solution. So, definitely check it out because she speaks to it in a way that I could never.

[clip from Asmeret Berhe's TED Talk, "A climate change solution that's right under our feet"]

There's more carbon in soil than there is in all of the world's vegetation including the lush tropical rainforest and the giant sequoias, the expansive grasslands, all of the cultivated systems, plus all the carbon that's currently up in the atmosphere, combined and then twice over.

So yes, check her out. And then in terms of regenerative agriculture, I do think it sounds— it makes me really hopeful. I do want to highlight that many Indigenous farmers have always done what is now renamed 'regenerative agriculture' and the Hopi nation is one that

comes to mind right away. Hopi and Pueblo farmers have had methods of regenerative agriculture, and I think this comes back to methods and means of wanting to live in reciprocal relationships with our environments as opposed to extractive ones.

Alie: There's one million questions but we are not going to get to them all. This just means that if you have an interest in soil, go run with it, literally, like Lydia did because there's so much intrigue in it!

Let's see, just one last listener question, people wanted to know about safety and contact with dirt, what is clean dirt? Two people said: Tell us about soil-related fungal illnesses like Valley Fever, et cetera, things like that.

Lydia: Yeah. Valley Fever is a huge one out here in the Sonoran Desert. I've been fortunate not to get it, but it's really common for people's dogs to get it and I'm constantly afraid about that with my pet. In terms of the safety, many people, when we're out field sampling, will wear masks. I think for myself, I've been checking out our state public health websites to see how common it is right now.

Aside: So yes, head to the CDC for weekly reports on how many cases of Coccidioidomycosis, AKA Valley Fever, have been reported. And Arizona, you got a lot of copper and coccidioidomycosis... them the good news and the bad news. And if you have been in arid southwestern areas and you have lung symptoms like coughing, fever, sweats, fatigue, and maybe even a spotty red rash on your legs, maybe get checked out. It might totally resolve on its own, but my dear friend Dr. Teagan Wall, who hails from Arizona, had to get part of her lung removed because there was a fungal root ball in there from unchecked Valley Fever. Oh, and climate change with potentially wetter winters and drier summers is making it more widespread, not to freak you out, I know I just freaked you out.

Lydia: For myself, I'm more concerned about heavy metals in the soil. You have to think about the typical public health aspects of exposure time and exposure load, and that's different than having a fungal or microbial issue. I think those are the two pieces that I think about in terms of soil health.

Another part is just thinking about, in general, collecting soils as a woman soil scientist, safety. And you know, when I did some field sampling in California, I did get chased by someone [*Alie gasps*] and let me tell you, carrying a four-gallon jug of mud in waders and running is not easy. So, I think that like, those are also elements that we want to be thinking about soil health too is, I feel more comfortable with the soil than I do people. [*laughs*]

Alie: Oh man. What happened with that? Did they chase you off of public land, their land? Did you yell back at them? Can I find them and yell at them?

Lydia: Yeah, I mean it was myself and another woman, we were collecting soil samples and, I don't know, some guys were saying some kind of explicit things to us, and we got freaked out, naturally, because you can be pretty vulnerable. We had these big sampling tubes that we were like, "Okay, we could hit someone with this." But the best thing to do is just exit the situation. So, it made our research group reevaluate some of the safety protocols. And so I think... That is not the question that you were asking, and I apologize for taking it in a different trajectory.

But I think it's always just... having a good head about you in the field. And especially as an Indigenous woman, in general, I think soil science is a really safe field but there's always the human element, just like I think thinking about soil fungus, there are different methods

we do to protect ourselves, and being aware of wearing the proper mask and proper gloves and those types of things, and the proper awareness. [laughs]

Alie: My next question was, what is the hardest thing about what you do? And is there anything about soil, or about the work, or about systems that is the hardest?

Lydia: Yeah, I mean I think soil-wise, the hardest, and most challenging, and also I think the most fun, is analyzing your data and pulling out the story of the data. Yeah, there are long days in the field and the lab to come back and process, particularly with microbes, come back and process. And there are times where the first couple years of my PhD I was plating the microbes and you have to do this series of dilutions. I'd come back from four days of heavy fieldwork and have three or four days where I was based in the lab all day and all night if I could. You want to get your microbes plated as quickly as possible. ["I'm so tired."] So, that was just really hard energetically and personally.

But I think also what's really fun is when you have all the data, then to put it together and pick the story and figure out what the data is telling us about its health, about this landscape that you're studying. I think that's beautiful and also really challenging because you want to make sure that you're not having any biases in that.

In terms of the larger work that I do, I think for better or for worse, I've kind of made myself this... My Twitter name is @NativeSoilNerd and it's really important for me to talk about Indigenous soil expertise, both historically and in the present. I don't want to speak for communities that I'm not part of, or things that I don't know. You can see I'm really cautious about that, in part because I think, "You're Native, you're an expert in all of these things," and there are definitely things that I'm not and I'm responsible to multiple communities and all those communities will hold me accountable if I misspeak.

So, I think sometimes, there is that, knowing how to hold strength and that accountability and how to try to use your voice for the best. But also, my community will tell me if I mess up. That's not... having any auntie be like, "Tshh, why are you doing that?" is never an easy part, the criticism, right? So, I think that is an important piece of the challenge, of coexisting in multiple spaces and wanting to be responsible and appropriate in each of those spaces.

Alie: Mm-hm, that's got to be a lot of effort to make sure you are doing right by everyone.

Lydia: Yeah, and I think sometimes the best thing I can do is not speak on something in a way and let someone else from my community speak who is more appropriate. And that's hard because also, there are different value systems associated with academic spaces and then Indigenous community spaces, or at least my tribal nation community spaces. So, in some of those contexts, there are not things I'm supposed to speak on, but in academia, they're like, "You're the expert." And like, am I though? It's hard, is it because I'm feeling hesitation because I'm an early career academic, because I'm a minoritized woman in the academy? There are all those different layers that make up the onion that is Lydia.

Aside: Lydia also recommends that people check out the American Indian Science and Engineering Society, that's at AISES.org and that supports professionals in STEM fields through professional development, career opportunities, and networking. Lydia says that by showing up as herself, including making the time for important things like tribal ceremonies, she hopes she'll make it easier for other students and make them feel less isolated and give future mentors a better idea of how to make space for those kinds of

experiences for students, especially since it can only broaden the scope and the impact of the science itself.

Alie: What about your favorite thing about what you do?

Lydia: My favorite thing. I think, so I love teaching because you can talk about something, but when you see students and it lights a light inside of them and they get excited, it's really amazing. I also think teaching has made me feel so hopeful in a way that... you read typical science, climate science literature, and that applies to soils as well, and it can be really depressing. But then you can constantly be so inspired by the students that you work with and know that the future is in good hands. They're going to have a lot to deal with, but there is so much passion and strength in these students and I think that's what makes me feel really hopeful.

Also, the other part is working with really— Some of my collaborators are doing such phenomenal work and it's so awesome to be... these are people I looked up to and now are my coauthors, right. And I think, wow, we're doing the work that fills gaps that I always wish I had had as a student, and now we're creating that. One of the great things about being a scientist is if you can write a good grant for it and get it funded, you can study that. And I think, you're never going to get bored in this line of work because you have a question, you can write a grant, and get it funded, and explore. What a privilege that is, that that is your profession. So, I think those are the things that make me feel really hopeful. And then when in doubt, I just go for a run with my dog and see how happy she is just to get out of the house, that's what also fills me with joy.

So, ask smart people the simplest questions and go paint with dirt, go smell the soil, watch a mining documentary on YouTube, it's none of my business. But do follow Indigenous pedologist Dr. Lydia Jennings on Twitter @1NativeSoilNerd or on Instagram @LLCoolJennings, or you can check out her website at NativeSoilNerd.com. A donation went to RisingHearts.org and there will be more links to all of that and info at AlieWard.com/Ologies/IndigenousPedology which is easily linked in the show notes for you too.

We're @Ologies on Twitter and Instagram and I'm @AlieWard on both. Thank you to all the patrons at Patreon.com/Ologies. Thank you to everyone who has merch from OlogiesMerch.com. Thank you to Erin Talbert who moderates the *Ologies* Podcast Facebook group with assists from sisters Boni Dutch and Shannon Feltus. Happy belated birthday Lily Talbert too. Thank you to Emily White of the Wordary who makes our professional transcripts, Caleb Patton who bleeps them. Those are up for free at AlieWard.com/Ologies-Extras. Thanks, Noel Dilworth, for all the scheduling and more and Susan Hale for being the best. We also have shorter classroom-friendly cuts called *Smologies* up at AlieWard.com/Smologies, or in this feed. Those are edited by Zeke Rodrigues Thomas and Mercedes Maitland and many thanks to lead editors, Jarrett Sleeper and Mercedes Maitland of Mindjam Media. The theme song was written by Nick Thorburn.

And if you stick around, I tell you a secret and today's secret is that I started the morning with a very large Thai iced tea that I made at home with some Thai tea and vanilla creamer, and I apologize to all of Thailand for that but it was delicious. Okay, berbye.

Transcribed by Aveline Malek at TheWordary.com

Links to things we discussed:

You can follow Lydia's adventures on [Twitter](#), [Instagram](#) or at her [website](#)

A donation was made to [Rising Hearts](#) and to Lydia's film, [Will Run for Soil](#)

[Evaluating the Biotic Potential of Degraded Soil Development on Reclaimed Mine Tailings in Southern Arizona](#)

[How Two Indigenous Runners Made a Film Connecting Running and Environmental Activism](#)

["Run to Be Visible"](#)

["Will Run for Soil"](#)

[Gardening for health: a regular dose of gardening](#)

[Gardening can cultivate better mental health](#)

["Identification of an immune-responsive mesolimbocortical serotonergic system: Potential role in regulation of emotional behavior"](#)

[Growing Hot Cheetos](#)

[Karen Vaughn's Art of Soil: soil-based art supplies](#)

[Lumbee: People of the Dark Water](#)

[The Lumbee Tribe](#)

[Biogeochemist Asmeret Asefaw Berhe's TED Talk about soil](#)

[Death Valley man talks when 1,000 year flood hit](#)

[2007 Article: Soil Bacteria Work In Similar Way To Antidepressants](#)

[The US Forest Service is like, get your keester in the out of doors!](#)

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