Disease Ecology with Dr. Andrea Swei
Ologies Podcast
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Oh heeey, it's your Ol' Uncle Dad, who's not too proud to shove a finger in each of his ears when a fire truck goes by (it's too loud), Alie Ward, back with another episode of *Ologies*. Alright, diseases. Nobody likes them. Not even vectors, probably. But isn't it nice to be united in a common dislike of them? So let's clamber down into a big, juicy vat of tick-borne illness. Shall we? So we covered acarology a few weeks ago, and I promised I would hustle to get you a follow-up on tick-spit souvenirs that they can give you. This week is the week!

Did you come out of *Acarology* liking ticks? Just a little bit? Because I didn't. I still hate them very deeply, and they've silently crawled to the very, very tippy-top of my shit list. So let's talk about what they can do to us.

But first, lemme talk about you, and just how much I like you. Thanks to everyone who is supporting the show via Patreon. I could not make *Ologies* without you. Thank you to everyone getting *Ologies* merch at OlogiesMerch.com. Also, I put out some social media posts this week that if you got merch in the last few weeks and it seems oddly late, if you didn't hear the secrets at the end of the last few episodes, I had my wallet stolen in a Wal-Mart last month. All of my cards were canceled, so there was a delay with the merch site. Anyway, everything is fine now. There are still a couple of orders shipping out. I'm so sorry if yours was late. I care so much and I'm so sorry.

Thank you also to everyone who is subscribing and rating, and most of all, reviewing the podcast so that I can lurk and read your nice words. I just pick a fresh, fun one each week, such as this one by Maria who says,

> *Ologies has taught me to look at trees and watch what ants are up to. I spend so much of my time appreciating the smallest of things, which add up to several hours of my week being filled with both peace and excitement.*

Anyway, let's get the hell right into this: Disease Ecology. Ecology, as we know from the last few episodes, means 'dwelling'. That's the root of it. Where something lives. Now, 'disease' is ol' French for a 'lack of ease'. So simple. Dis-ease. So a Dis-ease Ecologist is like, "Okay, shit that bums us out, where are you? Where are you living?" This is a great companion episode to the acarology one all about ticks; how ticks work, what they want from us, how stabby are their mouths, how do you get them out of you? So if you'd like to not get a tick-borne illness, start there for prevention. That is the base. That's the 101. Amazing episode with Dr. Neeta Pardanani Connally, who has a lab in Connecticut. They know a li'l summin' about ticks.

Also, two quick corrections. Before you douse yourself or your life with permethrins, don't use the stuff directly on the skin unless it's prescribed by a doc. Also check with a vet because liquid permethrins can be toxic to kitties. So ask first about that. Now if you're like, "Is permethrin the name of a dragon in a fantasy franchise?" No. Again, listen to Acarology. You'll get it.

Okay, so this disease ecologist is one of the best. She studies the whereabouts and effects of baddies like Lyme disease, and babesiosis, and other things that like to live in your body without permission. She's an assistant professor at San Francisco State University. She's a research scientist for the Bay Area Lyme Disease Foundation and a member of the California Department of Public Health Tick Working Group. She runs her own lab at SFSU dedicated to research on these very topics. She hopped in a sound booth at 826 Valencia in San Francisco and we chatted about how

many times she's been tick bit, what to do if you find one that's been on you, how animal populations carry Lyme and other diseases, why opossums and western fence lizards are our friends, and what scares her the most about ticks. So button up your cosmic lab coats and take a microgander at Disease Ecologist Dr. Andrea Swei.

Alie Ward: So tell me what you study. Tell me what your work entails. This is so exciting.

Dr. Andrea Swei: Yeah, so my work is really… if I were to summarize it, it's trying to understand diseases and how they're transmitted, and how ecological factors, environment and vertebrate communities, sort of natural communities, might influence how they're transmitted and where they are. Many of the diseases that I work on happen to be zoonotic. So that means that they're pathogens that are naturally maintained in wildlife and in wild situations and can also cross over to humans and cause disease in humans. And so zoonotic diseases are a huge part of the burden of infectious diseases that we see in the world, and many of the diseases that we're facing that seem to be new or seem to be emerging, actually come from wildlife reservoirs.

Alie: A lot of the diseases that we're seeing that are tick-borne, those have existed in populations in animals and wildlife well before?

Andrea: That's right. Yeah. I mean, nothing is really new in the sense of, you know, spontaneously generating. We're starting to see some of those with antibiotic resistance and new genetic strains, but many of the pathogens that we talk about as being new, they're really just new to us, or new in terms of causing harm in human populations.

Alie: Now, tell me a little bit about when you decided to be a biologist, or when you were like, "Mmm, this is my deal. This is what I'm going to do."

Andrea: Yeah. I've been sort of reflecting on that a little bit recently after listening to a few of your shows and I think it happened pretty early on. I've always really been interested in science. I remember getting my first microscope when I was 11 or so, and I wanted to put everything under the microscope. And I totally got shamed once because someone caught me putting a scab under the microscope. [*laughs*] I really wanted to see what that scab looked like. And then after that, I started doing it more in secret with the things I looked at under the microscope.

It wasn't until I got to college that I took a class and I realized that I really was interested in understanding animal populations, and how understanding their populations has all of this relevance for human wellbeing and our way of life. So I began to be interested in field ecology, so I started taking classes that took me into the field all over the place. I started learning how to do things like trap mammals. And that was really, I think, maybe the moment when I realized that this is really cool. I could go out there and set out a little trap, bait it with oats and peanut butter, and then come back the next morning and there would be, like, a little surprise present inside. And you didn't know what it was until you opened it up. ["*Hey, fancy meeting you here."*]

So I got a lot of experience working with small mammal population genetics, and because I knew how to trap small mammals… I somehow learned about a field assistant position in upstate New York on a Lyme disease project. And so that's how I got into studying Lyme disease. So I really got into it for the cute, fuzzy mammals and then I stayed for the tick-borne diseases.

Alie: That's a common marketing ploy, you know. "Come for the animals, stay for the diseases."

Andrea: Yes. Yeah.

Aside: So Andrea got her Bachelor's and PhD in Integrative Biology at UC Berkeley and her doctoral dissertation was on the ecology of Lyme disease. But I just… I have a lingering question.

Alie: I have a question. Did you ever eat any of the oats and peanut butter balls? Because that sounds really good.

Andrea: You know, I never did, even though it smelled good. We mix it in these big vats, and it's just not appetizing. Although, my students do make jokes about how as starving grad students, they can dip into it if they really needed to.

Alie: Sounds good. It sounds like cookie dough, but I guess in a five-gallon, Home Depot bucket mixed with, like, a stick, it's a little different.

Andrea: Yeah, exactly. It's really about setting the mood for eating, and that's not it. [*frufru female voice, "I'm really not very hungry."*]

Alie: And so you were working in upstate New York, and how long ago was this, and how has the prevalence of Lyme disease or the way we study it changed since then?

Andrea: So this was about 20 years ago that I got this first experience working with Lyme disease, and I'd say that a lot of what we do in terms of collecting the data in the field, a lot of that has sort of stayed the same. You know, we go out and we trap these mammals. We look at how many ticks they have on them. We can test their tissues for infection prevalence. I would say in the lab is where things have changed, where we have much more sensitive techniques, much more specific techniques to detect pathogens. So for a long time, what we do is we would look for the bacteria under darkfield microscopy. You can see them swimming around.

Aside: Darkfield microscopy side note is when the background of the object you're looking at is dark. So the background is dark. It's good for spying on things that you can't stain or that are transparent and don't absorb a lot of light. So it's kinda like photographing your evening look if you were a Lyme spirochete. And no offense, but I would hate you.

Andrea: They're pretty distinctive. You know that you have a spirochete. But we didn't necessarily know what species of a spirochete we had. Now we're realizing that there's all of this diversity by using much more specific sequencing methods. And now of course, we can look for not only the spirochete, but other microbes, and other bacteria, viruses that are also coexisting in this tick milieu. We can kind of look at that whole community within a tick as well.

Aside: Okay so let's direct our gaze and we'll zoom in on Lyme under the scope.

Alie: And when you talk about Lyme disease and being a spirochete, can you kind of explain what that looks like? If you're looking at a drop of blood, is it hard to come by the spirochete or is it just lousy with spirochetes? Is it just a spirochete party in there?

Andrea: Yeah, that's a really good question. So it turns out there are a lot of different spirochetes and some of them hang out in the blood. These tend to be a relapsing fever *Borrelia*, and these are things like *Borrelia miyamotoi* or *Borrelia coriaceae*. These are different types of

spirochetes. The one that causes Lyme disease and related ones, they actually don't hang out in the blood for very long.

Aside: Aah. What? Really? This totally surprised me, and to be honest, ticked me off a little bit. I said it.

Andrea: They pass through the blood really briefly. Actually, detecting them and blood is not the best way to pick up Lyme disease infection prevalence. For that we actually go for tissues. So we'll try and get some ear tissue, or if you have a whole animal you can go for some other organ. That's where the *Borrelia burgdorferi*, the pathogen that causes Lyme disease, that's where it will migrate to eventually and sort of hang out. In the blood, it depends on what kind of *Borrelia* you're talking about. But if you do see one, what it looks like is just a little squiggle and they kind of vibrate. [*"I feel like I'm vibrating."*]

One nice thing about the semester being over is I actually get back into the field and back into the lab. And so earlier this week I was culturing some bacteria and it was so nice to sort of see, again under the microscope. I still love looking under microscopes, so that was really fun. And when you see the spirochetes, they kind of vibrate in the culture, in the liquid culture that we grow them in. They kind of look… I was putting a talk together recently and I made a little pun about a twist of Lyme, which I was very pleased with. And then I realized that it kind of does… they do almost look like a twist of Lyme, you know, when it kind of curls around. So that's sort of what they look like. And they move. So they can… they use their whole body to sort of corkscrew through things and that's how they can tunnel into tissues.

Alie: That's such a brilliant and wonderful visual pun. You get, like, 20 dad joke points for that. That's amazing. Before we dive more into Lyme, can you give me kind of just an overview of some tick-borne diseases that people might be a little bit worried about? I know in the tick episode, I focused a lot on the US, but I've heard from Australian friends that there's a tick paralysis. What are some of the baddies out there?

Andrea: Well, I mean certainly Lyme disease is the most prevalent one that most people will know about. There are actually several different species of *Borrelia* that cause Lyme disease. In North America, we have *Borrelia burgdorferi*. In Europe, there are other species like *Borrelia afzelii* and *Borrelia garinii*. They all cause what's called, collectively, Lyme borreliosis.

Aside: So there can be different species of *Borrelia* that are transmitted by ticks and cause Lyme disease. Of the 52 identified species of *Borrelia*, 21 are known to cause Lyme disease or borreliosis. Now, if you look up a Lyme spirochete, they're kinda like curly little worm-looking bacteria or bits of those little paper streamers that spring forth from a New Year's popper. You know those things that go "POP" and you go "Ah!"? Those, but they're alive and they live in your body. So 'a twist of Lyme' is brilliant.

Oh and that Australian paralysis tick, they tend to be on the eastern coastline of Australia, and it's not a pathogen that does the paralysis-ing, but a neurotoxin in their saliva. It can cause paralysis and respiratory failure, even death. So what is our motto? [*bullhorn*, *"Check your crevices."*] Now let's zoom out a little bit and back to some other diseases.

Andrea: Then in terms of other pathogens, I think one of the scariest ones to me is Powassan virus, which is a virus obviously. But what's really scary about it is, it can get transmitted really quickly after a tick attaches. Within minutes, maybe 15 minutes or so, it can be transmitted and it's fatal. That sort of cushion of time that we have with detecting a tick

for Lyme disease prevention, we don't actually have that for Powassan virus. ["*That sucks."*] Luckily, it's not very common.

Alie: What's the range of that?

Andrea: It's mostly in the northeast, and a little bit in the Midwest, I believe, but it's pretty limited in distribution.

Aside: I looked into Powassan disease, named for an unfortunate city in Ontario, Canada. The tourist board of which is probably not stoked because this viral disease: not a good one. So some folks won't have any signs, but if you're infected, symptoms could include fever, headache, vomiting, weakness, confusion, a loss of coordination, trouble speaking, memory loss, and encephalitis, which is swelling of the brain. Just the last month, two folks from Hampton, New Jersey have come down with Powassan virus from a tick bite, and one, 80-year old Armand Desormeaux, did not survive. Only 33 people were diagnosed with it in the US last year, so it's very rare, but it can be fatal. So check yourself before a tick wrecks yourself.

Andrea: Other diseases that are emerging are babesiosis, which is caused by a parasite, actually. It's a protozoan parasite. It's apicomplexan, so it's related to malaria. So ticks can harbor all these different kinds of pathogens, really diverse and varied. And babesiosis can be caused by *Babesia microti* in the east coast. More recently we've been doing some work on the babesiosis in the west coast. It turns out that it's caused by a different parasite that's called *Babesia duncani* that has a really different life history, different tick associations, different seasonality.

Aside: *Babesia* is not the same as *Borrelia*. I know, I know, they sound like the names of twin Ukrainian princesses, but *Babesia* is a round little protozoan parasite. It lives in red blood cells, and it gives you symptoms like malaria. Sometimes anti-malarial drugs are used in treatment. Now our other enemy, *Borrelia*, is that twist-of-lime spirochete. So *Babesia*: round, lives in the blood cells. *Borrelia*: spiral and it goes honky-tonkin'. It could be anywhere in your body. It's hard to find. So guess what? They both suck, and they both come from a tick. So thanks, you tiny thirsty little assholes.

Andrea: One of the things in my work that I'm really interested in exploring is how these ecological changes can lead to differences in how a pathogen is transmitted and what that means for disease control and public health awareness. Because these different ticks have different affinities for biting different people and then they can affect different populations. So you need to know what the vector is. You need to know where it's found.

There's so many different tick species. One tick species might transmit one pathogen and another one might transmit another one. But a lot of people don't really recognize that there are multiple tick species and that there are very specific host associations. And so, you know, sort of getting the word out on that is one of my research goals.

Alie: I'm sure there are people wondering who is at more risk? Do they really prefer particular people? Like if you have more sugar in your blood or you're more caffeinated? Or redheads, for example. Fake redheads, are they at greater risk? [*laughs*] For instance.

Andrea: [*laughs*] Yeah, I mean, there are definitely personal differences between people. I personally do not… I don't seem to be very liked by ticks in terms of a blood meal. I've had very few ticks attached to me. And you know, despite working in tick-borne diseases for over 20 years, I think I've maybe had two ticks attached to me ["*Only two."*] in that whole time. Last year we actually tried to… I tried to get a tick to bite me for a video segment

that this other program was putting on and it wouldn't. It refused to bite me. ["*Nah, dude."*] It actually… I saw it as it rolled itself off of my arm. So, I think maybe a common theme is that people that work on these things are not necessarily the most prone to getting lots of tick bites. Maybe just out of selection. There's these sorts of occupational hazards.

I know that I am not preferred by ticks, and I know that other people, if they come into the field with me for an hour, they will get a tick bite. So there are definitely those preferences, but I don't know if anyone really understands what's driving that, what are the mechanisms behind that. Ticks also have preferences for different host species as well, in the field. So we know that… Like in California, we have this amazing tick host that's a western fence lizard. Those are the blue-bellied lizards that you often see. Bright blue bellies, really ubiquitous in California. The western black-legged tick that we have here really loves that host.

Aside: Ugh. Okay, I hate how cute this next part is. Thinking of ticks being like, "Whoopdeedoo. What do I want?"

Andrea: Someone actually did an experiment where they gave them a little bunch of tunnels to different hosts. One of them had a lizard, one of them had a mouse, and one of them had a bird. Most of the ticks went for the lizard. So they are picking up on pheromones, or chemicals, or something, but it's really a little bit unclear what that is specifically.

Alie: And now that species of lizard has something in its blood that interacts with the Lyme spirochete? What is happening there?

Andrea: Yeah. So that is another reason why that host is so important. In its blood, as part of the immune system, it has proteins that will actually kill the Lyme disease bacteria. And so if a tick is infected with Lyme disease, with the pathogen, and it bites a lizard, that lizard's blood, the immune system of the lizard, will kill the bacteria in the tick. And those ticks will all drop off uninfected. [*clip from When Harry Met Sally: "I'll have what she's having."*] Yeah, it's an amazing interaction that we have here in California.

Alie: I understand also that opossums are big tick eaters. Do they get bitten by ticks a lot, or do they just do the biting of the ticks?

Andrea: Yeah, so I think what they do is, the ticks will bite them and then they'll end up biting them off and eating them. And many of them don't survive.

Alie: God, I need more opossums and more western fence lizards. I don't want the opossum to eat the lizard though. Just leave them alone. When it comes to Lyme disease, can you explain what is happening with it? What does it do? How does it infect us?

Andrea: Yeah. So, when a tick is out looking for a blood meal… You know, these ticks, the eastern tick, and the western black-legged tick in California, they are sort of related species and they have really similar morphology and general life-history traits. But in California, they have a three-year life cycle. So they go from a larval stage, which is the smallest, tiniest stage, to the nymphal stage, to the adult stage.

Aside: PS, side note. Tick larvae have six legs and then they molt and the nymphs have eight legs. They eat, they molt, the nymphs have eight. So eggs, then larvae with six legs. And nymphs and up have eight legs. Just in case you're squint-counting at one under a microscope.

Andrea: And each of those life stages takes a single blood meal. So they will find a host and attach to it, stay on for three to seven days, take a big blood meal, and then drop off until they molt into the next stage. Each of those blood meals is an opportunity for that tick to pick up the Lyme disease bacteria. Fortunately, there's no vertical transmission of the bacteria, so an adult female that is infected does not transmit that pathogen to her offspring, to her copious, you know, thousands of larvae that she lays in these eggs. So, fortunately, the smallest stage of these ticks, which are really, really tiny... I mean if you think a poppy seed is small, these are about a tenth the size of that, and they are sometimes transparent, so they're incredibly hard to see.

Aside: Those larval ticks have six legs, once again, and they're like tiny, tiny little ghosts, and sometimes they're called seed ticks. I have heard ghoulish reports of walking through a tick bomb containing *thousands* of these newly hatched nightmares. But they tend not to have diseases because they've not fed yet. But their first meal is where they can pick things up. Just like licking doorknobs. So carry duct tape and pick them off you thusly. You can just kinda wax a bunch of baby seed ticks off of your body and clothes. Isn't that disgusting? But it works. And then throw all your clothes in the dryer on high when you get home. Take a shower. Maybe douse yourself in holy water. Take a priest to Raging Waters and be like "Father, bless this mess." Also, do a crevice check. But don't worry too much about the larval ones, Andrea says.

Andrea: Fortunately, they are not infected when they hatch out of their eggs. They can only get infected when they take their first blood meal from an infected host. So, first they have to find a host, and then if it's uninfected then they remain uninfected. If it is infected, then that's when they can pick it up. And so it's that next stage, that nymphal stage where they can first transmit the pathogen. A lot of my work is really looking at, where are these larval ticks taking their blood meal? What is available to them in their community, and what are their infection prevalences? How good are they at transmitting the pathogen? Because at that nymphal stage, it's still pretty small, but if it bites you… that nymphal stage transmits most of the Lyme disease cases in the United States.

Aside: So remember, eggs and then a six-legged larval seed tick that drinks animal blood like a horror villain and gets infected with a disease, molting to become a tiny, tiny poppy seed disease-infected, eight-legged nymph. Then they latch on to your sacred butt crack where it can spread infection before molting into an adult, which can also spread infection.

Andrea: And so when that tick attaches to you, it has to prepare itself. It takes a while, about 36 hours or so before anything really gets injected into you. At that point is when you start to get the bacteria getting injected into you as it salivates into you. Then the bacteria, as I said, it only stays in that local area near the tick bite for a very short time. It quickly disseminates through the blood, through the tissues, all over the body. And so that's why Lyme disease is so hard to diagnose. We don't really know where to best look for it. Blood draws, which are the most common ways to detect a lot of other pathogens, don't really work for Lyme disease.

Aside: Just feel free to let out a collective frustrated [*drawn out*] groan or scream like a Klingon grieving a howl into the sky. I know I did. Now remember, over 300,000 new cases of Lyme a year in the US and a lot of people might be getting the wrong tests. Also side note, I would like to take this opportunity to say I had a weird, low-grade anxiety attack writing and researching this episode because Lyme disease is such a

controversial topic. Some people might not know that. I know eight people who have had Lyme disease and each of them struggled not only with a bunch of physical issues like joint pains, and fatigue, and headache, and autoimmune issues, and brain fog, but also had to deal with this weird, emotional maze of some people or some doctors not believing that they were still struggling with Lyme symptoms after treatment. This is known as the Lyme Wars.

Now, in terms of chronic Lyme disease, the CDC does not recognize chronic Lyme disease as a thing. Symptoms could linger for years, and some doctors do acknowledge post-treatment Lyme disorder. Around 10% of patients who get Lyme disease and are treated for a few weeks with antibiotics won't fully recover. These patients might ask for longer courses of antibiotics or have to follow certain anti-inflammatory dietary protocol. They might try supplements or other ways to try to fight this spirochete, which some research suggests can hide in a little cloak called the biofilm, so it's hard to kill. Chronic Lyme disease, poo-pooed by many.

Some doctors acknowledge post-treatment Lyme disorder, but there's still a lot of flimflam out there. There's a lot of skepticism. There's also a lot of people who are just still suffering from symptoms of Lyme disease and people don't know why. I read a blog post from a doctor at Harvard who said it reminds him of the first stages of HIV and AIDS when there were a lot of rumors and not a lot of research, and a lot of patients were getting blown off by doctors. So, more research. In hindsight, we'll probably look back and think, "Wow, what a big, murky mess." But the first step to any of this is getting a diagnosis, which Andrea said that blood draws don't really work that well for Lyme disease detection.

Alie: What does work? I mean, I know it seems like so many people are frustrated by, maybe, feeling like they have Lyme disease, but their tests show they're fine. So what is medical science doing to address that?

Andrea: Serology is one way that you can detect things without detecting the thing, right? You're detecting the signal, the immune response to the pathogen that you're interested in. The problem with serology, it's not very specific and so you often get cross reactivity. You'll get things that will have the same signal. So it's really hard to say for sure whether or not the serological signal matches the pathogen that you want to definitively diagnose.

Aside: Oh heeey, Serologists. Holler at your Dad.

Andrea: That's why it takes so many markers of these serological approaches to be able to say, "This is definitely a Lyme Disease case." This is what led to the CDC two-tiered testing to make sure that you are not picking up false positives. There are approaches now that people are trying to develop to be more specific and more sensitive. One possibility is maybe looking at the host's immune response. We can look at gene expression in different individuals and it's becoming cheaper and cheaper to do that. So, one way might be to look at what genes are up-regulated in an individual who has had an acute infection with Lyme disease, or maybe a longer-term infection with Lyme disease.

So, there are other methods and maybe other secreted proteins that might also be picked up by some more sensitive tests. There are people that are working on better diagnosis, but it is a really difficult problem. It's something that… it just really has to do with the way that the bacteria behaves in our bodies. It doesn't stay in one place for us to pick up really easily.

Aside: I looked up what these gene expression tests are all about. A 2016 study published by SF University and Johns Hopkins University showed that in people infected with *Borrelia*, remember it causes Lyme, there's a unique gene expression pattern in their white blood cells, so certain genes turn on or off when infected with Lyme, and that continues even after their antibiotic treatment. More of that gene expression testing might be on the horizon. Or... Or you could just ask a witch to turn you into a rat today.

Alie: Why can't they use the same type of tissue tests that you would use on, say, a mouse in the field on just a hooman being? Could you use the same kind of thing? Like, "I'll send you a piece of my ear?"

Andrea: Actually, I don't know. We know that when we take a little bit of the mouse ear that we are not necessarily catching every single case, right? It's kind of a sample. So, our objective isn't necessarily to diagnose every single mouse. We're trying to get kind of a population-level average. The objectives are a little bit different, but I do think that probably tissue biopsies would be more effective than blood draws, but it's really hard to convince people to undergo a tissue biopsy. I don't think it's practical, and so it hasn't really been discussed as a potential way forward. But certainly, if at the site of the tick bite, if you get it early enough, a tissue biopsy would… you would get the bacteria there.

Alie: They should just offer free ear piercings with every test. That way at least you walk away with a new piercing, tiny bit of tissue. I'm sure that'd work fine.

Aside: Sidenote: I just looked up how much gauging your ears costs. It can be like 75 bucks a pop. But Lyme disease tests can be in the hundreds, depending on your insurance. Now, they usually start with an enzyme-linked immunosorbent assay or an ELISA test. Those look for antibodies. And then something called a western blot test can confirm, but according to some research, those are only about 50% accurate.

Now, some folks who have been diagnosed with Lyme say that the immunoblot IGeneX tests are more effective at detecting it, but ask your own doctors if this is something you suspect that you have. Again, this is just a podcast. I'm not your doctor. I'm sorry.

In researching this, I stumbled across such a dark Go Fund Me blog post from the company just subtly suggesting "the best ways to crowdfund for Lyme treatment" since most insurance companies don't cover much beyond that first round of antibiotics for an initial diagnosis. So, good to know help is out there in the form of… suggestions on how to crowdfund your medical treatment here in America.

Alie: And so what exactly is Lyme doing in the body? Is it causing a lot of inflammation? Is it affecting neurological function? Joints? Where is it hanging out?

Andrea: Yeah, I mean pretty much all those things you just mentioned. It will go, it'll sort of embed itself into joints, into muscular tissue, in neurological tissue, and cause inflammation. A lot of what we think some of the, maybe, longer-term symptoms might be, or it might just actually be the immune response responding to that infection of trying to fight it. So, up-regulated cytokine inflammation leads to a lot of the swelling and pain that people associate as well.

Aside: So the body's immune system kinda freaks out and chemical messengers named cytokines might kinda still be ringing the ol' fire alarm, which triggers inflammation, which can cause arthritis-like symptoms. Now, some folks with post-treatment Lyme seem to feel better on anti-inflammatory diets, skipping ingredients like gluten or sugar. If someone doesn't have technically Celiac disease, which in itself is a

serious and huge bummer, but someone's eating gluten-free or sugar-free anyway, just give people a break. People know their own bodies best. Let them eat or not eat what they don't want to eat or not eat. Anyway, autoimmune disease and inflammation to be discussed in a future rheumatology and/or immunology episode.

Alie: Is that how maybe it could be linked to autoimmune disease because your body's immune system just freaks out?

Andrea: There are some similarities to how some people respond to a Lyme infection and some autoimmune diseases. It does seem like it may have some sort of long-lasting immune consequences that, maybe even after the pathogen has gone, it might still be that the immune system is sort of over-sensitized.

Alie: Do you ever have to get involved with the debate between late-stage Lyme and chronic Lyme? Do you kind of stay apart from that medical controversy, or do you have to weigh in at all?

Andrea: Well, I actually did a short postdoc where I studied that issue. We were really trying to look for some of these gene expression markers in people with this late-stage Lyme disease. We didn't really find a really clear signal there. So I have worked a little bit on it, and it's really complicated. I know there are good people that are trying to come up with better diagnostic tools and people that are trying to work on vaccines and on all these different things.

The bulk of my work is really on the ecology. And so, one thing I always say is that if you have a tick, if you pulled the tick off of you, we can test that tick and be fairly certain whether or not it's infected or not. It's much easier to do that than to try to query an entire human body and not really knowing whether or not we're picking up the pathogen or not. But if you give us a tick, we'll crush the whole darn thing up [*"Exactly! See. I'm crushin' it!"*] and we can look for the pathogen in the tick. We can't really do that with humans. We can do that with a tick. A lot of my work is really focused on the tick because we can learn so much from it. Our diagnostic tests and tools are much more effective when you have a tick.

Alie: If people pick a tick off and they've put it in a freezer bag, you know, like a little Ziplock. Are there labs that would be like, "Send me your ticks," or is that pretty hard to come by?

Andrea: They are actually increasing numbers of labs that will do that, where you can send them your ticks. I know Bay Area Lyme Foundation does that. Tick Encounter might also do that. I just heard about another organization that'll take your pets' ticks as well. They don't necessarily test them all, and you may not necessarily get a test result as a result right away. But I know there are a lot of agencies that are trying to use this method to surveil tick-borne pathogens much more broadly and comprehensively by having people send in their ticks.

Aside: I looked this up and the TickEncounter.org site, remember that was the non-profit that Acarologist Dr. Neeta Pardanani Connally chose, they have great resources. That's TickEncounter.org. And they pointed to TickReport.com, which has instructions on how to send in a tick for testing. It costs fifty bucks per tick, but it includes *Borrelia*, which is the spirochete, the Lyme-causing one, and *Babesia*, which is that round, malaria-like protozoan. Also in that same test, it includes Powassan and Rocky Mountain spotted fever, a whole host of things. And results can come back in 72 hours. That's TickReport.com. They have info on how to send in your non-alive ticks that you have

plucked off of your or a loved one's body. [*clip from Monty Python's Holy Grail: "Bring out your dead."*] … ticks, that is. They also send a micrograph of it in case you just want to look at it up close. Maybe print out a picture and have it framed. Make a dartboard.

Now, what about distribution of tick-borne diseases? As a disease ecologist, Andrea fundamentally studies where these bad feeling-causing things dwell.

Alie: One thing that I found so fascinating looking at your research is the percentage of ticks that are infected with Lyme, even on the west coast. It seems like a big myth is that Lyme is only in the northeast and chances are there's no way you could get it in California. But do you do a lot of fieldwork like in Tilden and in the areas around San Francisco?

Andrea: Yeah, I do. Most of my field sites are from northern California. Actually, the hotbed of Lyme disease on the west coast is from about, I would say, around San Francisco, up north into Mendocino County along the coast. They need certain conditions. They need it to be moist. They need certain habitats. They need to have all of these different hosts required to complete their life cycle. And so there's really a kind of a narrow range where they can be found. But in California, that range is sort of the entire coastal region of California north of, I'd say, Santa Cruz or so. After that, lower down south it becomes much too dry for them, although you do still see them. And I do have some projects down south, so I don't want to say that it's not there. But the majority of tick abundance, the highest tick densities, are along those northern areas. Also, infection prevalence can reach 20-25% in certain areas. So, pretty high prevalences.

Aside: 25%! Ughhhh. There's so much groaning in this episode, but I feel like it's warranted.

Andrea: I think one of the things that distinguishes how the west coast is different from the east coast isn't just the ecology, it's also the way that humans interact with their environment. I think on the east coast, a lot of people live in the woods. You know, they have these houses that are surrounded by secondary forest that has been known to come back with lots of the hosts that are responsible for maintaining tick populations. In California, we have a lot more, sort of, primary growth forest that hasn't been cut down before. And we have a lot of logged areas too as well.

The way people come into contact with ticks, it tends to not be around the home as much. You know, most people live in more dense urban areas. And so to encounter a tick, it kind of means you're camping, or you're biking, or you're going on a hike or something. A lot of the work that I'm doing is looking at how habitat fragmentation size influences things like tick abundance and also the community composition of the vertebrate hosts that are involved in tick ecology. And so some of the bigger sites are where we have more diverse rodent communities and where we also have top predators.

So, we actually have a lot of relatively intact, food webs on the west coast where we have sites with pumas still wandering around. And so those help to control the deer populations. And this is something that they don't have on the east coast. I think a lot of these ecological differences also are shaping the differences that we see in Lyme disease ecology in California.

Aside: I was gonna put in a really bitchy "West coast Best coast" clip here, but honestly, all coasts and areas inland are lovely. You really don't need to heighten these Lyme wars with any regional rivalries. We may have ticks crawling around our crotches

giving us diseases. We don't need any more drama today. I love you all. Please check your bodily crevices.

Alie: I've seen some people argue that doing more deer hunting would actually help control the deer population and it's kind of better ecologically than maybe eating factory-farmed meat. As a disease ecologist, do you see too high a deer population as kind of a consistent problem or is that a myth?

Andrea: Certainly on the east coast, the deer populations are really unchecked, right? There isn't that much hunting, and there are no top predators that are keeping those populations down. So, deer are an important part of that equation, I think. Here in California, the deer populations are a little bit more stable. They have predation. I don't know if hunting is more or less common here, but I certainly think that especially in areas where you don't have natural predators of deer, hunting might actually help stabilize those populations.

Alie: Right. And I know different wildlife ecologists advocate for that, and I'm sure some others disagree with it, but it does seem if we've killed off a lot of the wolves and the pumas in some areas, that everything could kind of get out of whack a little bit.

Aside: Okay, quick side note. I just read an article that addressed Connecticut deer populations. Although they are reaching lower, healthier levels due to some yearly hunts, one guy Stefano Zandri, who's a chairman of a deer management implementation committee, says that winter flyover counts, like a census of deer, averaged 42 deer per square mile in some parts of Connecticut. Some ecologists want to see it closer to 20.

I also started getting lost looking at statistics and figures of roadkill incidents with deer before these town hunts were started. About an equal number of deer died from being hit by cars as do now from hunting, but now the roadkill deaths have plummeted. About as many deer die with fewer accidents, and more deer used for food. I'm very much not a person who loves to think about animals being slaughtered, but ecologically I see the pro-Connecticut deer hunting point. I'm so sorry, deer!

Alie: Speaking of meat, what about this lone star tick meat allergy situation? What is happening?

Andrea: That is a really interesting thing. That isn't a pathogen. That is just the saliva of the tick. [*"Wait, what*?"] The tick doesn't have… it's not transmitting any kind of pathogen. It's just proteins in the tick's saliva that are inducing this allergy. An allergy to alpha-gal, which is a protein that is found in mammals. Basically, it's called a red meat allergy, but it's really a mammal allergy.

Alie: Wow. Did that start recently or are we just hearing about it more?

Andrea: It does seem to be much more common and I don't know why. I don't know if it's because the ticks are becoming more abundant or common. They are a very aggressive tick and they do seem… their populations do seem to be growing, but I don't know. I don't work on that species of ticks, so I don't know if there's good data to support that or not. But certainly the reports of these red meat allergies are becoming more common.

Aside: By the by, I was like, "Lone star ticks, yeah, they got a big white dot on their back. I got it." But I just looked it up and only the adult females do! So TickEncounter.org has you covered on what every stage looks like, and it also says that lone star ticks are very aggressive biters. I hate them also. Ticks, I just fucking do not like you. I tried to

wonder and respect you, but if I had a genie with a lamp, I would be like, "Number one, global warming: Fix. Cancer: Figure it out. Number three: Ticks, fuck off and die.

Anyway, this alpha-gal acquired meat allergy with lone star ticks can cause *serious* reactions from the meat of mammals, from their dairy products, even from gelatin from their hooves, or exposure to wool fibers. It's a huge pain in the ass. About 5,000 people a year in the US get this alpha-gal sensitivity, which is up from 3,500 two years ago. Rising temperatures could be at play. Also, in a sense, just increased awareness?

Alie: I wonder if it's just because we have more Twitter so there's more, like, "My cousin got that." There's just… we hear about it more. Are there any myths about tick-borne diseases that really, as my dad would say, "Fry your legs," which means 'make you mad'?

Andrea: Well, the biggest one for me is that a lot of people think that there is no Lyme disease in California, and as someone who has been studying it for a while, it's definitely here. When my field assistants or our students have an exposure to a tick bite and they go in to see a doctor, a lot of times they just won't consider Lyme disease. We have to tell them, "Look, we have tested the ticks in this habitat. We know that the infection prevalence is 20%, so, you know, give me the prophylactic antibiotics." We do have to push for that sometimes knowing that we are in these risky habitats. A lot of people really don't know about it.

It's definitely not as common or as prevalent as it is on the east coast. There are about a little over a hundred cases a year in California that are not traveled associated, so figuring out which ones are sort of locally acquired. But it is definitely here. And it probably is in certain areas more common than we think.

Aside: So, like having to watch live shows that are actually pre-taped and aired three hours later, the west coast gets east coast feeds just on a little delay. This time, I guess, it's to our benefit. My friends who have been diagnosed with Lyme have mentioned co-infections. I wanted to ask, "what was the deal with that." So I did.

Alie: Do you find that there are a lot of co-infections in ticks? I've heard about that a bit, where maybe someone might not just have Lyme, but they'll have a few different things happening at once.

Andrea: Yeah, that can certainly happen. I think it's more common on the east coast, where *Borrelia burgdorferi*, the Lyme disease pathogen, and *Babesia microti* tend to be co-transmitted more often than you would expect by random chance. So there is some risk of co-infection there, but in California we don't see a lot of co-infection. A lot of the pathogens that we look at are pretty rare on their own, so the chances of seeing them in the same tick vector or in the same host is pretty rare.

Aside: Okay, so co-infections. This is like the two Ukrainian princesses, *Borrelia* and *Babesia*, just hanging out together in your blood. But it's more common on the east coast. Also, I don't know anything about Ukrainian royalty, so I just had to google, "Does the Ukraine have princesses?" I found some history on one named Olga, which does not sound like a tick-borne disease. Then I started looking up gendered Ukrainian baby names to see if any sounded remotely like *Borrelia* or *Babesia*, and literally none of the popular Ukrainian baby names even started with a B! They were like Anastasia, Yelyzaveta, Oleksandra.

I was like "Does Ukrainian even have a B?" Yes, the Ukrainian alphabet *does* have a B. But… shit, it's pronounced like a V. I'm sorry Ukrainians who have been screaming at me while you're driving in your commute. *Babesia* and *Borrelia* would never be Ukrainian

princesses. But at least you know now, they're different diseases from ticks, and one is a Lyme spirochete, *Borrelia*. The other is a round parasite that lives in red blood cells, *Babesia*. Right? Let's just change the subject, okay?

Alie: Can I ask you some Patreon questions from listeners?

Andrea: Yeah, of course.

Alie: Listeners have a bunch of questions.

Aside: So now's the time for your questions submitted through Patreon. Before we get to those, we have some words from sponsors who make it possible to make a donation to a charity of the Ologist's choosing. This episode we donated to two. One being 826 Valencia in San Francisco who hosted Andrea for the recording of this episode. They are a nonprofit organization dedicated to supporting under-resourced students ages six to 18 with creative and expository writing skills. It's a really awesome literacy program. I love them. They also have a storefront at 826 Valencia in the Mission District of San Francisco where you can purchase pirate supplies. Highly recommend. I have several fake mustaches from that establishment.

Another donation went to the Union of Concerned Scientists. Andrea chose them and said they are a wonderful science advocacy organization of nearly 250 scientists, analysts, policy and communication experts. They're dedicated to combating climate change; developing sustainable ways to feed, and power, and transport ourselves; to reduce the existential threat of nuclear war; to fight back when powerful corporations or special interests mislead the public on science; and to ensure solutions to these issues advance racial and economic equality. So, two great donations, Union of Concerned Scientists and 826 Valencia. Now a few words about our sponsors making those donations possible.

[*Ad Break*]

Okay. Back to your questions.

Alie: Ruby Oestreich asks: How close are we to a human vaccine? The dog one is very effective and lifelong ramifications of Lyme disease are awful. So can you tell me a little bit about how the vaccine works and how it works on pets versus humans?

Andrea: This isn't my area of specialty, but from what I understand about the vaccine is that there was a human vaccine that was available and was pretty efficacious. It was taken off the market for a couple of reasons. One was that the sales were not that good. The other one was that there was a class-action lawsuit against the manufacturer. I think subsequent to that, they found that there really was no biological reason why it should have been taken off the market.

Basically what it is, is that it was FDA approved already. And so there are vaccines in development that are basically the same as the previous vaccine. But I don't know of any company that has, sort of, taken that on because of the difficulties that they had previously.

Aside: So the Centers for Disease Control website states grimly, "The Lyme disease vaccine is no longer available. The vaccine manufacturer discontinued production in 2002 citing insufficient consumer demand." I feel, tonally, this is like when someone wants to shit talk someone else so bad but remains diplomatic. Like, "The split is amicable and we request privacy during this time."

You *can* vaccinate your dog, though. According to one study published by the Companion Animal Parasites Council, nearly 6% of five million dogs tested in the US did test positive for Lyme infection. But the Lyme vaccine doesn't protect against other tick-borne infections. One vet, Dr. Betsy Brevitz called the Lyme vaccine "like wearing suspenders when you're already wearing a belt." It's a good backup, but the belt is really tick control. That's what's most important. Do tick checks whenever your pup comes in from outside to potty, or going out on a walk, or just going romping. Ask your vet about good tick-killing agents because that's number one. Same for kitties.

Okay. Back to that hooman vaccine. Is there any hope for us?

Andrea: It's very likely that a vaccine will be developed in the near future because we had a good working vaccine before. There's no biological reason why we don't have one now. I think a lot of it is more financial and political.

Alie: Yeah. Oh, that's a bummer. I'm like, "Get that recipe down. Let's remake that." I would have that in a second. Sav Cheri says: I live in Germany where tick-borne encephalitis has had an outbreak and there's apparently no cure. And their husband, a doctor, says that the tick has to be on you for two days before you can get any diseases from it. Heard anything about it?

Andrea: I don't know as much about the transmission of tick-borne encephalitis, but if it's anything like Lyme disease, it does take a couple days for pathogens, at least the bacteria pathogens, to be transmitted because the tick just takes a while to have the pathogen move from the midgut to the salivary glands and sort of settle in for that blood meal. I'm not exactly sure how long it takes for tick-borne encephalitis, which I know is a big problem in Europe. And it's transmitted by the same tick that transmits Lyme disease there.

Alie: Oh, really? Okay. That's interesting.

Aside: So tick-borne encephalitis (or TBE by the way), can be what's called biphasic. It first presents with either no symptoms or about a week of vague symptoms like fever and fatigue, maybe muscle aches, headache, kinda barfiness, like a flu. And then things calm down. You feel better for a week. You're like, "Look at me! I sprung back!"

Then the second phase hits, and that's neurological. It can involve meningitis, brain swelling, paralysis, with a death rate of up to 2%. There is a vaccine though, so folks in riskier areas for TBE like central and eastern Europe, northern Asia, at least you're as protected as our dogs are from Lyme in America. So that's a plus.

Back to Lyme and pets. There were more questions about this from Brynn Speer, Hannah Lease, Trisha, Emmy Bee, Marghie Seymour, Sarah Paterson, Annie Burwell, and Isabelle B Holper.

Alie: A few different people kinda wanted to know if the symptoms in pets are similar to what humans get?

Andrea: I'm not exactly sure. I do know that dogs can get arthritis and joint pain. But I would imagine that a bullseye rash might be a little bit more difficult to detect in a pet. I would imagine that a lot of the symptoms, the acute symptoms would be pretty similar.

Aside: Okay, now what about that rash I have a hard time pronouncing. First-time question-asker Dawn Ewald asks: Why does the rash look like a bullseye? Why do some infected people not develop the bullseye rash?

Andrea: Erythema migrans.

Alie: I knew I was saying that wrong! Why exactly does that happen? Does that happen if a raccoon gets Lyme disease under its fur? Does that have a target logo, bullseye rash?

Andrea: It has to do with the immune response. So, basically there's a local inflammation that happens and it sort of spreads out. I'm not quite sure why the white ring forms, but it has to do with that local… as the immune system is recruited to that local site is what causes that distinctive rash.

Alie: Kristen Long wants to know: This feels like a stupid question, but is it possible to get Lyme disease without a tick bite, or are all cases related to tick exposure? I've heard that maybe mosquitoes can transmit it, but I didn't know if that was flimflam.

Andrea: I haven't heard of any other methods of transmission. It's possible that if you're working with it in the lab, if you have a culture of it, it's plausible that if you get a live culture on your unprotected skin that you could get infected that way because it does start out as a dermatological infection. That's why when we work with it in the lab, we work under Biosafety Level 2 conditions just to minimize the risk of transmission in that particular setting. I think a lot of the other methods of transmission are not really proven.

Aside: PS: I was curious what kind of precautions a Biosafety Level 2 lab had to take because I instantly envisioned just a bunch of scientists in biohazard suits, just talking about their weekend in the break room. But really it just involves lab coats, and gloves, face shields as needed, an eyewash station in the lab, self-closing lockable doors, and some biohazard warning signs. All of which are also just a great way to keep people out of your cubicle. Probably.

But, yes, getting back to it. Other methods of transmissions like mosquitoes, she says, are not really proven. Also, the question all of us want to ask but feel like shitty people.

Alie: Beatrice Rumfoord wants to know: Is it okay to kill ticks because they are disease vectors? Or do they play an important ecological role, and I should just let them live their lives?

Andrea: I say that you should probably kill any tick that you come across. That's totally fine. I mean, the ecological role, I'm sure there are animals that eat them. They probably play a role. They might actually play an important role in, sort of, population regulation in terms of keeping certain populations that are really abundant, if they have high tick burdens, it might actually slow down. So they might play an ecological role. But I would say it's a minimal one if you find a tick and kill it.

Alie: Okay. What's the best way to kill it? Just smush it with a rock?

Andrea: Well, I mean the way we do it as we put them in ethanol. I think if you were at home you could probably put it in scotch or something that you have lying around.

Alie: Maybe not your best scotch. [*laughs*] Put it in some Gilbey's gin from a plastic bottle. Crystal Mendoza has some questions, says: What is up with *Haemaphysalis longicornis*? And how scared should we be? Fully freaking out about it. Is that bad? And she says: Sorry for the multiple questions, but I work in a tick-borne virus lab. So she also does tick-borne work. So how scared should we be with *Haemaphysalis longicornis*?

Andrea: So, *Haemaphysalis longicornis*…

Aside: [*slow, drawn out, "Haemaphysalis longicornis.*] Aka: the longhorned tick.

Andrea: … is an invasive tick that was just picked up recently on the east coast. It's sort of spreading. I have to say it's a little concerning. It's spreading pretty rapidly.

Control… I know a lot of people that are working on this species and it's really hard to control tick populations. It's really difficult to do that because they just… they're not even like mosquitoes where you can go after the water body breeding sites or anything like that. They're just all over the environment.

This particular species can actually undergo parthenogenesis, so it can clone itself. It doesn't even need a male tick to complete its life cycle. I don't know if that means that it can reproduce faster or not, but it probably does because I think one of the limiting factors for other ticks is that they have to meet each other on a host, like a deer. That's, that's sort of the tick hookup spot. The males will hang out there and wait for the females. [*"Uh will go you out with me? Huh? Please."*]

The males aren't there for the blood meal because they don't take a blood meal. They just are there for the females, and they'll breed on the host. So for this invasive tick species, they don't need that. Potentially, their populations could expand at a much higher rate. So I'm a little concerned, and I'm not someone that sort of goes to that emotion very quickly. It's a little bit scary that it's here now, and it's spreading, and we don't know how to control it.

Alie: Yikes. What's the scariest disease that might have?

Andrea: I know it carries a disease in Asia where it's from, but I don't think that pathogen has been picked up here yet. I can't remember the name.

Aside: Okay so this longhorned tick can spread, according to my friend wickaperdia, Lyme spirochetes, spotted fever, *Ehrlichia chaffeensis*, Russian spring-summer encephalitis, Powassan virus, Khasan virus, tick-borne encephalitis virus, Japanese spotted fever. But the one I think she was referencing was the not-at-all-catchy-sounding SFTS, or severe fever with thrombocytopenia syndrome, which in northeast and central China has a fatality rate of up to 30%. Thirty percent!

So far, none of the longhorned ticks found in the US have tested positive for these diseases, but the fact that they just showed up and are spreading is freaking people all the way out, to put it scientifically. So, welcome to my shitlist, longhorned tick, you deserve to be here.

Alie: Kristina Meyers says: I live in a rural area, and although folks have kept poultry for various reasons forever, more and more I hear about how great they are at controlling tick populations. So I'm wondering if any one domestic bird species is better than the rest. Like ducks, chickens, guineas, or should we just work on domesticating opossums instead? Which is an idea that I love.

Andrea: I would think that chickens would be pretty good. I think a lot of the tick populations will not be particularly high in a backyard setting because they do need all of those different host species to complete their life cycle. They're not going to be able to… they shouldn't be very abundant in your backyard anyway, but it couldn't hurt to have some chickens. I think they would probably do an okay job, but I haven't heard of that as a control measure. Maybe you could create a little perimeter with chickens.

Alie: Just a chicken patch. Dan Sterrett wants to know: Is it true that ticks can survive in sub-zero temperatures and then when brought back to room temperature, they can continue on with their life as if nothing happened? Sort of like Walt Disney's wish. Okay. Berbye.

Is that true? Can you freeze them? And then they pop back?

Andrea: They can. I mean, for short periods of time. They couldn't do it for very long. They're much more humidity sensitive than they are temperature sensitive, so they can tolerate a wide range of temperatures as long as they have the right humidity. They probably couldn't live in a freezer for very long, but you could probably put them in there for, you know, maybe up to a day, half a day, I don't know, and they might still be alive afterwards, especially the adults. They can be a little hardier. I don't advocate these sort of experiments at home.

Alie: One last Patreon question. Juan Pedro Martinez wants to know: How does the tick affect the deer, and if you eat deer meat can you get Lyme from it?

Andrea: So that's a really good question. We don't really know how and if deer are affected by the pathogen. The evidence of it is that the deer actually are not really good reservoirs. They don't maintain an infection. They may actually fight off the infection, similar to how lizards do that. But there aren't a lot of studies that have really dived into this with deer just because they're kind of hard to work with. The evidence is that they actually are probably not a really important source of infection for the tick population, and probably are able to fight it off.

Alie: Oh, wow.

Aside: So I looked this up, and again, according to the CDC you will not get Lyme disease from eating venison or squirrel meat. [*DJ airhorn*]

Alie: The last two questions that I always ask are: What is one thing that's just the *wooorst* about what you do? Anything?

Andrea: I have a couple of things that really suck. [*Alie laughs*] Probably the worst is poison oak. So, doing fieldwork, the poison oak in California is a big hazard. People can get really sensitive to it. I've had students go to the hospital because of their reaction to it. And that's where the ticks like to be, right underneath that poison oak. Sometimes if we're sampling we have to go through it and you just have to dive in and pray for the best.

The other thing that is really unpleasant is with trapping small mammals. Sometimes predators will find the traps and then they leave us a nice, juicy, dismembered body or something like that. And so that's pretty unpleasant as well.

Alie: Aww. Usually when you're sampling a little rodent, are you able to sample it and let it out, or do you have to take it into the lab with you and it's game over for the little mouse? [*game over digital noise*]

Andrea: Oh, no. Most of the animals we sample in the field, we process them in the field and release them. So we're really interested in sort of how it's maintained in natural populations. This way we can go back year after year. We know, "This is A2591. We caught him last year and he was infected. Is he infected this year?" And so we can look at those long-term population trends with this sort of data.

Alie: Nice. So they're like, "Oh yes, it's peanut butter oats season!" They're like, "I remember this! This is delicious!" They're maybe not the mice that learn super-fast.

Andrea: Yeah, no, they are not trap averse. There are some species that you really have to coax them in. This is why it's really hard to work on western gray squirrels, which are also a potential reservoir, or they are a reservoir of Lyme disease in California. We could not get them into our traps. They just… they stay away. But a lot of the others, the mice and the wood rats, they're happy to spend a night in our little peanut butter hotel. We have no problems coaxing them in.

Alie: Uh, I would stay in that hotel easily if it was just filled with peanut butter oat balls. I'd be like, "Check me in! Pierce my ear. I'm out. See you next year."

And then, what is your favorite thing about what you do, and about science, or about working with tick-borne illnesses?

Andrea: Honestly, all of it. I mean, I just love every aspect of it. And unfortunately, I don't have a lot of time to do it myself these days. And so, you know, when I do have more time, I'm thrilled. I get to go into the field, and I get to work with my students, and catch animals, and bring the ticks back. I love looking at stuff under the microscope still. Whether it's the bacteria or the ticks themselves, we collect thousands of ticks and every single one has to be identified. I get a lot of help from my students who do a lot of that work, but I love to get under the microscope and see what we found. They are really intricate and interesting when you look at them under 900x.

Alie: Do you have a microscope at home too? Just for funsies?

Andrea: I have a really crappy one that's, like, a kid toy one, but I've been toying with the idea of bringing home a better one just because there's lots of fun stuff to see at home, too.

Alie: Yeah, I was thinking, like, there's so many people that have a record player at home for vinyl, which is great, but I feel like if everyone had a microscope at home… It's kind of like unlimited entertainment, you know? Especially if your Netflix is down or something. You can just put anything under there.

Andrea: Oh yeah. I totally agree. In fact, I'm going to bring a microscope home.

Alie: Thank you so much for talking to me over Skype. I turned off the air conditioning in my house because it was too loud, and I'm sorry I'm just melting like a candle and I'm not much to look at, but thank you for being so patient.

Andrea: Of course. This is so fun.

Alie: Say hi to the ticks. And by hi, I mean tell them I hate them.

Andrea: Yeah, I'll put them in ethanol for you.

So maybe treat yourself or a loved one to an affordable microscope. And ask smart people stupid questions, because it just might save your body the trouble of fighting off something nasty, and you the trouble of having to crowdfund medical treatment. Bluh!

More info on Dr. Andrea Swei's work is at SweiLab.com. You can keep up to date with her science badassery on Twitter @SweiLab or @AndeSwei. I'm going to put links to those in the show notes as well as sponsor links and the non-profit links. And more links and info are always up at AlieWard.com/Ologies. It'll be at AlieWard.com/Ologies/DiseaseEcology.

I am on Twitter and Instagram @AlieWard. The show is on both @Ologies. You can say hi. You can tag your merch photos with #OlogiesMerch or artwork at #OlogiesArt. I love to see and repost

them. Merch is available at OlogiesMerch.com. Thank you to sisters Shannon Feltus and Boni Dutch for managing that. Do check out their brand-new podcast *You Are That*. New episodes drop on Mondays. The first episode last week featured melittologist Amanda Shaw, and it was a goddamn delight.

Thank you to Erin Talbert and Hannah Lipow, you wonderful beings, for adminning the Ologies Podcast Facebook group. Thanks to everyone who signed up on Patreon.com/Ologies. Thank you to the very handsome Jarrett Sleeper of Mindjam Media and the podcast *My Good Bad Brain*. He also has a martial arts podcast *Fight Stuff!*. He helps with assistant editing and helped me move last week! Amid a very busy month. You were amazing.

And of course, a huge thanks to editor Steven Ray Morris who hosts *The Purrrcast* about kitties and *See Jurassic Right*, which is about dinos. He stitches us all together each week. Always saves the day. The theme song was written and performed by Nick Thorburn of the band Islands.

And if you listen to the end of the show, you know I tell you a secret. And this week, I realized that when I turn my phone to airplane mode, I get approximately one million percent more work done! So thank you to Jarrett Sleeper for that suggestion. He was like, "Why don't you just turn your phone to airplane mode?" And I was like, "Pfft! That's not going to work." And then I was like, "Oh my god! I got so much done! How is this possible?" I need a brainologist to explain what happens when brain-thoughts are interrupted and why it takes so long to get back on track.

Also, if I'm slow to return anyone's texts, please know it's just because I'm busy getting a chest tattoo that says "Airplane Mode or Die" in very ornate font.

Okay remember, check those crevices, my wonderful friends. And ticks, if you're listening, I respect your very effective life cycles, your thousands of children in one go. I think your knife mouths are amazing. Your thirst for horror is just so edgy. But still, I fucking hate you so much. So leave my bathing suit areas alone. Okay. Have fun out there. Check your crevices.

Berbye.

Transcribed by Deborah Ward

Some links which may be of use:

Listen to the Acarology (TICKS) episode

Follow Dr. Swei on Twitter @Andeswei or @SweiLab

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