Phenology with Dr. Libby Ellwood
Ologies Podcast
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Oh Heeey, it's your ol' Pops, wearing a cardigan, sitting on the porch with a cup of instant coffee, just watching the wind blow! Smellin' the storm a-comin'. It's Alie Ward, back with another episode of *Ologies*, Fall-ogies, if you will, [*ba-dum-TSH!*] because this topic I have talked about on a previous episode, a minisode, last year, the year before, just mentioning that it exists. But this year, we dove face first into a pile of crispy, rustley leaves to bring you a one-on-one interview all about the changing of the seasons. But, before we drift into it, a little business up top.

Thank you to all the patrons on Patreon.com/Ologies for belonging to the backstage club and submitting your questions to the ologists. You too can join for as little as 25 cents an episode if you would like. We could not make the show without you. Thanks to everyone who rates and subscribes to Ologies, it keeps us up there in the science charts with the big giants. Just little ol' us! And especially to those folks who take a few minutes to use their thumbs to write a review for me to lurk on like a creep, and I can just pluck a freshie each week to prove it. Such as, for example, Erin Miranda said:

> *The other day, I was telling my aunt about ticks (acarology), and she said, "Fifty percent of me is like, wow, you're such a cool person. And fifty percent of me is like, wow, you are exceptionally weird." And I think that was the best compliment I have ever received. Thanks, Dad, for teaching me everything I know.*

Erin Miranda, thank you for that. That was lovely. Also, thank you to Terry's child for stealing your mother's phone to write a review, I appreciated it.

Okay. Phenology. The first thing you need to know is that this isn't Ph*r*enology, there's no 'r' in there. No 'r'. Phrenololgy is a weird, racist, antiquated study of human skulls that is pure flimflam. Phenology, however, comes from the word 'phenomenon', which means 'to show' in Greek, and it's the study of the timing of natural events, or the influence of climate on the cyclical natural happenings. So, seasonal business!

An ecologist named Charles Morren first used the term in 1849. Thanks, Chuck! So what better time to get all up in phenology than as the summer turns to fall, colors start warming up, the air cools, squirrels hoard things, the trees in the yard start becoming mustard, and ochre, and russet, and ruby. People stop shaving all manner of body parts, and hot girl summer turns into hot nerd fall. It's a real hashtag. Get into it.

So, I was looking for a good phenologist, and came across a recent special issue of *Applications in Plant Sciences*, and it was titled *Emerging Frontiers in Phenological Research*. And this ologist was a co-editor of the entire issue, and I was like, boy howdy, I bet she knows her phenological shit, man. Obviously, she lives in a thatched masonry cottage in the New England woods. But, lo! No, she's based in Los Angeles?!?! Why? Why!? Can I ask her about it? I can. And I did. So, I toddled over one sunny, hot September afternoon, like last week, to her office at the Page Museum at the La Brea Tar Pits. She met me in the parking lot. We were both in jeans, but only one of us was cool enough to be wearing a Ramones t-shirt, and sneakers, and a museum employee lanyard. Spoiler: that person was not me.

We went down to her office and settled in for a chat covering all things cozy. Like leaves changing color, and crisp autumn skies, cider versus pumpkin spice lattes, migratory bird gossip, how climate

affects flora and fauna, how to make your backyard into a critter-kegger, and the technology making phenology easier, and how you can get involved.

This episode has so many twists and turns, and she is so charming, and funny, and candid, and real, and parts of this episode surprised the hell out of me, and in those parts, there's minimal to no editing. You'll know it when you get there. So, without nattering on, put the kettle on, grab a kerchief, and cozy up to ecologist and seasons-researching phenologist, Dr. Libby Ellwood.

Alie Ward: Are you an East-coaster by birth?

Dr. Libby Ellwood: I am. I'm from Long Island, New York.

Alie: Heard of it.

Libby: Yes, and did my undergrad at the University of Rhode Island. I got a Bachelor of Science in Marine Biology.

Aside: Marine biology? Yes, indeed. So, she then got a master's in teaching at the University of Southern Maine – amazing fall foliage – and got her PhD in biology in Boston. Massachusetts, your foliage also slaps. Now, she had been studying marine biology from a molecular level, and she says what drew her were the big questions, the "how do all these systems fit together?" questions, which led her to study ecosystems terrestrially.

Alie: How did you become a phenologist?

Libby: When I was in grad school and I was reaching out to my advisor, before he was my advisor, I was interested in how climate change was affecting plants and animals, kind of in a big-picture type of way. I was thinking about migrations and just ways of examining how climate change is impacting critters and plants.

Phenology is the study of cyclic events in a plant or animal's life cycle. So, it's everything from when plants flower, to when insects emerge, or when migratory birds arrive. All of those kinds of events that happen usually every year, it can be more than that, but usually on an annual basis. And that is often associated with other variables, like for example when plants flower in the spring it's usually because the temperature has reached a certain temperature, and then it's warm enough for them to bloom. So, we could record that date, and on and on and on. Over the years we can get a lot of information about that.

Alie: Do you have to study a bit of astronomy as well, to understand how the Earth is going around the sun? How much does that play into the basis of your work?

Libby: Not too much. It's a lot of other, more earth-bound variables that we look into, so lots of climate variables, temperature, precipitation, or even things like humidity or soil temperature, things like that, that might impact the organism here and now.

Aside: The Earth's axis is what scientists call 'wonkified'. Just kidding, that's not a term. What I mean is that the Earth's axis is just tilted, so as we cruise around the giant fireball in the sky, one hemisphere gets more direct sunlight (hot girl summer), the other gets less of a sunlight blast, hence, hot nerd fall.

Now, what about sweater weather? Well, Weather.com conducted a poll of over 6,000 people, and that crisp, nippy, grab-a-cardigan weather was on average agreed upon to be [*drumroll*] right at 60°. Sixty degrees? Grab a sweater. Of course, that's the average for the United States. Now, if you live in South Dakota, you likely can get down to 51° before you

consider shoving a hoodie in your bag. But Nevada? You're looking at a dip to 65°, and you're like, "Whooo! It's chilly! Gotta pop on a sweater!"

Alie: Do you think that in terms of phenology and in terms of seasonal changes especially, are fall and spring the ones you pay the most attention to, or is there just as much action happening in the dead of winter and the heat of summer?

Libby: My work was mostly in the New England area, where that is definitely the case, where spring and fall are the big seasons, because things are relatively quiet in the winter, so spring is all of a sudden a big event. It's when the flowers come out, it's when insects emerge, it's when the birds return, all of that kind of stuff. So, that's true for a lot of temperate regions in the northern hemisphere, and oppositely in the southern hemisphere in the fall.

During the summer, a lot of things have settled down. So once the migratory birds have arrived, for example, they're there to breed. They do their thing all summer, they're hanging out, and they will start their southern migration usually in the fall. That's another thing we are on the lookout for. Also that would be when the leaves start to change color, and leaves fall. Then it's pretty quiet for the winter.

Those cyclic events are pretty common, like you said, in the spring and fall. But in other places, like in the desert, or in even here in southern California, those events could be happening at other times of the year, and it could be more dependent on rain, which might come in the winter. Or drought, which might happen later in the summer, or things like this.

Alie: So there's like cacti that are like, "Don't sleep on me! I'm over here. It rained, I'm blooming! I'm noticed right now!"

Now, you're from the East Coast. You live in Los Angeles. You must get this question so much. How do you deal with the lack of seasons that are as dramatic as say, on the eastern seaboard?

Libby: Well, thank you for phrasing it that way, because I feel like at least at first when I moved out here, I really felt the lack of seasons. And any Angelino, would say, "Oh no, we have seasons. Just give it a little while and you'll get it." And still, after four years of being here, I'm going to maintain that the seasons might exist, but they are pretty subtle.

Alie: Very subtle.

Libby: Sometimes you kinda miss 'em, like if we have a dry winter and it doesn't rain that much, it just feels like extended spring or something. So, yes, that did take some getting used to, and I'm still getting used to it.

Alie: Does that drive you crazy at all?

Libby: It does. It absolutely does. Like today, it's the middle of September, and to me it could be July, it could be May, I don't really know what month it is, so I often find myself still kind of confused. I feel like it should be getting onto sweater weather, and it's not quite sweater weather.

Alie: I know! I have an aspirational flannel with me. I'm not gonna put that on! I'm in a tank top! I wore boots today and I'm like, "I should have worn flip flops." Yeah, there's a heat advisory.

So, why are you doing your work here in LA, instead of deep in the woods over a covered bridge in Vermont?

Libby: Well, that covered bridge in Vermont does sound pretty nice. It was the two-body problem that brought me out here. I was a post-doc at the time where it was a position I could do remotely, and my husband got a position out here. So, truth be told, I was a trailing spouse.

Aside: Libby says that her job was flexible, and after that position ended, she started a new one at the La Brea Tar Pits analyzing plant matter and mammal bones un-mucked from the sticky asphalt vats outside, to help understand paleo food webs. So, she can work on seasons even if LA doesn't really have intense seasonal shifts, we'll say.

Alie: Is it weird for you to talk about the weather in a way that is not shallow? Because you talking about the weather is like some deep shit . That's your life. How do you approach people chitchatting about that?

Libby: Oh, I love it. I love weather chitchat. I could weather chitchat all day long. You know when you're the first couple of people on the conference call and you're waiting for the other six people to show up, ["*Heeeyy, it's Tina. Who else is on the call? I – wait- no – you go. No, you go!"*] and it's that awkward small-talk time and they're like, "Oh, how's the weather by you?" I'm like, "Yeah, let's talk about that! Let's go deep on that."

Alie: You're, like, taking data sets. "What temperature did you say, Randy? Okay, 78. Got it, got it."

Libby: Yeah, exactly. "Is that unusually warm or cool for you? Huh. Interesting!"

Alie: What does your work entail? What kind of numbers are you crunching? Are you looking at plants? Are you looking at leaves changing? Are you looking at birds? All of the above?

Libby: Yes to all of that. It is a lot of data crunching, that's really the crux of it. When I'm looking at addressing climate change, for example, which is really at the heart of a lot of this, it's understanding how things were and how things used to be, compared to how they are now. For that we need historic data sets.

We have to kind of be creative about how and where we get those, and that's kind of what brought me to the museum world too, is access to data from 100, 200 or more years ago. Because at museums there are specimens, there are berm specimens, so pressed plants that are housed and maintained at museums, and those are just a wealth of data for understanding what plants were like, for example, 100 or 200 years ago. That's one way of getting the data and the numbers that I need.

Another way is to look into the archives of sometimes museums, but also libraries and special collections, things like that, and that's where you'll find field notes, or journals with people recording their observations of what they saw, when they saw it, and all of that. One of the things that has been really fruitful for me and for the lab that I was a part of in grad school, was the journals from Henry David Thoreau and his musings as he walked around Walden Pond, and he took notes of what flowers were in bloom, what birds he was seeing, and all of that.

Alie: Do you think more people should be journaling, nature journaling?

Libby: Heck yeah!

Alie: And then just give it to a museum! "Here, I saw a daffodil, it was..." whatever, January probably by that point because we're… so screwed.

Do you have any kind of personal affinity toward that kind of journaling and that kind of history? Did you grow up loving natural history?

Libby: In a really casual way I guess, in more of a walk-in-the-woods kind of way than the journaling kind of way and appreciation for taking notes like that. I think a general appreciation for observing the world around me, or just enjoying time outside.

Alie: Getting back to collections and archives, you mentioned, like, a leaf that was pressed. What kind of information are you getting from that? Are you just looking at it? Has it changed color over the years? Do you stick it through a chromata… graph? [*laughing*] Not a word.

Libby: Not so much with the chromatograph – that might be a thing – but it's not something I usually use. What I'm looking at is some kind of evidence of a phenophase. So, is it flowering? Is there some kind of reproductive phase that's represented on the plant? A flower, a fruit, a seed, something that is evident on the plant. Even a twig, for example, could be a phase that this plant was dormant, so this was during the winter, hopefully, probably, in the northern hemisphere. Then maybe later in the spring, that plant would have flowered. Even that kind of information is informative.

Or, if it doesn't have a reproductive structure like a flower or a fruit, and it's just leaves, that too is a phenophase. If it's fully leafed out, that means that it was probably growing and representing the growing season being up and running where that plant was living.

Alie: And usually they'll tag, like, "It was the 13th of March…"

Libby: Yeah, all that information is really critical to it. It would have the collection date, and the collector, the species name, all of that information we'll use to understand when that phenophase occurred, and where, and put our little dot on the map and be able to crunch all those numbers.

Aside: PS, I didn't know what a phenophase was, so I looked it up. According to the USA National Phenology network, it's "an observable stage in the annual life cycle of a plant or animal that can be defined by a start and end point." So, it's usually pretty short lived, it's things like, "Oooooh! A new flower!" Or, "Oooh, the tree is yeller, I done saw it!"

Alie: How do you just go for a walk, how do you walk through your parking lot without being like, "Oh, look at that! Oh, look at that!" It seems like there's data everywhere.

Libby: There are, and that's fantastic. And if you've ever been on a hike with botanists, it's just great. You're never that one who's out of breath and huffing and puffing, because we're stopping at every plant! Identify it, check it out, look at the birds, it's great. [*"Oh, wow!!! Look at this!"*]

Alie: Okay, real, real stupid question. Let's talk about leaves changing color. Because we're in September, it's "fall" in Los Angeles.

Libby: Big air-quotes, yeah.

Alie: Leaves. Why do they change color? How does it happen?

Libby: It has to do with chemical changes in the leaf that are probably mostly impacted by the changing levels of light. A tree, a plant, will be able to sense that the light levels are changing, that it's getting lighter later and darker earlier, and that will be a sign for them to stop making chlorophyll, and as the chlorophyll amount, concentration, decreases in the leaf, it will be less green, and therefore the other colors that are naturally in the leaf will become more visible and more vibrant.

Depending on what other chemicals are in the plant, some trees or some plants might change to these beautiful reds, or yellows, or oranges, while other trees or plants might just

turn brown and the leaves just kind of fall off. It all has to do with the environment signaling to the plant that the season is changing. Cooler temperatures can also do that, or even drought conditions, or dryer weather, or if the plant is under stress, that can also indicate "Ehh, I'm just going to give up and drop all these leaves."

Alie: Oohhh, they're just donna dip!

Libby: Yeah. They're like, "Try again next year."

Alie: "Uggghhh this sucks, see you guys next fall."

Let's say you're looking at an orange leaf, or a beautiful yellow leaf. That color was there all along, but the green was just kind of stealing its thunder?

Libby: Yeah, exactly. And I don't know off the top of my head what the orange flavor is, versus the red one.

Aside: Now, in case you're on a too-quiet car ride through the leafy woods and you need a topic of conversation: carotenoids and flavonoids bring the yellow, carotenoids responsible for the orange hues too. See also: the stuff in carrots. Anthocyanins are the compounds producing those beautiful reds.

In the spring and summer, there's a lot of light and warmth, so there's tons of chlorophyll production, but those flavonoids, and carotenoids, and anthocyanins are hanging out underneath the green.

Libby: Those are always there in lower concentrations, and then the chlorophyll is just so important for the tree or the plant to be producing lots of chlorophyll to be able to photosynthesize all through the growing season, that that's what we see as the green leaves.

Alie: What's the point of a tree having a growing season and a shedding season, versus, say, others, evergreens, perennials that are like, "No I'm in it to win it all year round." Who's doing what and why?

Libby: Plants have all kinds of different evolutionary strategies that have made them successful over eons, so it really depends on – because even within the same ecosystem you could have deciduous trees and evergreen trees, and it's just working for them. Even trees that are evergreen will often lose some of their leaves in the winter and then grow new ones in the spring. They just sort of appear to be fuller than a deciduous tree. It depends just what advantages or disadvantages that particular species has found to be most successful.

Alie: And the trees that shed their leaves, they're living off sugars in the root system and in different parts of the tree?

Libby: Yeah. Yep! Which is similar to how a deciduous tree is doing it too, it's just, yeah, it's how all trees are doing it. It's what is available to them at that time. Often in cooler areas is where you'll have more deciduous trees because they'll drop their leaves and during the winter be more dormant, because they're not as able to suck up the water and the sugars and do what they need to do as trees. So they do become more dormant in the cooler weather, and that's a strategy that works for those plants.

Alie: And human beings, who just….

Libby: [*whispering*] Oh god…

Alie: Sweater weather. Couch weather.

Libby: Yeah. What's that Swedish…

Alie: *Hygge*.

Libby: *Hygge*, yes!

Aside: So, side note: this word looks like 'higgie' but it's pronounced 'hoo-gah', and in the Cabinology episode, I made my friend - Scandinavian Gizmologist Simone Giertz, [phonetically: Yetch] which looks like 'Geertz' - pronounce it, and it's [ph: hoo-GUH]. Cabins, laziness, throw blankets, is there ever a bad time for these things?

Alie: *Hygge* as hell. Just bundle up. Do you tend to get fall fever, or are you more excited about spring?

Libby: Hmm… Equal excitement. A colleague of mine, who was in grad school at the same time as me in the same lab, would wake up just sweating, in a cold sweat, each spring, like "Oh no! I missed the first flowering of this plant!" and she would be weeks off from actually doing that. But you can have phenology nightmares, phenology terrors, in the weeks and months leading up to those important seasons.

Alie: Do you ever notice… In fall, do you ever notice the first leaf you see drop? That happens to me some years where I'll see a yellow leaf flutter, and I'll be like, "Oooh!!!! It's the first one!!!" Does that happen to you?

Libby: Oh yeah, for sure. And getting back to your spring or fall question, I think I'm more of a spring person, and that sort of romantic hopefulness and optimism that comes with it, versus the fall, which I appreciate for the cooler weather and the beautiful colors. It does also feel a little bit… can I say depressing?

Alie: Yeah! Sure. Hell yeah. [*sad trombone*] I mean, Seasonal Affective Disorder spells out SAD. That's the most obvious backronym ever.

Aside: PS, one of my favorite words is 'backronym', and it means an acronym that on purpose spells something cheeky or cheesy, or obvious. I hate backronyms themselves, but I love that we have a word for backronyms.

So, Seasonal Affective Disorder was coined in 1984 by psychologist Dr. Norman Rosenthal, and it affects women four times more than men, and folks in the northern US more than the southern US, according to research. A 2016 article in *Psychology Research and Behavior Management* found that winter depression affects between 1-10% of North Americans, and it's related to latitude.

New Hampshire? One study found that 9.7% of you have the SADs, but only 1.4% get it in Florida. And symptoms, in case you're wondering, include sleeping more, wanting to do less, wanting to eat carbs… I can't figure out how 90% of the population *isn't* afflicted with this all winter long. But anyway, Seasonal Affective Disorder is serious, and it's a type of depression, and having it spelled SAD seems oddly both official and empathetic, kind of like a TSA agent putting their hand on your shoulder. Or a court bailiff giving you a hug.

Alie: What about… When's your birthday?

Libby: September.

Alie: Okay! Okay, you've just flipped my theory on its head! I have a theory that people's favorite season is always when their birthday is. Because I love fall – November birthday, and my sister, big fan of summer – July. So, my theory is garbage. I need more data. I need more data! I'm going to do a Twitter poll because of you.

Aside: I did some very official scientific research via a Twitter poll and found that only 32% of peoples' favorite season was also their birthday season. I thought this number would be 100%, because growing up, when that season came around, you were like, "Hooooo, shit! My birthday's coming up!" I am *so disappointed* that this number was less than 100%. However, 32% is 7 points higher than the 25% randomized probability.

Also, more U.S. babies are born in September than any of the other months. Researchers think that freezing cold winters and shorter days, not a lot of outdoor activities like badminton, or kick the can, have something to do with it. So: a lot of people born in September, the start of fall is objectively the best time of the year. I'm a genius, my theory is solid. Thank you for attending my PhD defense, I am a doctor now.

Alie: The seasons changing, and seeing that in birds and plants, that is partly daylight and partly temperature?

Libby: For most organisms, we find that it's temperature. Or at least, I should say, for plants it's definitely temperature. For birds, it's probably a combination, and even other behavioral factors, like birds can sense that they've been in a location for a particular amount of time, and heck, it's just time to leave. [*"Can we get the check please?"*] "It's time to go north. It's been three months here in Costa Rica, now I need to go back up to Maine," or whatever it is. They have to kind of be aware of the fact that where they're going might be ready for them now, so their food source might be ready and they need to hit the road.

Aside: [*megaphone voice effect*] Announcement. I have a very stupid question, and I'm asking it anyway.

Alie: Near the equator, are the seasons less distinct?

Libby: Yes.

Alie: Okay. So, does your work take you closer to the poles, would you say?

Libby: Yeah, at least that's what I'm most familiar with, and far less work has been done in tropical and sub-tropical worlds as far as phenology is concerned. That's kind of a wide-open area for research. There has been some work done on plants especially, that live in tropical and sub-tropical areas. But yeah, those cues aren't quite as strong, so if any of you guys out there have lived in Arctic or even temperate areas, you know that come spring, you kind of feel that energy to just live life again, and get out of your hole, and do the things. Animals and plants kind of feel that to an extent, too.

There is a real spring 'pop' of phenology. We have records for hundreds of years because of that, because hundreds of years ago, people were excited by that, like "Woohoo! I saw this first flower today! I saw this first bird today, after so long of not seeing it and being holed up in my living room for six months." Closer to the equator, there are certainly more subtle phenological events happening.

Aside: Of course, fall leaves may fall a week or three later than the previous year, or spring may spring early, so Libby says the more data you have, over more time, the better sense you get of the whole picture. And just like firstborns have way more baby pictures neatly tucked into albums than their younger siblings, some seasons have better records.

Alie: So, spring is probably better documented than fall, say.

Libby: Yeah, and likewise, it's easier to see when that first leaf shows up on a tree than it is to see when that first leaf falls off the tree.

Alie: Yeah, that's true. You're like, "I came out and there was a pile. What can I tell you?"

What is a run-down of the function of each season? We tend to think of summer as this feeding season, kind of like a feast and a famine through winter. Does that do anything for plants, to reset their cycles, or do anything for animals?

Libby: Oh yeah. Birds will often have, at least in the northern hemisphere, their breeding season is in the summer. During the winter they're fattening up, they're getting ready, they come back north and they're establishing their territories, building their nests, and then making a family.

There are those kinds of things with certain animals, and for plants too. Plants have a chilling requirement in the northern hemisphere. They'll actually need to be dormant for a certain amount of time to then recognize that it's getting warmer again, and to know they can start producing flowers and leaves and spring is here. But if they don't get that chilling requirement, if we were to have a really warm winter for example, and it doesn't get cold enough for them to meet their chilling requirement, then their spring phenology can be thrown off.

Alie: Okay, what about seasonal movies? Any movies that involve the changing of seasons, particularly fall, since it's late September, that you really feel get it right, or really annoy you?

Libby: It has happened, where I'm watching TV or a movie, and they'll claim to be in New York in October, and then you see that cherry tree flowering, and you're like, "That's April. That's so April."

Alie: They've just bussed in a bunch of silk leaves and put them on the ground. I always hate when there are people on a winter street, and they're all bundled up, but there's no breath coming out, you can't see their breath.

Libby: Yes!

Alie: I'm like, "You're all wearing earmuffs! Come on! What are you doing to us? Put it in post!" It drives me crazy.

Aside: Fun fact: the breath in Titanic was added in post! To make it, they had to get a really cold room, line it with black velvet, and have people talk as they filmed these puffs of warm breath. Then they took those and superimposed them on Jack and Rose floating on wreckage. Now, keep in mind, this was in 1997, when cell phones were the size of your shoe, and before you could use a filter on them to make you look like a tiger. So come on, movies, you can do this! [*clip of cheesy MIDI of "My Heart Will Go On"*]

Alie: Do you have any celebrations of your own when it comes to seasonal things? Are you ever hitting the scarecrow aisle at Michael's in August, or whenever they start putting it out?

Libby: Like my own personal phenology?

Alie: [*laughing*] Yeah!

Libby: I'm terrible with personal traditions and things like that, so maybe I just get enough of it in my day job that I don't carry it on into my personal life.

Alie: I do feel like commerce is screwing us up, because we used to wait until we saw these cues in nature, and now literally at Walgreens, it's back-to-school season in July. I just went to CVS yesterday, whole pumpkin aisle. What do you think about the way human beings take cues from their environment?

Libby: Well I think you right there just proposed a great Michael's phenology study, where you look at over time, when that pumpkin aisle establishes itself, and how that has just crept earlier and earlier, and it's probably due to climate change, so… You could probably publish that.

Alie: Oh my god. BRB, getting my master's.

Aside: Now that I have my PhD in Twitter birthday polls, I might as well get my master's in what the retail industry calls 'Christmas creep', or 'holiday creep', which sounds like a guy at a bar, who thinks his Santa hat is charming, but you're like, "Please under no circumstances talk to me." This early sales tactic, it's been in effect since Victorian times, and in a *Slate* article, they cite a *Philadelphia Inquirer* quote saying, "Gift-buying has begun in earnest. It seems to get earlier every year." That article was written in 1901, so people have been complaining about this for plenty of time.

Alie: How has climate change affected craft stores, and the planet, and phenology? I mean this is a *hot* topic, obviously. What is the data really showing?

Libby: The data are really clear that when it is warmer, or when other climate variables are out of whack, that the plants and animals are likewise out of whack. The most responsive seem to be the plants, and usually in the northern hemisphere, they will react with earlier phenology. So when it's warmer, they will respond with flowering earlier. That could be a couple of weeks earlier, it could be six weeks earlier.

Insects are slightly less so, it appears. They are less responsive to climate cues, and birds even less so. That could partially be because birds are migrating from elsewhere, where they're not getting the same climate cues. If it's a really warm year here, it might not be a really warm year in their wintering grounds, so they could be getting different cues.

But yeah, climate change is impacting all kinds of things. Not only does that impact that one organism, or even that one species, but if plants flower earlier because it was a really warm year, but then let's say the insects aren't responding quite as readily, but they're emerging at the same time they always did. Well when they emerge, those plants that they're used to munching on, those nice fresh young leaves, those leaves might be fully established and be rough, tough, difficult-to-digest leaves. The insects might suffer because of that, and then the birds show up at the same time *they* always do and maybe there are fewer insects, or the whole thing could just be messed up. That's called an ecological mismatch. Climate is a likely contributor to things like that.

Alie: Can temperature differences of just a few degrees make that big of an impact? How does that happen?

Libby: That too is pretty species specific, but yeah, even a couple of degrees can make a big difference.

Alie: What about fall? If it's staying warmer longer, what's happening with those cues?

Libby: Looking to plants again, just because plants are probably the most well-studied and the easiest to study, it's possible that some of them might drop their leaves earlier than they should, just because their leaves have lived their life.

Aside: So, plants may have a shorter growing season if it gets too warm, or the growing season might continue longer. Wait, is that good? Don't trees want to continue growing? And why aren't they marketed gummy vitamins that promise fuller leaves, and longer stems?

Libby: The growing season and the length of the growing season impacts all kinds of things like nutrient cycling. When a tree is active during the growing season, it's sucking up water, it's sucking up nutrients from the soil, and impacting the whole ecosystem in doing so. Then if it drops its leaves, it's doing less of that, so the more time that all those trees are active can really impact the whole ecosystem, not just that one tree or not even just the insects that might be depending on it, but everything all around.

Alie: When the leaves fall off of trees, who's munching on them? What's happening? Are they important for ground cover, or can they pretty much stay or go?

Libby: They're really important for ground cover. By the time the leaf falls, and is dead, and is on the ground, then you're entering the realm of microorganisms, and decomposers, and things like that. There are some insects and invertebrates that might munch on them, and then you quickly get into fungi and bacteria that are eating them and decomposing them.

Alie: Should you rake your lawn, or not?

Libby: I'd say not. Unless where you are, it happens to be a fire hazard, I don't want to encourage anybody to create fire hazards around them. But generally, maintaining things in the most natural way possible is the way to do it. Contrary to Trump's advice to rake our forests [*clip of President Trump: "We gotta take care of the floors, you know, the floors of the forest, very important."*]

Alie: All we gotta do. That's all we gotta do.

Libby: I'd say leave them, and maybe take on some other strategies to prevent fires. But yeah, leaving your leaves on the ground is good, because the trees have taken up those nutrients and created those leaves, and then when they fall, you're completing the cycle and the nutrients can return to the soil.

Alie: Could you rake your leaves in a pile and then jump in them and then spread them out again?

Libby: Heck yes. I highly recommend doing so.

Alie: Okay. Did you ever do that growing up in New England?

Libby: Yeah, a little bit.

Alie: We used to do that where I grew up, and now I think, "Wow that's so many mites on you," but I still want to do it. I just want to do it in a full scuba suit, because I'm afraid of lingering ticks and stuff.

Libby: Oh yeah, ticks are a problem. But I think otherwise you're probably boosting your immune system and interacting with all those great microorganisms. I think it's a good thing.

Alie: You just gotta check your crevices, then you're good to go. This time of year is my favorite time of year for dogs jumping into leaf piles. Oh, it's the best! And also, Halloween costumes.

What about flimflam that you would love to debunk about seasons or climate change? There's a lot there, but what myths about seasons, or autumn, are you like, "Mm-mmm."?

Libby: I'd say climate change is a huge… climate change is… I mean, we're screwed, right? Climate change is here, it's real, and it's big, bad news.

Aside: Let's repeat that. [*clip repeating: "Climate change is here, it's real, and it's big, bad news."*] What can we do?

Libby: But I think we also shouldn't forget about all the other big, bad news that's out there, like the Amazon rainforest is burning to the ground. In addition to taking big climate change action at a government level, at an international level, of course all of those things, but there are other conservation-related actions we can also take that helps give more species a fighting chance come climate change. Climate change is happening already, but if we don't plow over habitats, then we're giving more species a chance to have a go and actually survive through the changes that are coming.

Alie: Is there anything that you do in your life, knowing what you know, to help mitigate it on any level you can? Other than voting, which we all know is the most important.

Libby: Yeah, that is totally the most important. In addition, I killed all the grass in my lawn and have planted a lot of native plants, so created some habitat for some bugs, and birds, and you know, created our own little place where things can be a little bit, not even greener, but more natural and more inviting. In LA… LA is just such a huge city that takes up so much space, that having little pockets where plants and animals can be, is really helpful. At a really local, hyper-local backyard level, we can invite all of those things to live.

Alie: Do you ever sit out and bug watch, and bird watch, and see what comes and hangs out?

Libby: Yeah!

Alie: What have you got?

Libby: Well, I used to work from home, which was amazing, because I would just stare out the window all day with my binoculars and get really distracted but had a great time with my bird guide and identifying everything. For a while I had a trail cam set up in… I have a tiny, tiny backyard, in the middle of Los Angeles, but was constantly amazed and fascinated by the visitors we would get. It would be racoons, just having parties back there. [*creepy voice: "You wanna party?"*] Just seeing them do their thing at 2 a.m. on our camera was fantastic.

Alie: Are those expensive?

Libby: They're not. You can get one for $100 or less, and you should do it. I've been really tempted to take it with me if I'm camping, or on vacation somewhere, so I could put it up in the woods and sort of see what else is there. I haven't quite gotten to that step yet.

Alie: Just, next day, "Oh, four grizzlies! Look at that! I thought I smelled something! Interesting!"

Aside: Quick aside. What about hummingbirb feeders? Is it bad to leave them up? Flimflam. Consider it debunked. Having hummingbird feeders won't deter the little friends from flying south, and in more southern regions, keeping them up may actually help out migratory hummers who need a pitstop or who are overwintering in your region. You could also plant native flowers, especially those that have seeds, which is a more natural way to have birdfeeders in the yard, if you prefer to do that. I have a hummingbird feeder right outside my window. Let me tell ya. It's like having an aquarium made out of the whole world. Or maybe the hummingbirds are like, "Man! This restaurant's great. It's got a terrarium, with one big weird lady in it. And sometimes she doesn't even bother wearing pants." I can see a future me that's a bird lady, and I like her.

Alie: How are birders seeing the change in seasons? Do you get a lot of data from birders?

Libby: Thank god we do, because birders are just such meticulous note-takers. They love their life lists. That enables us to go back a couple hundred years really, to see when birds were

arriving, what birds were around, and so it's really a lot of the work of a phenologist is finding those old records. So yeah, birds are where it's at.

Aside: Oh! How did I not ask this next question yet? What in the daylight is wrong with me?

Alie: What do you think about daylight savings time?

Libby: Let's get over it! No more. Just, no more. Why do we have to do that?

Alie: Thank you! That makes me feel so much better. It usually falls right around my birthday, which is a bummer, and it gets dark so early. People have, like, heart attacks from losing an hour of sleep, it's so bad for people!

Libby: I know, heart attacks, car accidents. No, we don't need it.

Alie: Can I ask you questions from patrons?

Libby: Yes, please do.

Alie: Ohhhhkayyyy! So many!

Aside: Before we get to your Patreon questions, you may hear a few words about sponsors of the show, but before that, these sponsors make it possible for *Ologies* to donate to a different cause each week of the ologist's choosing. This week, Libby picked SaveGPOrangutans.org. This is the Gunung Palung Orangutan Project, whose mission is to protect orangutan populations and forest biodiversity in and around Gunung Palung National Park on the island of Borneo. They say:

> *Recognizing that most threats to orangutan survival are human induced, we take a multi-faceted community-based approach to conservation*.

Libby says they do great work, they're her favorite conservation organization. That is SaveGPOrangutans.org. There will be a link to that in the show notes, as well as a link to sponsors. If this is a newly-posted episode, you may hear some sponsor offers just for ologites.

[*Ad Break*]

Okay. Back to your autumny, springy questions.

Alie: Okay! From the mouth of a seasonal doctor! Let's see, Sophie Cousineau says: What is your favorite, most unusual seasonal phenomenon that people don't even know is linked to seasons?

Libby: Oh, interesting. I think there's a lot of phenology that we're actually not even super aware of, and most of our studies have been on the terrestrial world. But there's a whole lot of marine things happening out there. There are marine mammals that migrate. There are fish that migrate, and all these things that we're just not as in tune to as we are with those that are literally in our backyard.

Alie: Do terrestrial animals shed more in the fall, or the spring? Do we get hairier?

Libby: I don't think *we* do, although…

Alie: Speak for yourself.

Libby: [*laughs*] But certainly yeah, mammals will get hairier in the winter.

Alie: Really!

Libby: Yeah, they'll get thicker coats.

Alie: I wonder if that explains my upper lip. A lot of people had this question, and I'm going to say their names right now. You ready?

Libby: Ready.

Alie: Okay. Maya Price, Marissa Laws, Hanna M Childers, and Jessica Starkman essentially said: Why do we love to cronch so much? [*leaves crunching*] Why do we love a satisfying crunchy leaf? Do you stomp on crunchy leaves?

Libby: Yes, I do.

Alie: What do you think it is about us that likes that?

Libby: I think it's the sound effect, and the fact that we can do that knowing that we're not really doing any damage to anything. The leaves are dead, they're there, we're actually probably helping them out a little bit, getting them that much closer to being decomposed. It's so satisfying, isn't it? Just to hear that crunch? I think it's the sound effect mostly. But I think it's also doing some good.

Alie: I'm going to look up and see if there's a hashtag #leafcronch. If there are pimple popper videos, there's gotta be someone just leaf stomping.

Aside: [*leaf crunching sounds playing in background*] Sound nerds, can I recommend the Instagram @LeafCrunching? This is a bunch of nature-based ASMR videos of crunching leaves, and ice cracking underfoot in the winter, and snow squeaking. They only have 120 followers, as I research this, but I feel like you all could surprise them and blow 'em up with demands for more leaf-crunchy sounds.

Alie: This question also was asked by so many people, including Megan Johnson, Anna Thompson, Bathbunny Art, Juliebear, Maren Mossman, Nikki Finger, Heather Densmore, Kynley Wallace, Liv Shaffer, Henna N, Kate Stomps, and Kerri-Leigh, all asked: Why does fall smell so good? What is it about the smell that is so crisp and nostalgic, and it just is something you wanna huff? Why do leaves smell like that?

Libby: It's the microorganisms.

Alie: Really?!

Libby: I'm pretty sure. It's the same thing how rain smells like something, even though it's just water falling from the sky. But it's kind of enlivening microorganisms on the ground, and all of this. Fall is a similar kind of thing. You do have some of those rotting leaves. You have just that seasonal shift, where things are dying, some things are coming to life because of it, like the decomposers out there, I think that's a big part of it.

Aside: So I looked into this, and whoo! She was so right. A few things are at play. When leaves are dying, they emit gasses through pores on the surface, and those contain volatile organic compounds that are made of hydrogen and carbon, that are similar to the oils found on the leaf surface. Now, if you're an antique book-sniffer, you're also there for the volatile organic compounds. On top of that, or rather, I guess, festering quietly underneath it, is a blanket of fungus. In particular, it might be *Geotrichum candidum*, and I'm pretty sure that name means 'white hair of the earth', but it rots plants, and its burps smell like fall.

There's also something called 'geosmin'. This is the metabolite byproduct of a different microscopic critter, and it's the stuff that makes the smell of rain on the ground so perfect. That smell, by the by, has a name, it's called petrichor. Over 50 years ago, two chemists, Isabel Bear and R.G. Thomas put a name to the smell of raindrops hitting the dry ground,

and 'petrichor' means 'stone' and 'blood of the gods', so it's the smell of the blood of the earth. Augh! Such a beautiful notion! You'll get goosebumps under your sensible fall fleece. But that's not all that smells good.

Libby: In addition to pumpkin spiced latte… But I think we're talking more about the leaves.

Alie: Oh, we got a lot of questions about that. And in fact, Kacey Wight wants to know: Which camp are you, pumpkin spice or apple cider?

Libby: Apple cider.

Alie: Really. Any reason in particular?

Libby: Well, I do love pumpkin spice in its truest sense of the spices that you put in a pumpkin pie…

Aside: What spices even are they? Cinnamon, ginger, nutmeg, clove, and allspice. But wait, isn't allspice just the name of all those spices put together? No! Allspice is its own thing! It comes from a Jamaican pimento tree, and it's the dried unripe fruit. It's only called allspice because it tastes like a blend of the other fall spices. Also, it's used in Cincinnati Chili, which is a very terrifying culinary chimera of chili and spaghetti. Cincinnati, I love you, but this dish confounds me. It's like a centaur, or a half person, half octopus, and the octopus legs are spaghetti noodles, and the top half is a chili brain. What is happening?! Please don't @ me. I say this with love, with awe, with concern. Anyway. Pumpkin spice: cinnamon, ginger, nutmeg, cloves, allspice.

Libby: … and things like that, less so in the form of syrupy goopy form of pumpkin spice.

Alie: Okay. What about pumpkin spice candles? And there's all manner… I'm sure there's an Axe Body Spray that's like [*dude voice*] 'Autumnal Man'. [*both laughing*]

Libby: Yeah, I feel like in those kinds of ways, apple is a little fresher. I'm Team Apple.

Alie: Okay. I blame myself, because when I put up this Patreon question, I think I added something about pumpkin spice in the call for questions, because literally, that was asked by Elle McCall, Jessica Randolph, Shannon Palmer, Aki, Rot, Todd Peterson, Christa Avampato, Jenni Hoover, Brandon McKenna, and Liv Shaffer all asked about pumpkin spice lattes, and why you think companies push pumpkin spice flavor so much, when apple cider is equally perfect. Why is it, do you think? Do you think that they know that we're horny for seasons?

Libby: Yes. And that nostalgia, and even though we're in southern California where it is 100° right now and they're pushing pumpkin spice lattes on us, I think it is that nostalgia for our romantic idea of fall in the north. Leaves changing colors, the fireplace crackling away in the corner and our sweaters on, and all of that. I think it's… yeah, just really tapping into that primal feeling of seasons. [*"Humans are horned up for hygga"*]

Alie: Brendan Dean wants to know: As leaves start to change color, does it change how effective photosynthesis is?

Libby: Absolutely. The more they change color, the less green they are, then the less effective they are at photosynthesizing.

Alie: Which is kind of their point, they're like, "We're good, we got some stored up." A bunch of people, Kylie Sue, Kacey Wight, and Ellen Voss also wanted answers and confirmation that they don't have to rake their lawns: Does raking up leaves remove nutrients from the trees?

Libby: It doesn't remove them from the trees directly, but it does take them from what would be in the soil, which therefore makes less nutrients available to the trees later on. So, indirectly, yes.

Alie: If it's not a fire hazard, leave 'em be.

Libby: Leave the leaves.

Alie: Killer! So easy to remember!

So many people had questions about how trees change colors. Evan Jude, Jasmine Wells, Melanie Baker, Noe Gonzales, Mary Ann Moss, Megan Dawe, Heather D VanValkenburg (great name!), Leanna Eva Shuster, Christie Chapman, Mckenna Larson, Robyn Louden, Anne Delekta, Tamara Mann, Karen Burnham, Colleeneebee, Juan Pedro Martinez, and Shea Murphy all asked about – that's a lot of people curious about this! In Evan Jude's words, who is a first-time question-asker: Why do the same species of trees in the same area turn different colors? For instance, one maple in my yard turns red, but the other turns yellow. Is it genetic? Why does it vary so much?

Libby: My guess is that even the two maples in his backyard are different species. They might look kind of similar when they're green and fully leafed out, but my guess is that they're a different species. It is possible for there to be slight variation within a species for sure, and I'd be curious to see his leaves and how they're changing colors, and to know if that's happening every single year.

The other thing is that some trees will change colors more than once, in a way. So, they'll start off green, and then maybe they'll go to an orangey color, and then they'll turn redder, or something like that. It could be a gradient of change that happens. It could also be that one of those trees is further along than the other, and then, I would guess, the other one could catch up and they'll both be on the same color scheme, just on a slightly different timeline. [*"I'm sorry I'm late."*]

Alie: Yeah, why would one change earlier, would one maybe have less water in the roots?

Libby: It could be something like that. One is more stressed for one reason or another, maybe getting less water. It could be that one is a little bit older and more established and therefore has a larger root system and more access to water. One could be in a slightly shadier area: it could be under the eaves of the house, it could be in the shade of a larger tree, whereas one is getting more sun and therefore thinking that it's still a little bit more summery than the one who's in the shade of a structure or something and thinks its further along into the fall. So, there are lots of even those micro-habitat reasons that could influence why one tree is reacting differently than another.

Alie: Do you have to worry about that when you're looking through historical data? Like, what if this person says that the tree flowered early, but the tree just had a better spot in the yard?

Libby: Oh, that's totally a part of it. And that's why having tons of data will help shake out some of those patterns. When we're out looking for let's say, the earliest flower of a particular species, we'll try to find the warmest places. Maybe the sunniest places, maybe the places that are a little bit more sheltered from winds and things like that. That would be our first data point that we're actually seeking out, that first one.

Alie: Oh, so the most optimal conditions?

Libby: Right. And it's similar for people who are bird watching. It's really that first, first bird of the spring that you're interested in recording, even though that mass of birds might not show up for another week or two. That first one is often what we're after. Although, statistically, sometimes that mass or the full peak is what is most biologically important. Historically, sometimes it's that first one that people are actually recording.

Alie: Oh wow, so it's like the winner of a marathon versus the median time it took to finish that race?

Libby: Exactly.

Alie: Oh, that's so interesting! Caitlin Poindexter wants to know: Are there any indoor plants that change color with the seasons?

Libby: Well, most of our indoor plants are often tropical or subtropical plants that we have indoors. They're not necessarily plants that are native to your area; and we do like them to remain green all the time.

Alie: Yeah, that's true. Unless you're into orchids, in which case, you're just… I feel like people who like orchids can deal with cats. It's just like, "It doesn't like me sometimes, and that's okay."

Libby: Yeah, that's true.

Alie: A lot of returns that happened in October. "This plant died!" Like, yeah dude.

Chris Brewer wants to know if there's a place that's autumn all year round, because his allergies are better there.

Libby: Not that I'm aware of. I mean, some places, even in southern California there are places that are just 70 degrees all the time, but it's more eternal spring I'd say, than eternal autumn.

Alie: I guess you could just get a holodeck like they had in *Star Trek* and just… you know… beep bop beep bop, it's fall.

A few people, Uriaz Castillo, Kitti Halverson, and Eva all asked about SAD. Seasonal Affective Disorder: Do SAD lamps really work? Or should I spend my money on wine to keep me cheerful? Uriaz Castillo wants to know.

Libby: I'd say do both. I'm not totally up on the SAD literature, but I do believe that we do better in light sometimes, or at least certain of us do better in light and feel more energized when there's more light out. So, if that works for you, then totally get a SAD lamp. And sip some wine while you're in front of it.

Aside: For more remedies for SAD, I went to the source, NormanRosenthal.com. Remember, this is the guy who was instrumental in describing and naming Seasonal Affective Disorder, and he's also afflicted with it himself, so he knows his stuff. His website recommends getting outside on winter mornings, into the sunlight, or having indoor light boxes to supplement light. Exercise, like a nice morning walk, or a dance class, or regular trips to the gym also helps. So does watching your diet and avoiding sugar and starch binges. Talk therapy helps.

Winter vacations to a sunnier spot, if you can. Antidepressants if need be, and if all else fails, just move! Just pick up your life and move. Snowbirds in Florida are like, "Hey. We may be overrun with questionable tattoos and feral iguanas, but we are living life down here, year-round. They don't call it the Sunshine State for nothing!" Anyway, speaking of which…

Alie: Aarika asked about sky color: I've always thought that a clear autumn sky is a particular shade of blue, and I can see it getting closer to that shade in September. Is this real? Or is this just confirmation bias? I live in western Pennsylvania if that's relevant. Does the sky change color?

Libby: I believe that it could, because there could be different levels of humidity in the air for example. So, in the spring, let's say there's a lot of rain, and it's more humid, or cloudier, something like that, so the sky itself might appear to be a different color because the atmosphere is more dense with water molecules, that kind of thing. And in the fall maybe it's drier and it's just a different shade of blue. I would totally believe that.

I'd also say that it's possible that the juxtaposition of the sky against whatever else it is that you're looking at, especially if it's some nice orange leaves, or some bare branches, that that might appear different than blue sky against a full tree of green leaves. I think it could be related to all of those things.

Alie: Damn. Good answer. Any songs about September or October that you like? I keep thinking of "Wake Me Up When September Ends" or "Pale September" by Fiona Apple.

Libby: I really should have some kind of phenology playlist going.

Alie: You really should! Different seasonal ones? Spotify it up! Send me a link!

Aside: Let us not forget about the classic standard "Autumn Leaves," another classic, the GNR ballad "November Rain," which I *wish* were called "Autumn Petrichor Yum-Yums." There's also "Sweater Weather" by The Neighbourhood, Yo La Tengo's "Autumn Sweater," tangentially related is Weezer's "Undone (The Sweater Song)", or Neil Young's "Harvest Moon." I guess Ed Sheeran has a song called "Autumn Leaves." Wyclef Jean's got "Gone 'Til November," Morrissey's "November Spawned a Monster," which I thought in hyper self-awareness might be autobiographical, but no. Morrissey is a May baby.

And of course, the Green Day plea to sit the pumpkin-spice-back-to-school ramp-out out, asking only for us to wake them up when September ends. Billie Joe Armstrong, vocalist for Green Day, his birthday's in February. Makes sense.

Alie: Sydney B wants to know: Why do some areas have a "false fall," where the weather gets cozy and fall-esque, and then jumps back to summer for a few more days? Signed, a bitter Hoosier, who just wants it to be autumn, dang it.

Does that tend to happen? Is that a new climate change phenomenon, or has that always kind of happened?

Libby: It's always kind of happened to some extent. I think now we're a little more attuned to it, just because maybe that jump back to summer used to be a few degrees, now maybe it's a few more degrees, or maybe we're just extra sick of summer because it's been so hot and dry for so long, that we're extra ready for some cooler weather. But seasonal changes are notoriously bumpy. Even in the spring, you'll have some warm spring days and then all of a sudden, it'll drop below freezing for a couple of days. And then warm back up again. Those seasonal changes are pretty common and have been going on for a long time.

Alie: Okay. That makes sense, because there's always those April snowstorms, and New Yorkers are like, "How dare you?!" so yeah, that makes sense.

Madelyn Winter, of all names, says: Where I am, in Victoria Australia, Indigenous communities recognize six distinct seasons in the exact same climate where my own culture recognizes only four. Is this a common situation other places?

Libby: If you go back far enough in other cultures, yeah, they certainly have other ways of recognizing seasons, which was often very phenologically based in a way, because they would recognize a certain plant that has started to grow, a certain animal that has arrived, insects doing something. Their seasons will be based on that.

I know in Japan, for example, they've been studying the seasons for way longer than a lot of other places in the world and making written notes about this. We have records from Japan that go back to the ninth century, of phenology, and this is actual data that we've been using in scientific research to understand long-term phenology trends.

Alie: Do you ever have to go back in archives and study a haiku that has something to do with the seasonal changes?

Libby: I haven't studied haikus exactly, but in the Japanese work for example, yeah, you would be looking at old court documents where they said something like, "The cherry blossoms were in full bloom today, and we had our city-wide party under the cherry trees." Things like that are real data. Especially for cherry trees, where they're only flowering for a couple of days. We're looking at anything.

Alie: Wow. I feel like people have to dig up old Grandma's postcards being like, "Well, the rhododendrons have flowered today." And you're like, "Helpful information!"

Aside: Mooooving along…

Alie: A lot of people asked about migration. AJ Chlebnik, Anna Thompson, Michelle Lee, Taniya Heuchert, Eric Souders, Enrique I. C. Sarmiento, Madalyn Rogers, Iben Krutt, Chelsea, Allison Waring, OJ Carrasco, Charlotte Fjelkegård – I hope I said that right – Mckenna Larson, and Jessie Cole all want to know: Why do some species of birds migrate and others don't need to? What's happening there?

Libby: Similar to trees and how every tree is doing something different, lots of bird species do different things, and it's all what is evolutionarily successful for them. Even in some of the research I was doing, we were looking at historic records from Thoreau's time, for example, and we found that in the last 150 years or so, some species that used to migrate no longer migrate because it's warm enough in Massachusetts for them to just stick around all year.

Alie: Whoa!

Libby: So even those kinds of things that we think are really ingrained in a species can change if the conditions change, and that's a good sign in a sense that that species might be adaptable to something like climate change. It really depends on food resources, is for most species what it comes down to and why they might migrate. That, in addition to finding their own niche. Not all species can exist in that perfectly habitable place all year 'round, and so some have been able to find their niche way up in the Arctic, but they can only be in the Arctic for a couple of months in the summer, and then they might have to fly down to somewhere warmer for their winters where they can have their own niche there. It's finding your niche and getting the food resources that you need.

Aside: So, to find your niche, go where there's food and sex that people will let you have. Just keep travelling around until you're full of onion rings, and spinach dip, and adult person

consensually lets you get nude with them. That's where you belong! Someone does not want to mate with you? Keep it movin'!

Alie: A lot of folks asked about climate records, and Jessica Friz asked: Who are some of ye olde superheroes of recording seasonal data, who's records are still useful to us today? A few other people asked about Thoreau.

Aside: In this vein, the following folks asked about ye olde journaling superheroes, and also about helping scientists record phenological data. And they are, I will say them with my mouth: Elaine Barr, Ellen Voss, Ellen Silva, Alan Kaptanoglu, Juliebear, Shalise Quinlan, Michelle Mooy, and BooBooRocksOut.

Alie: Also, community science, aka citizen science, and how important is that in what you do?

Libby: Thoreau is definitely a hero. Aldo Leopold also made great observations of the plants and animals around him, so we've been able to use those records. Japanese recorders of phenological data are huge heroes, and that's been going on for centuries, so very cool. What was the second part of that question?

Alie: Community and citizen science. How much can people help?

Libby: I came into the world of community science when doing my doctoral research and realized that I was unable to be all over New England recording first leaf-out of every tree out there, so we developed a project to engage the public in helping us do that, in recording leaf-out on the trees that they had around them. That was hugely helpful, and really gave us a picture of when and how leaves were leafing out around the northeast. You too, can do that, there are lots of projects out there, the National Phenology Network is a good one in the United States. Project Budburst, I think it's just called Budburst now, is another one that is really accepting of people's observations. There are also lots of local ones too.

Alie: Has it changed at all that it's now *community* science, as opposed to *citizen*?

Libby: Here, where I work, we've had an institutional change from citizen science to community science to be more inclusive, but nationally and internationally it is still more widely recognized as citizen science.

Aside: Yes. So, once called 'citizen science', it's making a shift toward 'community science'. If you're looking to get involved and help out, search for both of those terms.

Alie: Leanna Shuster wants to know: What about the migration of butterflies? I've always loved monarchs and have read about their migratory patterns and loss of wintering grounds in Mexico. Do other butterflies seasonally migrate? How screwed are the monarchs by climate change and habitat loss?

Libby: Monarchs and lots of other butterflies are supremely screwed. [*extremely slowed down: "FUUUCK."*] Monarchs are one of the more charismatic species, so we have lots of great data on them, and so we are really aware of their migration and migratory patterns. So that's kind of let us know that yeah, in certain years especially, the numbers have been pretty low, and that's cause for alarm.

But making those observations of when you see butterflies in your backyard, and all of that, is important for us to know, and as citizen scientists or community scientists, we encourage people to do those things and to make contributions of those data so that we can understand more about where those butterflies are and what they're doing. We can only be in so many places at one time.

Aside: And just like you, and me, and the person in your office who ate your leftover pad thai without asking, butterflies gotta eat!

Alie: Native plants help as well?

Libby: Definitely. Milkweed, planting a species of milkweed that's local to your area can really help the monarchs and give them a place to munch on some yummy milkweed and do what they need to do. Each butterfly species has different host plants, so finding out what butterfly species are local to you and planting those plants can be a real help.

Alie: Not to mention, there's a butterfly party in your backyard! Like, yeah!! Juliebear wants to know if can elaborate on the technology that's being used in phenology field studies like drones, tagging, data sets, simulations, how is it changing with technology?

Libby: Hugely. So we've gone from – "we" meaning phenologists of the past – have gone from pen and paper kind of making observations of what we see, to be able to automate that more with things like pheno-cams. Where maybe you have a tower with a camera on it that's pointed out over the forest, and you could watch that forest green up over the spring and into the summer, and you could watch leaves change color, and senesce, and die off in the fall. That would be at a landscape scale, which is so much different than looking at it plant by plant, and gives us a whole different kind of data to work with.

The plant by plant is also really important and really interesting. We can also get phenology data from satellite images, where if you have an aerial image of a whole area, a computer program will count essentially how many green pixels and leaf-color pixels are in that image, and how that image has changed over time from week to week, or even day to day. We could watch that area green up.

Alie: With someone else counting the pixels!

Libby: So helpful! Another thing too, that's at the forefront of phenology is machine learning, and our ability to look at images, either photographs or herbarium specimens, and to programatically quantify a particular phenological state that is in that image without a human even having to look at it. We could feed thousands of herbarium specimens into this processing system, and it could tell us which of those specimens are in flower, or in fruit, and that saves us as humans from having to look at all of those specimens.

Don't get me wrong, it's a ton of fun to look at herbarium specimens and to go around and see them in person, but it does limit what you're able to do. You can't do things at a national or global scale. You can if it's been automated in that way.

Aside: This next topic was requested by listener Katie Pinette, who asked: Is there any way to preserve the color in leaves once they fall? I'm an artist and haven't found a good way online to preserve them where they don't fade relatively quickly.

Alie: Do you have a leaf collection?

Libby: Randomly. I have tons of books with leaves just shoved into them.

Alie: What is the best way to preserve a leaf?

Libby: Leaves are actually really easy, and plants are pretty easy to just… anybody could slip it in between sheets of a newspaper, I would recommend laying them out flat, and as thin as possible, so if you take a whole branch of something, you want it to be more than just a leaf thick, ideally, or a couple of leaves thick, if you have to. If there's a flower on it, for example, display with all the petals spread out, instead of just smooshed because however it

smooshes down the first time, that's how it's going to be forever. And then you could put it under some books in a dry-ish place. If you have a heater in your house, just put it near there for a week or two, and then you have little pressed plants.

Alie: Is there a good way to preserve the color on it? Or the color's going to fade?

Libby: Color's going to fade, almost no matter what. Certain species do preserve better than others, but there's more likely than not going to be some fading.

Alie: I feel like, if you're doing that to help the future generations, you should just have a Pantone wheel and try to match what color it was when it was fresh. Do you guys ever have to use the Pantone wheel?

Libby: I wish.

Aside: Pantone, by the way, is so named because its inventor, Lawrence Herbert, who worked at a printing company, wanted to standardize colors and capture them all under one system. So, 'pan' means all, and 'tone' means color. So Pantone – all colors. I'm guessing other phenologists are also into it, because in a 2016 article titled "It Was a Great Green Year: Identification of a Chlorophyll Dephytylase That Functions in Chlorophyll Turnover," published in *The Plant Cell* journal, opens with this sentence:

> *Green may have been the Pantone color of the year for 2013, but 2016 was a great year for articles on chlorophyll research at The Plant Cell and beyond.*

But instead of staring at color chips at your desk, you could get outside and see them yourself.

Alie: A few people had this question, Robin Kuehn, Kyla Kelly, Elle McCall, Francina Martinez, Kristina Weaver, Andrew Bain, all kind of asked about geography, and about New England: Where is the most beautiful place to enjoy fall foliage?

Libby: Go into the mountains where the air is crisp. You can get some hot cider, maybe some cider donuts, pick some apples, enjoy the foliage. I'd say don't overlook some of the higher altitude places for some nice phenology. And if you live in a place that might have some places that are above tree line, to have some nice alpine plants and flowers that are changing colors in potentially more subtle ways, but get on your knees and check 'em out!

Alie: Does Vermont rule when it comes to fall color-switching?

Libby: You can't beat New England. Vermont, New Hampshire, Maine, yeah.

Alie: All up in there. What's the best time of year to go?

Libby: October usually. There are some websites that will kind of, like, estimate and predict the best time for peak fall foliage, which is essentially a phenology calculator, so you can plan your trips around that.

Aside: So, leaf-peepers, look for fall foliage maps that let you know when the peak viewing times are. You can just bust out the Uggs, bring a sweater if it gets cooler than like, 70…

Alie: Last questions I always ask: What's the shittiest thing about phenology? What's the worst thing about your job? What's annoying?

Libby: The shittiest about phenology… I guess there are a couple. I'm sure everybody says this, but it's the desk work. We all got into this to be outside and just in the nature, and then here we are doing emails all day.

Aside: I don't think either of us were expecting this next part to go the way that it did. I'm just going to leave it all in, uncut. It's one of the most candid and powerful messages I have ever heard from a scientist.

Libby: That, and the fact that there's a lot of bad news that comes with studying the natural world that just takes its toll.

Alie: How do you get yourself out of that?

Libby: Yeah…. [*pauses*] Going into my backyard… [*Libby's voice trembles and trails off at this point*]

Alie: Ohhhh.

Libby: Oh man. It's so tough!

Alie: I mean, there's a lot of bad news.

Libby: [*with a catch in her voice*] So much bad news.

Alie: Oh, I'm sorry. I'm sorry to ask! I get it. I mean, literally, the world is burning.

Libby: Straight up.

Alie: There doesn't feel like a lot we can do one on one, sometimes.

Libby: Yeah. Yeah, find good news out there.

Alie: Is there anything you feel like you can have in your control at all? Or does it feel hard because it feels out of your control?

Libby: Yeah, it does feel out of control.

Alie: And this is from the mouth of someone who is knee deep in data about it. Does there ever feel like a way to have your work legitimized by people who don't want to believe it? Is that ever really hard? To be like, "I've been working on this for a decade. It's real."

Libby: Yeah, and there's… it's such a weighted issue on occasion, especially in this country, to feel like, "Is climate change real?" the fact that we're still having that conversation. It makes it feel like the situation is not only not getting better, but we haven't even agreed that there is a situation that we should be addressing, or should be paying attention to, let alone doing the things that need to be done to make it better.

Alie: It just feels like it's a long uphill climb before we even get to the battleground.

Libby: Right. And not only are we not addressing climate change, but we are, as a country anyway, rolling back the systems that we have in place, the checks and balances that we have in place to keep natural places preserved for the future, and to help keep the water clean, and the air clean, we're rolling all of those back. Not only are we not moving forward, but in some cases we're kind of moving backwards.

Alie: Yeah. Yeah, every single day in the news you're like, "Are you kidding me? Are you *kidding* me??"

Libby: Yeah. I can't listen to NPR on my commute anymore without coming in with red eyes and an inability to function.

Alie: I think it's really important that people know how real this is. You know?

Libby: Yeah. Real, and pressing.

Alie: And also that real people who are working on it see things so much sooner than the general public does. To be one of the people at the forefront, collecting the data, seeing how it's changing, seeing how dire it is, and the warnings aren't even being heard.

Libby: It's all of that, right? I think data don't mean the same thing as it does to somebody who's spending their days with it. I get that, I don't expect everybody to be knee-deep in the scientific literature to understand what's happening with climate change, and I certainly don't know everything that's happening with climate change, or so many of the environmental issues that are going on right now.

But I think the fact that there's not even trust for scientists and the people that are doing this, that doesn't help us any. If there were at least an acknowledgement that hey, I don't need to understand everything that you're doing, I don't need to understand all the data, but I trust what you're saying and okay, let's take action because of what you are contributing to this conversation, that's valuable, let's do something about that. I think that would be an important step forward to recognize that, yeah, data means something. And there are people that are thinking a lot about it.

Alie: It's just truth versus money at this point.

Libby: Oh, so much. That's what they say, we could study climate change all we want, but really we have to get through the capitalist greed to really work on it, to really address the problem. All the data in the world about every critter on the planet won't help us. It's getting through the greed.

Alie: Do you have a favorite thing about your job?

Libby: Yeah, getting outside! But seeing new places, meeting new plants and animals keeps me going.

Alie: Is there a favorite moment you've had outside?

Libby: Ooooh, let's see…

Alie: I'm going to make you cry again?

Libby: Probably. [*laughs*] Stop it!

Alie: It's a big, beautiful world out there.

Libby: Yeah!

Alie: For now.

Libby: [*voice is still shaky*] I… I've been able to travel to Kenya and Costa Rica, and South America, and seen… like, *National Geographic* scenery, and that keeps me going. This is too scratchy to use, isn't it?

Alie: Oh no, no, you're fine. So, just kind of remembering how beautiful the world is. How many critters are in it, right now. There might be some in your backyard.

Libby: Yessss!

Alie: Just munchin' on a seed.

Libby: Ugh. I can't wait to get home and check 'em out.

Alie: In terms of what you would leave as a kind of legacy, the kind of work that you want to do, is there a big picture goal for you that keeps you going every day?

Libby: Hmmm. Well, when we think about taking action towards ameliorating climate change, that… yeah, I guess… I hope my work could be applied to positive action. A lot of it is kind of esoteric in that sense, where it's not like "Do XYZ and it's all going to be fixed." It's really kind of, like, bird by bird and plant by plant, which only speaks to so much of the problem, but just being that drop in the bucket with all the other scientific literature out there that is pointing in the same direction. I think that's helpful to know about.

Alie: Yeah, that's super important. I think anyone who's listening who wants to help, knowing that there's community science and citizen science programs out there, where their love of being in nature and making observations is helping people like you that can't be in 50 places at once, that's such a powerful thing to be able to be a part of.

Libby: That's huge. I recommend people doing all the community science they possibly can. It contributes data, which we use all the time for the work we do, and also then gives people a deeper appreciation for the natural world, and so when it comes time for them to vote, they're more informed, and more curious, and interested in those sides of the issues that are really often overlooked, or we kind of make that decision with our wallet. Like, "Oh, do I want my taxes to go up a dollar to put in a public transportation system?" Things like that. Understanding more pieces of the puzzle from the natural world, I think, can influence how people vote.

Alie: Thank you so much for doing this. It's such… it's so many warm fuzzies and so many cold chill goosebumps at the same time.

Libby: Thank you, I could talk about this stuff all day long.

Alie: All season long. Thank you for doing what you're doing.

Libby: Thank *you*.

Alie: You're the best.

So ask the smartest folks the stupidest questions, and you may get answers that will gut you, that will inspire you, that will change your life, that will change the way you huff a leaf pile or stare at the trees on a walk. It just might get you to help these scientists gather more data and keep fighting the good fight.

To follow Dr. Libby Ellwood, and you should, she's @LibbyEllwood on Twitter, and there are resources in the show notes and up at AlieWard.com/Ologies/Phenology with the sponsor links and the codes, the conservation organization that got a donation this episode, and links to Libby's work.

Ologies is @Ologies on Twitter and Instagram, I'm @AlieWard on both. Thank you to Shannon Feltus and Boni Dutch of the comedy podcast *You Are That* for managing all that merch.

Thank you Erin Talbert and Hannah Lipow for adminning the *Ologies* podcast Facebook group, which just hit 10,000 nice people, so join that if you feel like chatting science with some fellow ologites.

Thank you to Jarrett Sleeper, of the mental health podcast *My Good Bad Brain*, for the assistant editing and for the extra research this week. And of course, to the pumpkin spice in our lattes, Steven Ray Morris of *The Purrrcast* and *See Jurassic Right*, who helps stitch together all these clips every week. Nick Thorburn wrote the theme song, and he is in a wonderful band called *Islands*.

If you listen to the end of the show you know I tell you a secret, and the secret this week, it's a pro tip of fall beverages. If you're making a chai latte, on top crack a little fresh black pepper, add a

sprinkle of cayenne… hot damn, you get spicier business. So just a little tip from ol' Pops. Maybe pumpkin and apple cider, take a little backseat, let chai lead the way this year.

Also, I know this episode was hard to hear, so please help scientists, help people in your community register to vote, get to the polls, it matters. Alright, next week, the start of Spooktober! There are five Tuesdays in October, which means five spooky episodes coming up in the next month. I can't even deal. Next Tuesday… you ready? An episode on bones! That's right. Skeletons, skellies, that's up next. Okay. Berbye.

Transcribed by Lauren Fenton.

Some links which may be of interest:

Dr. Libby Ellwood's website

Community or citizen science with National Phenology Network or Budburst

This guy coined "phenology"

"Emerging Frontiers in Phenological Research" issue

Weather's sweater weather

Seasonal Affective Disorder — how many people have it?

Interview with Dr. Norman Rosenthal, a SAD doctor

SAD advice from Norman

What is a backronym?

Coconut oil as a 77F weather vane

ASMR leaf cronch

@LeafCrunching in Instagram

Christmas Creep

Hummingbird feeder guidelines

Geosmin: why rain/petrichor smells so good

Booksniffers love VOCs: volatile organic compounds

Smell of fall: plant rot

Pumpkin spice blends

Pantone color guide

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