

# Bryology with Dr. Robin Wall Kimmerer

## Ologies Podcast

### June 30, 2020

Oh Heeey, it's the guy on Nextdoor who's like, "Does anyone want some zucchinis?" because no one warned him that unattended zucchinis can grow to be the size of a human baby, Alie Ward, back with an instant classic episode of *Ologies*.

This is an episode you're going to listen to more than once, I'm gonna tell you right now. Not because the subject matter demands it for comprehension, but because it is the very ethos of *Ologies* all wrapped up in the most soothing, mellow audio hug you will ever lay ears on. It's overlooked beauty. It's following bliss. It's myth-busting. [*grunt of there being no words in the English language to encapsulate how amazing this episode is*]

Let me just run through the thanks and get to the show. Thank you to all the supporters at [Patreon.com/Ologies](https://Patreon.com/Ologies). You can join for as little as a buck a month and submit questions - perhaps hear yours asked in future episodes. Thanks to everyone wearing *Ologies* shirts, hats, bikinis, and new face coverings at [OlogiesMerch.com](https://OlogiesMerch.com). Link is in the show notes. Tag yourself in #OlogiesMerch on Instagram. We'll repost you. Thanks to everyone who rates, subscribes, and leaves reviews. I read all of them. They help *Ologies* stay at the top of the science charts. Thank you, ilikecheeserich, who wrote:

*Not only is information put in accessible language, but it also opens up your eyes to all the wonderful things there are to know and do in the world.*

Oh, ilikecheeserich, you have no idea! This is right in line with that. If anyone else left a review this week, I 100% read it and appreciated it - including some suggestions for future episodes on rocks, and squirrels, and the unhoused crisis. Appreciated!

Okay. Bryology. Moss talk. *Bryo* in Greek straight up means 'moss', so thank you, Greek. That was quick.

This bryologist is perhaps the most beloved in her field. She got her BS in botany from SUNY Environmental Science and Forestry, and a master's and a PhD in botany from the University of Wisconsin. She has published numerous papers on mosses, and plants, and traditional ecological knowledge. She is a distinguished teaching professor. She covers botany, ethnobotany, and Indigenous environmental issues. She's been a TED speaker! She's an enrolled member of the Citizen Potawatomi Nation and the author of two huge books: the gorgeous *Gathering Moss: A Natural and Cultural History of Mosses* and the New York Times bestselling *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge, and the Teachings of Plants*. Many, many people have suggested and begged that I get her on this show, so thank you to *Brain Pickings*'s own Maria Popova for the nudge in her direction.

We set up a time to meet virtually. I have listened to this Ologist's velvety soft voice via audiobooks so much that I was so nervous. I was afraid I'd be too loud, or jarring, or I'd make an airhorn noise with my mouth, so I did my best just to keep calm. This episode is just a gorgeous stroll through the forest floor - an eye-opening, loupe-squinting gaze at hidden mysteries and an intro to your new hero. We cover what is a moss; where do they grow; can you eat them; should you have one as a bath mat; are they soft to nap on; what's up with lichen; how to incorporate your native teaching

into your science work or how to recognize and appreciate Indigenous knowledge without appropriating it; and moss smoothies, with the moss-wonderful bryologist, Dr. Robin Wall Kimmerer.

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**Alie Ward:** You're talking to me from New York right now?

**Dr. Robin Wall Kimmerer:** Yes, I live in Upstate New York.

**Alie:** How are the seasons changing right now?

**Dr. K:** Oh, it is just the height of June. I live out in farm country, so it's hay-making weather. The air is just full of the wonderful scent of newly cut hay and wildflowers. It's really the peak of photosynthesis right now. It's pretty lovely.

**Alie:** I know from reading your books that you've always been, obviously, drawn to the outdoors. Do you remember some of your first interactions with looking at plants and looking at wild growth?

**Dr. K:** It's really almost impossible for me to pinpoint that because I grew up in the natural world. It was always part of my being and part of my family experience, and so it's hard to say there was a moment when I really connected. I had the benefit of a rural childhood and parents who were avid outdoorspeople and naturalists. I think that I was mostly shaped by these old farm fields that were around where I grew up: that meadow, the array of wildflowers and wild strawberries, and all of that was certainly the formative landscape for me as a naturalist. I'd call it my backyard except it was the landscape and not my yard.

**Alie:** What about different plants? What drew you to mosses in particular?

**Dr. K:** It's an odd story in that I've always been, of course, drawn to plants. When I went away to college to be a botany major, I took every botany class I could get my hands on, and there were a lot of them, and the only one I didn't take was Ecology of Mosses. I left it to the last, and I thought, "Really, it's just this tiny little green film. How could that be interesting?" [*Alie and Dr. K laughing*] So I'm really familiar with this notion of the overlooked world because I did it myself. [*clip from Breaking Bad: George, "Right under my nose"*]

I was really interested in forest ecology, so I overlooked the mosses. Then I took one class and at that moment, I remember - it was the first day of my Ecology of Mosses class and putting a lens on the mosses and seeing a forest in miniature. It was love at first sight.

**Alie:** I remember in *Gathering Moss*, you mention that you had a loupe - a magnifying glass - and you spent some of your money to get your own.

**Dr. K:** Yeah. And I still have it. When I think of the innumerable objects I have lost in my life, I have never lost my loupe.

**Alie:** This is obviously a stupid question, but what is a moss? For someone who doesn't know, how do you even define a moss?

**Dr. K:** I'm glad you asked because when people hear about my passion for mosses, they look at me really funny and they think, "You mean that green scum?" No, I don't mean green scum. Mosses are the oldest plants on the planet. People say they are primitive. Really, they are very sophisticated, I think. But they are primitive because they are so small and simple.

That's why people classify them that way. Mosses are members of the plant kingdom and the first plants to colonize land 350 million years ago. When I think about 'what is a moss', a moss is really a miniature forest.

**Aside:** Oh, did I just purchase a \$13 loupe to go look at mosses and pretend like I'm in a movie called *Honey, I Shrunk the Bryologist*? I moss definitely did.

**Alie:** Do they have root systems that are much different than trees? How are they able to cling to so many surfaces?

**Dr. K:** That's a really important question. When you said, "What is a moss," oftentimes the way to answer that is with what do mosses not have? Alie, they don't even have roots.

**Alie:** Really?!

**Dr. K:** No. [*very slow replay of Alie's shocked "Really?!"*] These are not rooted plants, and that's how they can cling. They do have these little threadlike structures called rhizoids which allow them to attach, but they're not absorptive the way roots are. They don't have the capacity to take up water and nutrients. They're really just points of attachment.

**Aside:** So, think of a mussel, like a bivalve, attaching to a rock or a boat. They're not eating through those fibers; they're just hunkered down.

**Dr. K:** When we think about what mosses are, one of the ways to characterize them is by what they don't have in comparison to all the plants that are around us. They don't have roots. They don't have flowers. They don't have the xylem and phloem - that vascular tissue that allows water to be moved within the plant. They don't have any of that. And yet they're able to occupy virtually every habitat on the planet and endure all different kinds of environments. They're super simple, but in their simplicity is the key to their success.

**Alie:** Without flowering, they reproduce with spores?

**Dr. K:** They do. Yep. Just like in higher plants there are females and males, there are eggs and sperm tucked in among the little tiny leaves of the moss. Like flowering plants, we know about insects moving pollen around for fertilization, but for mosses, they need water for that to happen. There has to be a continuous bridge of water between male and female for the sperm to swim along - sometimes just along the surface of a leaf - to go find the female.

**Aside:** The water acts like the ultimate wingman, passing along sperm like a note in class, like, "Hey, my friend wanted you to have this," then BOOM! You're pregnant with moss babies! [*splash sound*]

**Dr. K:** Once the sperm does fertilize that egg, it sends up this little stalk called a sporophyte that will puff out clouds of spores that will go off and germinate. They don't make seeds, but they work from the dispersal of spores.

**Alie:** All of this is happening in miniature when we're taking a walk through the forest and we maybe see a green log and take it for granted? All of this drama is happening?

**Dr. K:** All of this drama. Yes. You know, it's like anything. The closer you look, the more drama you see. If you start to set aside those notions of what mosses *don't* have and say, "Okay..." I think of mosses as real rulebreakers in the plant kingdom because they live their lives in ways that are so different than all of the other plants. But yeah, when you start to pay

attention, they are successful because of their differences, I guess would be the way to say that.

**Alie:** Where can they grow? You mention that they can inhabit all of these places other plants can't. I'm trying to picture the outer reaches. Where are some of the most surprising places mosses have been found?

**Dr. K:** Mosses can grow pretty much anywhere. The only places that they can't tolerate are salty environments. They are not in the ocean. They're not on the seashore. Every place else, they occur. We tend to think about mosses as, like you said, on a wet log. They're in a shady forest. They're next to a waterfall or a stream or a bog, wet places, but one of the most surprising places to find them is in the desert. There are mosses that live off of morning dew in the desert. That's all the water they ever get. To me, those are some of the most surprising.

One of the beauties of when you ask, "Where do mosses live?" there's the big answer of everywhere except for marine environments, but if we go smaller to think about the world like a moss, mosses live on surfaces for the most part. Think about where you see them. They're on logs. They're on trees. They're on rocks. They're on pavement in city mosses. Mostly they don't live on the soil - although some do - because they're outcompeted by the bigger, flowering, vascular plants, so they tuck themselves in on all of these surfaces where it doesn't matter if you don't have roots.

**Alie:** That's so smart. It's so clever of them. I know that we might take them for granted because our eyesight doesn't allow us to identify or notice their differences, but when you're looking through a loupe, how are their edges different and how are their forms and structures different?

**Dr. K:** Well, they are... At the scale of a loupe, and even at the scale of just being on your knees and looking carefully, one moss is as different from the next as an oak tree is from a birch tree, from a pine tree. Their leaves might have toothed-edges. A leaf might be pleated. The leaf might be round, it might be long, it may be like a hair-like extension. There's tremendous diversity of form within the mosses. And that alone is a wonderful introduction to mosses, just to see that they have tiny stems, and they have beautifully arrayed leaves. People think about them as a green film, almost. Like there's nothing structural within it. It's just like a green textile or something.

But no, they're tiny little plants with rolled leaves and leaves that might be flattened or spiraled. There's tremendous diversity of ways to be a moss. That's what I always say to people. People will say, "There's moss on that rock." Really there's no such thing as 'Moss', there are 'Mosses'. On any given rock there might be ten different kinds of moss that, until you start to look, it just looks like green wallpaper. But then when you stop and look, you see that it's a whole world.

**Alie:** How are all of those different mosses categorized? I know they don't have a lot of common names.

**Dr. K:** True. Unfortunately, mosses within Western natural history, shall we say, have been so overlooked that for the most part they don't even have common names. There weren't even field guides to them until a few years ago. There are now some nice photographic and drawing-based field guides and some attempt to put common names on them. I'll admit

they're not very interesting common names. Hooker's, branched, carpet moss; not very evocative. [Alie giggles] But as people start looking more they'll have better, more colorful names.

**Aside:** So, when you call a moss, side note, you usually call it by its buttoned-up formal Latin name. But since Dr. Kimmerer is *the* bryologist, I asked, [*conspiratorially*] "Is she going to get to name any?" Like 'Kimmerer's Shag' or 'Heckin' Cool Green Floof'? She was like, "Mm... I'm good."

**Dr. K:** I'm really more of a moss ecologist and so I'm more interested in their relationships and their adaptive structures. The names are convenient ways to discern one from the other, and of course they're important in understanding evolutionary relationships. But my fascination with them is much more in what they're doing rather than who they are in a taxonomic sense.

**Alie:** That's a great way to put it. What is their role ecologically? That's a huge question, I realize, but what are they busy doing?

**Dr. K:** Well, I'm so glad you asked because they're tiny little plants and yet they have a huge role to play. Where to start... One of the most important things to think about in terms of the roles that mosses play is that their whole bodies, their whole way of being is designed at the scale of water drops. They are designed to attract and hold water. So, one of their major roles is to do exactly that. Mosses are like sponges. They hold the water and release it slowly into the environment. So, they create humidity for example. They also create a moist seedbed for other plants seeds to fall on. Then those seeds are essentially falling on to a damp sponge that's holding on to that moisture.

Their moisture holding capacity influences nutrients too. Think about that moss on a log that you were invoking. Well, if that moss is keeping the log damp by virtue of being a sponge, that means that the decay fungi are hard at work inside that log breaking it down, recycling nutrients much more effectively than if that log didn't have a moss blanket on it. They keep the environment moist, which allows many, many other processes to unfold. That's certainly one of their major roles. You'll have to turn me off Alie 'cause I could go on and on. [*chuckling*]

**Alie:** No. I love this! My ears are open.

**Dr. K:** Okay. One of the other things that I think people are fascinated to know is that mosses have been termed the 'coral reef of the forest', because within a moss there are hundreds of little organisms living in that. When we say, "Well the mosses are a miniature forest," they're not only a miniature forest of tiny little trees, but they have, metaphorically, "birds" living in that canopy. There are all kinds of invertebrates that travel up and down the "trunks" of the mosses, if you will, from the top of the moss canopy down to the soil. There are herbivores. There are grazers. There are predators. There's a whole food chain happening inside a little clump of moss. [*female voice with British cockney accent: "The most insane festival the world has ever seen."*] So, they're tremendous reservoirs of biodiversity and that's why they get called the 'coral reefs of the forest'.

**Alie:** What eats moss? Who grazes on it?

**Dr. K:** Yeah, that's a great question. For the most part, mosses are so well chemically defended that not much eats them. Within that little microcosm there are some invertebrates which will eat them. The invertebrates that have piercing mouthparts will sometimes stick that stylet into a moss cell and take out the contents. There are some larvae that will actually consume the leaf. But for the most part, mosses themselves are not consumed.

So what do I mean by grazers? Well, within that little moss forest there are little algae, and bacteria, and fungi that live on the moist moss leaf surface, and there are little invertebrates that come along and actually scrape off the little epiphytic algae and fungi. That's what they're eating, not the moss. They're eating the stuff that's growing *on* the moss.

**Aside:** Okay, side note: epiphytic means stuff that grows on other stuff. So, any epiphyte is a plant that grows on another plant, and just needs air and moisture. It's not a parasite, it's just chillin'. It just uses the other plant for support. A few epiphytes are mosses, air plants, orchids, and Spanish moss. Which is not a moss. It's just named after its resemblance to a beard lichen, but it's also not a lichen, nor is it from Spain. So, whenever you feel bad about yourself, just remember: people had three shots to name Spanish moss and they screwed up three times. So, you're doing fine, buddy.

**Alie:** What kind of chemical defenses are the mosses producing?

**Dr. K:** Well, I guess I should back up to answer that, to say that for the most part vertebrates do not eat mosses. The only ones that do... Birds will eat the capsules, the sporophytes which are protein rich. But they almost never eat the leafy part of the plant, in large part because that leafy part of the plant is so low in nutrients. It's mostly just cell wall and water. There's not a lot of sugars or proteins in those leaves. So it's kind of a "Why bother? You shouldn't eat them because they are nothing but fiber." And they have a lot of antimicrobials in them, and that's where the chemical defenses come in.

I mean, if you think about it, it's a superb adaptation because mosses live on wet surfaces, right? They live on bark, and soil, and logs, and rocks, and so therefore, they would be subject, you would think, to attack by fungi and by bacteria. But they have, over long evolutionary history... They have antimicrobials, primarily polyphenolic compounds and tannins that are in those leaves that make them unpalatable as well as not very rewarding for any organisms to eat them.

**Aside:** So if you're like, "Yes, yes, a polyphenol," but you don't know what one is, don't worry, I got'cha! A polyphenol is a carbon-containing chemical, and it's characterized by, usually, many repeating phenol groups. A phenol is a  $C_6H_5OH$ . So polyphenols can do things like release or suppress growth hormones. They can protect plants from UV rays. They can deter moss munchers. They can even signal to other plants, like, "Hey, what's up! Let's ripen!" They can also fight infection. Those last types are called phytoalexins, in case of you're ever in need of that word.

Now, a tannin is a type of polyphenol. If you've ever had a 'dry tongue' feeling from red wine, or a green banana, or god forbid, you eat an unripe persimmon - which is so cringe inducing you might as well try to get a tongue transplant, 'cause it's brutal. It's game over. But yeah, then you've had tannins. Now, what if you ate stuff that other people don't want to eat. Would anyone want to eat you?

**Alie:** Have those antimicrobial properties ever been used by other animals in their own defense against microscopic critters?

**Dr. K:** There's a hypothesis that's exactly that. The only place in the world that vertebrates do eat mosses is the Arctic. Caribou will eat mosses. Lemmings and voles will eat mosses. Some of the studies have suggested that while they may eat them they can't digest them. There's just not really much to digest. But there's a suspicion that they eat them because of their antimicrobial properties and that they may do something to regulate digestion in the animals. It's not well understood, but animals do exploit the antimicrobial properties of mosses, including things like birds.

Mosses are really prime materials for nest building by songbirds. You'll often see songbirds foraging for mosses. They'll be flying around trailing some brachythecium from their beaks. They build it into their nest. It's soft, it's insulating, but it's also antimicrobial. The birds that primarily use mosses in their nests are the songbirds whose babies actually poop in the nest. So, the mosses in the nest are thought to have a hygienic effect on reducing the microbial load in the bird nest.

**Alie:** Oh, that's so fascinating. I mean in lieu of diapers, just have a... [laughs]

**Dr. K:** Yes, yes!

**Alie:** You can't potty train a tiny bird.

**Dr. K:** It's true. You're right. In fact, perhaps you know mosses have long been used as diapers by humans.

**Alie:** Yes, yes! Okay, tell me a little bit about that if you don't mind?

**Dr. K:** Oh no, of course not. Because of moss's absorbance, this ability to grab on to and hold water like a sponge, they've been very important culturally and ethnobotanically among Indigenous peoples worldwide. One of the very common uses for mosses is in diapering. Because the mosses are so absorbent of water, you put that dry moss around the baby... In fact, in my culture, in Potawatomi culture, we talk about wrapping the baby in what's called a moss bag. You stuff that bag with dry moss and then it's absorbent. It's like a disposable diaper. But it's also antimicrobial. So, you have this absorbent, antiseptic, soft, insulating diapering material. That's just one of the cultural uses of mosses that exploits their ability to hold water and to have these defensive chemicals in them.

**Aside:** In *Gathering Moss*, Dr. Kimmerer also mentions moss's use as a sanitary napkin, which she describes as, "difficult information to track down," because ethnographers collecting these stories probably did not have vaginas, so they didn't ask. But with all due respect, who knows how many stories have been lost of period-havers joking in their native language about having to 'ride the green carpet' that week. Too many to count and I'm sad about it. I asked her what else she came across in her research.

**Alie:** If there's anything about that you'd love to share, I know I'd love to hear it.

**Dr. K:** Sure. There are long lists of the ways that people have traditionally used mosses; diapering is certainly one of them, but they're also really commonly used for insulation. If you think again about mosses as being absorptive, they're holding water. Well, when they're dry all those little capillary spaces that *would* hold water, when they're dry they're holding air. It's

contained airspace between leaves and between cells, and that's essentially like closed-cell foam insulation. And so people for a long time used mosses as insulation in boots, and mittens, and hats, and bedrolls. So long as it's dry, it's a really effective insulation. It was even used architecturally in things like wigwams. Traditional wigwams, for the wintertime would have one dome and then another dome inside it, and then that intervening space would be packed with dry moss, an excellent insulating material. All kinds of uses for bryophytes.

**Alie:** I'm also trying to figure out how they photosynthesize under such a dense canopy. How are they doing that?

**Dr. K:** That's a great question! Many mosses are thriving at something like 5% of the ambient available sunshine.

**Aside:** Living on only 5% sunlight! Like, hit the dimmer switch, they don't care they're moss. They got this!

**Dr. K:** And their balance of chlorophyll a, b, and c is adjusted to the spectrum of wavelengths of light which is available to them in the dense shade. So they actually have a different pigment balance and modified photosynthetic pathway that allows them to be efficient at really low light levels. But it also comes from the fact that they don't grow very fast, they don't get very big, they don't have really high energetic demands either, so it's this matter of adapting to the resources that are available to them and doing it superbly. But at the same time, there are mosses that live in full sun in the desert, and so variable to utilize different wavelengths of light and they're really well adapted to those habitats.

**Aside:** So how are these soggy green babies also thriving in the desert? Dr. Kimmerer dishes:

**Dr. K:** But, you know, this gets us to one of the other totally amazing things about mosses. Think about that desert moss for a second. It has no xylem and phloem, it has no roots, it has no way to store water, so what happens to it is that it dries up. It dries up and just becomes this little black crust, on a rock or in a soil crevice, and if you just walked by it you'd think it was dead. [*“Wait, am I dead?”*] But it's not dead it's just [*overlay of deep voice*] waiting. [*Psycho creepy violins*]

And mosses are what is known as poikilohydric, which is... Well, you know there's poikilothermic, for cold blooded animals, animals whose temperature is the same temperature as the environment. For mosses, they are poikilohydric; their water content reflects the water content in the environment. So when it dries out, the moss dries out, but unlike the plant on your windowsill that gets crisp and it's done for, the mosses are not done for. They go into this state of... I guess we would just call it a state of suspended animation. They're dry, and crisp, and just sitting there. They can't photosynthesize unless they're wet, but they're just waiting - and then it rains. [*soft rainstorm*] And within 25 minutes they're back to full photosynthesis.

**Alie:** Oh wow!

**Dr. K:** It's amazing.

**Alie:** Ah! You mentioned it as sort of a crust on a rock, and I know a lot of people are so curious: how can you tell a lichen from a moss?



**Dr. K:** Hey, great question, because lichens and mosses often live together at the same scale. And lichens are not differentiated like a plant into stem and leaves. Lichens are going to be a phallus, right? Sometimes powdery, sometimes kind of leathery, but they're not going to have a stem with leaves on it; whereas mosses do. And lichens - which by the way are also poikilohydric - have this amazing water stress tolerance. They tend towards the spectrum of gray and blue, and sometimes have olive green, as well as the gorgeous orange and yellow ones: colors that you don't see in mosses.

But the real grassy greens are mosses - except for the ones who live in the desert - and they are black and crusty. The blackness of the mosses are caused by these flavonoids pigments, and it's essentially sunscreen. The mosses have laid down this pigment layer to prevent them from having the photosynthesis and the chlorophyll being photodegraded in the intense sunlight.

**Alie:** Ohh my gosh that's so smart! What about how air flow influences their growth?

**Dr. K:** What a good question! [*"Thank you!"*]

**Aside:** Oh man. I have been so nervous to meet her, because she's so cool, and I like her book so much, and every time she says I have a good question I just want you to know that I'm like, floating on air currents inside like, [*fangirling*] "Ahh oh my god oh!" Like I'm blushing talking about her right now. Okay, anyway...

**Dr. K:** Air flow of course is going to make things dry out, right? It's going to sweep that water away, it's going to increase evaporation, and because mosses can only photosynthesize when they're both wet and illuminated, air flow can be a great detriment to the growth of mosses. That's one of the reasons they are so small. Because it turns out that there are places in the world, in the whole landscape, where air flow is minimal. Those places of minimal airflow are what are known as the 'boundary layer'. And a boundary layer is this area of extremely still air, right at the surface of any surface: a log, a rock, a tree, your house.

There's this little area of still air, and because in that space the wind doesn't blow, there's just so much friction with the surface, this region of still air is where mosses live. They live within the boundary layer, and that way they can stay moist. They don't have so much evaporation because of wind flow. If the mosses got bigger than the boundary layer, which is created by their surface, they would dry out. And you can almost measure the depth of the boundary layer by the height of the mosses.

**Alie:** Oh wow! Ah! So ecologically, that's part of the puzzle, that's how it all fits together?

**Dr. K:** Absolutely. And that's why in the desert on a rock, the mosses are *teensy*. They might only be a couple of millimeters tall because they have to stay within the boundary layer of that rock's surface. Whereas if they're lying under the shady, moist canopy of a Hemlock tree they can be five inches tall, because there's a much bigger boundary layer there, because of the trees overhead and the logs that they might be living on, so they can live within that little area. That little boundary layer is not only a place where the wind doesn't blow, where theoretically it's absolutely still air, but if you think about every surface having this little boundary layer over it, it also means that within that area it's warmer, because the sun will shine on the log, let's say. And then it's reradiated as heat, and that heat doesn't blow away. There's not as much convection, and so it's caught in this little boundary layer.

The moisture that's coming off from that log gets caught in the boundary layer, so mosses are essentially inhabiting a little greenhouse! A little green house that occurs naturally over every surface, a place which is warmer, moister, and as it happens, richer in carbon dioxide than any place else, and that's where the mosses live. They're exploiting these little microhabitats, rather than trying to dominate and control the habitat, they're taking advantage of the laws of physics and exploiting these naturally occurring little greenhouses.

**Alie:** You know, that brings me to a question - we like to debunk flimflam, we like to bust myths with ologists when we can - but is there truth that moss tends to grow on the north side of trunks or is that total bunk? [laughs]

**Dr. K:** [laughs] It's so great that the one thing people think they know about mosses isn't true! No, this idea that moss only grows on the north side of the tree - no. If you use that for direction finding, you would be going in circles.

**Alie:** [laughs] Okay that's good to know!

**Dr. K:** It is true that mosses will grow more prolifically in the cooler, shadier place. And are the north sides of trees cooler and shadier than the south? Sure, unless there's a forest gap overhead, or unless that tree is leaning in a certain angle, unless there's a ravine over there... There are so many other factors that influence it. I think the only place that it would really make sense as a way-finder is in places that are totally flat, with a uniformed kind of forest vegetation, and so it might be in - and there's greater evidence for this - in the boreal forest, there is more moss growth on the north side of the tree, but only in those circumstances of flat terrain and homogeneous vegetation. So, no, bring a compass instead.

**Alie:** [laughs] Bring a compass! Moss is not your GPS!

**Dr. K:** Mm-mm.

**Alie:** And I wanted to ask, before we get into listener questions, a little bit about your writing, because it's kind of surreal to talk to you because I've listened to your audio books. You narrate them, you read them, and you're so... You have such a wonderful voice and cadence. When you first decided to write *Gathering Moss*, what really moved you to take that sabbatical and put of that work into words?

**Dr. K:** You know, Alie, it really came from a certain kind of frustration of only writing for peer reviewed, technical, scientific audience. I've spent so many wonderful years of my life learning from mosses, just being with them. And when I test a hypothesis and report on it in an article for *The Bryologist* everything that I've learned had to be boiled down into data tables and p-values, and there was no room in that kind of writing for wonder, or for talking about the amazing little things that you see, and the things that the mosses have to teach you. And there came to be a place where, ironically, as a scientist, I felt like I couldn't really tell the truth by using only scientific writing.

So, having been given this privilege of spending my career among mosses, I felt like I really needed to do justice to the mosses and tell a little bit more about how they live their lives, and their incredible ways of being, and lessons that they have for us. So I set myself this goal to see if I could write in such a way that people could fall in love with mosses. That was really my intent: tell the truth about mosses in such a way that these overlooked, ancient, wonderful, little beings would get a chance to tell their story.

**Alie:** You even express personal experience, and observation, and setting, and atmosphere so well, as well as your history and your Indigenous culture, which *Braiding Sweetgrass* also just hit the *New York Times* Bestseller List too, right? A few months ago? Congratulations on that!

**Dr. K:** Yeah, thanks.

**Alie:** Can you tell me a little bit about what that's meant to you to get to express that to a more public audience than just to your students or other biologists?

**Dr. K:** Yeah, it has been so gratifying and, admittedly, very surprising to see their response to both of these books, in particular, *Braiding Sweetgrass*. For me, it has been so hopeful because I really have this sense, with both *Gathering Moss* and *Braiding Sweetgrass*, that those books are meant to awaken something in readers; this sense of wonder for sure, but also the sense of wisdom of the living world, the wisdom that plants have for us. And I'm so gratified to know that people are open to that idea, that they're open to think about learning, not just about plants, but learning *from* plants, and willing to walk that path with me, as a writer, of trying on these different perspectives; of 'Let's look at the world through the lens of Indigenous ways of being.' "Let's look at the world through the lens of a tree, or a lichen, and what might we learn?"

It's just been so rewarding to have readers from so many different places, and cultures, and experiences embrace that. It makes me so happy to think that the plants' stories get to be shared so widely and that it might ignite even more stories of people, and their relationships to plants. [*"I got sixteen plants!"*]

**Alie:** I have so many questions from listeners. Obviously we're not going to get to all 316 of them. [*laughs*]

**Dr. K:** [*laughs*] Oh my goodness! I hope there's some overlap!

**Alie:** There's some overlap, but people are excited! I'll just dive in if that's okay?

**Dr. K:** You bet!

**Aside:** Okay, so we will get to those questions in just a moment, but first, a word from sponsors who make it possible for us to donate to a cause close to the heart of the ologist. This week, a donation is going straight to SUNY College of Environmental Science and Forestry's Center for Native Peoples and the Environment, which was founded by none other than Dr. Robin Kimmerer. They are located within the original territory of the Haudenosaunee, or Iroquois Confederacy, with a mission to create programs that draw on the wisdom of both Indigenous and scientific knowledge in support of shared goals of environmental sustainability.

The SUNY center includes a significant outreach element that's focused on increasing educational opportunities for Native American students in environmental sciences. There are also research collaborations and partnerships with Native American communities to address local environmental problems. There are scholarships and fellowships also available.

We're also sending a donation per Dr. Kimmerer to the American Indian Science and Engineering Society, whose goal is to substantially increase the representation of American

Indian, Alaskan Native, Native Hawaiian, Pacific Islander, First Nation and other Indigenous peoples of North America in the fields of science, technology, engineering, math, and other related disciplines. They were founded in 1977, and they have awarded nearly \$12 million and counting in academic scholarships. They also offer internships, professional development, conferences, and more. So, first donation was to ESF Center for Native Peoples and the Environment, and another donation to the American Indian Science and Engineering Society. Thank you for the heads up on those, Dr. Kimmerer. So, a donation went to them thanks to some sponsors, who you may hear about now.

[Ad Break]

Okay, and now on to questions submitted by beloved Patrons.

**Alie:** First-time question-asker Sikwani Dana says: I am Penobscot, a tribe from Maine, and I also teach high school science. I find that I feel like I live in two worlds and they often clash. How do you mentally bridge Indigenous culture and intuition with Western science?

I hope... I read that earlier, and I tried to make sure I pronounced it right, but I'm not sure if I did. I will rerecord it if I didn't.

**Dr. K:** No, it was perfect.

**Alie:** [relieved sigh] Okay.

**Dr. K:** Yeah, I'm really grateful for that question. I think one of the ways that I try to bridge that, that I work both in my own writing and with my own teaching, is to think about the fact that within Indigenous knowledge systems, we recognize that human people have at least four different ways of understanding the world; certainly with the intellect, absolutely a mental way of processing and generating information. We also have physical knowledge from observation, from measurement, from sensing the world.

If we continue around that... think of it as this Medicine Wheel model, we have the knowledge of the mind and the knowledge of the body in two of those quadrants. But then we have the emotional intelligence and we have spiritual knowledge, spiritual ways of knowing. All of those ways of knowing are valid and important. They're like different tools that you deploy for different purposes, for different questions that you might have. It's a very holistic way of thinking about knowledge as embracing all of those ways.

But in Western science, we've truncated that. In Western science, we privileged the knowledge of the intellect, and that which we can measure, and very explicitly set aside emotional and spiritual knowledge and say, "That doesn't count, that doesn't matter, that's not the real 'valid' knowledge." So, the scientific way of knowing is a subset of Indigenous knowledge. That's the way I try to present it, is that one is a subset of the other. Each of them has these powerful ways of knowing, engaging different tools that we as people have.

The real key to navigating that boundary of two worlds, which I experience and understand, is to think about them as different gifts, as different tools. When you have a true/false question, the scientific ways of knowing and hypothesis testing, that's a darn good tool for a true/false question. But what if your question is bigger than that? You need not only what is true, but what is right, and what is meaningful, and what are the implications of it? And then, the holism of Indigenous knowledge can bring you to wisdom rather than just information.

**Alie:** That's great.

**Aside:** To learn more about this, you can look up medicine wheels, which can also represent the four directions; north, south, east, and west; the seasons; spring, summer, winter, and fall; the elements of earth, wind, water and fire; or those four aspects of mind, body, emotions, and spirit.

Now, if you are a non-Indigenous person, and you'd like to make sure your naturalist teachings touch on Indigenous knowledge in the right way, patrons Ira Gray, Olivia DeBourcier, Anne-Sophie Caron, Schmitt Thompson, Liz Roepke, and first-time question-askers, Lana Mack, Brigid, Gwen Kelly, and Sayyada Dharsee all submitted awesome questions wanting to know:

**Alie:** ... if you think there are any good tools for non-Indigenous folks to incorporate that into their teaching or their botany courses? Allison Bray says: What are some ways that non-Indigenous naturalists and educators can engage with or teach about traditional knowledge about native plants in their area without appropriating native cultures?

**Dr. K:** Yeah, excellent question. I'll return to the prior question, because these ways of knowing that we might call Indigenous ways of knowing; mind, body, emotion, spirit, those are human ways of knowing. Bringing one's full humanity to being a scientist and teaching science is, I think, really important. More specifically, to the question of how to teach about Indigenous ways of knowing without appropriating: One of the most important things to do is what we do in Western science as well, and that is cite your sources, right? Acknowledge where that knowledge came from, and not to portray it as one's own, but to give full credit to the people who created that knowledge, who learned these things, and passed them on. To me, that the first step, is to know where that knowledge came from, to honor it, and essentially, cite it the way that we do in Western science.

I think it's also really important, when we're avoiding cultural appropriation, to have an authentic experience of engagement with place. You don't need to say, well, "Native people tell us to be grateful for the gifts of plants around us." Um, yes, that's absolutely true, but the way that you manifest that gratitude should be in your own cultural framework. You don't have to take another way of showing gratitude for the gifts of the earth. You can show it your own way. Coming up with authentic expressions of your own relationship with the living world is a way to make your experiences much more powerful because they're your own, and it avoids cultural appropriation as well.

**Alie:** That's a beautiful way to look at it.

**Aside:** By the by, I listened to some of *Gathering Moss*, sitting on a rock, under an oak tree, in unceded Tongva Territory in Southern California. Now, 10/10, highly recommend enjoying her dulcet voice on a blanket, watching squirrels, maybe on your city balcony looking at a bee waggle its butt, or on a walk through the woods, even while finishing your taxes. Really, actually, no bad time or place come to think of it. Anyway.

**Alie:** This is a funny question. Rebecca Pancoast, first-time question-asker says: When I was little, I always imagined a patch of moss would be the most magical and comfortable place to take a nap. What species of moss do you think would make the best napping spot? And, Emily Roth asked if you've ever slept on a bed of moss, and if it's comfortable? [*laughs*]

**Dr. K:** The answer is: Yes, I sure have! *[laughs]* And you know, I'm not the only one, of course. Moss as bedding is a common traditional practice. Even Linnaeus, the so-called father of Western botany... as if before Linnaeus people didn't have botany, but that's a different story. But Linnaeus is said to have traveled with a bedroll made out of a *Polytrichum juniperinum*, a wonderful mossy bedroll.

So yeah, I've taken a nap on all kinds of mosses. But one of the things to be really sure about is to think again about that notion that they're sponges. They're full of water. So, I have had many a wet bottom by thinking, "Oh, this would be a really nice place to sit," and no.

**Alie:** *[laughs]* Not so much. [*"Slight soggy bottom, there."*]

In terms of the things that are living in there too, Lillian Ledford and Julianne Gibson had similar questions. This is an adjacent question from their friend, Emily Ford: Do you squeal and coo with delight when you find tardigrades in moss specimens? And Julianne wanted to know: How many tardies can moss hold? Do you ever see little moss piglets?

**Dr. K:** Oh, they're just amazing, aren't they?

**Alie:** YISSS! [*quietly contained exclamation of excitement*]

**Dr. K:** Yes, I do squeal with delight! *[laughs]* Such remarkable beings. In terms of how many are in a little clump of moss, you know, that depends on the moss. Tardigrades especially like sphagnum moss, peat mosses, because they're consistently moist. They also like the log mosses, those big, robust wefts that grow on logs. But the shorter turf mosses will hardly have any tardigrades in them. The answer is the answer to most ecological questions: It depends.

**Aside:** If you're like, a tardigrade? What's that? Oh, well welcome to the best thing you're going to learn ever! They're water-dwelling, eight-legged, segmented micro-animals. They're also called water bears, or moss piglets, and they look like kinda little loaves of bread, but with stumpy little legs, and then they have a face that looks kind of like a robot's butthole. I love them. They can live in space, they can live completely desiccated for long periods of time, maybe they're aliens. They're not, but what if they were?

Anyway, I've never seen one IRL, but now I know to go for the bigger, more robust, longer, soggy mosses. Don't mess with the shorter turf mosses! There's no water bears there! That's not where the Tardi-Party is at! Don't be tardy to the Tardi-Party... or your ass is grass!

Speaking of: Andrea, Kendyll Burnell, Elle McCall, Leah, Sarah Lucchesi, Evan Jude, Amanda Mueller (whose name I say wrong every time - I think it's Muller - I'm sorry!), Kourtney Ryan, Jay Gordon, John Sansone, Ellen Skelton, colleeneebie, Jessica Mazzola, Amelia Heins, Meggie Bender, Emily Elayne LaBorde, Samantha Heinicke, Nicole Wackerle, Cory Laino, and NotACephalopod all asked this next one, it's a good one, that's why so many people asked it.

**Alie:** A bunch of people asked about moss lawns, replacing your lawn with something more sustainable, and less water hungry. How do you feel about that?

**Dr. K:** The answer there is also, it depends. My take on moss lawns is that if the mosses come to your lawn, encourage them. Help them become a moss lawn. But in most cases, it is very difficult and *not* sustainable to try to replace a *grass* lawn with a moss lawn, because mosses

will almost always lose out in competition to rooted plants. There is this movement to, “Let’s go buy mosses and install them in our lawn so that we can have a lawn that we don’t have to mow or water.” If those mosses were capable of growing in that setting, they would probably already be there. I am really not a fan of the notion of transplanting mosses from the places where they are perfectly happy and doing their work and bringing them to places where they are not going to thrive.

You can create the conditions for them. What I always say to people when they ask me about this: if you build it, they will come. [*“If you build it, they will come.” repeated in echoey, apparition-like voice*] If you make a place which is moist, and shady, and not conducive to grass or ground cover, mosses will come there and they’ll colonize it very happily. But for the most part, transplanting... there’s some exceptions to this, of course. For the most part, transplanting mosses, or using this moss milkshake method for getting moss lawns started is, I think, unfair to mosses.

**Alie:** Hmm. That’s good to know!

**Aside:** If you’re like, did she just say moss milkshake, did I hear that right? She did. You did. A moss milkshake is something that you can purchase in what looks like a milk carton, or you can frappe up one yourself! You can just grind local moss and water, with a little cornstarch... sometimes yogurt! People do all kinds of things. You make a bubbly slurry, and then you just paint it on objects, and cross your fingers. But remember: Right place, Right moss is the key. Know your moss.

Also, some folks use this method to create alive murals, and if you don’t believe me, you can google ‘moss graffiti’. So is your home even cute if it doesn’t have a moss mural? Speaking of Pinterest design aspirations, a lot of people, so many, including, Amy Carr, Adam Weaver, Madison Johns, Molly Johnson, Lacey Ireton, Addie Cappello, Brittany Panos, Megan Luschen, Elle McCall, Kethry Warren, Kimberly McCall, and first-time question-asker Sakura wanted to know about this next one:

**Alie:** What about bathmats? Have you seen this?

**Dr. K:** I have. No, no, and [*very deep*] no.

**Alie:** And to summarize, no. In conclusion: No. [*both laughing*]

**Dr. K:** No! I put that in the realm of moss torture.

**Alie:** Aww...

**Dr. K:** Will they absorb water? Sure they will. Will they like chemicals, and soap scum, and fluorescent light? No, they will not. And they will just die. Leave them in the forest and have a cotton bathmat.

**Alie:** Yeah. And that kind of brings me to my last question from listeners. Two people wrote in, Addie Cappello and Carrie Cimo. I’m not sure if those names are familiar to you, but they are both students of yours.

**Dr. K:** I was going to say, those *are* familiar names!

**Alie:** And Carrie, a former student, says: I took Biology and Ethnobotany with Dr. Kimmerer at ESF 2008 to 2010. I love you, Dr. Kimmerer! You’ve been such an inspiration, just moss-

some. And they are a restoration practitioner in Boulder County now. One of the questions that Carrie had was: Is unsustainable harvest still an issue in the Pacific Northwest? Can we kind of discuss taking moss from one area and using it for something else? What should we know about that?

**Dr. K:** Thank you so much for that question. Because one of the unintended consequences, of course, of people coming to love mosses is that they want to commodify them. They want to have them around, and much of the unsustainable harvest of the epiphytic moss communities of the temperate rainforest in the Pacific Northwest is for horticultural work. You know, people are harvesting these old, beautiful moss carpets out of the woods and using them to line flower baskets, or flowerpots, or in some cases, sewing them onto fabric to make these moss carpets for displays and so forth. And the mosses grow back really quite slowly. It is, I think, an unsustainable practice at the current level.

And especially when you think of everything that's lost by taking them; all those invertebrates, the coral reef of the forest, you know, made to line a flowerpot. That doesn't seem to me to be an honorable way to relate to forest bryophytes. And there is a permit system in place in the Pacific Northwest to regulate moss harvest. I am not current on the at-the-moment state of affairs, but the last time I really looked into this, it was largely unenforced. There's a permit system, but nobody there enforcing it. So again, it's something that I would say, is an unsustainable practice.

**Alie:** Oh, and one more question, people are going to be so mad if I didn't ask. Casey Sisterson wants to know: Does the proverb 'a rolling stone gathers no moss' bother you? In terms of, as though gathering moss was a bad thing, I guess?

**Dr. K:** I've never understood that proverb. Somebody told me that what it really means is that if you don't stay put, you'll never get rich, you'll never accumulate wealth, i.e. gather moss. I don't know if that's really what it means or what its original intent was. But one of the beauties of mosses is their ability to remind us about being still, about staying in place.

Mosses have very high fidelity and loyalty to their home places, which is why they don't transplant well. They want to live here. Not somewhere else. They're very specific and invested in their places. And I think that's one of the wonderful teachings that they have for us. So, yeah, a rolling stone gathers no moss. Okay.

**Aside:** PS: I always thought that this meant that you have to keep on your hustle or else you'll become green and hairy. And yes, I looked it up and it was originally supposed to mean that a tree that's moved a bunch bears no fruit. Also, sidenote, the Rolling Stones just got that name when a journalist on the phone was like "Hey, what are you called?" and Brian Jones saw a Muddy Waters album on the floor and read off one of the tracks on it, being like, "Uhhh, Rolling Stones?" Like Jan Brady-George Glass style.

Also if you think the 'rolling stone gathers no moss' proverb is confusing, consider also that in the 1950s, psychiatrists would read this idiom off to you and if you couldn't explain what it meant, metaphorically, they would diagnose you with schizophrenia, according to the 1956 publication, *Clinical Manual for Proverbs Test*, by one Montana-based Psychological Test Specialist. What?! This proverb doesn't even know what this proverb means! Anyway, I don't think they do that anymore, because it sucks. Now, in that vein... **Alie:** The last two questions I always ask any ologist is, what is the hardest part about your job, or about being



a biologist, or what's frustrating, or even if it's petty, or even if it's, you know, deep or silly? What's one thing that kind of sticks in your craw?

**Dr. K:** Hm! I have never been asked that question, and I so love being bryologist that I have a hard time thinking of that. Honestly, I can't think of anything. In a way, I suppose the thing that frustrates me is that people overlook mosses. There are times in the plant ecology literature, scientific literature, when they're describing a forested community, they'll have a category called 'moss', and like, "Really? That's all you got?" That's a category kind of like 'tree', because mosses have so much ability in their specificity to tell us something about that place. Just to lump all these, you know, 17,000 species of beings into a category called 'moss' is frustrating.

**Alie:** Yeah, that's so valid. And then, this is going to be hard, but what is your favorite thing about moss? What is the thing that just gives you the butterflies the most, or just makes your heart swell?

**Dr. K:** Hmm. Straight up: their beauty. I've been looking at mosses for, oh man, half a century, and it still gives me a thrill when I put my lens on them and think, "Oh my gosh! This is perfection in miniature." Their beautiful intimacy with water, their quiet kind of elegance. I admire them.

**Alie:** That's beautiful. That's awesome. I think there will probably be a lot of people inspired to invest in a loupe.

**Dr. K:** I hope so. Do you have one, Alie?

**Alie:** Not yet. No, but I was thinking about it, just looking at the rocks in the yard and thinking, "Oh gosh, I want to see so much!" So yeah, I think that's next on my list.

**Dr. K:** Yeah! Oh, do it.

**Alie:** Absolutely. I can't... It's just this idea that there's this magical world that's right underneath you, that if you just kind of open your eyes and get still enough to look... I love it.

**Dr. K:** Yeah, exactly.

**Alie:** Thank you so, so much for talking to me and doing this, and you've just been... You've been on my list as someone I've wanted to talk to for so long and it just feels surreal hearing your voice talk to me. [*laughs*]

**Dr. K:** A person who reads you to sleep at night. [*laughing*] I know, it's weird!

**Alie:** You've been with me on hikes and all kinds of things. You've done the dishes with me. So to have an interaction is really surreal. Thank you so, so much for doing this.

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So ask mossome bryologists great questions, or any smart people stupid ones, and just know that there is a universe around you that is unfathomably large, and it keeps expanding, and then there's also worlds in miniature underfoot living out love and drama! Now, Dr. Robin Kimmerer's books, once again, are [\*Gathering Moss: A Natural and Cultural History of Mosses\*](#), and [\*Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge, and the Teachings of Plants\*](#) and both are wonderful. If you just fell in love with her words, and her cadence, and her outlook, get them in audiobook form if you like and you can have her in your ears as you go about your days. You can also become her fan at

[Facebook.com/BraidingSweetgrass](https://www.facebook.com/BraidingSweetgrass). There will be links to those in the show notes, as well as a link to donate to the [Center for Native Peoples and the Environment](#), should you choose.

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Thank you everyone on [Patreon](#) for helping me pay these amazing people to help out. Also Noel Dilworth helps with all the scheduling, she's an angel on Earth. Kelly Dwyer updates the website at [AlieWard.com](#). Jarett Sleeper does the first pass edits and cuts out all my 'ums' and other nonsense. And the wonderful Steven Ray Morris stitches all the pieces together to make the moss quilt you hear today. Nick Thorburn of the band Islands wrote and performed the theme music, which I think we should get on the iTunes store. What do you say, should we do it?

Now, if you stick around until the end of the episode you know I tell you a secret and this week's secret is that sometimes when I eat a carrot I eat, like, all the way up to the butt of it, you know? Sometimes I'll even munch the butt a little bit. And I was telling my friend Micah [phonetic] about this once, and he was like, "You can do that?" And I'm like, "I think?" And anyway, he ate the whole carrot butt and then he got terrible food poisoning, and now whenever I eat a carrot up to the butt, I think, "Oh man, poor Micah. I probably shouldn't eat the top of the carrot." Sorry, Micah. Yoikes... Anyway I guess at some point you just gotta stop eating the carrot and get another carrot. Please nobody do this and get food poisoning. Thank you for listening to this public service announcement.

Alright, berbye.

*Transcribed by*

*Ashley Thurber*

*Scott Metzinger*

*Ruby-Leigh Tonks*

*Brixton Moss in Portland, Oregon*

*Aska Djikia on unceded Musqueam, Squamish and Tsleil-Waututh territory.*

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