

# Sciuridology with Dr. Karen Munroe

## Ologies Podcast

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Oh hey, it's your neighbor with the smelly trash cans; what's in there? Alie Ward, I'm going to make this intro as short as possible because I have squirrels in my pants, I want to start this. First things first, I wanted to interview this person for years, somehow my emails never got returned, my dreams never materialized, and then one day, I realized she followed me on social media, hot dang! I DM'd her with so many exclamation points, it was embarrassing and from the first second of this interview I'm losing my shit and I think you will too.

So, she got her undergrad in cellular and molecular biology at Arizona State University. She did a master's in ecology and evolutionary biology at Purdue and then got a PhD in wildlife ecology and conservation back at the University of Arizona. We're going to talk about it. She's now a Professor of Biology at Baldwin Wallace University in Ohio where she has done many things, one of them, co-creating a full-length dance work called "Liars in Fur Coats" about the social and mating habits of squirrels. She's studied fox squirrels, gray squirrels, ground squirrels, and more for decades and her handles on social media reflect this commitment. @Sqrldoc, it's linked in the show notes.

Also linked, [Patreon.com/Ologies](https://patreon.com/Ologies). For a buck or more a month, you can submit questions ahead of time and I might say your name with my face. *Ologies* merch is also linked in the show notes and thanks to everyone who leaves reviews and subscribes. I read all of them such as this one left this week by iFamily who wrote:

*There are a billion podcasts, but not all are worth a regularly scheduled listen. This one absolutely is.*

Thank you so much. Also, I've been told that this particular episode has the potential to make life good again, no pressure. So, let's get into it.

So, sciuridology, it's hard to say but it's a real word, people, and it comes from the Greek for 'shade tail.' We're going to talk about who's who in the family of *Sciuridae*, we'll also chat about the best part of the acorns, how many trees squirrels plant, why they're so good at bird feeders, do they glow in the dark? What their chirps and barks mean, flying squirrels, ground squirrels, litter sizes, cozy nests, if squirrels love you back, their absolutely glorious and terrible sex lives, hoarding, hiding, gliding, conservation statuses that might shock you, and why you should never, never put a squirrel in your pocket before you board an airplane, and so much more with mammalogist, biologist, and most importantly, sciuridologist, Dr. Karen Munroe.

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**Karen:** My name is Karen Munroe and I use she/her pronouns.

**Alie:** My god, it's you! It's really you! Ahh!

**Karen:** It's really me. I promise it's me.

**Alie:** Literally so many people in my life know today is a really exciting one for me.

**Aside:** No chill, zero chill whatsoever. And that is the correct way to be when talking to Dr. Karen Munroe.

**Alie:** By the way, do you know that sciuridology... Do you know... have you ever heard the term?

**Karen:** No, I've always referred to myself as a mammalogist.

**Alie:** You're very good at squirrels though.

**Karen:** Yes.

**Alie:** And I just want you to know that out there in, just, the miasma of life and words, a sciuridologist is a term for someone who is very good at squirrels.

**Karen:** [*chuckles*] I know this term, I believe you. I was going to say, I've studied squirrels for a very long time, longer than I've been married, since my freshman year in college so since I was 17, I've studied squirrels. But I still, to this day, have active squirrel research because people are just fascinated by it.

**Alie:** We love squirrels, but we're scared of most other rodents.

**Karen:** [*laughs*] Right. Why is that? It's the fluffy tail, isn't it?

**Alie:** It's got to be. I mean, that's where they get their name from even.

**Karen:** Right, shade tail.

**Alie:** Shade tail! Wait a second, wait a second. Their tail is for shade?

**Karen:** Partially, sure. All kinds of thermoregulation so, you know, they can use it as an umbrella if it's just kind of, misting raining. But yeah, cover yourself in the sun or, you know, when they splat, when they lay flat and they're trying to thermoregulate, it's a way for them to give off heat, pick up heat, however you'd like.

**Aside:** More on body heat in a bit but we have a whole ding-ding episode on Thermophysiology and body temperature regulation, as well as a kid-friendly *Smologies* episode on it with Dr. Shane Campbell-Staton but I am getting ahead of myself.

**Alie:** I've got to admit, I've wanted to talk about squirrels for a long time, but I don't think I've ever thought about the function of a squirrel tail. And of course, they have a function! They wouldn't have evolved to have it otherwise.

**Karen:** Right. And then when you watch them jump and fall and stuff like that, they also use it to totally right themselves so that they land on all fours.

**Alie:** That makes so much sense. Is it kind of like when you see a tightrope walker that has one of those really big poles?

**Karen:** Yeah, absolutely. They kind of like, well, I don't know about poles... But at the Yankees game last night, probably 10 people sent me this clip. There was a squirrel in the outfield and the fans were shocked by this, it's running across, and then it falls, it falls 8 feet onto the ground.

*[clip of commentary from Yankees games:]*

*Commentator 1: Now he's become a flying squirrel.*

*Commentator 2: This is not good.*

*Commentator 1: He sticks the landing much better than we would, I'll tell you that.*

*Commentator 2: Oh yeah.*

*Commentator 1: Like it's nothing. Off to the races.*

You just watch it and it kind of goes side to side to side and you can watch the tail work as a rudder and then it lands just fine and runs away.

**Alie:** Is there any part of that that is like a parachute to slow it down?

**Karen:** I don't know about a parachute. I think more like flying squirrels; the gliding, with that membrane, is better to catch some air. But gray squirrels, this was just a gray squirrel, they use it more as a rudder side to side.

**Aside:** Oh boy howdy, we will address different kinds of squirrels; gray, fox, giant, dwarf, flying, marvel. But first, let's talk about the specimen Karen Munroe.

**Alie:** I've got to ask, how did you get so, I'm going to say lucky, that somehow life just shot Dr. Karen Munroe down a path, from the age of 17, where she gets to study the most beloved woodland creature there is?

**Karen:** The perfect confluence of luck and mistakes, I guess. [*Alie laughs*] So, when I was in high school, my high school guidance counselor was like, "Oh, you like biology; you should become a vet or a doctor," that was pretty much the two career paths. And there was no way I could ever tell somebody they had to put their pet down, that was not even an option for me. So, I was like, "I'll be a doctor. I like people." And I really liked kids, so I was like, "I'll be a pediatrician." And my undergraduate advisor, one of the smartest things he did was he made me go shadow a pediatrician for a week and I learned two very important things during that week-long shadowing experience. [*"Let's hear it."*] 1) Sick kids are no fun 2) Parents of sick kids are even less fun.

But he, at that point, had already enveloped me into his lab so I was working for him mainly as an undergraduate hourly job collecting acorns and feeding acorns to squirrels as part of his lab component. I told my students all the time, after I figured out that I did not want to be a pediatrician, I tried to find an area of medicine that I liked, and I really didn't. I tried to find somewhere else for me to go; what is it that I was really interested in and what did I like? I ended up thinking – I was at this small liberal arts college – that if I transferred someplace bigger, because I was from a small town, if I went to some place bigger, I would have more opportunities and figure it out. And so, I transferred from Wilkes University – which was at that time, I think, 1,300 students – to Arizona State University.

**Alie:** Oh, huge!

**Karen:** So, across country, 1,300 students to 40,000 students.

**Alie:** Climate differences even.

**Karen:** Yeah, climate, cultural, everything, and anything you could possibly imagine. What I really figured out at Arizona was that there were even less opportunities as a lowly undergraduate to get involved in research and figure out what it was I wanted to do.

**Aside:** So, Karen was majoring in cellular and molecular biology but couldn't seem to get lab experience in Arizona. So, hungry for research, she would spend summers and spring breaks not getting crunk on Four Lokos in Miami Beach but heading back to her small town to work on squirrels.

**Karen:** So, I kind of did a huge 180. So, my undergrad degree is in cellular and molecular biology. I went to Purdue and eventually ended up leaving there with a master's in ecology and evolutionary biology, but it meant I had to take all of those classes. Ecology, evolution, animal behavior, advanced mammalogy, all those kinds of things I took as a graduate student. And that's when I kind of really started putting things together that all this cell and molecular genetic stuff I really liked in college, I could actually apply that to the squirrels and systems I knew so very well from working in the lab.

So, that's kind of where my PhD ends up. My PhD is actually in wildlife conservation management, and it really is the confluence of those two things. It's applying all the genetic stuff to an animal of

conservation concern, was my original thought. But in that way, to a group of animals that have a great conservation concern.

**Aside:** Are squirrels in trouble? It seems like they're everywhere. Maybe one even tried to steal your croissant yesterday. They seem like they're doing fine to some of us, but we will get into how different species are doing later in the episode. But yes, her interests and experience all converged to make her a truly lauded sciuridologist.

**Alie:** It sounds like one was the peanut butter and the other was the bread and you're like, "Oh, I guess I could make a sandwich."

**Karen:** "You got my chocolate, my peanut butter!"

**Alie:** *[laughs]* Exactly. So, when it comes to your work, was there anything about the fieldwork that you were drawn to or was it more systemic that you liked?

**Karen:** No, it was much more systemic. I mean, I really enjoyed the fact that I could walk... and I do this now, I walk outside, and my study organism is right there. It's not like I need to get on a plane and fly 3,000 miles with all this equipment and things like that. It's right there, which means it's accessible and I can talk about it to the public and I can talk about it to my students, so I really enjoy that fact. At the same point, I've also worked places where I've had to drive 6 hours to the top of a mountain to work with a species. So, there are those distant and far away species as well, but I really like the fact that, especially as an undergraduate, I would get on my bike and bike across campus and start trapping squirrels and making observations and things like that. It was so accessible, I think, is probably the reason I got really hooked and involved.

**Alie:** I've got to say, anyone who is listening to this who's, like, working on permafrost stuff is probably like, "Ohhh." Fewer frequent flyer miles but still, the availability of squirrels, it's why we love them!

**Karen:** It is! And everybody knows them and loves them and everybody, everybody, everybody has a squirrel story.

**Alie:** Yes! *[laughs]*

**Karen:** I go to dinners that have corporate people and business people and whatnot and they're like, "Oh, a scientist, we're not going to be able to talk to you." And I'm like, "I bet you, you are. *[Alie laughs]* I bet you, you will. By the end of the night, you and I are going to be friends and we will have shared stories."

**Alie:** Surely. They're attention-gathering, no matter who you are though. But where do squirrels live? Speaking of tundra and permafrost, what continents, or rather, I guess, where don't squirrels live?

**Karen:** I think Antarctica is the only place squirrels do not live. From the Arctic Circle, down into the tropics, and from east to west across the way.

**Aside:** So, if you're on a continent, squirrels are native to it, except Australia, where American gray squirrels were introduced to Melbourne in the late 1800s, and then a few days later, a scurry of northern palm squirrels busted out of a zoo in Perth! And honestly, it's all over the place how many there still are out there. Oh, and squirrels are also not native to Antarctica, in case you're listening there, and I'm impressed that you are, and that you have Wi-Fi, and I hope you didn't bring a squirrel there.

**Alie:** And since you have such a systemic mind about that, what are squirrels doing right to not only capture our hearts but also to be so omnipresent and to be able to live in all these different biomes? They've figured it out, kind of.

**Karen:** They're just so charismatic. They have the little pointy noses and the face and the hands, so you can sit there and watch them rotate the acorn in their hand and get it just right so they can take the perfect bite. They're not intimidating, right? Even when they make noises and things like that, I've had people be like, "The squirrel is just saying hello," as they're like "Chirp! Chirp! Chirp!" and flapping their tail at them. [*squirrel chirps and warnings*] And I'm like, "No, they're saying that you're a predator and they're trying to make sure everyone else knows you're a predator and to get away." But I think they're just the right size and shape and they're just charismatic.

**Alie:** From an evolutionary standpoint, what do you think has helped them survive on prairies and mountains, in the cold, and in jungles?

**Karen:** I want to say that they're such generalists, kind of across the board, that they're willing to eat just about anything. But that is not always true, because there are definitely cases where they really do specifically eat, you know, a very small number of plants, things like that. Ground squirrels really specialize in a plant type and their whole physiology and when they come out of hibernation or torpor really is tied to that specific plant type, and precipitation, and things like that.

But then I think of the classic gray squirrel, and they will eat anything from plants to animals, eggs, insects, and truffles. Human food is kind of the last resort. That's not generally what they're after, but their diet is so general and they have the ability just to— They're scatter hoarders, so they put a little bit of food here, there, there, and there, they like to take things like mushrooms and fungi up into the trees and they will dry it and then put it into their drey nests with them for the winter.

**Alie:** No! Wait, they have better meal planning than I do. That hurts so bad, and I'm really impressed. [*Karen laughs*] I can't do that.

**Karen:** Right? I have a squirrel in my neighborhood that has taken a chunk of a Halloween pumpkin and put it up in the tree to dry and, I'm sure, stored it away for the winter.

**Alie:** How many of our trees are because of forgetful squirrels?

**Karen:** Almost all of them. I know from my undergraduate research that if an acorn is handled by a squirrel, even if it is half-eaten by the squirrel, it will germinate better than an acorn that has not been touched at all by a squirrel.

**Alie:** So, we owe so much carbon capture to squirrels.

**Karen:** I mean, they really are the gardeners of the planet.

**Aside:** Half-eaten? Really? Yeah. Just saunter over to the 1993 paper, "Tannins and Partial Consumption of Acorns: Implications for Dispersal of Oaks by Seed Predators," and you can get a little fact snack like:

*Germination experiments revealed equal or greater germination frequencies for partially consumed acorns than for the intact acorns. We suggest that the higher tannin levels may render the apical portion less palatable, and thereby increase the probability of embryo survival after attack by seed consumer.*

... which would be the squirrel. I guess more delicious fat is at the top of the acorn. And remember this for later because something's going to blow your mind related to this.

Also, for anyone who has ever, I don't know, found a handful of loose Reese's Pieces in a blazer pocket that I rarely wear, you should know that the tastier the acorn is, the more likely the squirrel says to itself, "None of those other Jabroni squirrels are going to eat this good one," so they bury them farther away, where they might not find them, which gives the acorn distance from the parent tree, which it needs to not get choked out by its siblings. All of this drama, under our noses,

under our trees. Also yes, I did eat the Reese's that I found in my pocket. And no, I don't know how long they had been in there.

**Alie:** How many acorns are boreal squirrels stashing away? I read something that they really only remember, like, 10% of them. Or they don't even remember, they just look around and be like, "Where might there be acorns?" And it might be someone else's acorns but they're like, "Yep, they're acorns."

**Karen:** Exactly. As part of an undergrad project, we tagged thousands of acorns and put them out in a forest, little brad nails, and then walked for hours with a metal detector trying to recover acorns [*rustling of leaves, beep of metal detector*] to see how far squirrels were actually dispersing them, and it's quite a distance. And they are so smart, they know acorns that are infested with weevils or other insects that are not going to make it through the winter and they will either eat them immediately or excise the insect and then bury it. They will flip the acorn over; they will use their front incisors to scrape out the cotyledon and then stash it so that it won't germinate and it'll be there longer.

**Aside:** So yes, squirrels do not have a 100% recovery rate with their food, all right? And they don't pretend to. It can range from 25-95% recovery rate depending on the species, area, and food. But a ton of research has shown that squirrels have excellent spatial memory, and they know to head back to their cache, but if they smell a neighbor's food buried on the way, they might eat that too. Also, according to the 1996 paper, "Grey Squirrel Food Preferences: The Effects of Tannin and Fat Concentration," squirrels know which acorn species are more perishable and they may bury, like, red oak nuts, because they'll last longer and germinate in the spring. But they might eat white acorns because they germinate earlier, in autumn.

Although, years later, scientists at Berkeley were like, "Mm, not so fast." It might just be that some acorns are just bigger and it's like taking a few bites of a huge calzone in October and then just digging a hole in the backyard, tossing it in there to snack on during the Superbowl.

Also, scrape out the what? The cotyle- who? Okay, so cotyledon, it sounds like a very expensive shade of paint everyone would be telling you to paint your kitchen but it's actually an embryonic leaf or a pair of them. They're in seeds and in acorns, for example, it stores a lot of energy, and while the squirrels usually only bury about an inch deep in the soil, their whole food festival area can be up to 7 acres wide. They're hard workers and also liars.

So, a 2008 study titled, "Cache protection strategies of a scatter-hoarding rodent: Do tree squirrels engage in behavioral deception?" [*gasps*] It showed that in about 13% of caching events on a specific college campus, squirrels dug a hole, pretended to drop their acorn into it, but kept the acorn in their mouths, and ran away. This may have been the result of a lot of squirrels being around and they didn't want anyone to see where they were stashing their booty. And I didn't even think to ask this but in the paper, the researchers mentioned that they could tell which squirrel was which by noting distinctive markings or, according to the study, "Others were uniquely marked with small spots of various brands of men's hair dye, applied with a plastic dropper from a short distance, without restraining the animals." So, squirrel researchers, they're just out there, they're offering snacks, makeovers.

And then in another study published in 2017 out of UC Berkeley titled "Caching for where and what: evidence for mnemonic strategy in a scatter-hoarder," that one found that fox squirrels buried their food in different areas depending on what the food was! So, if they got a mixed batch of almonds and hazelnuts and pecans and walnuts, they spatially chunked their caches by nut species. But only when caching food that was taken from one single location.

And I'm reading this paper and I'm like, one of the authors is none other than Mikel Delgado, who was the expert in our legendary Felinology episode which I will link in the show notes. But the point is, these fuzzy little babies, they're organizing their dirt pantries. And again, unlike me, they have apparently something akin to self-control.

**Karen:** You know, they only eat an acorn based on how much other food is available because the plant is smart and puts tannins into the acorn and as it gets closer to the cotyledon, it puts more tannins, so it tastes more bitter, if that's possible. If you've ever eaten an acorn, it is incredibly bitter. But the concentration of tannins increases as you get toward the cotyledon so they will just eat the top half of the acorn and drop it and so, it is nice that, kind of, back-and-forth evolutionary adaptation between oaks and squirrels. They do that for lots of seeds and things like that. So, we really do have squirrels to thank for most of our trees and mature hardwood forests.

**Aside:** For more on eating acorns as humans, you can listen to the Indigenous Cuisinology episode which I will link in the show notes, it's a great one.

**Alie:** I'm so curious what a squirrel's yearly planner looks like. *[Karen laughs]* When are they sleeping? When are they up? When are they getting it on? What's their year look like at a glance?

**Karen:** So, if I kind of take a traditional gray squirrel, North American squirrel. In the wintertime, they're mainly active in the middle of the day and that's when they're relying on most of their storage foods and things like that. Typically, once it gets warmed up, I will say February – although with climate change it's getting earlier and earlier and I've actually seen squirrels mate as early as December – once buds on trees start happening and things like that, you'll get the first round of reproduction. And squirrels will eat the inner cambium off of tree branches and limbs as well as other insects, forbs, grasses, things like that.

**Aside:** Inner cambium, side note, is part of a tree. It's specifically the sugary, really nutrient-heavy layer of new growth; it's just below the bark. We talk all about it in the Dendrology two-parter with J Casey Clapp. But yes, some squirrels, thanks in part to climate change, are having steamy romantic Hallmark holidays and canoodling in December. But usually, they hold off until around Valentine's Day when spring is springing, the days grow longer, and the world grows ever hornier.

**Karen:** Once young are out, usually it's springtime and food is abundant and available. And if squirrels are in good enough body condition, they can reproduce again, so a few weeks later, they'll go through that whole process again. Most squirrels will not reproduce until they're about a year old, so we classify typically juveniles are less than 6 months, and then subadults, and then once they mate, we usually refer to them as adults. So, they don't really... Most squirrels are not true hibernators, they'll go into torpor for a day or two when it's really cold, we know they like to nest share a lot.

**Alie:** Really?! I love that. I love a co-op.

**Karen:** So, if it's really cold out, why not get with a bunch of your friends all cozy in together and save some body heat?

**Alie:** It's like *Hygge*, it's like that Scandinavian concept of just, like, cozy up!

**Karen:** Nuzzle down. And we know that different species do it slightly differently. So, in gray squirrels, they tend to be matrilineal and so females that tend to have some kind of relatedness will tend to nest together. And there can be the little bachelor groups as well, to help save some of that body heat and whatnot. And they'll move from nest to nest from night to night, it's not like one nest, one squirrel. So, they're kind of communal, they'll move from group to group.

**Aside:** So, no, squirrels aren't setting up Ring cameras and calling the cops if someone naps on their couch. And if you need a visual, their dreys are like twigs on the outside for structure and

then they're stuffed with a leafy lining for insulation, and then there's a little inner mattress of moss and fur. So, when you see a clot of leaves in a denuded tree in winter, just think, there might be a snoozing squirrel burping up your bagel in there, just heaven.

**Alie:** Well okay, here's the thing. I try to think about a squirrel home, and I always think about a hollow in a log or something.

**Karen:** Oh, sure.

**Alie:** But I live in California where we don't have the same sort of bare winter branches that the East Coast does; we've got a lot of palm trees, we've got oaks. But I thought when I saw clots of nests in bare winter trees, I thought those were big bird nests and someone told me, "No, those are squirrel nests!"

**Karen:** They're squirrel nests. Yeah.

**Alie:** How do they make a nest in the top of a tree on skinny branches, out of leaves?

**Karen:** You just kind of weave it in together. You can usually tell it's a squirrel nest not a bird nest from the doming on the top. When you look at bird nests, most of them are flat and curved on the bottom. But dreys have a shelter top so they are kind of curved on the top, especially when they're being used a lot. As they become less used, they will sink down a little bit. But yeah, those big, clumpy, leafy pieces are squirrel dreys.

**Aside:** So, a nest is shaped like a bowl, and for birds, and a drey for squirrels is more like a bubble or a dome. And no, you didn't ask, but the study of nests is called nidology, and not two hours from me is the world's best museum of nests. It's called the Western Foundation of Vertebrate Zoology, it's in Camarillo and it is home to more than 18,000 nest specimens. Ah, I want to go there so bad! But back to tree holes.

**Karen:** And they absolutely will use cavities too in trees. So, a cavity is definitely prime location and real estate, particularly if you're going to raise young. So, like, if you want more protection from not only outside sources but predators as well, the cavities are the preferred location to raise young. But then there are issues with things like mites and fleas and things like that, so squirrels do move between nest sites.

**Alie:** And let's say that you love a squirrel, you love all squirrels, and you would like to offer them a home in your yard. My dad and I shared a love of squirrels, and my dad built several squirrel condominiums and just hoped that someone would take up residence. I think he put a "For Rent" sign on one. So, is there a protocol? Is there a good way to attract a squirrel or to say, "Squirrels, please, I would like to be your friend?"

**Karen:** I mean, certainly there are squirrel nest boxes that you can build and put out, and I've seen squirrels use nest boxes, but I think it kind of depends on where you are and what kind of squirrel you want to attract. Where you are, ground squirrels probably have more ground nests than they do nests up in the trees and things like that. But for those people who are in the Midwest and the East Coast, having oak trees, having edge of forests; gray squirrels really like forest edges, much like white-tailed deer, they really like those overlapping branches, they like that high number of tree counts. If you are a true Midwesterner and you like those big, chunky fox squirrels...

**Aside:** So, these are the ones with the grayish-brown fur, but they have rusty reddish coloring on their faces and paws and tails and when I leave peanuts out for the crows, the fox squirrels come by and say, "Thank you very much," and they probably pretend to hide it if they think that I'm watching.

**Karen:** ... which are easily 20% if not 50% larger than gray squirrels, they really like a much more open parklike place. So, they don't want lots of overlapping trees, they really want to come down to the ground and do their eating and whatnot down on the ground. And so, it kind of depends on where you live and what kind of squirrels you really want to attract.

**Alie:** I have to ask, as a sciuridologist, have you ever gotten in a fistfight with birders?

**Karen:** So, usually– I mean, I've been asked to come and speak to all kinds of Audubon societies and birder groups or whatnot, and usually one of the first questions they want to ask me is, "How do I keep squirrels out of my bird feeder." [Alie laughs] So, I do address this. I usually start off with, "Okay, let's talk about the elephant in the room first."

**Alie:** The first thing you do, you break a bottle on the side of a table. [laughs] "Listen!"

**Karen:** [laughs] But I talk about how cool squirrels are to watch and we talk about a lot of their behaviors. When I go and talk in public about squirrels and what it is I do and why it's important, one of the first things I try to bring up is that it's really only here, in the US, that we think of squirrels as pests, and a species to be managed and hunted. 80% of the world's squirrel populations are threatened or endangered.

**Alie:** Oh! I didn't expect that!

**Karen:** Right? And for that reason alone, we should take advantage of the fact that we have this opportunity and try and study them and learn more about them so that we can help answer questions for those places. A lot of it comes down to habitat availability.

**Aside:** 80% of squirrels are in decline? Okay, so the International Union for the Conservation of Nature's Red List of Threatened Species lists the Namdapha flying squirrel, which is globally critically endangered, it's currently described by one known specimen that was collected in northeast India in 1981. It's the Sasquatch of squirrels; people think they see it sometimes, but they're usually confused and looking at a red giant flying squirrel. And then there are 11 more globally endangered squirrel species like the northern Idaho ground squirrel, there's only about 1,000 left, and Nelson's antelope squirrel, which is native to this vast California Central Valley that's mostly become farmland. I looked at pictures for longer than I needed to. That antelope squirrel? Oh, it's a cutie! So, we've all been distracted by the really successful and ubiquitous park squirrels, and yes, sometimes they are invasive, but meanwhile, other squirrels need our help. Well, they need their land back, really.

**Karen:** One of my favorite places to talk about squirrels is Japan, and really the only places you find squirrels anymore in Japan are the really old, sacred shrines because those are the only places left that have enough large, old-growth trees to support a population of squirrels.

**Alie:** My gosh, just thinking about them getting shrunken and shrunken. I didn't realize that they were so threatened. I would always think they must be a species of least concern because they're so visible and that's so fascinating. I'm also wondering, how many kinds of squirrels are there? And what's the difference between a ground squirrel, a tree squirrel, and a flying squirrel? Where are chipmunks in this mix? Who are they?

**Karen:** Chipmunks are cousins, they're a cute cousin, we keep them in along with the groundhogs and other marmots and things like that. I believe– I had to look this up actually because I wanted to make sure I gave you the correct number [Alie laughs] because I believe two weeks ago, there was a publication about a new species of squirrel found. So, I believe we're up to 289 species of squirrel worldwide.

**Alie:** Fewer than I thought, to be honest.

**Aside:** Right around 300 species from ones that glide where zip lines wish they could go to ground-dwelling tunnel cuties that I want to kiss, but I won't.

**Karen:** It really comes down to where they're used to nesting, what do they prefer, tree squirrels versus ground squirrels. Flying squirrels are definitely a different grouping, a lot of physiological and anatomical differences there. But tree squirrels, I think they're usually what people picture when they think about a squirrel with the fluffy tail and everything. Ground squirrels are, to me, even more fascinating if possible because we know a little bit less about them. They're underground doing all these things we can't really see, and I really want to know what they're doing under there. But they are highly related. They have lots of the same kinds of timings, and activities, and behaviors for sure.

**Aside:** So, to recap, the family *Sciuridae*, is in the order *Rodentia* and it involves squirrels, chipmunks, and even marmots and prairie dogs. But there is a smaller genus of just squirrels. But in general, all of these squirrels we're talking about may live in trees or the ground, or have wildly different diets and lives, living up to 10 years in the wild, or 20 in captivity. Imagine a squirrel that could legally get a driver's license but not really because it's a squirrel.

**Alie:** You've had the privilege of being in this field since a young age, and technology has changed so much. Have you seen things change in terms of knowledge now that we can put a fiber optic camera and record on a tiny SD card that costs a dollar? How has your work changed now that you can spy on them?

**Karen:** So, for my dissertation, I studied a species of squirrel called the round-tailed ground squirrel, it does not have a round tail, I don't know why it's called that.

**Alie:** [laughs] You didn't name it!

**Karen:** I didn't name it. It looks like a little baby prairie dog, and it has, kind of, a long thin tail, and they live in the ground in the desert. We really wanted to know how social these squirrels were; they were once thought to be this great model outlier in that the literature and all the models say they should be very solitary and alone but the two papers that were published in the mid-'70s said, "No, they are highly social, they are like prairie dogs, they form these family groups. Oh, my goodness, they have all these social behaviors." So, one of the first things we wanted to know was, okay, so they're going down in their holes, entrances, everywhere, how many of those are connected? What are they doing down there? Is there a lot of social behavior going on under the ground? And my field site was the Casa Grande Ruins National Monument in Coolidge, Arizona where there are 69 recognized archaeological sites within one square mile.

**Alie:** Oh my gosh.

**Karen:** It's a beautiful, stunning place but there was no way they were about to let me dig up and look at a ground squirrel burrow in any way, shape, or form. In my four years working there, they did bring in an expert that had ground-penetrating radar and they were using it to look at some of their archaeological sites, and we were actually able to try and use it to kind of, map out a burrow area. And we weren't incredibly successful, not as much as I wanted it to be. ["That was a long... time ago."] But now, I think in terms of fiber optic cameras, yup, you can just slide one of those down and in and sure enough, really see the extent of the burrow, and possibly you could actually even leave the camera down there and see any kinds of social behaviors, and actions, and things like that. I know I was there to study their mating system and things like that, and I never saw squirrels mate because they clearly were doing it underground.

**Alie:** Really? I guess they like their privacy, I suppose.

**Karen:** They like their privacy, yes. We saw evidence of mating; we saw copulatory plugs, and things like that but never an actual mating.

**Alie:** A copulatory plug?

**Karen:** Copulatory plugs. [*laughs*]

**Alie:** Really?

**Karen:** Yes. So, copulatory plugs are this proteus gelatin piece that males will deposit in the female reproductive tract to try and stop her from mating with any other males.

**Alie:** Well, that's a dibs.

**Karen:** Lots of squirrels have this, lots of mammals have these. And most of the time, in just about all the squirrels I've studied, females will just take them out and mate again. [*Alie laughs*]

**Aside:** Augh! This drama continues. Literal cock-blocking, actual cock-blocking going on in squirrel romance but before you go around flipping the bird to insecure male squirrels, please know that copulatory plugs are also common in some primate species, bees, kangaroos, reptiles, rats, rodents, mice, scorpions, spiders. But back to squirrels, we're talking about squirrels. So, ground squirrels might keep this jiz tampon in for almost a day, but I found a study in the *Journal of Mammalogy* titled, "Removal of Copulatory Plugs by Female Tree Squirrels," which described these in fox squirrels and eastern gray squirrels as, "Opaque white with waxy to rubbery consistency." And if you're eating right now, I'm sorry, and also that's not my fault. But now that the scene is set both visually and from a tactile perspective, it continues:

*Although copulatory plugs are hypothesized to prevent the successful copulation of subsequent males, female tree squirrels often remove the plug within 30 seconds of copulating and either discard or consume it.*

Yeet it or eat it, babies! Yeet it or eat it. He's not the boss of you.

**Alie:** Can they have litters with different paternal...?

**Karen:** Yes.

**Alie:** They can?? How many uteruses do they have? One big one?

**Karen:** It's kind of this weird, kind of, corkscrew-shaped uterus. So, round-tailed ground squirrels, I had a litter of 13 squirrels for one of my females. I would say the average is usually three to four, and in eastern gray squirrels the average litter size is between two and three. But absolutely the squirrels can be sired from different males.

**Aside:** Okay, so usually just a few baby squirrels, or kits, sometimes they're called kittens, unless you have 13 at a time, and perhaps that squirrel mom is related to my Catholic grandmother who had 11 children by the age of 30 and stark white hair. But let's get off the topic of my deceased and beloved Catholic grandmother and talk about group sex in your backyard.

**Karen:** We know that female gray squirrels will mate multiply. They're only in estrous for 8 hours, so they're only receptive to mating for 8 hours, and in those 8 hours, I believe the published number is 24 males. She will mate with up to 24 males in that 8 hours.

**Alie:** Oh, get it girl. Is that 8 hours a day or a year?

**Karen:** Mating season, so maybe twice a year.

**Alie:** Wow! So, she goes fast and hard. And then is there any paternal care or are they just, "I don't even remember, it was an orgy."

**Karen:** Nope, just there and gone. [*“See ya never.”*]

**Alie:** And if they can reproduce more than once a year, do they tend to give a lot of resources to their young or is it, kind of like, “We make as many as we can and wish them well?”

**Karen:** I mean, we know that lactation is incredibly expensive, and they tend to stay in the nest for probably 6 to 8 weeks with mom after that. And then you can actually watch them. It’s one of my favorite behaviors to watch; you’ll watch the juveniles come out of the nest and play and then you’ll see the female, you’ll see mom come out and yell at them and chase them off and then they’ll come back at the end of the night and everything. But it’s this kind of ritualized, like, “You kids, you quit this [*gibberish*] Go!” [*“Get out, go outside, and play right now.”*]

**Alie:** What about rat kings in squirrel nests? I’ve seen saps that can glue their tail together, it makes me want to throw myself in the ocean. It’s the saddest, cutest, most terrible thing I’ve ever seen.

**Aside:** Yeah okay, I explained that poorly but sometimes squirrel tails will get glued together by tree sap. And we discussed this notion of a rat king in the Urban Rodentology episode with Dr. Bobby Corrigan, but it’s just awful, please call a wildlife rehabber and unless you see it in real life, don’t look it up. Don’t look it up, don’t look it up.

**Karen:** I get people all the time who call me with baby squirrels who have fallen out of a nest and things like that and that is not my jam in any way shape or form, I have several wildlife rehabbers on call so I send them to places like that. But I will also get calls about squirrels who have mange, who have lost fur because they have a flea infection or something. And you know, I tell people, “They know what they’re doing, they know how to treat it. Let them go and they’ll be okay.”

**Alie:** What about rodenticide? Is that a threat since some of them are generalists?

**Karen:** Absolutely. Yeah, I’ve definitely worked in places where it’s one of the main ways they will control squirrels, particularly ground squirrels, when they don’t want them in a place.

**Alie:** I mean, I feel like gophers are like, “Everyone hates a gopher.” Culturally, people are quite unfair to gophers. But do ground squirrels cause that kind of damage to lawns and sports fields and stuff like that?

**Karen:** They can. They certainly can.

**Aside:** And now, a once-in-a-lifetime chance to ask a personal, burning question.

**Alie:** I cannot believe that I have the opportunity to ask a ground squirrel expert about some hazing that I got from a squirrel. Can I play you a noise and can you tell me what’s going on?

**Karen:** Sure.

**Alie:** Okay, I was having a bad day last week. You know me, I get personal here. I was bummed and my husband was like, “Let’s go to the park and let’s walk around,” and I was like, “That’s a good idea.” And we did. And then this squirrel started yelling at us. This might hurt my heart, what you have to tell me, but that’s okay. [*repeated high-pitched chirps*] A little guy or girl is hanging out, just under a bush maybe five feet away from us.

**Karen:** Calling you a predator. [*chirps continue*] Little California ground squirrel. Probably has young down in the burrow so it’s just kind of that warning.

**Alie:** We are such dipshits. Here we were standing there longer because we’re like, “Does she need help? Is she the Lassie of a squirrel family?” [*dog barks, “What is it, girl?”*] We were like, “What do we do?” And the whole time she was like [*“Go away, I hate you.”*]. But I mean, there’s a reason dog squeaky toys sound like that, right?

**Karen:** Exactly. And really, if you did not know right where she was, it would have been hard for you to locate it, it's a single tonal whistle, it's really hard for a mammalian predator to echolocate that and figure out exactly where that is.

**Alie:** So, she probably had some cute little babies that were underground not far from us?

**Karen:** Yes.

**Aside:** And if you've ever heard chirping or barking coming from a squirrel, there are correct terms. I just learned that sciuridologists have words for those barking, like, clicking, Donald Duck calls; they're called kuks, quaas, and moans and according to the paper, "Joint tail and vocal alarm signals of gray squirrels," in the journal *Behaviour*, researchers from the University of Miami flew gliders, painted like hawks and they drove robot cats around campus toward squirrels and they found that only sweeping back and forth tail movements, known as flags, and vocalizations called moans are associated with a certain predator type. Moans happened more often when there were aerial predators present and the flagging with the tail happened when the cat approached. But they also found quaas, more strongly associated with aerial threats too. They might also clack their teeth at other squirrels. But my point is that if a squirrel is chirping at you and twitching its tail, it wants you to please go to hell, it hates you.

**Alie:** I've never seen so many ground squirrels in my life. I was like, I mean, they were everywhere. This was a couple of weeks ago, so this was late spring. Would there be a reason why they were out so much? Or do you think it's just a really good place for ground squirrels because of oak trees?

**Karen:** I think it's probably just a great place for ground squirrels.

**Alie:** It's just a party. Oh, that's exciting.

**Karen:** I know when I started to study round-tailed ground squirrels I was trying to find a population that would be good to study, and I was having a hard time locating a good, dense population. I actually went to some snake researchers and I was like, "Can you look at your records and tell me where you have good populations?" And they came through. This was the perfect confluence.

**Alie:** No one tell the snakes; they're going to blow up this restaurant.

**Karen:** But the squirrels, they have a relationship with the snakes as well. It's not like every time the snake sees the squirrel, the snake gets the squirrel. The squirrels fight the snakes right off. I saw a pregnant female totally chase off a rattlesnake. You could tell from the roundness of her belly that she was pregnant, and the snake was just coming through and she started on high alert, let everybody know. And when it's a ground predator like a snake, they will also thump their back feet to let anybody underground also know that there's a snake. And she just completely chased them away and it did not bite her, it didn't even really try to bite her, and she just kept pouncing on it and forcing it away.

**Alie:** Okay, so I'm learning squirrels are cute and beautiful and they also will talk shit.

**Karen:** Oh, they're badasses.

**Alie:** Yeah, and they'll cut you.

**Karen:** We know that they have some resistance to some venoms and possibly even some rattlesnake venoms. We don't know quite how much but they certainly have some resistance.

**Alie:** In all of your work, have you ever been bitten by a squirrel?

**Karen:** I have never been bitten by a squirrel.

**Alie:** Oh, I'm knocking on so much wood.

**Karen:** I have come close once and gotten a blood blister from getting squished but when we handle them, I use a cloth handling bag that's in the shape of a triangle, I actually usually describe it as a giant pastry bag. So, if you imagine a giant pastry bag made out of a denim material; we wrap the wide end around the trap opening because it's really easy to catch a squirrel; peanut butter, sunflower seeds, things like that. But then you have a very angry squirrel in a metal cage. So, if you wrap the big end around the trap and open the door, the squirrel does not want to be in the trap and will run out and basically run into the narrow end and basically just wedge themselves into this pastry bag, and it's like being swaddled physiologically. So, they're in there, they're all nice and tight, their eyes are closed, usually their nose, kind of, sticks out the very end and they're very calm. They can't open their mouth to bite me and therefore I am very calm. They're not trying to run away, they're not trying to move or anything, they're just basically chill.

**Aside:** Yeah of course I looked this up and I found fieldwork photos of Dr. Munroe on a campus lawn. In her lap, a pillowcase-sized dark blue canvas sack pointed at one end. She is wearing a school bus yellow T-shirt and it matches the shirts of her student assistants. And there's a small logo over the breast, an official seal of some sort but on the back of the shirts, in bold lettering, it reads, "It's the squirrels. They're watching me."

**Alie:** What kind of alien abduction science do you have to do in order to make sure that their population is healthy? Do you have to weigh them? Do you have to take their temperatures? Do you have to check them for fleas? What kinds of things are scientists looking for?

**Karen:** Usually this is everything that we're doing: we catch them, we weigh them, we take a whole set of morphological measurements. We want to know not just how much they weigh but how much of that is fat versus bone and things like that. Certainly, I look for flea infections, I usually feel around, see if they have any broken bones, and check their tails. I usually will check to see if they're pregnant, or if they're lactating, or things like that; check to see if the males are active in reproduction. And then we mark them, we put unique colored ear tags, uniquely numbered and colored tags into their ears, and when I do that, I take a DNA sample. And then sometimes if we're going to see how far they're going to go and things like that we can put a radio collar on them which is a necklace, weighs less than 5 grams. And then we can get an idea of the number of males, females, juveniles, and things like that.

**Alie:** If there is one that's injured or has an infestation, because you're a researcher and not a wildlife rehabber, where's the line between getting it help and letting nature do its thing? How do you decide?

**Karen:** My general default is to let nature take its course. I think if it's something that I personally have caused, I definitely have had a squirrel get a piece of skin on their nose or whatnot scratched from the metal trap or whatever, I will tend to swipe a little piece of Neosporin on that nose before I let them go. But generally speaking, I let nature take its course. I have not ever come across a squirrel that I have needed to do something significant about, and I'd like to keep it that way as well.

**Alie:** Yes! I mean, I feel like they probably just got wind of you and respect you a lot.

**Karen:** It would make it so much easier if they would just stand up and be like, "Hi! I weigh 250 grams, Here's my measurements. I'm not pregnant."

**Alie:** "I'm real knocked up right now. [Karen laughs] Oof, had a great time a couple of months ago." What about... Augh, I have a million questions for you, I cannot tell you how exciting this is. If you could stand on a cosmic soapbox and have the biggest bullhorn ever to bust some flimflam about squirrels, what is the biggest misconception that you're like, "People, it's not like that."

**Karen:** I would say people often ask me about rabies like, they're afraid to catch rabies and things like that. And there's never been a case of a rodent carrying rabies, so there's never been any kind of report of squirrels carrying rabies and so, that's why I don't mind working with undergraduate students with them. I'm always present when undergraduates trap but really the only thing they carry is tetanus so, as long as students have had their tetanus shot, I'm generally not so worried.

**Alie:** You were in Arizona, and I feel like in my brain, something says, "Squirrels, Arizona, bubonic plague."

**Karen:** Plague, yes.

**Alie:** Did I make that up?

**Karen:** So, bubonic plague is definitely a thing to be worried about. When I worked at the Casa Grande Ruins, since it's a national monument, they would have their fleas tested annually to see if there was any chance of plague and fortunately, all four years that I was there, there was no chance of plague.

**Aside:** Okay, so according to the CDC, small rodents like squirrels, hamsters, guinea pigs, chipmunks, rats, gerbils, mice, and bunnies, are almost never found to be infected with rabies and they have not been known to transmit rabies to humans. However, groundhogs, they got a little more chunk in their trunks, they have bigger bodies, so they do get reported as rabid from time to time.

Now, the bubonic plague has been transmitted by fleas on ground squirrels, and wood rats, and prairie dogs but it's very rare. And please, I beg you to channel your anxiety toward really anything else, or as a *Slate* headline from the summer of 2020 read, "You do not need to worry about the bubonic plague squirrel in Colorado." And just reading that like, whew, what a time machine, what an eventful few years it's been on planet Earth. Just can we catch a break? But if you do feel very sick and have giant lymph node-area nodules, just please see a doctor if you're in trouble. Speaking of being in trouble, and confronting that sweet, sweet ache of mortality...

**Karen:** The most endangered mammal in North America is a squirrel species. The Mt. Graham red squirrel is the most endangered mammal in North America, it only resides on one mountaintop. When I was there studying them, their numbers were probably in the 200 to 300s. I could say that a few years ago they were down below 100, they've come back a little bit but...

**Alie:** Is that all habitat loss or climate?

**Karen:** It is a... Mt Graham is a whole ecosystem of a mess. So yes, there's a lot of habitat loss, it was slated to have two dozen telescopes built on the top of the mountain and they were denied, and some were built. Then there was an insect infestation, it's sacred Native American land, there were several large forest fires, there's an endangered raptor that comes through that eats them, there's an introduced squirrel... Every plight that has affected an endangered species is there on the one mountain top.

**Alie:** Augh, sounds like they were cursed by a witch. [*Karen laughs*]

**Aside:** Oh boy, so now might be an okay time to tell you that we have episodes on Fire Ecology, Indigenous Fire Ecology, Fulminology about lightning strikes that cause forest fires, and a recent Field Trip episode about raptors. I'll link them in the show notes.

But yes, Mt. Graham is a 10,000-foot-tall peak in the southeastern corner of Arizona. So, this Mt Graham red squirrel, it's about 8 inches long, it has dark gray, brown fur and a white belly I want to

pet, and enjoys a diet of seeds, pinecones, and air-dried mushrooms. Now, this critter is endangered but at one point in the era of Camaros and Aqua Net, there was no hope.

**Karen:** They actually thought that they were extinct into the mid-'80s, and a hunter brought one in and wildlifers were like, "Oh, that is not the Abert's squirrel that you should be hunting. That is the endangered Mt Graham red squirrel."

**Alie:** That must have been a huge day in the sciuridology community. They must have been popping bottles. I know that they couldn't text each other, but they must have been paying long-distance fees to be like, "Barbara, I got some news."

**Karen:** "Can you believe this?!"

**Alie:** That is so exciting. What about tiny squirrels on the big screen? Is there a favorite squirrel in film or TV that you're like, "They got that right," or "I like that one?"

**Karen:** *[laughs]* You know, I do love me a Scrat. *[scratching, sniffing, squeak sounds]* I keep waiting for Squirrel Girl to come out, I have a number of Squirrel Girl paraphernalia in my office and things like that. She was supposed to be in so many Marvel superheroes. I have so many figurines of her, I cannot wait for her, Doreen, to come out and show everybody what a badass she really is. Because she supposedly has kicked Deadpool's ass, Thanos' ass, and Wolverine. She is just this badass in the Marvel world and yet, I'm waiting. I'm waiting!

**Aside:** Just a short PS, so LA is very small and I happen to know Milana Vayntraub, the actress and the director who was slated to play Squirrel Girl for Marvel and I texted her, I told her that she has a friend in the squirrel world and she said that that was the "Most giantest honor I know" and she passed it along to Ryan North, the comic book creator who is the real hero behind Squirrel Girl. And also, there's a six-episode scripted podcast series starring Milana called *Marvel's Squirrel Girl: The Unbeatable Radio Show*. But if you want that movie or TV series, just feel free to get those petitions going folks. Ologites, I have faith in you.

**Alie:** Can I ask you listener questions?

**Karen:** Sure.

**Alie:** I told them you were coming on, I told them that this was the best day of my life. *[Karen laughs]*

**Aside:** But before your questions, each week we donate to a cause of the ologist's choosing. This week we're going to split it between two for Karen. One is Letter to a Pre-Scientist, which connects students to STEM professionals through snail mail to broaden students' awareness of what STEM professionals look like and do at work. And the other is to Squirrel Mapper, a community science project that helps researchers identify populations of squirrels and their morphs. Why? They ask. Because "Together we can crack this nut!" So, find out more at [PreScientist.org](http://PreScientist.org) and [SquirrelMapper.org](http://SquirrelMapper.org). And those donations were made possible by sponsors of the show.

*[Ad Break]*

Okay, your questions. Let's start with one about goth squirrels, shall we? Asked by Cooper Moore, Kyla Murphy, and Clay Mohrman who says: I've seen a ton of melanistic gray squirrels in Ohio and Toronto but none in New England, what's the deal? And Jess Chrzan has seen them in central Illinois but almost none in and around Chicago. Huh!

**Alie:** Populations, pockets of squirrels like the all-black squirrels in DC, the Canadian black squirrels, how did they get to DC? And also, LA, not supposed to have a lot of fox squirrels and yet here we are, they're everywhere. How did these Canadian squirrels get to DC?

**Karen:** People love squirrels, so they move them everywhere. [*Alie laughs*] That's the easy answer. I'm here in Ohio and the very classic answer is that a man went on vacation in Canada, found these black squirrels, fell in love with them, caught 10 of them, brought them back, and released them.

**Alie:** Oops.

**Aside:** So, like anything having to do with love and smuggling, it's complicated. But the Smithsonian in Washington says that it has the receipts dating back to the year 1900 when the superintendent of the National Zoo, one Frank Baker, was thirsty for the squirrels that Canada had and got about 8 or 10 of them sent. They were the talk of the town at the zoo in Washington DC. Six years and a few litters later, they were like, "Listen, the gray squirrels here in Washington are getting hunted too much. What say you to a little city upgrade by releasing a few of these melanistic ones, just on the zoo grounds?" Of course, that didn't go as planned, nature finds a way, so the squirrels that you see in parts of the northeast, sporting this lustrous jet-black fur, are technically gray squirrels.

**Karen:** It's a single gene. If you're missing one little part of your gray gene, you become this dark black squirrel. If you get both copies, you're black, if you get one copy, you're more grayish and you're missing your white belly and things like that. But certainly, when we had black squirrels here in Ohio, they are coming, moving down from Canada and dispersing down. Once the trait gets into the population, it just spreads. It's a dominant trait, so if you get one gene, it's going to be expressed. So, we see them more and more and more. I'm willing to bet that there is probably some thermoregulation advantage, but no one really knows why.

**Aside:** Listen, I know not everyone has a thermophysicologist that they can text on a whim, but I hit up my friend Dr. Shane Campbell-Staton of the Thermophysiology episodes and he said:

*I would imagine being able to absorb more heat from the environment during a time when heat is at a metabolic premium, like winter, would have clear benefits. However, there is also a trend called Gloger's rule that says mammals should get lighter toward the poles. Ultimately, it probably comes down to which aspect of the environment is the biggest challenge.*

And sure enough, yup, research has shown that black mammals have 18% lower heat loss in temperatures below -10°C. And also, when it comes to these squirrels, the darker morphs may survive the city better because researchers say they're more visible to drivers who are looking to avoid squirrel murder on their way to the post office. But remember, this morph didn't evolve to live in this part of the continent.

And now also is a great time to plug Dr. Campbell-Staton's new and really stunning PBS show called *Human Footprint*, which just premiered a few weeks ago. I've known he was shooting it for years, I'm so excited for you to see it so I'll link it on my website. It's called *Human Footprint* on PBS; you can look it up. But yes, any melanistic squirrels in DC are likely descendants of Frank Baker's quest to populate the nation's capital with pretty little squirrel babies.

**Karen:** People always say that they're smaller, or they're meaner, or more aggressive, and I've not seen any of that. In my studies, they weigh the same as gray squirrels. I've definitely seen litters that are mixed black and gray.

**Alie:** [*squeals*] Maybe different dads?

**Karen:** Possibly different dads.

**Alie:** I mean, mm-hm.

**Karen:** But yeah, you know, it's just brunettes versus blondes.

**Alie:** Al Hamm is a first-time question-asker who appears to know a little bit about this and asked: Are the black squirrels introduced to several areas of the USA (Kent, OH, Holland, Mi, some areas of AZ, et cetera) are they considered feral because they were maybe escaped pets? Or does that even matter at the end of the day?

**Karen:** Most of the time it doesn't matter. So, gray squirrels, whether they're black or gray, have been introduced all over the world and they typically will cause trouble wherever they go. They are able to outcompete most of the other squirrel species and we don't have a really easy answer as to why that might be. But people just love squirrels so they take them and introduce them to places where they really shouldn't be.

And places like California where there is a western gray squirrel, the western gray squirrels are getting outcompeted by the eastern gray squirrels; same kind of thing in Arizona; same kind of thing in England, in Italy. There are reports of eastern gray squirrels in the hazelnut farms. [*I love it, I love it, I love it.*] That's a problem economically, and then if they are able to somehow get over the Alps, they'll be into Asia and then can easily spread all over Asia. So, there are a lot of management concerns with people releasing "pet" gray squirrels and there are lots of conservation organizations looking to rein them back and control them and manage those populations.

**Alie:** I've never thought about if you've got an almond or walnut orchard. Do they just not like the tannic hull of those nuts?

**Karen:** It's so much better. Why would you eat an acorn when you could eat an almond, or a walnut, or a peanut?

**Alie:** So, then I wonder what almond farmers and stuff do about that? I definitely see a lot of owl boxes near orchards which... you know.

**Aside:** Okay, so I did look this up and a catacomb of webpages led me to something called UC Integrated Pest Management program which said, deep plowing, also known as ripping, along perimeters of fields will destroy burrow entrances and will help slow the rate of ground squirrel invasion in orchards. They also say, "Burrow fumigants, toxic baits, and traps currently are the most effective control methods."

And I feel like I say this all the time, but on the topic of human footprints, even the most well-meaning diet still affects the ecology. It just does, I have no answers for you, just an urge to have perspective. Okay, moving on.

**Alie:** I thought this was an absolutely unhinged question and I'll ask it, Kate Webb, first-time question-asker says: There are species of flying squirrel in Michigan that fluoresce?

**Karen:** Yes! We didn't know that until just a few years ago. No one had any idea and they accidentally turned on a black light and it was like, "Oh crap, this is bright pink, bright purple." It's pretty amazing.

**Aside:** For more on this you can see the paper, "Using mass spectrometry to investigate fluorescent compounds in squirrel fur," which will treat you to the visual of this fuzzy, furry, flying squirrel, cradled in the palm of a researcher, exposed to black light, and the squirrel's belly looks like a neon pink hallucination. Why is this happening? Well, like many things, no one knows shit. But some sciuridologists hypothesize that fluorescent coloration on their bellies may help camouflage flying squirrels against predators that are UV detecting like owls because there are plants and lichen that also glow similarly. Also, might be for mating. Might be a communication tool. As a human, you would need a cannon event-level breakup and a quart of Manic Panic to achieve it. It's amazing. 12/10.

**Alie:** That is like the Bob Marley poster that no one knew they needed. Is there any reason why these squirrels would fluoresce? Kate Webb wants to know.

**Karen:** I mean, they can see each other, other things can see them, or not see them. The amount of UV radiation that happens at night is very different than what happens during the day. The types of eye receptors and things like that.

**Alie:** Do you think that they are better equipped to see that with night vision?

**Karen:** Yes.

**Alie:** [*gasps*] Which brings me to Madison Hunter's question, says: Not sure if you will cover flying squirrels but I had one as a pet when I was in middle school and noticed it was quite active at night. I would usually play music to sleep, and I often caught it doing what appeared to be dancing to the music. [*Karen laughs*] Do you think it is possible that squirrels get down? [*"Let's boogie."*]

**Karen:** I've never personally seen it. I don't want to say that it couldn't possibly, but I've never seen it. [*laughs*]

**Alie:** And what about the nocturnal versus diurnal? Is it totally dependent on the environment and the squirrel?

**Karen:** So really, there aren't very many tree squirrels or ground squirrels that are nocturnal, usually it's the flying squirrels that are nocturnal.

**Alie:** Ohhh! And those again, in Leila Laco's words: Are flying squirrels closely related to 'walking' squirrels, or is that name just a misnomer?

**Karen:** It's just a total misnomer. They don't fly at all, they glide. They have no capacity to actually gain lift by flapping or anything. They literally are just taking advantage of the ability to get from Point A to Point B much faster by gliding than by going down the tree, running across the ground, and going back up the tree.

**Alie:** But them is squirrels?

**Karen:** Yes, absolutely.

**Aside:** So, everyone such as Donia Conn, Irena DeZazzo, Erin Gunderson, Brittany Shafis, Frances Hurst Brubaker, Kimberly Bryant, Hudson Ansley, and The Squirrel Queen who asked about flying squirrels, the expert word is...

**Alie:** So, the flying is a no, the squirrel is a yes.

**Karen:** Yes, yes. [*laughs*]

**Alie:** [*laughs*] Okay, good to know. Oh my gosh. I've never seen one in person.

**Karen:** You need to go to Japan. One of the questions I almost always get asked is, "What's your favorite squirrel?" They're like children, you cannot pick a favorite child. But if you're going to press me, I will typically tell you it's the two Japanese squirrels, the Japanese pygmy dwarf squirrel, which is a teeny-tiny little puffball, and musasabi. Musasabi is an 8-pound flying squirrel.

**Alie:** What?! That's a baby! That's the size of an infant human!

**Karen:** It's like the size of your house cat. So, when it glides over your head, it's like somebody has hurled a trash can lid over your head. Speeds up to 35 miles an hour, when they hit the tree, when they land, you can just hear this slam, and then you hear them climbing up and then they'll take off again. So, I want you to picture a group of researchers in a very sacred Japanese shrine, at 2:00, 3:00 in the morning, with our red headlamps on, running from tree to tree as we try and follow these

musasabi. I was for sure, like, there are going to be headlines, “American squirrel researchers arrested...”

**Alie:** *[laughs]* Well, someone asked if there was a black squirrel lab breach conspiracy, AZM. Have you heard that they escaped from a lab? Is there a conspiracy about this?

**Karen:** No, and generally speaking, taking squirrels inside is not always a good thing. They really do chew everything. I would not want a lab full of squirrels in any way shape, or form. “Squirrels stay outside,” is what I always tease my students.

**Alie:** If you had a pet male squirrel, would it be so horny all the time? Because that must be why they have giant balls right?

**Karen:** Right. There would definitely be points where it would be super aggressive and wanting to be outside and things like that, absolutely. People who keep squirrels as pets generally don’t keep them for very long because once they get to that point, they are just aggressive, and bitey, and want out.

**Alie:** Well, you’ve been in academia a long time, and you’ve been researching squirrels a long time and we had a ton of people, who I will list in an aside...

**Aside:** Including Adrienne – who works on an elementary school campus and whose students have become obsessed with “crime squirrel”, one who rifles through their backpacks – and patron Alex Joseph, whose friends have “college squirrel trauma” and Mary Concannon, Nathalie Jones, Chelsea-Victoria Turner, Cassandra Graftstrom, Terra Tiger Studio, RJ Doidge, Emily Stauffer, and Kyla Murphy...

**Alie:** ... want to know about college squirrels. They want to know: Why are they so big? One says: What’s up with U of M squirrels? RJ Doidge says: I dare say you haven’t seen Rutgers’s squirrels? Emily Stauffer: What is up with squirrels on college campuses, they seem to never have a fear of people? Nathalie Jones says: I’ve seen a college campus squirrel drag a whole bagel away. [*“Stop, don’t. Come back.”*] What is it about college campuses and squirrels?

**Karen:** I mean, they’re diurnal, college students are mostly diurnal, *[both laugh]* so they just go kind of hand in hand. I think because they are so charismatic, people feed them all the time. I can tell you that the squirrels on my campus are 20% larger than if they were, just, out somewhere else and people know that I study squirrels on campus, I’m well known, SqrIDoc is well known, but people still will feed squirrels. There is an Instagram account that is not run by me just for our campus squirrels and I sometimes get salty with them because I will submit good pictures and they are not chosen to be featured on the Instagram feed.

**Alie:** How dare? How dare?! Patricia G notes that they found a squirrel eating a hotdog bun in a tree a few weeks ago. Just the idea of them eating a whole hotdog bun. Chandler Witherington wants to know: How do they not get poisoned when they eat mushrooms? Do they ever get high? How do they know? I can’t forage for mushrooms, and I have a computer in my pocket!

**Karen:** *[laughs]* So, they do eat mushrooms that would be poisonous to us, so they clearly have a different digestive system, processing system than we do. They probably do occasionally have psychedelic mushrooms. I’ve seen videos of squirrels drunk after they’ve eaten pumpkins or apples or things like that that have fermented and have alcohol in them, and they can’t climb up a tree very well, they keep falling off and falling over, lack of coordination.

**Alie:** Do you think they’re having fun, or do you think they’re like, “What the fuck? Why is the tree moving? Why is the tree spinning?”

**Karen:** Both.

**Alie:** Probably both.

**Aside:** Sometimes, it's a fermented pumpkin, sometimes it's a fizzy crabapple, and sometimes it's standing under a keg like a rainforest shower, reported by Buzz60.

*[clip from Buzz60 report:]*

*Operators of the Honeybourne Railway Club say when they opened up, they found beer spilled all over the floor, glasses knocked off the shelves, and bottles scattered everywhere. Employees thought they'd been burgled but then the culprit staggered into view, a slow-moving squirrel still apparently intoxicated from lapping up the fruits of his destructive rampage.*

So, it happens, and this is why squirrels don't have driver's licenses. Sad.

**Alie:** Jess Donald wants to know: How many nuts can they fit in their mouth? Apologies if that sounds inappropriate. How big are their face purses? When it comes to their ludicrously capacious face, how much can they fit in there or do chipmunks really have that down?

**Karen:** Chipmunks really have that down. Squirrels still have pouches, and they can pack some good food in there, but chipmunks are the ones really who have that big, expanding piece. I do catch chipmunks in our traps and my favorite thing is when you grab them, the first thing they do is regurgitate all that's in their mouth, and it all just, like, *[mumbles]* just falls out. Like, "I am so sorry, you can have this later, I won't take it. You can come back for it. I'll leave it right here." And better yet, or worse yet, depending on how you think about it, because I use peanut butter to play the trap, they will have their cheeks stuffed with peanut butter so then it's like the playdough factory, peanut butter being squished out.

**Alie:** They're like, "Just take it, just take it."

**Karen:** "I don't want this."

**Alie:** Nick Mikash wants to know: Did squirrels invent maple syrup? Have you heard this?

**Karen:** No. Certainly, they will eat sap, certainly, they will pull the outer bark off and eat the inner cambium, and things like that, particularly when there's not a lot of food to eat. So, maybe you could say that they have longtime taken advantage of that resource.

**Aside:** What? It's true. According to the *Journal of Mammalogy* paper, "Maple Sugaring by Red Squirrels," in which Dr. Bernd Heinrich writes that red squirrels make a tap via a single pair of chisel-like grooves from one bite into the sappy xylem layer of maple trees. But...

*The dripping dilute sap was not harvested. Instead, the squirrels came back later and selectively visited the trees that had been punctured, after most of the water from the sap had evaporated.*

Yes! So, they found this all over Vermont and Maine, and the Haudenosaunee legend credits squirrels with teaching Indigenous folks how to tap and evaporate maple sap. So, waffles, brought to you by squirrels.

Oh, speaking of food and water, patron Iris Hutchings had a question about what happens when squirrels get thirsty?

**Alie:** Where are they drinking water from actually? Do they get it from the plants they eat?

**Karen:** From everything that they eat.

**Alie:** Is it a good idea to set up a little water feature fountain?

**Karen:** You can, they usually won't drink from it though.

**Alie:** So, don't get your feelings hurt if they don't.

**Karen:** No.

**Aside:** And this one about squirrel memory was on the minds of Popita, Diana Teeter, Alexandre Catulle, Anke Lausch, Laureen Evans, Taylor Faulkner, Jeff Berg, and Alex Keeley.

**Alie:** A ton of people want to know: How do they remember where they hid their food? Do they have that kind of memory year after year?

**Karen:** Probably not year after year because most of the resources are probably gone within a year. We do know that the size of their hippocampus, which we know is used in spatial memory, does increase in the fall when acorns are present. There's research that clearly shows that. I was part of that as an undergrad as well; the size of the hippocampus in spring versus fall, it's much larger in fall, for them to try and remember. But that's a great question. It's one of the things that my lab has just started to try and take on. I have some hypotheses that say that some species of squirrels are probably... I don't want to say that they're better at remembering but probably better at relocating scatter hoards of acorns and things like that.

**Aside:** Also, in case you think scatter hoarder is an unnecessary insult, it's not just a way to say that you're a mess, squirrels, it's just a mammalogy sciuridology term for hiding your shit in a few different places, which is a thing you might do with lip balms or money except it's lunch and it's in the dirt.

**Alie:** A few people including Amanda and Chase Penix want to know... By the way, I just want to say, never in 350 episodes of this podcast have I gotten so many questions that start with a story, and that is the best. *[Karen laughs]* Amanda says: I have a squirrel that comes to my window and waits patiently until I give it nuts. It looks like she gets excited when she sees me and recognizes me. Can squirrels recognize individual humans like crows can? And Chase and others want to know: Do they remember friendly faces? Or are you a vending machine?

**Karen:** I don't think so but I'm willing to bet that her behavior is the same every time and so she recognizes the same behavior.

**Alie:** Madison Hunter and some other people...

**Aside:** Also, WildPackOfDogs, Nicole D-G, Dave DeBaeremaeker, and...

**Alie:** ... first-time question-asker Julia Suomela wants to know if you've seen Mark Rober's squirrel obstacle course videos?

*[clip from Mark Rober's Squirrel Olympics video:]*

*So, the first challenge is the bridge of instability. This may look easy, but the trick is, it attaches at a single point on each end, and from a physics standpoint, that makes it no different than trying to crawl across a tightrope.*

**Aside:** So, these videos went up during the early pandemic and they feature a backyard squirrel, well several, going through what is described as an *American Ninja Warrior* course to reach a bird feeder. These videos have racked up hundreds of millions of views.

**Alie:** How do you feel about them?

**Karen:** I mean, it's awesome and I love that, I love when people ask me about... They'll describe their entire setup of bird feeders and things like that, it's so great. And it just shows really how smart they are and spatially conscious. And then he has the whole piece about when they get launched that they

always do land correctly and you can really easily watch how they use that tail as a rudder in there and everything. So, it's just perfect, it's great. People do this all the time, they'll be like, "I have this spring and then I used Vaseline and I greased this, and this is far from here, and they have to do this and go here," and yeah, it's amazing.

**Alie:** Everyone, I guess with a backyard...

**Aside:** Looking at you Katie Courtright, Ann Eby, Sage Scarberry, Grace Robisheaux, Katie Armstrong.

**Alie:** ... wants to know: How do we keep the birdseed safe? Jenny Lowe Rhodes wants to know: Why do they eat ALL the birdseed? And ReigningEmily asked this question: So, my grandfather is constantly at war with squirrels because they eat his birdseed. Is it bad for squirrels to eat birdseed or just some beef that my grandfather has with the squirrels? And I was like, "Emily, I hate to tell you, I think your grandpa is just Team Bird, here." But is there anything bad about bird seed or it's just that they're taking from birds?

**Karen:** No, it's just yeah, there's nothing bad about birdseed or things like that. My answer, my best answer, so listen up, is hot pepper birdseed. Go someplace that sells specialty birdseed, get the hot pepper birdseed, it'll stop the squirrels from eating it, it'll stop the deer from eating it, it'll stop the raccoons from eating it. And then once you've dissuaded them that the birdfeeder is not where they want to be, then you can mix 50/50 hot pepper birdseed and regular birdseed and maybe go back to regular birdseed until they figure it back out again and then you have to go back to the hot pepper birdseed. But that is my only... it's my best advice.

**Alie:** And that's nature. That's just, birds can't taste it so... We did a chickens episode recently about putting red pepper flakes in your chicken feed. Not only are the squirrels like, "Hell no," but also, you get really beautiful orange yolks. But it does bring me to a question a lot of people want to know.

**Aside:** Such as Cynthia Conner, Katherine Finney, Megan Guthrie, Maya, Jeri Webb, Pascal Perron, and Jackie Ross.

**Alie:** How does one protect their gardens? As much as they love them, Allison P, first-time question-asker: How do I get squirrels to stop stealing my sunflowers? Katherine, apparently squirrels are digging up their vegetable garden. Heather Heater did call them furry terrorists. Jackie Ross: Is there any real way to stop them from eating your plants?

**Karen:** Nope, world domination for sure.

**Alie:** [laughs] What about a net? Get a net?

**Karen:** I mean sure, you can try a net to keep them and the birds out but they're pretty smart and they can usually get between the fence and the net, unlike the birds who just go for the top. So, it's hard, especially if you live someplace that has ground squirrels, groundhogs, or woodchucks, you're in trouble.

**Alie:** Well, they got some judgment from people who wanted to know: Why do they taunt us by not eating the whole thing?

**Aside:** Camille Charlebois, RIP to your half-eaten tomatoes and...

**Alie:** Nina Giacobbe says: Why do they taunt me by leaving half-eaten strawberries on the edge of my garden? Marijke: Why do squirrels leave treats and leftovers on my windowsills? Why do they not finish?

**Karen:** I have complained about this too. They will eat one bite of a tomato and put it down and reach for the next one and eat the next bite of the tomato. So, it's not like they respect me either. I think it comes from that natural behavior to not eat the whole acorn, not eat the whole seed. They'll eat the top half of the acorn because it has less tannins, so it means more protein for them, and then drop it and move on to the next one. Because it is so abundant, we could use our marginal value theorem to talk about optimal foraging, that it's just better to take the best bite and move on.

**Aside:** Take the best bite and move on, people. Horrible strategy for humans, works good for squirrels.

**Alie:** Who can be so frustrated with them? Who doesn't, I guess, want to just go to a smorgasbord, try a little nibble of everything I suppose.

**Karen:** Eat the best part of the strawberry and just you know, dump the rest of it.

**Alie:** Stephanie Coombes wants tips on keeping them out of her shed aside from rebuilding it. If they trap them, will they come back? And again, a great story but in terms of hiding mushrooms, apparently Stephanie's rubber boots were filled this year with mushrooms, which is so cute. But if you wanted to keep them out of a structure.

**Aside:** Such as attic squirrel having Hannah Nolen, and James Nance, and Kness, and Sydney I, and Abby Grieb, who struggles with garage squirrels.

**Karen:** You need to make sure there's no way they can get in. Block up any holes or entrances or things like that because if you don't take them *very* far away, they will most likely come back.

**Alie:** Art\_By\_Di has a weird one [*"Bring it on"*]: My neighbor had a squirrel one-by-one steal all the bulbs off her string of deck lights, chewing them off at the cord and then just running away with them. Have you ever heard of this?

**Karen:** Yes, and I don't know why. So, their incisors continue to grow so they have that need to continue to gnaw for their entire lives to keep their tooth-wear down. There definitely are some plastics that seem to be more favored than others. So, I don't know what the component of the plastic is. I can tell you, on our campus they bought some of the recycled plastic picnic tables that are supposedly made from corn cobs, apparently, those are very tasty. Any hole or break or anything, squirrels are just in there gnawing and chewing. I don't know if it's because it's ever such a slightly softer plastic or if there is actually something tasty leftover in that corn plastic.

**Alie:** Well, I've got to say, I had a Prius, horn stopped working out of nowhere. I took it in and said, "What's up with my horn? Let me know if you find any dead raccoons in there, LOLOL." They call me back and they're like, "You've got a nest in your car." They cracked open my hood, half an orange, a bunch of snail shells, and apparently, the wire harness in Toyota Priuses is lubed with soybean oil and it is scrumptious. You've heard, I'm sure you've heard this a lot, right?

**Karen:** Yeah. That soy plastic so...

**Alie:** Augh! It was so cute but there was also so much poo and I was like, "You guys!"

**Karen:** That almost sounds like...

**Alie:** Rats?

**Karen:** Right.

**Alie:** Yeah, it's probably rats. Okay, squirrels, you're off the hook. Another reason I love Patreon questions is because this, I did not know. A lot of people...

**Aside:** James Hales, Ama Craig, Sydonie S,

**Alie:** In Iris Hutchings' words: Is it true that red squirrels will chew off the gonads of gray squirrels to decimate the gray squirrels' population? Is that true that they castrate each other with their mouths??

**Karen:** Never.

**Alie:** Never?!

**Karen:** No. Red squirrels are definitely far more aggressive than gray squirrels or fox squirrels. I generally say, my rule of thumb is, the smaller the squirrel the more aggressive, or the larger the squirrel the more dopey it is. But no, there's none of that happening. So, if there are red squirrels around, they will typically chase off the gray squirrels and fox squirrels but there's no interaction like that.

**Alie:** Augh, flimflam busted.

**Karen:** So, I think sometimes people kind of misjudge that because when males are sexually active, you can clearly see their testes, they're rather large. [*"You've got a set of balls."*] But when they're not sexually active, those testes regress back up into the body cavity, so then you don't see them.

**Alie:** Ohhh! So, they put them into retirement.

**Karen:** Yup!

**Alie:** Okay! Well, that's good because I was about to... That blew my whole mind but as long as you're busting flimflam, let's talk TikTok. Amanda Lask, first-time question-asker, and a bunch of other people...

**Aside:** Matthew Whitman, Lene Olszeth, Laurel, Jenn 'Squirrel' Alvarez, Amy DuCre, Steven Shelley, and Danielle Zonis all asked about TikTok user @AndyWych's February 2023 video that apparently demonstrated some kind of squirrel mind control by undulating an outstretched arm toward a squirrel on this suburban street. Andy Wych, how literal is that last name? Because I love it. Also, what? And why? How?

**Alie:** What the hell is up with the wave hand motion thing that is supposedly mind-controlling squirrels? Do you know what I'm talking about?

**Karen:** [*laughs*] I know completely what you're talking about.

*[clip from aforementioned TikTok:]*

*Want to learn a cool life hack of controlling squirrels? You could actually control squirrels by using your hand in a wave motion and you can see that the squirrel comes toward me. I learned this from a friend who was in the squirrel club. So now, the squirrel is super close to me, you can do this on all squirrels. Be careful.*

I had to try it because I was like, "I've never seen this, I have no idea." I've had zero luck, so I don't know what this is. The only thing I can think of is that it mimics the giving of food so maybe squirrels who are in urban parks who are used to being fed by humans recognize that, kind of, up and down motion. But I don't have another explanation.

**Alie:** Well, as long as we're communicating with appendages, Chris Whitman, Jeanette Moss McCurdy, Megan Guthrie, they want to know, in Chris's words: What does the fast tail twitching mean? What are they communicating with their tails?

**Karen:** Typically, when it's flipping back and forth it's a predator alarm call, it's a visual predator alarm call.

**Alie:** Okay. If they're twitching and screaming at you, they're like, "You're going to kill me, get out of here, I hate you." [*"Stranger danger!"*]

**Karen:** "I'm telling everybody around me that there's a predator here."

**Alie:** They're trying to cancel you, is what they're doing. Because we could kill them...

**Karen:** "I see you."

**Alie:** We are predators. Squirrel hunters are out there. Have you ever eaten squirrel?

**Karen:** Not knowingly. I feel like that's a line you can't cross. I'm sure that somebody has fed it to me at some point but not knowingly.

**Alie:** [*softly*] Do you have any enemies? Do you think anyone has done it just to spite you?

**Karen:** No, not that I know of but I'm sure somebody would think that that would be a welcoming kind of thing.

**Aside:** And if your toes curled and your throat seized hearing that, I do have some historical news. A lot of humans have been eating a lot of squirrel, for a long time. Squirrels have been called the "Chicken of the trees" and in some cultures, squirrels are considered kids food, truly the chicken nuggets of the woods. And there are 1.5 million registered squirrel hunters in the US. Many ecologists and chefs praise squirrel hunting as more humane and less ecologically devastating than factory-farmed meat and a potential control of invasive species of squirrel. It's also, from a taste perspective, said to have a nutty, gamey quality that can be swapped out for rabbit in some recipes. You know, President James Garfield, he liked this protein source so much that the *1887 White House Cookbook* features a recipe for squirrel soup and that involves lima beans, potatoes, tomatoes, corn, butter, celery, parsley, and the use of a coarse colander, "So as to get rid of the squirrel's troublesome little bones," the recipe concludes with a self-review, "Very good."

**Karen:** Squirrel hunting is a million-dollar-a-year business in Mississippi, it is a hugely popular pastime, so it is a reason for management of the squirrel population to keep numbers high so that people do have access to them. The squirrel that was introduced on Mt Graham was introduced purely for hunting purposes so that people would have a squirrel to hunt.

**Alie:** Oh, wow. Until we did a mountain goat episode, I didn't realize exactly how much, obviously, conservation effort is also like, "We've got to crunch some numbers so we can figure out how many it's cool to kill," which is better than not crunching the numbers. But historically, a lot of conservation is also paid for by hunting licenses too, so it goes back and forth. I think that there maybe might be a notion that if you hunt this animal, you don't care about their well-being but it's way more complicated. We covered this in a deer episode too, but I feel like there's a very urban and rural divide where it's, like, if you go out and hunt any animal, you are a sociopath, but it's absolutely fine to have bacon at a diner in the city, you know?

**Karen:** Right, right. I get asked questions all the time by squirrel hunters, they want to know better ways to find squirrels, catch squirrels, and things like that. I also get asked by fishermen about squirrels because squirrel fur is used in a lot of fishing lures, so fly-fishing lures.

**Alie:** What about Jacqueline Whelan, Katie Armstrong, and Vita Trincali want to know, in Katie's words: Is it true that a squirrel has a range of about 10 miles, and it can find its way home if you find it 10 miles away and drop it off?

**Karen:** Probably 10 miles is a little far but not crazy far. Yeah.

**Alie:** Really?

**Karen:** I've definitely taken squirrels 5 miles and had them reliably come back. Particularly during mating season and things like that, males will go pretty far.

**Alie:** How are they doing that?

**Karen:** World domination. *[both laugh]* No, I mean, they spatially have good recognition. Clearly, they have some kind of, I don't want to say homing, but they clearly have some kind of spatial recognition where they can come back.

**Alie:** That's amazing. I wonder if we'll ever find out they have, like, pigeon magnets in their head.

**Karen:** Right, some kind of compass, you know.

**Aside:** And that compass might be the hippocampus which not only helps squirrels with their spatial memory to recall all that scatter hoarding, it could be at play when it comes to squirrels making their way back home, which can definitely happen when people trap, like, an attic squirrel and then drive 5 or 10 miles away and release it in a new part of town and they're like, "Phew, glad that's over." And then a few days later it's like, back at your window being like, "Wow, ghosted. Brutal." And then you have to atone to their furry little faces, which you maybe never wanted to see again. I don't know, blame their brains. World domination.

**Alie:** Megan Lynch, who was a carobologist who studies carob trees in Davis left a question about an introduced species learning to break into these tough raw pods of another introduced tree. Does one pioneer squirrel learn something and do they teach each other? How much of that communal living in squirrel dreys is teaching each other things?

**Karen:** I mean, we don't really know about social learning in terms of, like, feeding an acorn or things like that but a lot of their food has that harder outer shell so acorns, buckeyes, walnuts, all those things have that really hard carapace that they have to get through and de-shell. And so, a carob pod, to me, probably isn't all that much different than a buckeye or something like that and they really have to break off that outer husk to get to the inside piece. Those teeth are sharp, and they have a lot of pressure, they can crush a lot of things.

**Aside:** For more on carob, the not-chocolate tree with a bonkers history that might be growing on your street, we'll link that episode in the show notes.

**Alie:** Last listener question. I could literally talk to you for like 10 hours, you are so lucky that you did not get seated next to me on a flight to New Zealand because you'd be like, "I need to sleep." A good question that I didn't even think of, so many people...

**Aside:** Brittany Kaufman, MN\_09, and of course, Camille in...

**Alie:** Camille Charlebois' words: What's up with squirrel poop? I have never seen it, does it exist? Where is it?

**Karen:** It's in the grass, it's in the ground. It's kind of like Tic Tacs, like jellybeans.

**Alie:** Do they poo in their nest or is that a no?

**Karen:** Yeah, typically there is an area where they'll collect things like that, but if possible, they'll go outside.

**Alie:** Other than podcast hosts, what's the worst thing about your job? Other than me asking you questions forever because you're the best.

**Karen:** That's just it, that's not a bad part of my job. *[Alie laughs]* When I realized I could mix the genetics and wildlife piece to be helpful you could think about charismatic megafauna and how cool it would be to work on mountain lions and things like that. And then it was like, no, I could have this

charismatic minor fauna, I don't want to say micro because they're not that small, and they're not meso because they're not kind of medium, like skunks and raccoons. But you know, everybody knows them, and pretty much everybody has a love-hate relationship with them. Those are the things that make the best stories and allow you to connect with somebody and have them learn a bit about ecology and the world, and talk about things like climate change and forests, and hook somebody and make them passionate, and make just a genuine human connection and really see each other past all the other stuff. So, it's kind of nice. There really isn't a bad part.

**Alie:** But what does suck about it though? Get real with us.

**Karen:** When I was in Arizona and trapping at 110° [*Alie gags*] or on top of Mt Graham and in 10 feet of snow in snowshoes trying to find the one squirrel nest and determine if there is a squirrel. That's not always the most fun, not always the most comfortable.

**Alie:** [*laughs*] What about... have you ever had a favorite moment on the job?

**Karen:** I do. So, when I started here at Baldwin Wallace, they were very concerned that people would be worried that I was harming squirrels and PETA would be protesting and things like that. I was like, "I invite anybody who has any questions to come with me. Come trap with me, come watch the squirrels, watch what I do. You will see that I am not inflicting pain, that they are happy to be there, they're happy to have their peanut butter treat and we try to minimize any discomfort in the time that they're with us and things like that." And so, I have a film crew from a news station with me, I have university relations with me, and I have two students, and we're catching squirrels and going through.

And at some point, a summer camp realizes that there's something going on over here and wants to see what's going on. So, at some point, I look up from measuring shinbone lengths and things like that and I am surrounded by probably 30 kids, every color, size, shape, every kind of background. And they're all just watching me, just completely fascinated. And they don't know what's in the giant pastry bag and they're trying to figure that out and they're asking me questions. My students are trying to be calm and answer questions and the news is fascinated, so they're showing the kids and showing me and showing the kids.

And it's the moment that you realize, this is what you want as a scientist, this is what you want. You want to ask questions, get answers, and then have that information put out into the world. So, there's a picture of me, it's me and I have a squirrel sitting on my leg and there's a squirrel on the ground and my two students are doing things and you can see these legs, these legs of the students in the back of the picture and that's probably one of my favorite, favorite moments.

**Alie:** Ahh. This has been just such a joy. I cannot tell you the emotions I had when I clicked on your Instagram and saw the "Follow back." I was like... "KAREN MUNROE KNOWS ABOUT US!"

**Karen:** See, and I had just the opposite, the complete imposter of, like, "Why does she want to talk to *me*?"

**Alie:** No trust. I looked at your research and I was like, "This is the squirrel expert for me, I will accept no others."

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So, don't be scurred to ask smart people squirrelly questions and then just scatter hoard that information for your next dinner party. Now, you can follow Dr. Karen Munroe at @SqrIDoc, which is linked in the show notes. We also linked to the two causes we donated to in her name.

We're @Ologies on Twitter and Instagram, in case you're still on those, I am. I'm also @AlieWard on both and on TikTok @Alie\_Ologies. *Smologies* are kid-friendly, shorter episodes and those are

linked in the show notes, thank you to Zeke Rodrigues Thomas and Mercedes Maitland for working on those. Susan Hale is our managing director, she keeps the ship sailing, including dealing with merch at [OlogiesMerch.com](http://OlogiesMerch.com) where we sell shirts, and bags, and stickers, and bathing suits, and hats. You can find other ologites in the wild that way. Noel Dilworth schedules the interviews. Erin Talbert admins the *Ologies* Podcast Facebook group with assists from birthday lady, Boni Dutch and her sister Shannon Feltus. Emily White of The Wordary makes our professional transcripts which are linked for free in the show notes. Kelly R. Dwyer tweaks our website and can build yours. Mark David Christenson and Jarrett Sleeper of Mindjam Media assistant edited this and lead editing was performed by Mercedes Maitland of Maitland Audio who also produced this episode alongside us. She does so much for the show I cannot thank her enough and she does it all the way up in her cozy Canadian drey. Nick Thorburn wrote the theme music.

And if you stick around until the end of the episode, I tell you a secret. This week it's that I am still sick with pneumonia. I'm recording this in bed, where I've been for the last 12 days, and I keep getting a lot of messages being like, "Don't work! Don't work! Don't work!" and I'm like, "How do I not?" But also, I love this job, and let's be honest, I'd probably be researching squirrel brains anyway. But I'm on the mend and that's good. And another thing I've been doing in bed is I have this workbook that my therapist gave me, it's on self-compassion. It was written by Kristin Neff I think, and I'm making notes in the margins and doing the exercises and having compassion for yourself, if you're not used to it, is *hard* at first, but I'm learning, I'm learning every day. So, if self-compassion is something that you struggle with, might I suggest a workbook on it because hey, our little squirrel brains, we love to learn things. Every day can be a little bit better than the last. All right, okay. Berbye.

*Transcribed by Aveline Malek at [TheWordary.com](http://TheWordary.com)*

### **Links to things we discussed:**

Follow Dr. Karen Munroe on [Instagram](#) and [Twitter](#)

Donations were made to: [Letters to a Pre-Scientist](#) and [Squirrel Mapper](#)

[Shadow Tail: The History of 'Squirrel'](#)

[Squirrel goes NUTS at Yankee Stadium, scurries across outfield fence!!!](#)

[Predicting the spread of the American grey squirrel \(\*Sciurus carolinensis\*\) in Europe: A call for a coordinated European approach](#)

[Invasive species with charisma have it easier](#)

[Do Squirrels Eat Meat? {Birds, Mice, Lizards and Snakes!}](#)

[Tannins and Partial Consumption of Acorns: Implications for Dispersal of Oaks by Seed Predators](#)

[One paw washing the other: Oak trees and squirrels have evolved to help each other](#)

[Researchers Tackle The Nutty Truth On Acorns And Squirrels](#)

[Grey Squirrel Food Preferences: The Effects of Tannin and Fat Concentration](#)

[What's a cotyledon?](#)

[Caching for where and what: evidence for a mnemonic strategy in a scatter-hoarder](#)

[Cache protection strategies of a scatter-hoarding rodent: Do tree squirrels engage in behavioural deception?](#)

[What controls the caching behaviour of squirrels & how do they find their buried nuts?](#)

[Tracking rodent-dispersed large seeds with Passive Integrated Transponder \(PIT\) tags](#)

[Some woodland metal detecting sounds](#)

[Baby Squirrels Nesting | Wildlife On One | BBC Earth](#)

[Squirrel Nests & Refugia](#)

[Squirrel Nesting Boxes on Etsy](#)

[Fauna of Australia](#)

[Japanese And Siberian Flying Squirrels Are Probably The Cutest Animals On Earth](#)

[Musasabi squirrels flying](#)

[Mating plugs](#)

[Removal of Copulatory Plugs by Female Tree Squirrels](#)

[Squirrel Noises and Sounds: Barks, Screams, Chirping-What Do The Calls Mean?](#)

[Rabies in rodents and lagomorphs in the United States, 1995–2010](#)

[You do not need to worry about the bubonic plague squirrel](#)

[Casa Grande Ruins National Monument - National Park Service](#)

[White House, black squirrels: How 8 'desirous' Canadian rodents ended up overrunning Washington](#)

[Western Foundation of Vertebrate Zoology](#)

[Scientists identify two new species of a big, strange flying squirrel](#)

[These 6 Baby Squirrels Accidentally Got Into a 'Rat King' Situation](#)

[The secret lives of squirrels being researched at Baldwin Wallace University: Animals in the News](#)

[Joint tail and vocal alarm signals of gray squirrels](#)

[The Mt. Graham Red Squirrel Research Program](#)

[Marvel Characters: Squirrel Girl](#)

[Marvel's Squirrel Girl: The Unbeatable Radio Show](#)

[Milana Vayntrub Finally Gets To Be Squirrel Girl In A New Marvel Podcast](#)

[Thermogenic Capacity in Gray and Black Morphs of the Gray Squirrel, \*Sciurus carolinensis\*](#)

[Human Footprint on PBS with Shane Campbell-Staton](#)

[White House, black squirrels: How 8 'desirous' Canadian rodents ended up overrunning Washington](#)

[Maple Sugaring by Red Squirrels](#)

[Liars in Fur Coats](#)

[Using mass spectrometry to investigate fluorescent compounds in squirrel fur](#)

[Traditional Animal Foods of Indigenous Peoples of Northern North America: Tree Squirrels](#)

[1887 White House Cookbook](#)

[2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation](#)  
[Rack of squirrel, anyone? The chefs putting invasive species on the menu](#)  
[Natural Selection Favors Black Morph of Eastern Gray Squirrel in Cities](#)  
[Secret of the squirrel brain: Memory tricks investigated in new UC Berkeley study](#)  
[Radcliffe scholar tracks squirrels in search of memory gains](#)

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