Smologies #36: FEATHERS with Dr. Allison Shultz
Ologies Podcast
January 20, 2024

Oh hey, it's that rock that you found at the lake that for some reason just said, "Hey, put me in your pocket," Alie Ward. And welcome to the *Smologies* episode of Feathers, very exciting. What is *Smologies* by the way? If you've landed here, *Smologies* are shorter, classroom-friendly, kid-safe episodes you can listen to for all ages, kind of like digests you can listen to with the family. If you want the full episode, it's linked in the show notes, but this one, we made safe for you and your kids. You're welcome.

Okay, let's get into it. Plumology, did you know this was a thing? I did not. So, it comes from the Latin for 'down' or for 'first beard', and later, 'plume' came to mean like, a stream of smoke. So, we're talking all manner of feathers. Oh, feathers! Now, I have already covered ornithology, it came out in November 2019, but I was thrilled when this ologist at the Natural History Museum of LA suggested, via email, that there were many, many more sub-ologies with feathered friends including them dang feathers themselves. So, I made haste to the museum one sleepy Wednesday afternoon right before they closed for the day, and I met up with this ologist, who was wearing a flowery blouse and a museum ID on a dangling lanyard, and I asked her all the quilled questions that would rattle out of my dome, as well as yours.

So, shake off the dust, and get ready to soar the sky and learn about what makes a feather a feather, how they evolved, why they're important, the longest bird tail, peacock plumes, iridescence, the blackest black, tiny feathers, huge ones, dinosaur myths and mysteries and more with feather researcher and professional plumologist, Dr. Allison Shultz.

Alie: Now, you are a plumologist?

Allison: Yeah! So, I'm a plumologist, I study bird feathers and how they evolve, and kind of more specifically I think about the colors of feathers but the structure, the development, all that is integral into the whole picture.

Alie: Do any other living animals on the planet have feathers that aren't birds?

Allison: No living animals.

Alie: Okay, okay.

Allison: So, actually, we used to think that that was one of the defining characteristics of birds, was feathers, but once they started finding feathers in all of these non-avian dinosaurs, that became not true anymore. So now, we know that feathers evolved long before birds did.

Alie: And all birds are dinosaurs?

Allison: All birds are dinosaurs, yes. That is true.

Alie: That still, like, rocks me. Living dinosaurs. So, okay, feathers. Is a feather like a modified hair? What's happening?

Allison: That's a great question. They're somewhat related to hair since they're made out of keratin and they're an external structure that grows out of the skin but they're actually much more related to scales. [*"What?"*] So, both feathers and hair are made out of keratin but different kinds of keratin.

There's this kind of keratin called alpha-keratin that mostly makes up hairs and our fingernails and like, mammalian structures whereas beta-keratin is what makes out bird feathers and actually, reptile scales and stuff like that.

Aside: Okay, quick aside. Beta-keratins are the proteins that make reptile and bird scales tough and waterproof, but they are not to be confused with beta carotene, which is a pigment that makes fruits and veggies orange. Now, beta-keratin, again, is in birdy scales and beaks and claws and feathers, which evolved from scales. Imagine something like an alligator scale splintered into thousands of fluffy shreds, selected through millions of years. Boom. You have feathers. Well, you don't. But birds do.

Allison: And feathers and such complex structures that we do think that they first started off as kind of very simple, almost hairlike structures and then evolved these more and more elaborate structures.

Alie: And so, do you think they were more like quills? Like a porcupine quill?

Allison: No. They would have been soft. They would probably look a lot like fur.

Aside: So, a bunch of dinos had fur-esque proto-feathers and they were stomping around like big, fuzzy Muppets and even before *Archaeopteryx* – which was a raven-sized, feathered, avian dinosaur, long considered history's first bird – flight feathers were all over the place in dinosaurs. Anyway, the feathers came first and then the flight.

Allison: Feathers, you think of them as being really important for flight, which of course, they are. But evolved long before flight did so they actually didn't evolve for flight, they were co-opted to be used in flight.

Alie: So, walk me through the anatomy of a feather. There's like, the main shaft, almost like a leaf has a vein, and then the ones off the side... What's going on?

Allison: Yeah, that's a good question. So, the main shaft, we call that the rachis. So, there's going to be this part that actually has all these little branching structures and this part that's bare, that's at the bottom and that's what's going to be attached to the skin. If you think of a writing quill, that's where you would dip the ink in and use to write with. So, those little branching structures off of the main shaft, we call those feather barbs, and each of those feather barbs actually has little branching shafts off of *them*. These are hard to see with your eye, but you actually can if you look really, really closely, called barbules. And in many feathers, especially feathers that need to be strong like flight feathers, the barbules also have these little, tiny hooks that we call barbicels that actually link them together.

So, think about, if you find a feather on the ground and you kind of break it, you know what I mean? You can split the different barbs, and you can zip it back together. So, that's actually because you're making those little hooklets reattach to each other. So, that's how feathers maintain their shape.

Alie: They're like little Velcro-y kind of a hook?

Allison: Exactly! Just like that.

Alie: Oh my gosh.

Allison: Really cool.

Alie: In terms of the functions of feathers, can you walk me through some different varieties, like a menu of feathers?

Allison: Yeah. So, feathers have many different functions and one thing that makes them really interesting to study is that oftentimes, they're doing these functions simultaneously. Let's think about this really complex structure and try and understand what it's doing and how it evolved. My specialty is in feather color evolution, and feather color itself has many different functions. So, for example, thermoregulation, birds keeping warm, that's one obvious use of feathers.

Alie: And that just... Does that trap air so that it retains heat?

Allison: Exactly. So, it's like having this really warm air blanket right next to your skin, basically. Birds can actually control how warm they want to be by either fluffing themselves up or having the feathers be more flat. So, if you think about a really cold morning, I was in Boston for a really long time and sometimes when it's snowing you see a bird outside and it looks like a little puffball. [*Alie squeals*] That's because they're increasing how much warm air they have next to their skin, which is pretty cool.

Alie: Oh my god, I had no idea they could do that. So, they're like, "Watch this. I'm going to get cuter and warmer."

Allison: Exactly. "I'm adorable. I'm going to become almost a complete sphere."

Alie: [*laughs*] So, they have a combination of down like an undercoat, and then do they have flight feathers on top of it?

Allison: Yeah, so there are different types of feathers. Downey feathers are one type of feather, and those feathers don't have the central rachis in the same way that what we call a contour feather, which is what a body feather has, or a flight feather would have. They also don't have all the little hooklets that are going to be hooking their feather barbs and barbules together because they don't need to be hooked together. It's actually better for them to be more unorganized because they can trap air molecules more efficiently that way.

Aside: So, there are the contour or body feathers, the warm down feathers underneath, and then what other kind of feathers?

Allison: There's another type of feather that is really cool called rictal bristles. So, if you've ever looked really closely at a bird, like maybe... There's a bird called a nightjar or a bird that as an insect eater like a flycatcher, you might see like little, they almost look like little hairs coming right around the bill, almost like whiskers, kind of. These are special feathers that only have this central rachis, they don't have any barbs or barbules. For a long time, people didn't know what these feathers were doing but what they're probably doing is actually protecting the eyes of the bird.

Alie: Really?!

Allison: Yeah!

Alie: So they can't hit themselves on things?

Allison: Moreso like little debris doesn't get in the eye. So, when you're out chasing a bunch of bugs in the air, your eyes aren't getting full of junk from it.

Alie: Oh my god.

Allison: There are other birds that have, like, crests or other various special feathers. So, we talked about thermoregulation is one use but one of the other big uses of feathers, of course, is signaling. So, whether that's being cryptic, so you're trying to hide from predators, think about a brown bird that's maybe on the ground and hard to see, or to become more conspicuous, so they're actually trying to show off because plumage color is one of the things that bird can actually use to demonstrate its quality. They actually use their color to attract mates for example or to fight off

rivals. Males, instead of fighting over a territory or something like that, males will be able to look at some of these colored patches and decide, “Oh, this guy’s not worth my time,” [*Alie laughs*] or, "This guy is going to be a competitor, I better actually fight him.”

Alie: [*laughs*] That’s so judgy that’s amazing. They’re looking each other up and down, like, sizing each other up.

Allison: Yeah.

Alie: Oh my god, that’s so petty. I love it.

Allison: There’s actually this really awesome bright orange bird and the males will actually, they live in the rainforest in South America and males will fight over patches of light and that’s because they’re all together in the same place. And then when the female comes, they’ll all get in their little light patches and jump around and try and get her to choose them.

Alie: Oh my god. Like they each have spotlights on them?

Allison: Exactly. [*Alie gasps*]

Aside: So, male birds are sometimes up in treetops just like, having a Lady Gaga spotlight moment. How do they get into the treetops? Good question. Flight feathers, of course. So, how are birds achieving all of our wildest dreams and soaring through the air so casually? Well, folks. Feathers. That’s why we’re all here.

Alie: How are these flight feathers working?

Allison: Yeah. So, one of the key aspects of a flight feather is that it’s asymmetrical. The way it works is that when air goes over these feathers and over the wing itself – wings are not flat, they’re kind of concave – the distance it has to travel going over the wing is shorter than it has to travel going under the wing and so, because of that, air molecules are going to try and fill that pressure differential that it creates and actually, it’s going to create lift. So, part of that is actually the structure of these asymmetric feathers.

Alie: Really?

Allison: Yeah. And those feathers and probably the most constrained of all bird feathers. So, you think of it, once you start looking at bird wings, you’ll start noticing that even though many other parts of the bird will be many different colors, those feathers are never any other color and that’s because one of the types of pigments that color birds’ feathers, melanin – melanin is familiar, it’s also what colors our hair and our skin, it’s very common throughout the animal kingdom – it also provides strength for feathers. So, you almost always see flight feathers, they’re going to look almost identical, not completely but much more than any other feather on the body and that’s because they evolved to be so specifically tailored to be able to provide flight.

Alie: And they’re usually the darker ones on the bird?

Allison: Exactly, yeah. So, that melanin gives them this kind of blackish-brown color.

Alie: Now, what about different color plumages? What range are we talking? Like, can they go everything from, like, opalescent obviously to black? What colors have you seen working in feathers?

Allison: Oh, that’s a great question. So, one of my favorite topics: bird colors! Birds can come in every color of the rainbow, including colors that we can't see.

Alie: Really? Other birds see it?

Allison: Yes. Other birds can see colors that we can't see. So, birds can actually see ultraviolet colors.

Alie: Can they?! I didn't know that.

Allison: They can. So, we can see if you think about what is color, it's actually wavelengths of light. We have cone cells in our eye that will be activated or not by certain wavelengths, and that gets translated into our brain as a color. So, we have three types of cones in our eyes that can see from about 400 to 700 nanometers, but birds actually have four types of cones in their eyes. So, they have a whole other kind of cone, and that cone resides from about 300 to 400 nanometers. So, they can actually see from 300 to 700 nanometers.

Alie: So, there could be disco birds out there that we have no idea about?

Allison: There could be. I actually brought a few birds out here with me and one of the birds that I brought was this bird called a Palm Tanager. This bird, you look at it, it looks pretty grayish, yellowish, not that exciting. But if you actually look at this plumage using what's called a reflectance spectrophotometer – which is a machine that we use to actually objectively measure how much light is coming off of feathers at certain wavelengths – you can see that almost all the reflectance is in the ultraviolet.

Alie: Really?

Allison: So, this bird would be much, much brighter to a bird than it is to us.

Alie: [*soft gasp*] So, it looks kind of like an olive color, a green-grayish color, but it might be just holographic disco bird.

Allison: I mean, probably not holographic disco bird, [*Alie laughs*] but it would be quite a bit brighter.

Alie: Do you think it would be in the greenish spectrum?

Allison: So, UV is much more like purple-ish.

Alie: Okay. How come there aren't more blue birds that would blend in with the sky?

Allison: Oooh, good question. Part of that has to do with how blue is made. There are only two ways that birds can make colors. One is by refracting color off of the structure of their feather, so that means, when light comes in, certain wavelengths might be reflected based on how the feather molecules are shaped. And the other is based on pigments that absorb certain wavelengths of color.

Aside: So, color can be straight-up pigment or structural. Got it.

Allison: We talked about melanin, so browns and blacks, those are all melanin molecules. Melanin is a pigment that absorbs almost all wavelengths of light. There's a pigment called carotenoids, which is the other most common bird pigment; this produces almost all oranges, yellows, and reds in birds. But blue in birds is not produced by pigment, it's produced by the feather structure.

Alie: Oh! Okay.

Allison: So, it might be harder to evolve a blue feather structure, for example.

Alie: Augh! That's so interesting. I never knew that.

Aside: Okay, so I looked this up and it's almost like there's a spongy layer made of keratin and air that sits on top of a melanin layer and it's the structure of that sponge that throws light in the blue range back. Now, iridescent colors have a few layers of melanin that scatter light depending on your angle to the Sun and the feather. Now, all of this is happening deep in the teeny barbs and barbules to make up birds in all shapes and sizes and degrees of flamboyance.

Allison: Can I just tell you a quick feather fact that's super cool?

Alie: Oh yes!

Allison: There's this really unknown but really cool species of bird called a Sandgrouse, so it's a species that lives in the desert and actually the adult birds have very specialized belly feathers that hold water. So, they'll fly for kilometers every day to the watering hole and soak their bellies and then fly back to their baby birds and bring them back water so they can drink it. So, they actually drink the water from the belly of the adult bird.

Alie: Oh, that's the cutest thing!

Allison: And they're these really cool-looking, spiraly feathers if you look at them under a microscope.

Aside: Okay, yes. So, I looked these up, and instead of straight barbs, they're helical, kind of like a curly ribbon on some festive gift wrap, just slurpin' up water for the babies.

Now, we're about to get to Patreon questions, so many good ones! But before we do, each week we donate to a charity of the ologist's choosing. This week, Allison chose the Ornithological Council which is BirdNet.org/OC. They do a lot of great work to connect ornithologists to the public, including with policymakers, they provide timely information about birds to help ensure scientifically based decisions and management actions. So, a donation went to them and that was made possible by sponsors of the show, which you may hear about now.

[Ad Break]

Okay, and now back to the feather questions that tickled your curiosity.

Alie: Allison Einolf wants to know: Do feathers really carry diseases?

Allison: Birds do carry diseases and certainly contact is one of the ways that diseases get carried. So, just like we carry diseases on our hands, birds carry diseases on their feathers as well. Birds also have parasites; they'll have lice for example and those can carry diseases. So, it is true. Thinking about like, you find a feather on the ground, I'm not super worried about getting a disease from that because most diseases from birds don't jump to humans although that's not necessarily true; West Nile virus for example... Maybe don't pick up a dead crow that you see. [*laughs*]

Alie: Okay. Unless you're a museum...

Allison: Unless you're a museum person, yes.

Aside: Now the folks who asked that, by the by, were Melissa Vono, James Huffstulter, Allison Einolf, Jessica Chamberlain, Kira Gowan, and Jessie Dragon. And yes, I checked that out and I didn't know that West Nile virus is a mosquito-transmitted disease that has corvids as a reservoir. That was news to me. Also, let's just make a pact right now, let's not pick up too much dead stuff right now. Let's keep our hands clean. All right? Agreed? Appreciate it.

Alie: Are there certain seasons where you're bound to find more feathers on the ground?

Allison: Oh yeah, definitely. During, let's say transitional times. A lot of birds... Some birds molt in the fall, some birds molt kind of in the spring before breeding season. Generally, you won't find many feathers during the breeding season because birds don't want to do expensive things like feeding young and molt at the same time.

Aside: And by the by, when a feather is molted, how does a new one come in? Well, it grows in as a pin feather, or a blood feather and it looks like a spike and it's filled with blood to help it grow and birds have to nip and preen the keratin sheath off of it as it grows. So, bird owners, you gotta look

out for pokey pin feathers as they grow in. Also, understandably, pin feathers, a little sore. A little ouchy.

Alie: Tineasha Brenot wants to know: Why do birds grow feathers as opposed to fur or hair?

Allison: That's a great question and that's due to evolutionary history. So, hair and fur evolved in the lineage of mammals which of course branched off from the common relative of both birds and mammals, long before either hair or feathers existed. So, you never know what evolution is going to come up with. In the case of mammals, it came up with fur, and in the case of dinosaurs actually, it came up with feathers and these proto-feathers before they became the complex feathers that we know of today.

Alie: So, just roll of the DNA mutation dice.

Allison: I would say so.

Alie: Mo Casey, first-time question-asker, wants to know: How do waterproof feathers work? Primarily on puffins because they are the cutest but other waterproof birbs are good too.

Allison: Yeah, so most feathers on birds are waterproof to some extent. On a bird like a puffin or even a penguin that spends a lot of time, there will be a certain density that's going to make it very difficult for water to go in.

A bird on the opposite side of things, a bird called an Anhinga for example, this is a bird that dives underwater, that actually has very dense barbs and feather barbules, and this actually helps them to dive down because they don't have all the air trapped. Because water will get in, then you see them standing with their wings outstretched. Cormorants will do this sometimes too, they're actually drying themselves out.

Alie: Oh! Robin Kuehn wants to know: What is up with emu feathers and their double feathers? Do emus have double feathers?

Allison: Yeah. So, the double feather is a feather called an afterfeather. So, that's just true of some birds. Some birds have that and it's especially true of birds that are flightless. So, emus, for example, they can't fly; same with cassowaries, kiwis, ostriches. Once you lose that flight constraint, your feathers can do a lot more things because you don't have to worry about being aerodynamic anymore or having these flight feathers so then they can evolve. A lot of them have lost their hooklets that hook them together. Think about an emu plumage, they're pretty furry-looking, it's kind of hairy. So, that's just because they don't have to fly anymore so they can use their feathers for other things.

Alie: Lena Faye, first-time question-asker wants to know: When doing stuff like mating dances, how much fine motor control do birds have over their feathers? Can they move clusters, or does it just look like it?

Allison: That's a good question. So, birds do have actually pretty fine control over their feathers.

Alie: Realllly?

Allison: Not really over individual feathers but they can control what are called feather tracks. So, feathers don't continuously cover a bird's body. They do when they're all spread out, but the way feathers are grown in specific regions of a bird's body. So, there will be, just like she said, clusters of feathers that they can control all together.

Alie: So, they *can* move them around.

Allison: Oh yeah.

Alie: Okay, Miranda Panda wants to know: Which bird has the longest feather recorded?

Allison: So, in terms of any feather, there are breeds of chicken where they have actually bred them to have these incredibly long tails. I don't remember exactly how long those are, but I want to say something like five feet long.

Aside: Okay, side note. After this interview, we went to the bird hall, and I saw this rooster with maybe an eight-foot tail, and of course, I took a picture. And also, some of these long-tailed fowl can sport a party in the back up to 14 meters or 45 to 50 feet long! Their breeders have to roost them in these special sleeping armoires, so they don't tangle up at night because they grow like a meter or so a year! Can you imagine stepping on your own feather tail? I don't even want to think about bird doo-doo in a 35-foot-long feather train.

Alie: What about the coolest thing about feathers? What's the neatest? What just gets you up in the morning?

Allison: It's just thinking about the fact that my job is to understand why birds are the color that they are! I mean, how cool is that? Just think about colorful birds, why are birds this incredible rainbow or iridescent colors, browns, blacks? We just described a new type of plumage called super-black plumage which is where the way the barbules are shaped will actually collect more light than just regular feathers. The barbules, instead of just being flat, they're actually thicker and pointed at about a 40-degree angle and that angle actually captures more light than just... yeah, on a barbed one.

Alie: That is amazing. It is really velvety, it's so pretty. Thank you so much for talking about this with me!

Allison: Yeah, it's been really fun, my pleasure!

Alie: Yay!

So, ask smart people stupid questions. Okay, so to learn more about the Natural History Museum of LA County, you can visit NHM.org, I love them! To follow Allison, she is @AJShultz622 on Twitter and her website is AllisonShultz.com and I will link those in the show notes. More links to videos we talked about and references from each episode are always up at AlieWard.com on each individual episode page. We are @Ologies on Twitter and Instagram, I'm @AlieWard on both. Also linked is AlieWard.com/Smologies which has dozens more kid-safe and shorter episodes that you can blaze through. Thank you, Mercedes Maitland of Maitland Audio and Jarrett Sleeper, of Mindjam Media for editing those as well as Zeke Rodrigues Thomas. Since we like to keep things small around here, the rest of the credits are in the show notes.

At the end of the episode, I tell you a piece of advice! This week, it's that if you find a feather, you happen upon a feather, what I like to do is glue the tip of it or tape the tip of it onto a pen I already have because it makes writing, for some reason way more fun, just writing with a big feather pen, even if it's just a turkey feather that you found. You might want to spray it with a little bit of Lysol or something ahead of time. But yeah, I have a couple pens that are feathers that I found in my backyard. All right my little birdies, berbye.

Transcribed by Aveline Malek at TheWordary.com

Links to things we discussed:

Visit Dr. Allison Shultz's website and follow her on Twitter

Full-length (*not* G-rated) Plumology episode + tons of science links

More kid-friendly Smologies episodes!

Sponsors of Ologies

Transcripts and bleeped episodes

Become a patron of Ologies for as little as a buck a month

OlogiesMerch.com has hats, shirts, hoodies, totes!

Follow @Ologies on Twitter and Instagram

Follow @AlieWard on Twitter and Instagram

Sound editing by Steven Ray Morris, Mercedes Maitland of Maitland Audio, and Jarrett Sleeper of MindJam Media

Smologies theme song by Harold Malcolm