[MUSIC PLAYING]

KATE WEXLER: You are listening to *Brains On,* where we're serious about being curious.

MOLLY BLOOM: I'm Molly Bloom, and we want to revel in the newness of this new year by talking about some newer news about something very old.

KATE WEXLER: We're talking about dinosaurs.

MOLLY BLOOM: That's Kate Wexler. If you've been listening to *Brains On* for a while, you might remember her as the co-host of our episode about extinction.

KATE WEXLER: That was a long time ago.

MOLLY BLOOM: Not as long ago as dinosaurs, but yeah, it was one of our very first episodes. It's also a personal favorite. So if you haven't heard it, go check it out. Thanks for being here, Kate.

KATE WEXLER: Oh, yeah, of course. I love it.

MOLLY BLOOM: So time has passed, and you're now officially taller than me, but you're also still interested in dinosaurs.

KATE WEXLER: Yes. I really want to know more about dinosaurs.

MOLLY BLOOM: And since you follow the latest dino and fossil news, we asked you to come back to help us with an interview about a very exciting recent discovery.

KATE WEXLER: A baby dino tail trapped in amber complete with feathers.

MOLLY BLOOM: That's right, an actual dinosaur tail with feathers preserved in amber. There's a picture of it on our website, brainson.org. It is super cool. A Chinese paleontologist named Lita Xing found this amazing piece of Amber at a market in Myanmar.

KATE WEXLER: Amber expert, Ryan McKellar, worked with Lita to study the dinosaur tail. Ryan is the curator of invertebrate paleontology at the Royal Saskatchewan museum in Canada.

[CLAPPING]

How do we know if it's a dinosaur tail? And how old is it?

RYAN MCKELLAR: This particular amber deposit or Burmese amber is 99 million years old. And they've been able to date that based on both the fossils that are found in the surrounding rocks, and more recently, some of the grains of sediment that are stuck to the outside of the amber. How we know that we're dealing with the dinosaur tail in this case and not a bird tail, because they both existed at the same time, with the dinosaur tails, the vertebrae or the individual bones haven't fused together to form a solid rod, whereas bird tails have something called a PICA style that's a series of fused vertebrae that support the tail feathers. And in this specimen, we're not seeing the PICA style or the fused vertebrae.

KATE WEXLER: So why is this a big deal?

RYAN MCKELLAR: Well, this is a big deal because it's the first time that we found dinosaur bones in amber. Here, we get to see everything preserved in 3D down to the finest level of detail. So we can see things like the barbules, or the finest structures on feathers, and how they're arranged relative to each other, how the feathers attach to the body, how the skin is on the outside of the body, how the feathers insert into the skin, things that we just don't get to see in other fossils.

KATE WEXLER: Wow. It amazes me that this can happen, that we are finding these. What is amber?

RYAN MCKELLAR: Amber is fossilized tree resin. So if you've ever climbed a pine or spruce tree or cut one of them, it's a defense product the trees release to keep things like insects and fungi and bacteria from invading them.

KATE WEXLER: So what is the piece of dinosaur tail? Is there a name for the species?

RYAN MCKELLAR: It belongs to a broad group of dinosaurs. Because we only have a small section of the tail, we can't say exactly which species or which genus it belonged to. We can say it belonged to a group called the coelurasaurs, which is a very broad group of dinosaurs that spans everything from tyrannosaurs all the way up to modern birds. So we know we're somewhere near the bottom of that group. Something that's a little bit more similar in terms of body shape and things like that to dinosaurs like tyrannosaurs and velociraptor than it is to modern birds.

KATE WEXLER: So when the dinosaur was alive, what could the possible feathers look like?

RYAN MCKELLAR: Well, they would have been-- if you're familiar with robins or most songbirds, they have body feathers that are covering things like the chest and above the tail feathers. Those are called contour feathers. And the structure that we're seeing in the amber specimen, or the feather structure, is very similar to those, except it's a little bit more fuzzy.

So you can almost picture petting this animal. It would have been sort of soft and fuzzy, a little bit more fuzzy than sleek, for lack of a better description, and sort of chocolate brown or chestnut brown tops of the tail and a paler white under surface of the tail. And the tail feathers coming off in ridges on the sides of the tail, as opposed to being a nice, smooth coat all the way down the tail.

KATE WEXLER: Cool. So what are the possible uses for having the feathers?

RYAN MCKELLAR: Well, it gives a couple of different options because these feathers are sort of fuzzy and floppy, for lack of a better description, they probably wouldn't have been much used for flight. And if the entire tail was covered in this sort of feather coat, it's very unlikely the animal would have been capable of flight or powered flight. So we're looking at a situation where it's probably used for things like insulation or maybe camouflage or that weird contrasting pattern that we're seeing between the dark top surface and the pale under surface of the tail.

But it might have been used for things like visual signaling, like in modern birds where they flash their tails or things like deer do it too, to signal predators or to scare off predators, that sort of stuff.

MOLLY BLOOM: Kate, have you seen the movie *Jurassic Park?*

KATE WEXLER: Yes, many over and over and over.

MOLLY BLOOM: It's a fun movie. How does that movie relate to this interview?

KATE WEXLER: In the beginning of the movie, they found a piece of Amber with a mosquito with blood in it, and that's how they found dinosaur DNA. And this really reminded me of it because it's an actual dinosaur tail with feathers and all, and it could kind of remind me, it's like, can we actually make those dinosaurs?

MOLLY BLOOM: Right, so we had to ask the question to Ryan.

KATE WEXLER: Do we have a *Jurassic Park* scenario on our hands?

RYAN MCKELLAR: With this, it's a resounding no, unfortunately. So the tail is neat because it has soft tissue preservation of some form. But we get to see just how degraded the material is. The skin and things like that and muscle tissue are only really left behind as a thin film of carbon, so it's not much more wet or interesting than pencil lead or coal, for lack of a better description. It's not the sort of material you can get DNA out of. We may not be able to bring them back to life. But we get a pretty good detailed view of what it would have looked like.

MOLLY BLOOM: So it won't be hatching in a lab anytime soon.

RYAN MCKELLAR: No, unfortunately. I'm usually the party pooper.

KATE WEXLER: Darn it.

MOLLY BLOOM: It's cool, anyway.

KATE WEXLER: Yeah.

RYAN MCKELLAR: Yeah, I think so.

[MUSIC PLAYING]

MOLLY BLOOM: So alas, no dinosaur clones. But even though it's been millions of years since dinosaurs walked the Earth, there are still new discoveries happening all the time.

KATE WEXLER: And these discoveries lead to new questions and mysteries to be solved.

MOLLY BLOOM: Speaking of mysteries. It's time for the mystery sound.

[MUSIC PLAYING]

AUTOMATED VOICE: Mystery sound.

MOLLY BLOOM: Here it is.

[STRANGE SOUND]

Despite our previous conversation, it's not a dinosaur. This mystery sound was sent to us from a *Brains On* listener from Georgetown, Texas. So Kate, do you have any thoughts on what that might be?

KATE WEXLER: A little bit. It sounds like somebody is eating, and it sounds like they're walking in thick plants.

MOLLY BLOOM: OK, so we know there's an eating sound and some walking in plants. That's an excellent guess. We'll be back with the answer right after this.

[MUSIC PLAYING]

We're currently working on an episode all about ants, and we want to know this. What would you do if you were the size of an ant? Where would you go? What would the world look like?

Send your answer by email to brainson@m-- as in Minnesota-- pr.org. We'll include some of the answers in our episode. You can, of course, also send us your questions, mystery sounds, and drawings any time to that same email address. We love hearing from our listeners.

And in order to say thanks, we started the Brain's Honor Roll to give shout outs to all the amazing kids who keep the show going with their energy and ideas. If you've written to us, we will get to you, we promise. But we're hearing from so many of you that there's a bit of a wait, so thank you for your patience.

[LISTING HONOR ROLL]

[MUSIC PLAYING]

Let's go back to that mystery sound. Let's hear it one more time.

[STRANGE SOUND]

KATE WEXLER: It still sounds the same.

MOLLY BLOOM: Still the same guess?

KATE WEXLER: Yeah.

MOLLY BLOOM: All right.

KATE WEXLER: Well, it kind of, for some reason, sounded like running water in like one point. I don't know, in the very beginning.

MOLLY BLOOM: Here's the answer from Beatrix.

BEATRIX: The sound you just heard is the sound of Lulu the horse eating hay. I help take care of Lulu by feeding her grain and hay. I also groom and muck the stalls. I have been riding horses for two years. Lulu is a sweet and gentle pony.

KATE WEXLER: Oh.

MOLLY BLOOM: You were close. You got the eating part. You got the eating. And you heard the-- the hay kind of has a plant-like sound.

KATE WEXLER: Yeah.

MOLLY BLOOM: You were close.

KATE WEXLER: It reminded me of like carrots for some reason.

MOLLY BLOOM: Yeah.

KATE WEXLER: Like the sound of carrots. And I did have a picture of a horse in my head.

MOLLY BLOOM: See, you were right on. The first ancestors of modern horses called hyracotherium or eohippus lived in North American forests about 55 million years ago and were closer to the size of dogs than the horses we know today.

AUTOMATED VOICE: Ba, ba, ba, ba, ba, ba, ba, ba, ba, ba, ba, brains on.

MOLLY BLOOM: The piece of amber studied by Ryan McKellar that we talked about earlier is about 99 million years old.

KATE WEXLER: And that puts us smack dab in the Cretaceous period, a very, very, very, very, very long time ago.

MOLLY BLOOM: And that got us thinking about this question.

JONATHAN: My name is Jonathan.

ELLISON: And my name is Ellison.

JONATHAN: From Oak Park, Illinois. And our question is, how do paleontologists know how old dinosaur bones are?

MOLLY BLOOM: To figure out how scientists know how old dinosaur bones are, we're going to visit a bakery. A bakery? Is that right? OK.

[MUSIC PLAYING]

GRIFF JENKINS: Hello, *Brains On* listeners. You ready to get righteous? I'm celebrity cake chef, Griff Jenkins. You might have seen me on my many shows like *Cake Attack* or *Extreme Frosting.*

BENNY: Or our first show, *Tea and Crumpets with Griffin.*

GRIFF JENKINS: Shut up, Benny. I don't talk about that anymore. And it's Griff now.

BENNY: Sorry, Griffin, I mean, Griff. My bad.

GRIFF JENKINS: That's my assistant, Benny. Don't mind him. Now I'm going to show you how scientists figure out the age of a fossil using a five layer ice cream cake.

[MUSIC PLAYING]

BENNY: I've got the cake right here, cut in half just like you asked, Griffin, I mean, Griff. Look at all those layers. It's so pretty.

GRIFF JENKINS: Extremely pretty. So why do we have an ice cream cake to talk about dinosaur bones?

BENNY: Great question, Griff.

GRIFF JENKINS: Well, dinosaur bones are found deep in the Earth. And the Earth is kind of like a layer cake. If you cut the Earth in half, which would be extreme--

[CHAINSAW]

--then you'd see lots of different layers of dirt and cooled hardened lava and other stuff. We call these layers strata.

BENNY: Like your cake right here.

GRIFF JENKINS: Exactly, my friend. So let's look at this cake a little closer. We got five layers. On the bottom, there's cake, then a layer of ice cream, then a middle layer cake, then another layer of ice cream, finally, the top layer, cake.

[PIANO NOTES]

What a beast this dessert is.

BENNY: So the layers are cake, ice cream, cake, ice cream, cake. Got it.

GRIFF JENKINS: Now, Benny, in this cake, which layer do you think is the oldest?

BENNY: If I would have to venture a guess like you're asking me to, I would have to say the one on the bottom of the cake. I mean, you had to put that one down first.

GRIFF JENKINS: Bingo. You nailed it, bro. And the Earth is the same way. Generally, the deepest layers are the oldest. Over time, new layers are added on top of those by rivers, erosion, or some such thing, and they cover the older layers. So you can assume the deeper layers are older than the ones near the surface.

BENNY: Griff, that actually makes sense.

GRIFF JENKINS: Now, I've hidden cookie crumbles in each layer.

BENNY: You did? Griff, I love cookie crumbles.

GRIFF JENKINS: I know, pal. That's why I put them there. Righteous red shift. So let's say you find cookie crumbs in the bottom layer of the cake and the middle layer, which crumbs were sprinkled first?

BENNY: Oh, yeah, sure. I'd say the ones lower down on the bottom layer of the cake were laid down before the ones on the middle layer of the cake since that layer was added after the bottom layer.

GRIFF JENKINS: Ba-da, boom. You nailed it, Benny. It's the same with bones found in the Earth. Scientists know bones found higher up in the Earth are probably younger than those found deeper in the Earth. This method of figuring out the age of bones is called relative dating.

BENNY: My mom told me I'm not supposed to date relatives, even though I have lots of cousins.

GRIFF JENKINS: Benny, geez. That's not what I meant. It's called relative dating because you can say one set of bones is older or younger relative to another set of bones.

BENNY: Oh, yeah. That's what I meant too. Yeah.

GRIFF JENKINS: The problem with relative dating is you can't say how old the bones are, just that they're older or younger than something else. But sometime in the last century, scientists came up with another way of figuring out the age of bones.

BENNY: How is that?

GRIFF JENKINS: They discovered a lot of these sedimentary layers have small, harmless amounts of radioactive elements. These radioactive bits, they break down over time at a specific rate. So if you find some of these radioactive elements, you can see how broken down they are and determine how long ago they formed.

BENNY: I got to be straight with you. I don't get it.

GRIFF JENKINS: One step ahead of you, Benny. Remember our cake is two layers of ice cream?

BENNY: Yeah, it goes cake, ice cream, cake, ice cream, cake.

GRIFF JENKINS: Yep, nailed it. All right, what happens to ice cream the longer you leave it out?

BENNY: It melts.

GRIFF JENKINS: Ha, double nailed it. Now, that ice cream melts at a steady rate. If we wanted to, we could analyze how much of that ice cream is already melted and work backwards from there to figure out how long it's been sitting out.

BENNY: Right.

GRIFF JENKINS: Obviously, the bottom ice cream layer, which was put on first, has been sitting out longer. Therefore, that bottom layer should be more melted than the higher layer of ice cream, which was added later on.

BENNY: So we can tell how old the ice cream layers are in this way.

GRIFF JENKINS: You, my friend, are totally getting it. That's similar to how these radioactive bits in the layers of dirt break down. It's like the ice cream melting. And by studying how broken the bits are, scientists can determine how long ago that layer formed.

But here's the catch. Not all layers have the right kind of radioactive elements to do this sort of study. Some layers have already broken down, so you can't tell if they were deposited a million years ago or yesterday.

BENNY: That's like the cake. The cake layers that are on ice cream won't melt. So how do we know how old they are?

GRIFF JENKINS: Here's where the magic happens. Scientists can look for the layers of sediment that do have these long-lasting radioactive elements like hardened lava. They can come up with an edge for those, then they can figure out the age of things in between them.

So if one layer deep down is 60 million years old and another layer higher up is 50 million years old, anything in the middle must be between 60 and 50 million years old.

BENNY: Just like the bottom layer of the ice cream was put on the cake three minutes ago and the upper layer of the ice cream was put on one minute ago, anything in the layer of cake between them must have been added between 3 and 1 minutes ago.

GRIFF JENKINS: Benny, my man, you are exploding with insight. This kind of fossil study is called radiometric dating because it looks at radioactive materials. And that, my man, is how scientists figure out the age of bones right now.

BENNY: Speaking of right now, that alarm means it's time for tea, Griffin, I mean, Griff.

GRIFF JENKINS: Tea? It's probably my alarm for spiking my hair, riding my motorcycle.

BENNY: It says right here in the daily planner, that's 2:00. It's time for tea and scones.

GRIFF JENKINS: Dude, just set out the plates and stop talking about it.

BENNY: You want honey and lemon in your tea?

GRIFF JENKINS: Of course, I want honey and lemon. That's it for this righteous science lesson, my compadres. I'm Griff Jenkins. See you around. Whoa.

BENNY: The kettle is on.

GRIFF JENKINS: Do we have Earl Gray?

BENNY: Of course. I've set out the China cups.

GRIFF JENKINS: Are they the ones with the ivy drawings on them? Bro, I love those cups.

BENNY: Yeah, so pretty.

GRIFF JENKINS: I hope that tea is hot.

[MUSIC PLAYING]

MOLLY BLOOM: That's our show.

KATE WEXLER: *Brains On* is produced by Mark Sanchez, Sanden Totten, and Molly Bloom.

MOLLY BLOOM: Special thanks this week to Corey Chappell, Shannon Custer, Chris Wechsler, Joshua Bond, and John Miller.

KATE WEXLER: You can keep up with us on Instagram and Twitter. We're brains_on.

MOLLY BLOOM: And we're on Facebook too.

KATE WEXLER: If you're a fan of *Brains On,* it would mean a lot to us if you would consider leaving a review of the show on iTunes. It really helps other kids and parents to find out about the show.

MOLLY BLOOM: And you can email your questions, mysterious sounds, and thoughts about dinosaurs to brainson@m-- as in Minnesota-- pr.org.

KATE WEXLER: Thank you for listening.

[MUSIC PLAYING]