Monumental Science
Episode 4 Transcript

Dr. Titus: Welcome to Monumental Science and informal look at scientific research that has happened in-and-around Grand Staircase Escalante National Monument over the last twenty-five years. I'm Dr. Alan Titus, paleontologists for the Bureau of Land Management's Paria River District. Today we're going to be joined by Dr. Gussie MacCracken, a noted expert on paleobotany and fossil insects. Thanks for taking the time out to be with us here today Dr. McCracken.

Dr. MacCracken: Ah, thank you so much for inviting me to talk about my research.

Dr. Titus: Yeah, I'm excited to hear what you have to say. So, I always like to start these interviews with getting a personal observation or reflection or anecdote from our guests, and so if you would maybe recall a special memory from the Monument or your work there, that means a lot to you personally. Or is there a particular place in Grand Staircase that means a lot to you, or you find special at a personal level?

Dr. MacCracken: You know that's, that's a tough question. I've had so many kind of life-changing-experiences in the Monument, but in particular, our work in the Kaiparowits Formation in the Late Cretaceous. Digging fossil leaves has been some of my favorite memories, and in particular there was a day, a couple years ago before the pandemic, when I was out digging fossil leaves with my mentor, Dr. Ian Miller who's now at National Geographic, and we were just watching the sun get lower in the skyline and finding so many fossils that, you know, we fill our backpacks full of fossil leaves and we have to help each other stand up there so heavy. And just kind of taking a deep breath in and looking at the beauty of the Monument. That's like a moment for me that I'll always remember.

Dr. Titus: Wow! Sounds amazing actually. I've heard rumors that some of these fossil-leaf sites are so incredible that you can sometimes peel still-pliable-leaf material out of the rock, is that true?

Dr. MacCracken: That is true. At some of the sites, we actually find leaf cuticle. That's the waxy surface of leaves, and it's so remarkable. You crack open the rock, you find a fossil leaf, and if you let it sit out in the sun for too long, the cuticle will actually peel off and blow away in the wind.

Dr. Titus: Wow!

Dr. MacCracken: So, we like to wrap them up and soon as we find them.

Dr. Titus: Amazing!

Dr. MacCracken: But it's just remarkable because the cuticle is the original leaf. It's the original material of the leaf, which is very rare in paleontology. Oftentimes, you know, the organism has been replaced, the original organic materials have been replaced by minerals, so this is kind of fun that you get actual leaf still preserved.

Dr. Titus: Yeah, not just a carbon film on a on a rock, but actually the leaf.

Dr. MacCracken: Exactly, yup.

Dr. Titus: Interesting. Well, can you tell us a little bit about yourself and how you developed an interest in your research?

Dr. MacCracken: Absolutely, so I just got my PhD from the University of Maryland this past December in twenty-twenty, and I study fossil leaves and the interaction between plants and insects in the fossil record by looking at the damage that insects make on those leaves. So, the holes or the leaf mines or the galls that you find preserved in the fossils, and it's kind of an esoteric field, but I fell in love with it when I was working at the Denver Museum of Nature and Science right after college, and going out to the Monument and finding all these amazing leaves, and then thinking about, how do you? How do you ask ecological questions of fossils? And I just started to fall in love with the fact that you get, you know, sample sizes of thousands and thousands of leaves and you can really start to put together, to reconstruct ancient landscapes and so it's really kind of a slow build through time – in college and immediately after college of coming out to the Monument, going out to the Kaiparowits Formation, and starting to think about what ancient ecosystems looked like. Yeah, so now I'm back at the Denver Museum as a postdoctoral fellow funded by the National Science Foundation and I am just biting at the bit to get back out into the Monument once the pandemic's over.

Dr. Titus: Yeah, well we can't wait to have you back, and don't sell yourself short here. I don't think your research is all that esoteric. I actually think that understanding the interactions of insects and plants in the ecosystem is really important – as I know, you know.

Dr. MacCracken: No, thank you for that. Yeah, I mean when you when you think about walking into a forest and the first thing you see are the plants. The second thing you might see are insects. They're just so diverse, there so important for ecosystem functions, such as pollination or herbivery. The things that eat dead things, the detritovores. You know insects or prey for all the non, or the avian dinosaurs today, so they're really important, but they don't get as much love in the fossil record as I think they should.

Dr. Titus: No, I agree, and everybody also seems to feel inadequate compared to the dinosaurs, right? It's like, oh it's not a dinosaur, but the fact is I think maybe sometimes we've inverted the importance of all these things, and really, it's the plants and the basis of these ecosystems telling us more about the actual environment than looking at the skeletons of these charismatic megafauna. But that's just my plug for your work, 'cause I think it's amazing.

Dr. MacCracken: Yeah, thank you. No, I mean the beautiful thing about paleontology these days, I feel is that we're all encouraged to collaborate, and so I get to learn about all these different kinds of organisms, for instance the dinosaurs but also things like the turtles, and lizards, and early mammals and things like that. And we all just get to work together to build up the ecosystems, to reconstruct them to be able to imagine how they change across the landscape and through time, so it's the work of everybody that's important. It's just how we work together, that I think the real meaning comes out. (07:23)

Dr. Titus: Yeah, and I happen to know you've actually found dinosaur sites as well. There's one in particular I remember called Gussie 's hadrosaur. Or can you tell us a little bit about that?

Dr. MacCracken: Yes, yeah uhm. Well, I found it before I was so entrenched in the leaves. But I found a skull of a hadrosaur, and it was really beautiful. I mean the top of the head is a little bit shaved off, and by shaved off I mean it had it eroded out of the hill before we had discovered it. But there's this beautiful skin impression around the neck that just gives you a sense of what it this thing might have actually looked like when it was alive. Just a remarkable, remarkable skull. But you know, the monument is so full of dinosaurs, in addition to obviously the plants, that I know you guys make just incredible discoveries all the time.

Dr. Titus: Yeah, amazing! Uhm, so the monument's obviously been important to your work as a researcher. Can you elaborate on that a little bit, like maybe give us a little more detail as to why the Monument's been so important for your research and then also make some reflections on what you personally see as the roles for National Monuments in research?

Dr. MacCracken: Sure, well I have to say my entire dissertation was based on fossils that we excavated from the Monument and so. How is it important to me? Well, I have a PhD because of it, so it's tremendously important. And you know, I can work on these fossils, the ones included in my dissertation, but also the thousands of other leaf fossils that we have in the collections at the Denver Museum of Nature and Science for years, decades to come. It's really a project that cannot be done in in one person 's lifetime. So, it's important to me because I also see a long future researching these fossils and understanding the details of these ancient landscapes. And it fits in nicely with how I view National Monuments in terms of research. They're really the protectors of these American lands, so they're incredibly important to the public.

Dr. MacCracken: But the fact that we're allowed to, as researchers, go in and dig up fossils and collect data and we get to reposit these fossils in perpetuity. It's just you know; I see National Monuments as one of the major instruments of research, paleontological research in the country. It's just so important, and it's also really nice being able to see citizens using the land, for instance, with ranching, and so it's this really, really gorgeous mixed-use land that means so much to me.

Dr. Titus: Well, changing gears just a little bit. What sorts of challenges did you face while you were doing your research in Grand Staircase? I know you mentioned just the sheer physicality of getting the specimens from the site back to the museum, but were there any other challenges that you experienced while you were out there? It take you out to the edge ever?

Dr. MacCracken: Yeah, yeah, I mean, I feel like a lot of researchers. You hit a point where you're just like what am I doing? Like what does this mean? I have all this data. What are the patterns that are coming out of it? But really, going back through the physicality of the site, I think that was the part that was one of the biggest challenges because I have to say I'm a little bit, I'm a little bit afraid of heights, so you know we'd be walking along these kind of sheer cliff faces or these extremely steep Badlands and just sort of clinging onto the sides of the Badlands to try to excavate fossil sites, and like one of my favorite leaf localities, we informally named the "scary site" because it was so treacherous getting out there, but it was so worth it, because like I said, you just have these incredible views and you collect some of the best fossil leaves from the Late Cretaceous in the whole world. So, you know it's always worth it, and I'm still here, and I'm still alive, and you know everything 's good, but uh, yeah, I think the heights, the treachery of some of the work we do is the most challenging to me.

Dr. Titus: No interesting. Yeah, I know that you and Ian have hiked on some pretty extreme terrain. So, regarding your work there, I noticed that as you started to uncover all these thousands of leaf specimens that you started noticing that there was a lot of damage on them. Can you elaborate on that, and how that developed into some of the hypothesis that you made in your dissertation?

Dr. MacCracken: Sure, so I'm looking through all these leaves. Thousands and thousands of leaves and noticing that the diversity of the types of insect damage that we find on them is quite high, as well as the intensity of damage. So that's how much leaf has been removed by insect herbivores, and you know, we would expect this to a certain degree because back seventy-five million years ago where we're digging these leaves, it was essentially very swampy. It was kind of hot and humid, and so I always like to think of it as looking a little bit like the swamps of Louisiana today, and so you would imagine that would be lots of different kinds of insects. In fact, they would be the most diverse group of animals in the Kaiparowits, more diverse than things with backbones, for instance.

Dr. Titus: Sure.

Dr. MacCracken: And so, you know, I start collecting all this data on the insect damage and finding some very unique types of damage. In one instance, we found a leaf mine made by a moth that we think is still around. Well, we know the type of damage is similar to an Extant moth today. So, a moth that's living today making this specific pattern of damage, and so we really hypothesize that some of the insects that were around seventy-five million years ago were probably the ancestors, or precursors, or relatives to the insects that we find in forests today.

Dr. Titus: And still doing the same thing, yeah.

Dr. MacCracken: And so, a part of my work has just been. Hmm?

Dr. Titus: And still doing the same thing ecologically, yeah.

Dr. MacCracken: Yeah, yeah. So, a part of my work has been doing that. Just kind of connecting the modern and the ancient, and also looking for really subtle patterns of damage. For instance, we found the oldest, what we call acarodomatia, the oldest mite houses in fossil leaves from the Grand Staircase-Escalante National Monument in the Kaiparowits Formation, and these are essentially holes in leaf veins. They looked pretty nondescript, but it tells us that plants and mites were involved in a mutualistic-ecological interaction even seventy-five million years ago. So, you know, you look at all these little damage marks, and they can actually tell you big things about the evolution of plants and insects. Or in this case, mites as well.

Dr. Titus: One thing I think is really interesting out of your research is that you're not actually finding the bodies of these insects, right? You're not finding the bugs themselves preserved in the shales that you're splitting, but you have unequivocal evidence that they were there. So even though you don't actually have the body fossils of the insects you have ironclad proof that these insects were in the ecosystem, right?

Dr. MacCracken: Exactly right. You know insects when they die, they are squishy, they're small. They decompose rapidly. A lot of other things will even eat dead insects, and so it takes a really special type of environment to preserve insects. And although I'm still crossing my fingers that will find some in the Kaiparowits, it's the trace fossils that they leave on leaves that are really just a great source of data for these insects that were not preserved. Uhm, so it is really important to be able to study the most diverse, probably the most abundant group of organisms in the in the Kaiparowits, even though we don't know what it looked like exactly.

Dr. Titus: So, do you think there's potential for actual body fossils of insects then out there in the Kaiparowits?

Dr. MacCracken: I actually, I really think so. We found a few parts and pieces of insects as we've dug for leaves but not a lot of body fossils, but I really do think they're out there. They require kind of slow moving or still water such as pond. They require rapid burial to avoid decomposition, and they require really fine sediments, and I think all of these things are known from the Kaiparowits, and so I have hope. I think they're out there. I just think maybe we need to figure out what we're looking for when we're reading the rocks.

Dr. Titus: Okay.

Dr. MacCracken: To find the perfect places to dig in the monument.

Dr. Titus: Well, I'm going to keep my fingers crossed for that.

Dr. MacCracken: Thank you.

Dr. Titus: I can't wait for an insect lagerstatte to come out of the Kaiparowits. So, what do you think some of the main take home messages are from your work for our listeners?

Dr. MacCracken: Well, I would say that sometimes the devils in the details. Sometimes you have to take kind of a careful look at the fossil site you have, and they can tell you some really kind of big evolutionary stories about life on earth and how it's changed or not changed very much through time. And I also think that just the study of paleobotany, the study of insect damage. You know, it's not as flashy sometimes, it's not as charismatic as some of these amazing things with backbones. The dinosaurs, the turtles, but the sample sizes are so big that we can ask all these ecological questions. We can actually collect all this data and run statistics on it and try to link the path to what we see today. And so, it's just about taking whole snapshot of an ecosystem and uhm, you know trying to figure out how it changes through time, how it changes across a whole landscape, how the plants fit in with the insects, fit in with the larger herbivores running around. So, it's really about how things fit together. It's this big ecological story.

Dr. Titus: And Grand Staircase is one of those places that you can get all those puzzle pieces and put them all together, right?

Dr. MacCracken: Absolutely, absolutely. The Grand Staircase is just one of the most remarkable places on Earth for paleontological field work.

Dr. Titus: Well, that sounds like a good place to end our interview 'cause that's about all the time we have. I'd like to thank Dr. McCracken again for joining us today and thank our listeners also for being with us and until next time, thank you.