Episode 260

Ryan: Yeah, we'll and then we'll edit it so we both sound brilliant. That's the goal.

Patrick: I'm interested to hear your edited version. There were times where I was like oh man, I like chopped that up.

Announcer: From Sciencesortof.com, you're listening to Science sort of.

Music

Ryan: Hello and welcome to Science sort of, you're listening to Episode 260 our theme this week is flame on! which is what Johnny Storm of the *Fantastic Four* yells to turn on his fire in case you thought I was just even weirder than usual. I'm your host Ryan and joining me to talk about things that are science, things that are sort of science and things that wish they were science is my friend and soon to be yours John Calder. Like me he's in the Department of Geology and Geophysics at the University of Wyoming. Unlike me, he has recently defended and passed his PhD. So he is technically Dr. John Calder. I've been interested in John's work for a while because it does some really cool stuff using late course to better understand fire, which we'll get to in a moment. And when I heard him interviewed on the short lived University of Wyoming Today podcast talking about his work, I also realized he might be willing to talk to me for a much, much longer time on this here show and he was happy to do it. Once our schedules worked out I went over with microphone in hand and we had a really good conversation about a lot of things really. The science that he does, the philosophy behind his science, some of the problems facing people who study climate and paleo climate and ecology today, all that good stuff. So, strap in, I'm going to break it up into two parts for you with a quick drink segment in between, but for now, let's enjoy listening to John Calder. Tell us about the basics of the science that he does. Here we go

Ryan: Okay, let's dive right on in.

John: Okay, cool.

Ryan: Alright, so today I'm joined by W John Calder, which I didn't know the W was there until I was looking stuff up and reading your manuscripts.

John: Or Esquire is also...

Ryan: I didn't know the Esquire part either. Wow.

John: Yeah, no. Okay, that one's not there.

Ryan: That's made up. According to your 2015 CV, so let's see how out of date things are.

John: Awww, no, that's good, actually.

Ryan: Okay.

John: 2016 was a low year.

Ryan: We're looking at a Bachelor's of Science from 2007 at Utah Valley University, and then a Master's from Brigham Young University's School of Plant and Wildlife Science. Your thesis was the “Eco Physiology Mechanism underlying Aspen to Conifer Succession”, which is a lot of big words.

John: Yeah, yeah, people, makes it sound better.

Ryan: And now you are a PhD candidate in my department, the Department of Geology and Geophysics.

John: That has changed.

Ryan: Yes, because you've defended now.

John: Yeah. And turned in.

Ryan: So, you’re a Doctor.

John: Thank you.

Ryan: So no candidate, just PhD.

John: Yeah.

Ryan: And your dissertation. Hopefully the title didn't change from 2015, “Paleo wildfires and sub Alpine forests, the influence of climate topography and vegetation feedbacks”.

John: It's changed. I don't know what it is now though.

Ryan: You don't remember own theses, or, your dissertation title.

John: Yeah, we wanted to let, yeah, it's changed.

Ryan: Okay. So my first question is broad and it's what kind of scientist do you tell people you are when it comes up?

John: I always make a joke. I like to self deprecate a little, mostly cuz I don't, too often people think like, oh, you're a scientist. It's like, yeah, I just like school. And I kept going, and it was fun. So when they ask, the joke that, well, my brother tells people that I studied dirt in Wyoming. That's not true. I actually study lake mud in Colorado. So that's my joke, well, it sounds pretty old man-esque. The, what I, what I do tell people is I study, I study wildfires I study past wildfires, past climate change, and how forests and plants responded to those...

Ryan: Fires is what I think of when I think of what you do.

John: Thanks.

Ryan: I associate you with like, big, gigantic mind boggling fires.

John: That's what I like to think of myself as.

Ryan: So, you say you're a fire scientist?

John: I say I like fire and then people laugh.

Ryan: Okay.

John: Because they think you like fire. But yeah, so I would say, yeah, fire scientist, I guess, that sounds good.

Ryan: But what would you say at a conference then if you're talking to like a colleague, or a potential colleague.

John: Oh, the ah, the like 30 second elevator speech, what do you do?

Ryan: Yeah, sure. Let’s do it?

John: Oh, I don't do that.

Ryan: You don't do that, you, you eschew the elevator.

John: No, I, well, I, I haven't followed that good piece of advice yet to give my elevator speech.

Ryan: To have like a 30 second spiel about what...

John: Yeah, I um, I'm actually leaving academics right now too. I should have told you this earlier. I didn't. I've been applying just for private industry jobs, just doing data analysis. So I've even forgotten some part of, that bit, part of my life even though I just recently defended.

5:03

But if somebody were to ask me what I do, I would say something along the lines of I want to understand the effects of climate change today. And to do that, I look into the past and when we had past climate changes to see how wildfire responded to the changes in temperature, changes in moisture, and then how forests, I like Rocky Mountain forest, so that's where I've been working my career. And so I want to know how, how those forests responded to both the past climate change in the past fire, changes in fire.

Ryan: Okay, so that's something that people might not think about is the fact that fire, like the way forests catch on fire, has itself evolved over time. Yes, no, maybe?

John: Well, at what timescale, yeah.

Ryan: Yeah. So what's the timescale are you working with?

John: Oh, yeah, that's...

Ryan: I'm going to ask a lot of dumb questions that I kind of know the answer to, but the listener needs to know the answer to.

John: Right. If I was working on, you know, if I was looking at multiple millions of years, then maybe we could say, because the oxygen content of the atmosphere has changed.

Ryan: Yeah, yeah, but the timescales you look at are...

John: The timescales...

Ryan: ...the oxygen is consistent.

John: Yeah, yeah, we've been at...

Ryan: 26%, is that, 23%...

John: Yes.

Ryan: The first thing I'm gonna have to look up.

John: This is good for our listeners. We don't know a lot...

Ryan: Nitrogen's like 70% right?

John: It's high...

Ryan: It's, it's in the 70% and then oxygen in atmosphere... 20.95% oxygen, 78.09% nitrogen, .93% argon.

John: That's good. That's what I was gonna say. I didn't know that one for argon, even, I wouldn't even put argon in the top four. I wouldn't have even known that it got a bronze.

John; Yeah.

Ryan: And then .04 carbon dioxide or as I like to call it just enough.

John: It is, it is just enough. That's a good argument.

Ryan: Naw, it’s way too much. We got to...

John: Okay, well, it was just an enough.

Ryan: I, ah, I was recently spending a lot of time with a lot of very conservative people. And when the subject of climate change came up, I just I had zero patience. Because, you know, every old argument was trotted out, of, like, well, I heard we're actually supposed to be going through a period of global cooling. Nope. Just like I just wouldn't even like let them propagandize. I was just hardcore. Nope, nope, nope, nope...

John: Nope, nope...

Ryan: No, Sun's not getting hotter. Like any, any Fox News argument you've heard is wrong.

John: Not true. Oh, there is some nuance to the we should be going into an ice age argument but...

Ryan: Right. But at this point that we're not...

John: We're not, which is an argument for anthropogenic climate change. The configuration of the Earth's orbit and relative to what we seen in the past. Not today or tomorrow, but within the next, I'm not sure what the models predict, but within the next few millennia, we would be returning into an ice age.

Ryan: Because of the Milankovitch cycling?

John: Yeah, yeah, yeah, just...

Ryan: Because the Milankovitch include, includes the wobble of our axial tilt, and the orbital eccentricity of our orbit around the sun, is there, there's one, I feel like there's one other.

John: Are those all included in Milankovitch? I'm not sure...

Ryan: Because I thought there were different timescales that the Milankovitch covers...

John: Yeah, there's, yeah, you've got like how the how circular orbit is, what, at what point is the earth closest to the sun?

Ryan: Apogee?

John: Perihelion.

Ryan: Perihelion.

John: So right now we're closest to the sun, right around the northern hemisphere's winter solstice.

Ryan: Is when we're closest to the sun.

John: Yeah.

Ryan: Or tilted away.

John: We're tilted away...

Ryan: So that's why it's colder in the northern hemisphere.

John: Colder in the... yeah. And then, so...

Ryan: This is hard to describe in a podcast.

John: It is hard to describe in a podcast. It’s hard to describe in a class. I, I use, like, videos to show this because it's really easy. But yeah, you're right. And then there's the element...

Ryan: If you want to send me a link to those videos I can include...

John: Yeah.

Ryan: We have extensive show notes.

John: Yeah, you do, yeah. Okay, cool.

Ryan: So I can include all the stuff in the show notes.

John: Yeah, I'm not the expert in Milankovitch cycles, but you should interview somebody about that. That's fun.

Ryan: Yeah.

John: It’s important to...

Ryan: We talked about it little bit before on the show, but it's the, it's the large scale control of how climate shifts.

John: Yeah. When we think like, what's the process controlling the last, when we see ice ages through the records, hat's controlling that. It's the configuration of the Earth's orbit. How much is it? What Where? What's that wobble doing, turning in terms of the tilt of the earth? And then where are we, when are we closest to the sun, when are we farthest? And then, even that will change, right now we're kind of in a little more oblong orbit, the ah, what's the word they use?

Ryan: Elliptical.

John: Elliptical orbit, and that will change that will go more circular to more oblong, or elliptical. And so all those factors combined to influence when we have ice ages.

Ryan: From what I've read, there's now enough carbon dioxide in the atmosphere that an ice age would be impossible.

John: It'll be a long time. There was an interesting paper that just came out a few months ago, and I don't remember the details. But before we have any ice accumulating it'll be, it was tens of thousands of years.

Ryan: Well because the carbon dioxide will only leave the atmosphere with silicate weathering, right?

10:01

John: Yeah, yeah...

Ryan: So basically...

John: We have to bury it deep where it’s not going to come out...

Ryan: We have to wait for Himalayan’s mountains to erode.

John: And they've been doing that for a while.

Ryan: I know. It's not, they’re still pretty tall...

John: But we're increasing the rate. Yeah, yeah, we could say like on...

Ryan: We’re definitely outpacing the silicate weathering cycle... I mean, the ocean is sucking up a lot of the carbon dioxide but that’s not good

John: Right. It needs to get fixed into a mineral form and then...

Ryan: Exactly.

John: buried at the bottom of the ocean and then, yeah.

Ryan: Carbon storage.

John: Yes.

Ryan: Sequestration.

John: Sequestration. Not on the timescales we're hoping for.

Ryan: No, no.

John: Not on human timescales.

Ryan: Could We just, if we could just figure out a way to export the carbon dioxide to Mars.

John: Yeah, yeah, yeah. That would be super cool, like Elon Musk. So that's my other pet project is nuking the ice, the polar ice caps and...

Ryan: You basically want to make it, you want to reach a point where Mars could have wildfires. Because those are your favorite things..

John: That's my goal. No, that's not what we want people to think. That would be cool though wouldn't it? That would mean we've terraformed Mars and that would be...

Ryan: Right.

John: Awesome.

Ryan: But I'm not sure Mars is...

John: Terraformable?

Ryan: Well, not in that way necessarily because I'm not sure, we've talked about this on the show before too, I'm not sure Mars is physically big enough to hold on to an oxygen rich atmosphere.

John: Yeah, no mag, yeah, magnetic field and those things.

Ryan: It is also lacking a magnetosphere. But if you've seen *The Core* we know how to get that restarted. You just...

John: Yeah, I missed that one. Man.

Ryan: I, you know, what...

John: I know Hilary Swank was in it and she's awesome. She kicks butt.

Ryan: I never actually seen it.

John: Do we just both know the premise...

Ryan: The premise is the magnetosphere... or, the core stops...

John: The core stops...

Ryan: ...spinning...

John: ...spinning and they drill down and they blow it up with the bomb to get it spinning again.

Ryan: Right.

John: Ostensibly.

Ryan: Yeah. Which somebody was asking me recently, how, what's the deepest we've ever drilled into Earth and we still never broken the crust.

John: No, no.

Ryan: Not even...

John: No. I think the Russians have gone the farthest...

Ryan: That's what I said. I said the Russians dug some hole deep enough that it was getting like really, really hot. But it wasn't beneath the crust.

John: No, yeah, yeah these...

Ryan: That's why vulcanologists are so obsessed with those 0H samples they love telling us about during seminars where I imagine you and I are mostly tuned out.

John: I'm not, yeah, I'm not tuned into those...

Ryan: The Ken Sims of the world.

John: Oh, Ken Sims is awesome...

Ryan: He's awesome but his science is very foreign to me.

John: Yeah, yeah.

Ryan: I mean, other than the isotopes which you also, we're both isotopeiers. Isotopers.

John: Yes. Yeah. I've dabbled, I've dabbled tried to understand them.

Ryan: ... the paleoclimate without looking at some isotopes, right?

John: Yeah, yeah, I got lucky I guess.

Ryan: Core people love, think cores are the answer to everything.

John: I do not. There are those people but um, yes, yeah.

Ryan: So you don't call yourself a pollenologist even though you're looking at pollen.

John:Um, I do pollenology.

Ryan: Okay, so pollenology is the study of pollen and...

John: Which sounds awesome.

Ryan: Every pollenologist I know only looks at lake cores. are there pollenologists who, just like, are just looking at pollen that doesn't come out of a lake core?

John: Yeah, people will. Sometimes I know people that will look at pollen that is preserved in fossil records. Like real fossil.

Ryan: Cuz lake cores are sub, sub-fossil, I guess.

John: Yeah, they're not, there's no like replacement of any atoms with rock.

Ryan: I think that's, I think that's one of the misconceptions about fossils, though. Is that...

John: Okay, that's one of my misconceptions...

Ryan: I would argue that there doesn't have to be any loss of original material for something to be truly a fossil, it's just a function of age. And it being preserved in some form, including original material up into the present. Because, you know, my isotopes wouldn't work if the entire fossil been replaced by rock, right? I wouldn't be able to...

John: Right, there's no isotopes...

Ryan: I wouldn't be able to do stable isotope ecology, I mean, think about like LaBrea. Right, LaBrea, the tar pits, none of that material is replaced. It's covered in tar and the tar definitely like stains and probably does in some ways chemically alter the fossil to a degree but it's mostly original material.

John: But you still call it fossils.

Ryan: Yeah, because it's old.

John: Okay.

Ryan: It's about 10,000...

John: ...with fossil pollen, so it can be like 100 years old or a few thousand.

Ryan: We call it sub-fossil.

John: Sub-fossils.

Ryan: Because it's older than like, it's not modern, you know, you're looking, you're trying to figure out a deep time question, right?

John: Mmmhmmm.

Ryan: Or a long time scale, longer time scale than like a modern ecologist.

John: Yeah.

Ryan: Would maybe care about.

John: Yeah.

Ryan: But, generally the cutoff is has to be older than about 10,000 years for us to say it is unequivocably fossil. With that said, I was recently working on a bunch of extinct ground sloths from the Caribbean that are probably less than 10,000 years old. But because there are no living ground sloths in the Caribbean, it's very easy to make the argument that those are fossils if only because they represent an ecosystem that doesn't exist anymore.

John: Gotcha. Gotcha.

Ryan: So it's fuzzy. I think it's a fuzzy boundary.

John: Yeah, I get it. Well, it kind of goes back to your first question was...

Ryan: What do you do...

John: Well, no is fire diff... was is, that, is fire different?

Ryan: Has fire evolved?

John: Yeah, has fire evolved.

Ryan: Has the way that forests catch on fire evolved?

John: And I only work in the last few thousand years. So I'd say no, and that's on purpose, because I want to understand why these forests are burning.

Ryan: You're trying to make it applicable to the modern. So if you were studying ecosystems that didn't...

15:01

John: Yeah...

Ryan: Aren’t really representative of what ecosystems are like now it wouldn't work.

John: Yeah, like if you go back long enough when oxygen gets high enough, supposedly oxygen content was high enough that wet vegetation would burn.

Ryan: So define wet vegetation versus dry vegetation.

John: Ah, that's a good one.

Ryan: Do you mean like succulents like like, you know, like, those...

John: Ah, vegetation not dry? How about that? That'll be our definition of wet, things not dry.

Ryan: Well, cuz I mean, obviously, I think of like a grassland as a dry vegetation, habitat.

John: Yeah.

Ryan: But do you, I mean, are we talking, like, rain forests or...

John: I’m only quoting that paper that I read that like it was,he said oxygen content was high enough that wet vegetation could burn so...

Ryan: See, as a mostly, like, animal focused person, when I think about the oxygen content getting higher, I think of like the giant insects and stuff. Because insect size is also limited by oxygen content.

John: Is it?

Ryan: Because they don't, because the way they respirate, they, is a surface area to volume problem. So the size, the maximum size, that, like, arachnids and insects can grow to is limited by the oxygen that they can diffuse through their cells.

John: Awesome.

Ryan: Yeah. So with increased oxygen content in the atmosphere, they can get physically bigger because they don't have to worry about that problem of suffocating as much.

John: Well there were really big fires back then too, I guess.

Ryan: Yeah.

John: So it was a...

Ryan: Scary world. Giant dragon flies and...

John: Wet vegetation, whatever that is, catching on fire fire.

Ryan: Have you ever been in a forest fire?

John: No. And I've, I wouldn't say I've tried. But I’ve wanted to be.

Ryan: I was in a controlled burn.

John: Were you?

Ryan: Yeah, couple of times.

John: I should of, me and my friends, we all realized after we graduated high school, we all had like a year off. And then years later, we said why didn't we fight forest fires that year? And we all agreed it would have been awesome, and we should have done it. But we didn't. I mean, instead, we just, like, rode bikes, mountain bikes.

Ryan: Which is, well, yeah, so mountain biking was when I wound up in a controlled burn.

John: Oh, wow.

Ryan: Yeah, I was out in Santa Cruz and the way it works was a vast majority of the campus is redwood forest with trails. And so you would bike up the fire roads to where campus split into a state park. And so campus didn't have any controlled burns but the State Park did. So we crossed over the road and we were in the state parkland and we're smelling the smoke and like we could tell something was going on. And so we all kind of stopped at this where the fire road and the trailhead kind of met and we're just waiting, not sure what to do. Like, are we allowed to bike here? This seems insane. And a ranger drove by in his truck at one point and saw a big group of mountain bikers. None of us knew each other. I was out with like one other friend, but all the mountain bikers had just kind of stopped because we weren't sure what was going on. And we're like, Can we bike here today? You guys are burning stuff. He goes, yeah, just stay on the trail. And so we biked through the controlled burn. It was like...

John: Awesome.

Ryan: It was like biking through hell. Like it was just smoky and ash white trees and like it was really surreal and creepy.

John: Yeah.

Ryan: And hot.

John: Yeah. No.

Ryan: I don’t know why he let us do that.

John: I don’t either.

Ryan: It seemed like a bad idea.

John: Just be safe.

Ryan: Yeah. Don't catch on fire. Okay.

John: No I really wanted to because in, so I work in sub-alpine forest, like high elevation for us in the Rocky Mountains, so like your pine trees, your spruces and furs. And a lot of times those trees will explode the, as the heat from the encroaching fire gets towards the tree. The water vapor, the water inside the tree expands, turns into vapor and it doesn't have anywhere to go. And there's a lot of volatile organic compounds within the needles. So the green piney, the piney smell that you get.

Ryan: That’s an oil?

John: Yeah, that's it and it's flammable. So, when you walk through the forest and you're smelling that really nice smell. That's the first thing that burns.

Ryan: It’s fuel.

John: It’s fuel. It's gas. It's the first thing that burns when a tree burns, or when you light, when you light the wood on fire, if you light a branch over that's the first thing.

Ryan: Is that when you throw, like, pine needles onto a fire they crackle.

John: Oooh. Yeah, yeah, and they burn so well because they’ve got these compounds that volatilize really fast and ready to oxidize. But what can happen is, like, the combination of those things, the water inside the tree expanding, turning into vapor building up pressure, trees will explode. If you ever, like, watch the fire line from a distance, you can kind of like, I've done that at least, like you know, from 50 miles away, you, it's a pretty sight to just that night watch, like the orange glow. And you'll see kind of, flares...

Ryan: Right.

John: ...pop out here in there. And that's these trees exploding. It's supposed to be terrible when you're, obviously, you don't want to be close to that. But just this idea of exploding trees sounds pretty impressive and...

Ryan: So it seems like within my lifetime, we've come around on the notion of like, the purpose of forest fires, is that something that is relevant to your work that you think about?

John: No.

Ryan: Okay.

John: Well, so what do you mean by that?

Ryan: I mean that like, I feel like when I was a kid, forest fires were just bad.

John: Mmmhmmm.h

Ryan: And now the thinking is certain types of forest. Need occasional burns to clear out underbrush, and help certain types of plants actually germinate, right.

20:00

John: Yeah.

Ryan: So, certain pine cones that won't open unless they've, and release their seeds, unless they've been through a fire.

John: Yeah, so we need to be nuanced and yeah, you're right. Like it's certain types of forest.

Ryan: Yeah.

John: Need, it's hard to say, like, need fire, ah...

Ryan: Fire is part of the cycle, part of the system.

John: Yeah, I think it's what do we want? If we want to preserve, so think about like, if you've ever, if like, if the listeners have ever been in the West, maybe they've been in California where you have like these nice open forests where you might have a nice big Ponderosa trees, and they'll be a lot of space in between the trees. Maybe, and they'll be a lot of if you look up into the sky, you see a lot of blue sky. And you know, when I say a lot of space, maybe like 20 to 30 yards between trees. As opposed to like when you go up high in the Rockies, anywhere in the west or Canada, you get a really dense tree canopy where you don't see much sky if you look above. Limbs from other trees are touching each other. That's like the normal forest. So if we go back to those Big open forests where you have trees spread apart. The, one way that that's maintained is by low severity, meaning not hot fires, fires that don't have this, they're not putting out that much heat. The flames aren't that high, go through and burn grass and brush and shrubs that could get higher and cause bigger fires if you let them grow. And so if we want to keep those big open forests, then I'd say yeah, we do need to have fire regularly.

Ryan: So it's a question of priorities.

John: Priorities. And, and we could say also too, the problem is, is once those fires do, once those forests do burn, it's like let's say those those open forests, you let shrubs build up and then the flames can then catch up into the high limbs of the big Ponderosa pines. Normally those, in the tree ring record you don't have much evidence of those burning like that. And so then the trees, the fire will burn from tree to tree top, kills the forest and often burns a lot of houses because we like to live in those forests. Those forests are generally low elevation. So like in Colorado, you have a lot of homes in those types of forest. In California, you have a lot of homes in those types of forests.

Ryan: Well, as Wyomingites aren't we required to say there's too many people in Colorado anyway, so what’s a few...

John: We don't go there.

Ryan: They’re greenies. We don’t want anything to do with that.

John: Just too busy. Yeah, so I think you could say fire is important in some ecosystems. And it's important to make that distinction. In, like, the forests, I work in, fires burn there about every 400 years or so. So, depending on where you're at, maybe might be this low is like 250. But if we suppress fires for 50 years, and they normally burn every 400 years, we haven't really done much to change that forest.

Ryan: That's a really good point. That's interesting. Okay, so human timescales don't really work...

John: Yeah...

Ryan: Thinking about...

John: Yeah.

Ryan: But, so wait, that's, that's weird to me. So like, are those the, I don't know, I just know that there are some kinds of pine cones that need the fire to open up. So does that mean that the, those trees aren't reproducing successfully for hundreds of years.

John: No, that's also a misnomer too...

Ryan: Oh, is it? Okay.

John: So, the misconception is that that's necessary for that forest to persist.

Ryan: Okay.

John: So that, so if you go into the, so as popularized with Yellowstone fire, and I guess, forest ecologist way to say that this fire was good because it was crazy. It was. I don't know if you remember it...

Ryan: I don't.

John: You were in West Virginia.

Ryan: Yeah, I wasn't paying attention...

John: Yeah, you weren't paying attention...

Ryan: ...to the West.

John: I grew up in the West. I was only six years old. But I had family that lived up near Wallace, Yellowstone. And so I was very well aware of it. Yeah, surprisingly, I remember like news stories, and I was six years old and super into it. But um, afterwards too, it seems like, this is my interpretation of, kind of, the history of news and the way that the Forest Service responded and the National Park Service responded to this fire was they said, well, it's a good thing that we had this fire too, because we have these cones that need fire, to open and for their seeds to germinate and then the forest can continue. If you go into those forests and look at the trees with those closed cones, they also produce cones that are opened.

Ryan: Okay, so they're using two types of cones.

John: Yeah, they'll vary in their level of how many do they produce or close...

Ryan: So they almost like, insure themselves in case there is a fire?

John: Yeah, yeah.

Ryan: Have some offspring, too.

John: Yeah, yeah.

Ryan: That's cool, I like that. That makes more sense actually.

John: Then there's really, yeah, yeah. Depending, and there's variations within stands on how much closed cones, how many cones do they have? So there seems to be like some...

Ryan: Have you read any of the research suggesting that pine cones evolved in to defend against sauropod like the long neck dinosaurs consuming them.

John: No.

Ryan: Yeah.

John: That sounds awesome.

Ryan: So nothing nothing today eats these things but these plants have, a lot of them, evolved in the Mesozoic when there would have been long neck dinosaur, or are you going to correct me...

John: Crossbills, yeah, yeah...

Ryan: What's a crossbill...

John: It's a bird.

Ryan: I don't know what that is.

John: They have...

R: I mean, I know what birds are...

John: The have a bill, they have, like, a bill that crisscrosses.

Ryan: Yeah, so, ah, okay, okay, I do know what you're talking about, yeah.

25:00

Ryan: Okay, so still a dinosaur technically.

John: Technically.

Ryan: Yeah, birds are dinosaurs.

John: Technically?

Ryan: Yeah.

John: Okay.

Ryan: Technically like...

John: I call them birds but go on. Just kidding.

Ryan: Ah, most real paleontologists...

John: Right.

Ryan: Now your ecological paleontology...

John: ... 3000 years...

Ryan: I also do call myself a paleo-ecologist, but I do a lot of modern work so, I've, I didn't say this at lunch because I thought my advisor would give me a weird look. But every once in a while, I'll put just the word paleo in parentheses. So like I say, I study ecology, but paleo like is a part of the ecology that I look at.

John: Yeah, yeah.

Ryan: Cuz that way, because yeah, your whole...

John: Mine always has an asterisk by it, I say I do paleo-ecology for the last few thousand years, asterisk for the last few thousand years.

Ryan: Right. I say, I do paleo-ecology, but I work on systems, I work, you know, like, I work with animals that are still alive today, too. So I'm not exclusively in the paleo realm, but I do paleo in ways that most modern ecologists would never think about. I've never set up a plot to monitor for a season or whatever. That's like, whenever I think of like, what actual ecologists are out there doing, I feel like they're always setting up some sort of plot.

John: Yeah, I've done that.

Ryan: With a treatment, you know, and so, I've never done that.

John: Yeah.

Ryan: Everything I've always done is still...

John: I'm glad that we're nuanced in our science as well as in the what we call ourselves. We're just as equally into shades of gray with our...

Ryan: Yeah, you have to be...

John: Terms for...

Ryan: Cuz science, I mean, everything so specialized, right? You have to, but, I mean, by the time you finish the dissertation, you're the only person in the world who knows or cares about, well, maybe not cares, but knows...

John: Shout out to Phil Higuera. I think he cares. He's up in Montana. He does a lot of work that I do.

Ryan: Okay, cool. So if you got one person besides yourself...

John: His students seem to read the paper too, but yeah.

Ryan: Nice.

John: I think they did. We'll see.

Ryan: But yeah, a friend of mine who was a paleontologist, came up with this idea that maybe pine cones that have like really severe and intense ornamentation evolved that because that would be really painful if you had a neck 60 feet long.

John: So that sounds cool. It's like that's bad enough when you chew a chip.

Ryan: Right.

John: Enough and...

Ryan: Oh, yeah, yeah.

John: And it goes those few inches. But does he have any evidence to support that? Or was he just arm waving?

Ryan: I think it was some sort of co-evolutionary arms race with the diversification of sauropods coinciding with the ornamentation of pine cones, you know.

John: So there is evidence, like in terms of like, ornamentation...

Ryan: I mean, he got a paper out of it, so...

John: Okay, cool.

Ryan: Yeah, I...

John: Ornamentation increases as...

Ryan: Sauropod diversity increases maybe...

John: Okay.

Ryan: So, the more sauropods you have out in the environment? I don't remember a couple years ago.

John: Oh, cool.

Ryan: I mean, it wasn't, you know, it was it wasn't completely laughed out of the room as an impossible notion, you know. I mean, there are dinosaur paleontologists, like if you ever talked to me or Mark or anyone in our lab about paleontology and like talk about dinosaur paleontology, like, there's a lot of poked fun at dinosaur paleontologists. It’s very different culture.

John: Yeah.

Ryan: Then like more recent mammalian paleontology.

John: Yeah. Then, it's like, I think it's like that in a lot, like, it's I feel like there's that same way in my discipline too. There's, yeah, we won’t...

Ryan: Yeah, we have to, we don't have to throw shade. But you know... So like, I've seen more ridiculous dinosaur ideas put out there than this one. And still get taken seriously...

John: Has evidence to support the claim or some line of logic...

Ryan: My favorite one to joke about, and it's like, it's entirely plausible, but it was one of those where I felt that the conclusions were overstepping the data. You know what I mean?

John: Yeah. Which that's what I would think with that mean, just, yeah...

Ryan: Totally, yeah, yeah. So and I think that's common for scientists to do because we get excited, we want to tell a good story. And so you're more likely to overstep the not, I think, in certain instances where you're like presenting at a conference or something like that.

John: Okay.

Ryan: Maybe, maybe I'm wrong. I don't know. But I remember a guy was putting forth the notion that like T-Rex would have pulled the skulls off of Triceratops by biting on the frill. And then the term he used was popping it, a triceratops, like a can of Coke.

John: It sounds cool but...

Ryan: And he had like a couple Triceratops frills that had some like bite marks and probably were a T-Rex. But you know, it's still an n of two. So to say this was like a common T-Rex behavior. That definitely happened all the time.

John: Yeah. Yeah.

Ryan: Which, again, I'm probably overstating what he was even saying in his conference poster because it was also just a conference poster. It wasn't like...

John: It seems to be a problem in all the Paleo, ash, ish, like archaeologists, paleo, like, whatever you call it, like, I see, paleontologists do that. Everybody I've seen that works in the past, unfortunately, I think makes too many arguments without enough data. Well, not everybody.

Ryan: Well, there's never enough data. That's the problem, right?

John: Is there never, is there never enough data?

Ryan: There's always less data than we could pull from like a similar study looking at a completely modern...

30:01

John: Yes, yes, but I would...

Ryan: Relative...

John: I would hope that we make, I mean, I'm trying to make a goal to make conservative arguments limited to the evidence.

Ryan: I think we all have that goal.

John: Yeah. Do we forget? Do we, like, lose sight of that? Because I wouldn't think it's not something we do consciously. You don't want to, like you said, tell a good story. You want to like, wow, your friends, but I don't want to BS anyone. Do we, do we, but maybe I do, maybe I do it subconsciously. I don't think, I'm too young in my career. I would, I'm afraid of a couple of people that I know are at conferences every time...

Ryan: Who would call you on it...

John: And I'm thinking of, yeah, a few people right now that would call me on it. And they should.

Ryan: Right.

John: And so yeah. I see this as a, I see...

Ryan: Well, maybe it’s a, maybe it’s a cultural...

John: I see it as a cultural thing...

Ryan: ... Yeah.

John: And I've been, I've been fighting against it my whole career. Because my whole career of six years in the Paleo realm, just because I don't think it's useful, but, that's, yeah. Who are your listeners? Are they scientists or are they, like, lay public? They'd be like, what are you guys talking about?

Ryan: It’s a mix, it’s a mix of both.

John: Yeah.

Ryan: We have, you know, we have a lot of lay people. We have a lot of scientists, we have a lot of educators. We have a lot of, like, young high school, college kids.

John: Yeah. And maybe they get to go to they go to the museum, they hear, they hear a paleontologist talk and they think you know what, that doesn't sound, I don't, they didn't present a compelling argument. Or you go and you, they show lots of interesting data and they have a pretty tight argument. I think we would see both. So if, if they do...

Ryan: A spectrum...

John: Yeah, if they go and see that, that's, that's kind of what we're talking about. And I...

Ryan: I think it's a, there's a culture within sub-disciplines.

John: Mmmhmm.

Ryan: And then within those sub-disciplines, like there's a culture within a legacy of P eyes, right. So like, I feel like, I feel like I try to interpret the data, the way my advisor would interpret it. And I feel like my advisor tries to interpret the data, in a way similar to how his advisor did it. And so there's almost like a legacy aspect.

John: Yeah.

Ryan: Because I come from this lineage of scientists, my method of interpreting data, and so I like I look back at the legacy of paleontologists, the lineage that I'm in...

John: Yeah.

Ryan: And I tell myself or at least pretend to myself that like, yes, this is totally how Stephen Jay Gould would have said it.

John: My academic great, let's see academic great grandfather, I believe. So my advisor's advisor's advisor...

Ryan: Yeah...

John: Reed Bryson died saying that global warming was false. And he was arguing for global cooling. So luckily, we've gotten past that. That legacy didn't persist through our generation.

Ryan: So my academic great, great grandfather is Stephen Jay Gould.

John: Okay.

Ryan: But, as a...

John: I don't know Stephen Jay Gould. Sorry.

Ryan: Oh, he was a pretty popular paleontology popularizer. He wrote, like popular books for the lay public. He was on *The Simpsons*.

John: I might have read, yeah, okay, yeah, yeah.

Ryan: Yeah.

John: I know Gould.

Ryan: I mean, come on, he's on *The Simpsons* like, that's pop culture cred, right?

John: I know the Simpsons. Better than these other questions. Yeah.

Ryan: He, in his time, produced a fair number of grad students that ended up being like pro-creationist and were probably in his program, fully aware that they were essentially like spies, getting a PhD from a respected paleontologist so that they could then go undermine...

John: Wow.

Ryan: ... the science. Like it was, uh, and that actually, still kind of happens. I won't name any names but I have like friends who are professors who have when they dig a little deeper on an application they've been sent it's clear that the person is a full on creationist who's trying to get in and get a degree so that they get a legitimate degree from a legitimate scientist from a legitimate University and institution.

John: Cool.

Ryan: That happens, which is weird.

John: Oh man, that sounds like a lot of work.

Ryan: Yeah.

John: Yeah, that's cool.

Ryan: One of my professors in undergrad had to reject a GSA abstract because they were...

John: They don't reject GSA abstracts...

Ryan: They got rejected because they were carbon dating dinosaur bones. Guess what is not a good method for dating dinosaur bones?

John: Dating anything, dating carbon with a half life of five, how many thousand years, yeah short, short half life.

Ryan: No, I mean, you can go back, like, I think 46,000 years.

John: Yeah.

Ryan: 50,000 years.

John: 50 to 60.

Ryan: Yeah.

John: But at that time, yeah, things are...

Ryan: I think the half-life is like 23,000, which means you can go double the half life.

John: Oh, man, no.

Ryan: I don't do any dating.

John: Well, one problem with going back about 60 is it's also this, well, now, we shouldn't you know, I don't work in that time, I'm not going to claim to know.

Ryan: Yeah, neither do I. I mean, I work in that time but I don't do any carbon dating.

John: Yeah, I don't do carbon dating at that time. I know there are problems back then.

Ryan: But it's ah, not a good method for dating dinosaurs, unless those dinosaurs are birds from the past...

John: Is there any carbon left in there, yeah...

Ryan: There’s carbon but it’s, but if it's

John: Is there any radio metric carb?

Ryan: Probably not, no, there’s no carbon 14 left so.

John: Yeah.

Ryan: So, like, they got, you know, they got that basically, their, their abstract was saying I dated these dinosaur fossils. I got the maximum age possible to get with carbon dating. So therefore these dinosaurs must be much younger than...

John: That's interesting. That's, that's kind of sad, because...

Ryan: It's a total misuse of the method.

John: Yeah, a total misuse of the method which I feel like my job as a scientist is to know a method really, really well to make sure I'm not using it improperly.

35:05

Ryan: Yeah.

John: And we still do a little bit and because we're humans. But yeah, that's been my goal to know those methods well, so I don't use them wrong.

Ryan: I think that's something people don't appreciate about what it is that scientists do all day. Because they think we just get data from somewhere. And I don't think most people think about the process of where that data comes from and the data always comes from a method that requires prep and time and effort and energy, and still could be wrong, and so you have to understand the limits...

John: You have to understand, yeah, you have to understand, yeah. Yeah, the limits and what you're doing where problems can arise.

Ryan: That’s why I put Janet on my committee, because...

John: She's very meticulous.

Ryan: Her, I mean, her mantra could practically be the machine will lie to you. Don't trust the machine to give you the right number, which makes me very sad because I'm like, what else do I have? Like if the mass spec lies to me...

John: You take multiple measurements.

Ryan: Yeah. But again, with paleontology, you don't always have enough sample to do that, yeah. So that's where being careful comes in right?

John: See we're on a different, when you when you talk about not having enough sample, I just have to do more work, there's plenty of lakes. So we didn't say this to the, ah, but I use lake, oh, I did say that. Yeah I use lake sediment, mud from the bottom of lakes.

Ryan: Yeah, let’s actually...

John: There's plenty of lakes for me to go get more samples, I just have to put in the time.

Ryan: So you sent me two papers to review. So let's actually get into those, let's get into your actual, your actual research and actual...

Music

Ryan: I’m gonna interrupt right now to bring you a short drinks segment since it wouldn't be an episode of Science sort of if we didn't tell you what we're drinking. I am drinking because I just finished editing this episode and I am worth it. So here's what I'm having. Funnily enough, both of the things I'm drinking today were given to me by my wife. So that's kind of cool. I'm having my newfound favorite rye whiskey, which is Bone Snapper Rye Whiskey. For the price point, I don't think you can find a better rye than this one right now. Man, it's over proof, which I also enjoy. And in that rye whiskey, I'm enjoying some Bittermens Burlesque Bitters, which my wife got me for Valentine's Day. She got me a couple other bitters as well that I

might feature on later episodes. But this was the one that surprised me the most it's not just a straight flavor like orange bitters or grapefruit bitters, or some other citrus I don't even know about yet. This is a blend of hibiscus açai and long pepper so it's sweet, spicy, floral, a little bit tart and it took me a little while to actually wrap my head around what was going on with these bitters because the bitters, I'm used to tend to be more of a straightforward one note sort of thing. So this one I had to play around with a little bit. But now that I have I love it, and the bottle design is really nice. And the dropper that it comes with is actually one of the more fun droppers I've ever gotten to us with a bitters which maybe that's a weird thing, but whatever. Have fun, don't don't overthink it. Just enjoy life, man, enjoy some whiskey, enjoy some bitters, and enjoy the second part of our interview with John where he tells us about some recent papers that he's just gotten out the door and found out some pretty cool things about fire and climate. And things you need to know about. So, that's what we're going to talk about.

Music

Ryan: So, which one do you want to talk about first?

John: I think, ah, so we've got two papers that I sent you. One is a chapter for my dissertation and one that was published last year. No. Last year, one of those published 2015, that I got, I got really lucky. And I was hoping for because it sounded cool. I got published in the *Proceedings of the National Academy of Science*.

Ryan: Which is pretty big.

John: I felt cool. I felt super cool.

Ryan: And you’re first author.

John: Yeah.

Ryan: Well, we can talk about that one first.

John: Okay, thanks.

Ryan: So “Medieval warming initiated exceptionally large wildfire outbreaks in the Rocky Mountains”. So I don't think when people think of medieval times they think about what was going on in the Rocky Mountains.

John: No, they don’t.

40:00

Ryan: That’s already kind of a story.

John: Yeah. So...

Ryan: Not to, not to paint you with a cool story brush.

John: If you think of medieval times, we can start with, well, it's easier to think of, um, what's the name of the amphitheater that Shakespeare used to perform in?

Ryan: The Globe.

John: The Globe. So when you go to like a Shakespearean festival you have, they’re cooking outside.

Ryan: But Shakespeare wasn't medieval.

John: Shakespeare wasn’t medieval. We're talking, I don't know the timescales, let me not do that.

Ryan: Shakespeare was Jacobian or...

John: Which was what, what year?

Ryan: Like 1600s.

John: 1600 AD would be, or, yeah AD. Oh, wow. Okay, so he's just, that's why they talk about it, because it's just before the...

Ryan: I listen to a podcast...

John: He’s just before the Little Ice Age. You’re right.

Ryan: I've talked about this before. I listen to a podcast called the History of English. Obviously Shakespeare comes up and one of, like, the great misconceptions is Shakespeare was speaking what is considered by linguists perfectly modern English. Like the language has not evolved enough since Shakespeare time to be considered a different...

John: Language...

Ryan: ...mode of it. So like Middle English...

John: Man, in the 11th grade I had a really hard time reading *Romeo and Juliet*.

Ryan: No, it's tough.

John: Yeah.

Ryan: It's tough if you're not, if you don’t live in it, but yeah, you have to go way farther back for that, like, it not to be considered a modern English.

John: Okay. And I was gonna use that example. But it would have been wrong because he's right before it starts to get cold for this brief little period we call the Little Ice Age, but that doesn't matter. So, yeah, so we don't think of medieval times, it's I don't exactly know when people call it medieval what, what in human, in historians...

Ryan: I feel like, it's like a 1000 AD or...

John: Yeah, so we're talking like...

Ryan: To like 1300 AD. Because I think the Renaissance kicks off in like, the 1400s, right.

John: Okay, yeah. So we're talking about a 1000 years ago. So that's about right. So yeah, so there’s this...

R: So a 1000 years ago, you get like, like Vikings running around. You get, like, the Christians taking over Viking places.

John: Is that what they were doing?

Ryan: Yeah, yeah, yeah.

John: I'm just worrying about the Rockies.

Ryan: Yeah, well, there were like, well, I mean, the Vikings were sailing in that direction. They just didn't make it that far into the North American continent.

John: Yeah, Eric the Red, ostensibly went over into Labrador...

Ryan: Free Columbia...

John: Or, no, Eric the Red's son.

Ryan: Right.

John: Went down from Greenland to Labrador. Hopefully that would have been sweet.

Ryan: But I mean, you spent time up there, so you probably...

John: Yeah.

Ryan: ...walked the same beaches.

John: I hope.

Ryan: That those Vikings first Viked on.

John: Probably not.

Ryan: But, so we're talking about that timescale. So about 1000 years ago, in the Rocky Mountains. And you, in the title, you talked about this medieval warming. So what happened there?

John: So, a 1000 years ago, it's, it's not over the whole globe, but it seems about, at least in the Northern Hemisphere, so we were, in Europe and North America. In most of it, we see this brief, warm period where it raised about half a degree C. It, it's different in different places. Where I was working, it was about half a degree where it went, yeah, so half a degree C or about one degree Fahrenheit.

Ryan: One of the ways you can, like, determine this, as good as, you may not care about this at all, but I think it's fascinating. One of the ways you can tell in Europe how warm it was at various points in history, besides all the methods that we commonly use as paleontologists, you can look at where the line between the wine growing regions and the beer grain growing regions is...

John: Yeah.

Ryan: It’s, that line moves right...

John: Yeah, so this line was, they were growing wine much, much further north.

Ryan: Exactly.

John: At this time.

Ryan: That's indicating a warmer climate.

John: Yeah. And, and spatially across, like, in different places it was warm at different times, too. But around that time...

Ryan: There's also a potato-tomato line.

John: Yeah?

Ryan: Yeah. So like, there's like...

John: Elevationally?

Ryan: No, no. Latitudinaly.

John: Latitudinaly.

Ryan: Yeah, yeah. So like Britain is part of, you know, Britain, Scandinavia, Germany, Northern France, like, they're potato Europe.

John: Uhhhuh.

Ryan: And then, like, Italy, Greece, Spain.

John: It was tomato Europe, but back then they got some tomatoes and not the way we grow tomatoes.

Ryan: Anybody who has been to a topless restaurant with Spanish cuisine has probably gotten patatas bravas which are, is a potato dish.

John: Ahhuh.

Ryan: And apparently they love potatoes in Greece, but I learned recently that that was like a propaganda thing. The old Prime Minister of Greece was trying to get people into eating potatoes. And so what he would do is he'd put a bunch of guards around the potato shipments to make it seem like potatoes were really valuable.

John: Yeah. Create scarcity then...

Ryan: They just didn't prosecute people when they stole them. No, stop, don't.

John: People think it's awesome, yeah, when you can't have it.

Ryan: Please, no, don't take the potatoes.

John: They're so important and expensive. I like potatoes, but...

Ryan: I like potatoes too, potatoes are great. What's not to love?

John: Yeah.

Ryan: Anyway, getting back on track. So 1000 years ago, it was warmer in the Northern Hemisphere.

John: Yeah. And actually, I wouldn't, I don't know what to say about other parts of the Earth but like North America and Europe. Yeah, we raised about half a degree C.

Ryan: That's where most of the land is, is...

John: That's where like all the peop... well, not, that would have been bad. That's where all the people were, except for Asia, South America. Yeah, there were a lot of...

Ryan: But I do think there are more people, at least today, in the Northern Hemisphere than the Southern Hemisphere.

45:02

John: Yeah, it's our Anglo Saxon heritage.

Ryan: Well, this is where the oceans are.

John: Yeah, yeah.

Ryan: I mean, like, there’s more water in the southern hemisphere.

John: Right, right, right. Yeah.

Ryan: Then there is in the northern hemisphere. I mean, Siberia.

John: Yeah, yeah. We left, we left Asia out. But yeah, so yeah, I don't, I don't know what the, I don't know the climate history of Asia. I don't know if they experienced some of this warming too. It was, spatially, oh, boy, heterogeneous, it was spatially varied, but for, that sounds terrible, spatially heterogeneous. But, ah, yeah, so what was your question? Sorry.

Ryan: Well, normally what we do with this kind of thing is we work through the title and make sure the title is at least clear.

John: Yeah.

Ryan: And so I think we've done that because I think medieval warming was probably the only term I imagine, that threw people.

John: Yeah. Okay. And then initiated, I don't know if initiated, warming initiated exceptionally large wildfire outbreaks in the Rocky Mountains. If I had one thing I really wanted to change it would have been, I wish I could write a better title. I, you get into different aspects of the paper and getting it published and you spend a lot more time in some parts than others and...

Ryan: So, what's your, what's your rewrite?

John: I don't know what my rewrite is. It wouldn't have initiated and it wouldn't have wildfire outbreak seems a little redundant. I would have just said maybe medieval warming... ah, it's...

Ryan: Begat.

John: Begat. Well, you don't want to say caused but yeah, yeah, medieval warming, yeah, that's good enough. Medieval warming initiated exceptionally large wild out fire, wildfire outbreaks in the Rocky Mountains. That sounds good enough.

Ryan: So what's exceptionally large mean?

John: Yeah, yeah, we have to establish what different is. So normally, if you take any, so what I did is I looked at this mountain range, which is about 1000 square kilometers and on any...

Ryan: When you say the Rocky Mountain Range do you mean, like, the Rocky Mountains or do you mean like...

John: A chunk of the Rocky Mountains.

Ryan: Which, which range?

John: So I'm looking at the little mountain range next to Steamboat Springs if you've ever gone skiing in Colorado.

Ryan: I have, I love it. Steamboat is actually one of my favorite mountains to go skiing on in Colorado.

John: Okay, cool. So it was that, was that area. So it's just about, just north of Steamboat Springs, maybe 60 miles. From Steamboat Springs, go north about 60 miles.

Ryan: And does it have its own name? Because I feel like here we have like, we have like the Snowies and aren't the Snowies just a part of the Rocky Mountains or?

John: They are, yeah, yeah. So...

Ryan: I've always been confused by that like okay, it's already part of a mountain range, why are you giving it another name? That would be like this section of the Mississippi River is called the Illinois River.

John: Right, yeah...

Ryan: No it's...

John: It's a chunk of the... man, the people that live there and love it, and I spent six years researching it, I want to say Park range.

Ryan: It's pretty far from Park County. I don't know if it I am...

John: But I'm hesitant.

Ryan: Yeah, I was going to say, is it in the, can I look through...

John: It might be so we could say it's in the Park Range.

Ryan: You know, PNS always has the the methods at the very end so...

John: Sorry. You want to ask me, I published this a year and a half ago what mountain range was it? That's...

Ryan: And you defended, haven't you defended this since then?

John: You know what...

Ryan: This is not...

John: What mountain range this is in didn't come out...

Ryan: The Routt, the Routt National Forest...

John: The Routt National Forest National Forest, a part of our national forests. I believe we call it the Park Range.

Ryan: Alright, I'll allow it. Mount Zirkel Complex.

John: My advisor may hear this and be disappointed in me because he's...

Ryan: I don't think Brian's gonna listen to this.

John: He loves mountains and he knows these mountains well.

Ryan: Is he gonna listen to this podcast?

John: He... I hope so.

Ryan: Okay.

John: He, so, one of the...

Ryan: I don't think, I don't think Mark listens, Mark if you're listening I'm sorry, I don't think Mark listen's to this.

John: Well, it's got a good backstory. So it, my advisor, when he, between his master's and his PhD, he hiked the Continental Divide from Canada to Mexico.

Ryan: I heard this, yeah, he told me this.

John: And one of the reasons why he's doing what he's doing right now is, is he's, you know, he started with a group of people and he finished alone. And as he's walking through the mountains, he he just continually had a thought, right? Where he thought, what is going on here? What was it like before, what is happening here? And that's what drove him to a PhD, or at least part of the story for what he's told me, is that's part of, I don't want to tell, say what he did, but that's why he did a PhD in paleo ecology, and why he's doing what he's doing now. And actually, he hiked through this portion of the Continental Divide. And so, so my field site study go through, my field sites go through the Continental Divide and ah, as he went, so when I told him what I wanted to do, he's like I know just the place.

Ryan: Nice.

John: Because he had slept there.

Ryan: And so what did you do? When you say you go out in the field, when you say you spent six years there, what are you physically doing?

John: So what I do is, I go, I hike to different lakes because most of these areas were in wilderness areas so we couldn't drive to them. But I hiked to lakes with equipment to take cores of sediment out of the bottom of the lake. So I go up there, hop on a boat, find the deepest part of the lake because the...

Ryan: How did the boat get there if there are no roads?

John: It was in our packs. It was, they’re super duper cool rafts that they call alpaca rafts. You can look them up. They're expensive, like 1000 bucks, but they're awesome. They weigh only a few pounds. Plop out on those rafts float around, find the deepest point of the lake. Because normally the deepest, normally the deepest point of the lake accumulates the most sediment. So I think gonna give us the most mud for the most...

50:02

Ryan: Is the deepest part of the lake usually near the center of the lake.

John: Yeah, generally, not always, but yeah. So you kind of go to the center and just kind of paddle around. And then I would, then I would...

Ryan: How do you measure where the deepest part of the lake is?

John: I was using a depth sounder.

Ryan: So you have a little...

John: It was from Cabella's or something.

Ryan: So, like something a fisherman would use to find fish.

John: Yeah, yeah. And then we would, then we would measure it with a tape measure to be sure. Because we would then drop this core in where we would push a tube, a big, big, like plastic tube, push it through the mud. And we had a little gasket on the top that would act like your thumb on top of a straw. And you could then pull that tube of mud out and you'd have, we used meter and a half tubes, so then we'd have a couple of meters long...

Ryan: A meter and a half long or...

John: A meter and a half long and...

Ryan: Are they like Pringles can in diameter?

John: Yeah, yeah. A pringles can, a little bit bigger than a Pringles can and size. Yeah, yeah, tennis ball-ish diameter. That we would then pull that out and have a big tube full of mud. And in about, ah, in the Rocky Mountains, if you take about a meter and meter plus meter, 1.2 meters, you get about 2,000 to 3000 years of mud.

Ryan: Oh, okay, so you were actually getting a range that went deeper in time than the period you were...

John: Yeah.

Ryan: Interested in.

John: Gotta look at before.

Ryan: That makes sense. But I wouldn't have thought of that. Like, I would have thought, you know, this is the oldest, if this is the part you're writing about, this is the oldest stuff you had.

John: Yeah, yeah, no.

Ryan: Okay, yeah so you all right, you did say that. So, it said “the sediment charcoal record spanning the past 2000 years.”

John: Yeah.

Ryan: And so we've so far been talking about pollen. But now your abstract is talking about charcoal.

John: Mmmhmmmm.

Ryan: So what's going on?

John: So if, whenever there's a fire up in high in the subalpine forests, we have to be specific to the forest we're talking about. So these high elevation forest...

Ryan: So when you say subalpine, when you say subalpine, wouldn't Alpine be above the tree line? And so there's no forest anyway.

John: This is sub Alpine.

Ryan: But what does that mean? So Alpine just means mountain, right? Is it like, what elevation are you working at?

John: Ah, up here, we're working around 10,000 feet, just a little bit below.

Ryan: Okay, okay.

John: Most of our...

Ryan: And the tree line is like around 11.

John: Yeah, yeah.

Ryan: Part of Colorado...

John: About that. Yeah. So if they're, if we're in that type of forest, where this is if the fire burns through the tops of the trees, we're talking about these high severity fires where fires burn from tree to tree top. If you've got a lake around one of those fires, if the fire burns within about a mile of that lake, so one to three kilometers or so, then charcoal will rise from that fire and be deposited into the lake. And then that charcoal will, on the surface of the lake, will eventually sink to the bottom and then get buried. A lot of it will come in maybe be washed from rain too. But it's got that range that if you have a fire within about a mile, anywhere within around a mile of the lake, you'll get this puls, you'll get this charcoal that will be deposited onto the surface of lake and then later buried. You know, create this, when you go back and you dig through that mud and you start and we start from the top and just start counting charcoal as we move down the core. Just take a chunk of mud count How many pieces of charcoal...

Ryan: This happens back in the lab though?

John: Yeah, so we take a piece of mud, count some charcoal.

Ryan: So how does that, you're just looking at it under a microscope or...

John: Yeah, you, you bleach it because and kill all the organics and the, the charcoal is already oxidized so it doesn't change color. And then you just have a whole bunch of little black flecks that you look under and you count them. The real science is just counting things most times, right?

Ryan: You don't have like a program that can count it for you.

John: That’d be sweet. They do. We don’t.

Ryan: You don’t get to use them.

John: The, you know, they're, the age of machine learning is now, this is six years ago, which when, machine learning was cruising, but we didn't know about it. I don't know if anybody's made any programs yet to identify charcoal. Every now and then you'll have pieces that are similar like a piece of a bug shell that looks pretty close.

Ryan: Oh, okay.

John: You poke it...

Ryan: So it does take some some experience, some expertise, some...

John: is Some steady hands.

Ryan: Yeah, yeah.

John: Yeah, you poke the and not really. But um...

Ryan: So, you said you have like a meter and change.

John: Uh huh.

Ryan: So, what how thin you know how thinly sliced is the, is the deli meat that is this...

John: I sliced it, so what we did is, we got radiocarbon dates before we diced it up. And so we knew about how much time had, had, had happened with this mud.

Ryan: Okay.

John: And so we shot for, we wanted about 20 years per sample.

Ryan: Okay. That’s pretty good resolution for paleontology.

John: Paleo, yeah, yeah, well...

Ryan: That's recent.

John: Yeah, recent stuff.

Ryan: But, I mean, so when you say like you're getting 2000 years of sediment. A, I imagine you’re not reaching all the sediment.

John: No.

Ryan: So these lakes are all older. Well, older than 2000 years.

John: Yeah.

Ryan: And they've been stably there as lakes that entire time.

John: Since the, the end of the last ice age. They've been accumulating sediment.

Ryan: So, 10,000 years.

John: Yeah, plus.

Ryan: So you could go way deeper.

John: You could but we were hiking in.

Ryan: Oh, sure. Yeah, yeah, yeah. No, I understand that there's limitations to the to the method and to the...

John: Yeah, we had a trade off. Do we want more? Do we want more lakes or do we want more time and we wanted more lakes.

55:01

Ryan: Okay. That's a cool way to distinguish it.

John: Yeah.

Ryan: And so then you, you went through every 20 years for the past 2000 years.

John: Yeah. So about for one lake, you get about 200 samples, obviously.

Ryan: Yeah, that's, that's how math works. And ah, and then you once you had all that data, you just map out the percent charcoal over time and see... fire was...

John: Yeah, you look at look at this concentration of charcoal, and a bunch of people before me have done really important work, understanding, working to understand when a peak of charcoal in the past represents a fire. So they've done a lot of modern studies, they've done a lot of simulation studies with computers to understand when can we say these peaks are real old are actually old fires or with a high probability? I didn't have to do all that work. But a lot of good scientists Phil Higuera is one and Dan Gavin is another that have done really good work to set me up so I could go back and do this work today.

Ryan: Cool. And what was the what was the main? I mean that it's a little bit in the title, but like, what did you see? What did you find?

John: So, what we had to do is, well, the one challenge was that because you only have you only know, from one lake record, it only tells you if there was a fire within a mile of a lake. And it only tells you yes or no.

Ryan: Oh, interesting. There's no way of telling the intensity.

John: Yeah, people have tried to work through that. Like they've thought well, maybe if the peak is bigger, that means something but it's...

Ryan: I would have...

John: Yeah, you would do that. Yeah. And, and people are somewhat divided on this. My interpretation and I would say because it's my opinion, a lot of the evidence suggests it’s, peak, we call it like, how big the peak is, doesn't tell you

information that we'd hope. If, fires really, yeah, so at least that was my interpretation. That's the framework that I was working on.

Ryan: Because as you kind of pointed out with, like, the mile radius and all that there's gonna be a lot of variability.

John: Variability, did it burn the whole area in that mile radius or did it burn a chunk?

Ryan: And you wouldn't know.

John: You wouldn't know. Maybe it did. Maybe the fire was just really close. And so you had...

Ryan: Maybe the wind was just blowing the wrong way that day.

John: Yeah. So you don't know...

Ryan: How long do these fires last, these exceptionally large wildfires, do you know?

John: Oh, well, we can get into that. I don't know. I mean, we think of Yellowstone it burned for months. It didn't burn. It didn't stop until snow fell. That’s...

Ryan: Okay.

John: Huge fire.

Ryan: I buy that.

John: Yeah. But so so it only tells you yes or no. So what we did is we then, or for that one mile radius around one lake. So what we wanted to know is, well, how big were these fires and did fire size change? Because what's interesting, if you look at, other people have done this work, if you look at a lake, one lake record, or if you take two lake records that are close by, and if you say what, if climate was controlling those two lakes, they're pretty close by, if climate was controlling the fire record of those two lakes, then the fire records should be similar.

Ryan: Right.

John: This was the paper that was the impetus for my dissertation, by Dan Gavin. And what he found was, he said, he looked at two lakes that were pretty close by, within similar forests. And what he found was the fire records were different between these two lakes.

Ryan: And they shouldn't have been different.

John: Well, if climate was the dominant control on fires, or at that, that scale, then they shouldn't have been different. But they were different. And so his argument was at that spatial scale, the control on fire isn't, well we don't see it climatic control on fire. We know that climate does control fire, but at that small...

Ryan: But it’s not recording it...

John: Yeah...

Ryan: In the way that you...

John: That we will be able to interpret at that smaller spatial scale. So in that article, he said, you know, at a certain scale, we should be able to see this climatic control on fire. So I thought, great, get more lakes.

Ryan: Right.

John: Get more area that we can sample because we know, so we can think of it, think of it like this, that if you were to go, say and go to any spot of ground on the floor, in a forest and say why does this spot of ground burn? If you just looked at a small spot of ground. And if you had thousands of years of data for what some reason, why does that one little spot of ground burn? It's probably going to look pretty random.

Ryan: Okay.

John: Is my guess based on this other work, too. But if you then looked at a whole, we would think that if we looked at, like a big, a whole forest and say, why does this whole forest burn? Well, we might be able to say something like, well, it burns during drought years, or burns when temperature is warmer during those certain years. That's the hope. So there is this issue of scale and at what scale do you see that process that you're interested in?

Ryan: And so with this particular paper, you've got a bunch of different lakes and I guess the hope was that they would all say yes, at the same time, or they would all say no, at the same time?

John: The hope, I mean, we thought if there was a climatic control on fire, we should sample a bunch of lakes and see what happened. So yeah, there was a hope but...

Ryan: Oh, okay. So, yeah, maybe, I'm ascribing too much emotion to your, to your process.

John: Yeah, yeah, yeah, I wasn't that, invested. I was like, this is, this is Interesting, I like doing this I wonder what we'll see.

1:00:02

There, we have this period, the medieval warm period and then a subsequent cold period. So it's like, well, that gives us a kind of good framework. I didn't know what to expect exactly but I thought, let's just see what happens. We had drought records too that we looked at but didn't see much from those.

Ryan: I don't know if you're a fantasy nerd. But the the medieval warm period followed by the Little Ice Age is one of George RR Martin's inspirations for...

John: No.

Ryan: The weird seasonality of Westeros.

John: Winter is coming.

Ryan: Yeah.

John: That's all I know.

Ryan: Yeah. Well, that's, that's what the Starks who are the, one of the Northern noble houses.

John: Yeah, okay.

Ryan: So they live close to where winter starts.

John: Okay, cool. Yeah, I don't know that.

Ryan: Okay. So what you found was during the medieval warming period, climate, we knew climate was warmer in this part of the world. And that coincided with more fire in, as recorded by the lakes you looked at.

John: Like, that, well, that's what we found. Yeah. What we found was that, is that you're asking?

Ryan: Yeah.

John: Yeah, yeah. What we found was, so this brief warm period of just half a degree C, we found that the rates of wildfire more than doubled.

Ryan: Half a degree C, so that's like...

John: Oh, sorry...

Ryan: 10 to 20 degrees Fahrenheit.

John: Yep. One, about 1°F, so, a small amount of warming led to more than doubling the rate of wildfire burning in this mountain range.

Ryan: That's a scary, that's a little scary considering the situation we're in right now.

John: Yeah, it is scary. I think. I don't like to be a doom and gloom type scientist. But it is it does give you some sense of the implications for small amounts of warming. Often, you know, I talk to family members or friends and they say...

Ryan: Isn’t a big deal.

John: “Well, yeah, climate change isn't that big.” Two parts are wrong with that. One, it will be big. And two is that even small changes have big effects. And so, like for this, in this example, we see very small increases in warming half, a degree Fahrenheit, and we see more than doubling the rates of burning.

Ryan: I think people don't recognize how sensitive the earth system can be. Obviously, there's some...

John: There's a lot of resilience in a lot of things too.

Ryan: Exactly. And, I think people just have zero conception of what will happen when feedback loops...

John: Yeah.

Ryan: Go, go, crazy.

John: Yeah.

Ryan: But, we lose like, when we lose arctic ice, and the albedo of that ice goes away and everything just starts snowballing.

John: What's the opposite of snowballing? But...

Ryan: Tumbleweeding?

John: Rolling forward? Yeah.

Ryan: Like that's, and, Tony Barnosky is a paleontologist, was at Berkeley, recently retired, wrote, has written extensively for both scientifically and for the popular public consumption about these things. And he, I thought came up with the best

analogy when it came to tipping points. He basically said like imagine yourself in a rowboat, there's a pretty good range that you can tilt the rowboat back and forth, and you're still going to make, maintain an upright situation. Eventually, you know, once the rocking stops, you'll you'll be upright again. But if you tilt it far enough even once that you actually tipped the boat, suddenly the new, the new normal is...

John: Upside down.

Ryan: ... is upside down. And it's going to take a monumental amount of effort to get the boat back up if you can even do it.

John: That's good. Yeah, but we don't normally. Yeah, I think I've had these discussions with, in, even, even family members that are supportive of that, that understand that climate change is happening, that it's real, and that the consequences will be bad. Yeah. We, you know, we only have so much time and we're not, unless we're scientists, we might not be spending time thinking about feedbacks and feedbacks within the climate system and how that's going to...

Ryan: I don’t expect people to be thinking about it, but just, I'm gonna bleep this, - - - - ing, listen to us when we tell you what's happening.

John: Yeah. I, I agree. I remember pre...

Ryan: I would love it if everyone was as educated as scientists, but that's unrealistic. So I would at least, I would at least accept the idea that we just get to like...

John: Just listen to me. No...

Ryan: Not even just listen to me, but just accept that like I, I feel like a lot of times, especially in the age of Google, you know, you, your opinion is as valid as my expertise. And that's, and it's...

John: That's not true...

Ryan: ...problematic and it’s not true. And so there are times where I just want to be like, I don't want to use an argument from authority, because I know that that is a logically invalid argument. However...

John: I did that at Thanksgiving. But yeah, go on...

Ryan: It may be logically invalid. But I'm still right about this as right as we can be based on the evidence that we currently have.

John: Yeah.

Ryan: And I could walk you through it. But if you're, the number of times I see people who are skeptical of like climate change and stuff like that, “well, have you thought about this?” And it's like, the answer is always yes.

John: Yeah.

Ryan: Have you thought about whether the sun's getting hotter? Yes. Obviously we checked that. Like...

John: I feel like, yes, that's my job, but...

Ryan: Right.

John: But, but, but on the flip side, too, I remember being an undergrad and I remember being uninformed about climate change and taking an intro to geology class, and the professor there didn't believe in climate change.

1:05:02

And I remember being concerned about it. And, and he expressed some hesitation. He's like, you know, they don't really know if it's warming. And I remember being so relieved. And I remember wanting to believe him. And I remember, when he said that, I thought, Oh, good.

Ryan: Everything's fine.

John: Yeah, everything's fine. Because I didn't, you don't want to believe that something like that, is that bad, is happening in my daily living using carbon to secure a living is contributing.

Ryan: Yeah.

John: And so I can appreciate not wanting to accept those facts and being relieved when you hear somebody making an argument against climate change, because I don't want to believe it.

Ryan: Right. I have an easier time with the people who just don't want to, or just deny it because of emotional reasons or whatever. I have a harder time with the people who deny it because they do the whole "well have you thought about this?"

John: Yeah.

Ryan: That would be like, so imagine, imagine your car breaks down and you take it into mechanic and the first question they ask you like, well, is it out of gas? It's like, yes, obviously, I made sure...

John: I checked that.

Ryan: Obviously, I may not be an expert in car maintenance. But I'm not an idiot.

John: Right, I think, yeah, maybe that's like, they don't appreciate what we do as scientists day to day.

Ryan: And that's why we try to do this podcast.

John: Yeah, yeah.

Ryan: Because we're trying to, like, you know, we're giving ourselves a platform to say like, this is how complicated it is.

John: Right. Like when I get a paper back, and the reviewers ask me, you get grilled and, and hopefully I've thought beforehand, "Oh, is that this? Is it that?" And I've worked through all of those arguments so that when we go to, because we get

those, we go to conferences, and we get grilled. Is it this? Is it that?

Ryan: Right.

John: And you have those slides prepared at the end of your talk to say, actually, no, I looked at it this way. We might not always be able to present all that information but...

Ryan: Yeah.

John: But unfortunately, yeah, maybe for the listeners, like, we're not perfect at it, but that is our job to try, to try to understand are all these other factors, are they contributing to it...

Ryan: Yeah. Control for as many variables as you can...

John: ... as we can, yeah.

Ryan: Do the statistics that then control for it even more to give you like a semblance of understanding of the things that you didn't even think to control for, which is why we're always reporting p values and our r squared values, you know.

John: Yeah.

Ryan: I, we can actually, this might be a good point to transition to your, your other chapter of your dissertation that you sent me. Because I noticed that you reported a significant p value but with an R square value of like .55.

John: That's, that's discipline specific man.

Ryan: No, all I'm saying is like, I don't think people understand. At least I don't think people typically understand that, like, statistically, definitely a valid result. But with my understanding of how R values work, your, your explanation of the system is explaining about 55% of what's happening.

John: Yeah.

Ryan: And there's 45% that you weren't able to control for. You weren't able to see in your data.

John: Yeah, yeah.

Ryan: So you're still seeing a significant control of the system you're looking at. But there's still a lot more stuff out there that has to be figured out and you understand that but that can be hard to communicate.

John: Oh yeah, yeah.

Ryan: And then...

John: To say like, I know, I know this much.

Ryan: Right.

John: And I know I don't know 45%.

Ryan: And I think scientists read it that way, especially scientists who do statistics heavy science like we do. I don't think a theoretical particle physicist would read it that way, but they...

John: They probably read it but I don’t know how they’d read it...

Ryan: I can send it to one, try and get some feedback for you. And so I think that, you know, you look back in time at the way science used to be written, and that verbosity of Victorian era writing, where Darwin or Freud or one of these other, I know Freud's science is mostly dismissed at this point, but like, if you read the way that they write, they'll write almost as if they're talking to a person who disagrees with them. And they say, like, well, and Galileo did that, too. You know, he wrote about the, the movements of planets as a dialogue between him and a guy who didn't believe him, you know. And so...

John: Yeah, yeah, he had to, I guess, right.

Ryan: And so, and so it's all about like, I'm going to present every counter argument that I could think of...

John: Yeah.

Ryan: In the writing of it, we just don't write that way anymore. And it’s probably good...

John: We don’t have the time...

Ryan: ...that we don’t write that way anymore.

John: Every now and then I'll read a paper that will like go through multiple arguments and say, and kind of lay out why wasn't this or that? This is kind of fun, but I was wondering that.

Ryan: Mmmhmmm. Yeah, but we often don't have, we, I don't think we have the space, the freedom...

John: No, we don't the space and time.

Ryan: It’s just not the style anymore.

John: No, like, I have so many figures I've made that don't go into the paper that show why things didn't work.

Ryan: Yeah.

John: That you just don't talk about. Yeah, so that's, yeah, that is, I don't know if you'd say unfortunate or we're limited. We don’t...

Ryan: It just, it just requires a different approach when trying to explain what we do to the public, I think. Cuz otherwise it's a little inside baseball.

John: Yeah, it is inside baseball.

Ryan: Just, sports, which is not science at all. So the title for this, ah, next we're going to talk about briefly here is "Extensive wildfires" so as opposed to wildfire outbreaks?

John: Yeah.

Ryan: "Extensive wildfires, climate change, and abrupt state change in sub Alpine ribbon forests, Colorado".

John: Let's not talk about the title, let's just say what happened in this paper because that title is too...

1:10:03

Ryan: I do want to know what a ribbon forest is.

John: Yeah, a ribbon forest is really pretty. So different portions of the, in the Rocky Mountains, along the Continental Divide, there are these forests that are made up of these kind of bands of forests where you have maybe forests that are really long, maybe a couple hundred yards long and maybe only 30 yards wide. And then they're separated by these open meadows, maybe 50 yards wide. And that and that pattern will repeat. If you hop on Google Earth, you might be able to see some there's some up in Glacier National Park. There's some down here by the Rocky Mountain National Park. So I was looking at part of those.

Ryan: I've heard of gallery forests.

John: I've heard of those.

Ryan: Gallery forests, from my reading, is a forest that grows just along like the sides of a river or a stream.

John: Hmmm, yeah, okay.

Ryan: Which we see here in Wyoming a lot, too.

John: Yeah, yeah.

Ryan: You know when you're driving out on the interstate...

John: Cold desert, yeah.

Ryan: Yeah, yeah, yeah. Like you only see little patches of trees where water is flowing through some grassland.

John: Yeah.

Ryan: And I only know the term because it's thought that certain types of ground sloths would have fed more or less exclusively in these gallery forests, instead of going out into the grasslands for food, so.

John: Gotchya.

Ryan: That's the only reason I know that. Um, yeah, okay, so we're gonna, we're gonna forget the title.

John: Oh, the title's, okay, but yeah, ribbon forests are super pretty.

Ryan: We support that. And again you were looking at, so here you're looking at pollen, not charcoal. And you're trying to see how, you're trying to see how the pollen changed as the fire regime change.

John: Yeah, so pollen we could say is like this proxy or it represents, or we use it to understand something about the plants that were growing on the landscape so...

Ryan: How specific can you get taxonomically when you're looking at pollen.

John: Pinus. So we look at, we can see pines...

Ryan: You get all the way down to the genus level.

John: It depends on the, it depends on the taxa. It depends on the species. So some species we can go to species level. Most...

Ryan: Can you do that visually like if I held up two photos of pollen, would you be able to like tell me which one it was...

John: If it was in the Rocky Mountains...

Ryan: Yeah, obviously, I'm not gonna...

John: Yeah, yeah, yeah, yeah, that was so yeah, one thing I did was count thousands and thousands of pollen grains. Identify the genus or...

Ryan: Did you wear glasses before you started your dissertation? Or did you just wreck your eyes?

John: Looking at my glasses? No, I did not. I've only been wearing glasses for last year. And they're great. I love them. But yeah...

Ryan: Yeah, there's that there's a correlation there. It may not be causal.

John: No, I definitely...

Ryan: May have ruined your eyes with your dissertation.

John: I also aged. Time. Time happened just so...

Ryan: Yeah. So maybe maybe your dissertation explains 55% of the...

John: Of the variation...

Ryan: Of the variation...

John: Yeah, my eyes got really bad this last, well man, I hope it wasn't from all that microscope work.

Ryan: And screen time, we're all looking at screens all the time everyday now...

John: And screen time. Oh, yeah. Yeah.

Ryan: Okay, so you looked at types of pollen.

John: The abundances of pollen, so, gives you, you know, some sense of like changes in abundance of trees versus grasses and shrubs.

Ryan: And is the lake sediment records, this also lake sediments...

John: Yeah.

Ryan: Is that also, you know about a mile around the lake for the trees?

John: No. It did change, this is much more complicated.

Ryan: Oh really.

John: It depends on the species. Like pine they have these huge sacks along their sides and so they can transport really far.

Ryan: Gross.

John: You can find pine pollen on the ice sheets of Greenland.

Ryan: Oh wow.

John: Yeah.

Ryan: Are there pine trees on Greenland?

John: No.

Ryan: Okay.

John: No. So those can go really really far.

Ryan: Are there any trees on Greenland at all?

John: That's not...

Ryan: Because I don't think there are any trees on Iceland, right?

John: I'm thinking, I'm thinking of the Ben Stiller movie when he's on Greenland. I can't remember.

Ryan: I don't remember that movie. I have no idea what you're talking about. *Something About Mary*?

John: *Walter Mitty*.

Ryan: Oh! A recent, a recent Ben Stiller movie. I thought you meant, like, classic Ben Stiller.

John: No.

Ryan: Yeah, I didn't see, I didn't see the *The Secret Life of Walter Mitty*.

John: *The Secret Life of Walter Mitty*. He goes to Greenland. It's pretty.

Ryan: Oh, okay. Because I read the short story in high school.

John: Greenland? Oh, I think it's Greenland.

Ryan: Iceland is also pretty.

John: Yeah. It might be Iceland. Aw, I don't, aw man...

Ryan: I feel like Iceland is the more popular place to go as a tourist than Greenland.

John: Yeah, you, have to go watch that.

Ryan: Have you been to Greenland?

John: No, I wish.

Ryan: Have you been Iceland?

John: No.

Ryan: Okay.

John: I want to. Both. Yeah.

Ryan: Get on it.

John: Yeah. Okay.

Ryan: Yeah, there's gotta be lakes, right?

John: I don't know about Iceland. Excuse me, Greenland. I'm sure there are.

Ryan: If Greenland had glaciers covering it entirely and now only has glaciers covering it partly, then those must have left behind lakes, right?

John: The ice sheet is still pretty dominant there. It's not going away...

Ryan: Is it really, I guess I...

John: Yeah, it's receding, it's mostly, like, volume is changing, not...

Ryan: Because I guess I'm just thinking of like in Canada, where, when the ice sheets retreat...

John: Oh, yeah, I guess...

Ryan: ...left behind lake after lake after lake.

John: Yeah...

Ryan: So I assume something similar might have happened in Greenland.

John: But I, was Greenland completely covered, I'm not sure.

Ryan: I don't know.

John: Yeah.

Ryan: The, we clearly have a lot to learn, still. So even though the lake sediment record when it comes to pollen is more complicated than it is for fire, it's still a record that tells you something.

John: Yeah. It tells us something about changes in vegetation in time.

Ryan: Okay. And so that's what you were looking at as a part of your dissertation.

John: Yeah. Yeah.

Ryan: How does the vegetation in the Rocky Mount region change over time in relationship to fire.

1:15:04

John: So in relationship to fire, can I talk about climate too?

Ryan: Please.

John: One thing that was really cool that we found with climate, you talked about isotopes earlier. There aren't very, you know, the climate records, high resolution and local climate records nearby where you're working, are few and far between. We were lucky that a woman at the USGS had done some work pretty close by, about 60 miles away and had a really interesting isotope record that we compared it to.

Ryan: And that's the Oxygen-18 values...

John: Yeah, yeah.

Ryan: ...you were using.

John: Yeah. So when you said like 55% of our data is explained by this. It was this oxygen isotope. And so what we found was that the, you know, climate changes on all scales. And sometimes those changes are rapid and quick and we didn't expect plants to respond quickly to them too. If you think of a forest you think of these big trees, they can withstand a lot of changes in in temperature, moisture. They're big they have deep roots. But what we found was changes in pollen track really closely with decade, well, sub century scale changes in climate.

Ryan: Okay.

John: We expected there to, it, you know, if the climate were to change there'd be some lag it takes a little while for the plants to adjust.

Ryan: Sure.

John: Especially if the climate changes quickly. That's what we expected. So we found, well, was it changed, it, you see, only 55% of the variance was explained.

Ryan: That's pretty good for...

John: It looks really good and...

Ryan: ...yeah, yeah, yeah. Well, I was just trying to make the point for the people who didn't understand what that value means. I wasn't trying to undercut your results.

John: Yeah. No, I'm not emotionally attached to them. But if you look at the lines on top of each other, the lines track really, really well which we were blown away by we didn't expect...

Ryan: Wiggle matching.

John: Yeah, wiggle matching. With...

Ryan:I know you don't like the term.

John: With regression.

Ryan: I know wiggle matching can be seen as a little bit of a dig.

John: Yeah, but we have a, we have a linear regression model go along with it. I think the...

Ryan: Right, is this the one you're talking about...

John: It's ah, further down, or this one

Ryan: Literally the last figure...

John: It is literally the last figure. Yeah. So when we look at, when we do wiggle matching, but we also, yeah, measure the linear relationship between these two variables.

Ryan: Wiggle matching with some statistics layered on top to make it robust, make it...

John: Yeah, well, to show wiggle matching, is, I yeah, is a...

Ryan: Loaded term.

John: Yeah, is a loaded term and probably not inappropriate use of, because our eyes can trick us. We can think we see patterns when there's no pattern.

Ryan: That's very true.

John: There's good evidence to say, like...

Ryan: But that's why we use, that's what we use statistics.

John: Yeah, yeah.

Ryan: Because statistics tell us if the pattern we think we're seeing is real or not.

John: Real, yeah.

Ryan: That's when you say with regression.

John: Yeah, with regression.

Ryan: That’s what you're referring to, is referring to a mathematical model built into the data, or used, you know, using the data to make sure that it actually is matching up in a way that's...

John: Yeah.

Ryan: ...real.

John: Yeah, we, we are trained to see patterns. Our genes are trained to see patterns and we think we see patterns. Is that really tracking closely? And so yes, that's where that comes from.

Ryan: But in this instance

John: Yeah, it is tracking closely. But what was so it was interesting, this is what we found that I thought was surprising and interesting and important for modern day climate change is we found that the trees responded closely to small changes in climate and quick changes in climate they seem to track quickly. But when we had those large fires, there was also a climate change associated with that, the oxygen isotopes show a climate change...

Ryan: So oxygen isotopes are a proxy for temperature.

John: I, you know...

Ryan: This, actually, I know a little bit about so I can speak to this if you're...

John: I think it's, in this context, I think it's still unclear.

Ryan: Okay. Traditionally...

John: Traditionally...

Ryan: Oxygen isotopes would be used as a proxy directly for the amount of ice on Earth.

John: Yeah.

Ryan: Essentially, depending on, depending on the system you're looking at, so typically, when we talk about like the oxygen isotope curve, we're talking about deep ocean core, which are tracking Earth broadly not it's not very specific to a geographic location. And the way that works is the oxygen isotopes, there's heavy oxygen-18, lighter oxygen-16. The heavy oxygen-18 is less present on the surface ocean is also physically heavier. And so when ice freezes, it's not sampling the 16 and 18 equally. So there's a preference a discrimination, we would call it where oxygen doesn't freeze equally. And so the ratio of available 18 to 16 changes predictably, with the amount of ice available. The amount of ice available is obviously controlled by temperature. So, that's what we mean when we say broadly, not necessarily for your study, but broadly that the oxygen record is tracking temperature.

John: Right. And I, and I, and I somewhat, and I actually, am, well, isotopes are complicated. And so I agree with you.

Ryan: Atoms.

John: Atoms, that atom, well, what I mean is, yes, yeah, you're right. I guess... complicated, they’re just fat atoms, duh.

1:20:02

Actually, in the beginning of the paper I show this is, the, the patterns that we see in the isotopic record are similar to the temperature trends that we see in other data sets from Michael Mann's,

Ryan: Hockey Sticks...

John: Hockey stick curve that was up there. And I show like the relationship between those data and this isotope record. So in that sense, I'm saying yeah, but there, there are, there, there are changes in precipitation that could also affect

seasonality of precipitation. If we're getting more rain water versus snow water that could change these isotopes.

Ryan: Oh, interesting. Okay, cool.

John: So, they'll fractionate differently as they come across. It seems to be a dominantly temperature...

Ryan: These the subalpine habitats there's weird stuff happening with the oxygen isotope as you move up and down elevation gradients too.

John: They correlate strongly, like when, we when I compare it to Michael Mann's hockey curve, and when I've compared to other people's temperature, they it seems to be a temperature signal, but there are other variables that could also change it.

Ryan: To put it simply, when clouds form over oceans, they form the, they form from the ocean water. So when the cloud initially forms, its forming preferentially slightly lighter because oxygen-16 is more likely to evaporate than oxygen-18 because 18 is heavier. So even once the cloud forms it's already not quite representing the ocean perfectly. The ocean is the standard by which we measure oxygen isotopes against the SMO, which is the standard mean ocean water. As the cloud moves inland, the 18 oxygen that did pick up is going to rain out first. By the time it reaches...

John: The Rockies...

Ryan: The Rockies, which is a continental like deep within a continent, mountain range.

John: Yeah, it’s crawling across the Sierras, it's gone across the basin...

Ryan: It's already lost most of its 18 and then as it moves up an elevation gradient, it's going to continue, basically it's going to get lighter and lighter isotopically until the time it reaches a subalpine forest, it's probably as isotopically light as something can, can be from an oxygen standpoint.

John: Yeah, maybe, I don’t know.

Ryan: It’s in there, right? It's getting more and more depleted in the heavier isotope.

John: Yeah, yeah.

Ryan: And so you're getting a skewed starting point, in the subalpine environment.

John: And then if it changes, and maybe it comes up from the Gulf instead, because in Colorado it could come up from the Gulf and it could be a different source area. So I wouldn't say so. I would say it does correlate, I would say it correlates with temperature. But there is variation in there, that could be coming from changes in precipitation regimes too. What nuance right, shades of grey...

Ryan: That's good.

John: But what's important is, is that the vegetation, whatever climate signal it represents, the vegetation responds quickly and linearly to these changes. So if it goes up a little bit, pine goes up a little bit at the same rate every time. But what we see when we have these large fires, so it tracks these changes and the small scale changes. And when we see a when we have these large fires plus climate change, the vegetation changes with that climate change. But it changes more than we expected with just climate alone. So we have these large fires, what we see at the top elevations is that this forest opens up it goes from looks from the pollens record, it looks like it's this dense closed forest. And then it gets a lot more open where we have a lot more shrubs and grasses. And part of that can be explained by this oxygen isotope record that is opening up was related to a changing climate that happened at the same time. But it's greater...

Ryan: But the change in climate that also affected the oxygen isotopes, but not super clear how.

John: Not super clear. Yeah, yeah. Yeah. Yeah. I guess I'm Pooh, poohing the isotopic geologists.

Ryan: That's okay.

John: But yeah...

Ryan: There's, there's like you said nuance.

John: Nuance. Yeah, I'm not, I'm not sure what the signal is, but it's there. And and the plants are responding to it. But they, but the response is more than what we would expect from just the change in the isotopes.

Ryan: So the plants are more sensitive.

John: No. So you have, so it's this. So what happens when we, what happens to plants when we have climate change plus big fires? Plants change. And the response, the response, makes it sound a little dumber than it really is, plants change a lot when there's big fires.

Ryan: No, I like, that, I like that.

John: The forest opens up, and it opens up more than we would expect than just with climate change. So it's this idea of how do these big fires, these like Yellowstone type fires, how do they affect forest? Well, if you combine them with climate change, they can change the forest quickly and they can change it, in our case, the forest change and it stayed that way for about 1000 years. So you can go from a closed forest...

Ryan: So, big quick impacts that last for a long time.

John: Yeah, these legacy effects are what we call it.

Ryan: Oh, I like that. That sounds important.

John: Yeah, legacy fires. Why is the forest the way it is? It's this legacy of this past fire 1000 years ago. What we see is that this big fire looked at the pollen, are similar to the pollen from these ribbon forests, today, immediately after the fire, and that persists for 1000 years.

1:25:06

Ryan: That's pretty cool.

John: Yeah, I thought it was crazy cool.

Ryan: And that’s like, that's one of the big takeaways from your dissertation.

John: Yeah, yeah, that, so it's this What, what's the, How do climate change and wildfire, or disturbances interact to shape the vegetation. And they can cause big changes quickly that persist for millennia, for over a millennia, almost.

Ryan: So if we're going to wrap it all up in a little nice little package, and if someone who listens to this podcast if you wanted them to know or remember or retain or understand one takeaway message, one thing about your research...

John: That fire is really sensitive to small changes in temperature and fire more than doubles when we just increase things by about a degree Fahrenheit.

Ryan: And the forests are very sensitive to the fires.

John: Yeah, and at that, that's a good one, the forest, well, the forests are very sensitive to the fires when combined with climate, with...

Ryan: So it has to be that one-two punch.

John: Yeah, it has to be a one-two punch. And then they can and that change can last for centuries or almost a millennia now is what we're looking at here.

Ryan: That's wild. Cool. So if people are interested in your work, I don't think you're, you’re not on like Twitter anything, are you?

John: Ah, I am...

Ryan: You have a website, I can link to your website but...

John: Oh no don’t.

Ryan: ...it seems a bit dated.

John: It was because of the class that we had to take, that Bobby taught.

Ryan: I made a website for that class as well.

John: And it's terrible. Your website right now though is beautiful.

Ryan: Oh, yeah. So what I did was I remade, I remade my website. I won't say what service I used because they're not a sponsor of the show, even though it's a service that sponsors many podcasts. But I had Brandon, before he left...

John: Oh, yeah, I had him to.

Ryan: I had him go through and put in a permanent redirect on top of my department web page to go to my actual website that I use now. But the website that I made for the class is still on the server so if you click through the link that's on the department web page...

John: We'll get to your really dumpy Google site.

Ryan: No, no, it gets to it for like a second. And then the redirect kicks in and it goes to my actual websites which is funny.

John: Your website is nice. You've got like a nice picture of you at a wedding or something looking handsome.

Ryan: Yeah. Well... gonna look for awhile... Got my Twitter feed. Yeah, I try. I put in, I put in a little bit of effort.

John: I did, don't go to my website, it's...

Ryan: So what would you recommend for people who are interested in learning more about the work you do following up on the project you've talked about?

John: So the one paper, the "Medieval warming initiated exceptionally large wildfire outbreaks in the Rocky Mountains", I think I got that right, that one's publicly available...

Ryan: It’s open access.

John: Yeah, it's open access.

Ryan: We’ll link to that in the show notes for this episode.

John: And I hope in the other stuff, we've been talking about, are chapters and my dissertation, those should be out soon. Hopefully. We'll see how that goes. But I'll keep updating people on Twitter, I think is the best...

Ryan: Okay, so what's your Twitter handle for people?

John: It’s @w_calder_calder.

Ryan: It's good.

John: It's me.

Ryan: Yeah, my Twitter account is just my last name. I got on Twitter early so I was able to get just my...

John: Yeah you did, good job.

Ryan: All right. 46 tweets so far.

John: Now, now that I've got an online podcast presence I will have an online Twitter presence.

Ryan: This is your second podcast you've done, technically.

John: Yeah, yeah my second...

Ryan: But I think this one we let you get a little bit more in depth.

John: Thank you. You did.

Ryan: Is this your, is this your field site in the background of your Twitter...

John: No, that's the Wind Rivers because the winds are awesome.

Ryan: Yeah, no, that's, I was gonna say there's not a lot of, there's not a forest.

John: No, no, I like being up high.

Ryan: You like being above the tree line?

John: Yeah. It’s beautiful. Pseudo tundra man, that’s where, I don't know about you, but I feel relaxed up there.

Ryan: I feel exposed.

John: Yeah, it’s...

Ryan: I grew up in Appalachia, like Appalachians is like crazy dense forest, you know?

John: You get up high where you can see, ooh, it’s awesome.

Ryan: I mean, I enjoy it. I do those hikes. You know, I try to hike, I try to hike Medicine Bow Peak at least once a week. And I did my first 14er year last year. Elbert was fun. I'd like to do another. Elbert is the second highest in the country.

John: Yeah. Yeah.

Ryan: After, it’s second, it’s the tallest peak in Colorado.

John: Is it the second? Okay, okay, so you'd like drove up to like 1312.

Ryan: Ah, we camped outside Leadville.

John: I'm just kidding. Oh, cool.

Ryan: And then hiked from there. It was a was a long day of hiking, that’s all it was. There was no, there was no you know, we'll make summit in the morning, that sort of thing. It was, we camped out below the tree line and then hiked up and did it but it was a big deal for me.

John: Yeah, that's cool. Good.

Ryan: I felt, I felt like I accomplished something by the end of that hike that day.

John: You did, you did.

Ryan: I'd like to do more, you know, I caught the bug enough. But yeah, there was a really fun hike, if you ever are out east, back east. Notice, people always say back back east and out west.

John: I never noticed it.

Ryan: Linguistic legacy of, of the of our European expansion across the North American content. There's a really fun hike. It doesn't, you're gonna poopoo it, because you're like a big alpine whatever.

1:30:00

John: Thanks.

Ryan: It's called Old Rag Mountain in Shenandoah.

John: Yeah, yeah, I've heard of Old Rag Mountain, Shenandoah.

Ryan: It’s so much fun. I think I might have jogged pretty close by there, but it was a socked in in fog. Brian and I were out there doing some field work with a bunch of other people from the university.

Ryan: Old Rag is maybe the most fun I've ever had on a hike, period. Because, it's you know, it's a it's about the same elevation gain you get if you do Medicine Bow.

John: Now, I've heard a podcast about Old Rag Mountain.

Ryan: Yeah, so it's like, you know, you use, it’s about 2,000 foot climb, but you do a bunch of switchbacks to start and then the trail just ends. And it just rocks with like spray painted arrows of like, this is the way to keep going up. And so you're just scrambling and climbing and it's so much fun.

John: Yeah, yeah, cool. No, I've actually heard a lot about Old Rag Mountain.

Ryan: It’s like the most technical climb you can do that doesn't actually require any actual technical...

John: You're on you, you're crawling on a couple spots, right? Like you're using your hands, scrambling.

Ryan: Yeah, scrambling, a lot of scrambling. Really fun.

John: Cool. I’ve been there.

Ryan: It was a good time.

John: Yeah, it was socked in in fog, so we weren't able to do much.

Ryan: Ours was foggy when we started the hike in the morning, but it cleared up by the time we reached the summit.

John: Cool.

Ryan: Yeah. Well, thanks for joining me.

John: Thank you very much.

Ryan: Appreciate it.

John: I really, I really appreciate you coming out, so, thank you.

Ryan: Yeah.

Music

Ryan: Alright, thanks again to John for giving us some of his time and telling us all about the cool work he's doing. Just time for a short Paleo POW which is coming up in the next segment. So I'll see you there.

Music

The Paleo POW is a segment of the show where we deal with feedback from the listeners. That feedback comes in all shapes and sizes and is essential for us to do the show because without listeners, why would I be talking to you? The answer is because I have to, it's a compulsion. I can't explain it. I won't explain it. But I'm glad you're listening anyway, so it doesn't feel like I'm just talking about into the void. This week I am featuring a quick donation from Philip Oh, who sent his donation along with a note: “Greetings Paleo Pals. Love the show yada yada yada. Seeing as Ben already gets money for Titanium Physicists over Patreon, I just thought it would be fair to send you a little something as well as I enjoy both podcasts equally. Still going through the awesomely big backlog but also listening to the current episodes, which sometimes feels like time traveling gone wrong. On another note, I live in Austria, Europe, no kangaroos, etc. and plan to head over to the US to see the solstice in August. Are you planning on doing some kind of event that listeners might be able to participate in? Or do you have any recommendations as what to do or where to go. Keep up the good work.” - Philip. That's a great question, Philip. I don't know that we've planned, we've done, well, I do know. We definitely haven't planned anything for the eclipse in August. It would be a little hard to coordinate something with all of us since we all live in different parts of the US. And I also don't know where in the US you're going to view the eclipse. Obviously, different places are going to have different visibility. But there's also going to be this kind of band across the US that's going to have great visibility as long as you're within that band. So we might need a little more info from you on where exactly you're going to give you recommendations on what to see and what to do. This would be a good time for other people to also give us some feedback, if they're excited about the eclipse, if it's a thing that we should maybe consider doing something special for a live taping of an episode somewhere or something like that. I'm not honestly sure how big a deal this is for most people. So you know, email us or go to the contact page on sciencesortof.com and let us know if this is a thing we should be planning for. I'm always willing to try something I just need to know that there'd be an audience there because again, I don't want to talk to myself alone, like I'm doing right now. Another quick thing to note is that Philip pointed out that Ben gets some money on Patreon and so no better time than right now to announce

that Science sort of is also now on Patreon. You can find our page at patreon.com/sciencesortof. I even recorded a short video that maybe you'll like, I don't know, go tell me if you like it or not.

1:35:05

If you don't like it, I'll record a new one because I'm vain like that. And if you have some extra cash and feel like contributing to the show, you can sign up to give us a recurring donation at various sciency levels that we had fun coming up with and hope you enjoy being a contributor at. So, that's something we're really excited about because it lets us put up goals for things we want to accomplish with the show. As we move forward. We think our goals are things that will benefit the listenership and audience that we've developed in addition to just being cool things to reach because it means we're making money to do the show, which means that we can set aside time to do the show and all that you know, you know how it works, you understand. It’s simple, straightforward it makes sense. So patreon.com/sciencesortof if you're interested in learning more about our Patreon and signing up for a donation. With that, I'm going to call it an episode. Thank you so much for tuning into listen. We hope to see you again next time where we will be sure to talk about a whole lot more science and other stuff because we’ve already recorded and we go off the rails because we gets very... Sort of.

Announcer: Visit sciencesortof.com for show notes, links to all the stories we talked about, and ways to interact with the hosts, guests and other listeners, Science sort of is brought to you by the Brachiolope Media Network of podcasts with audio engineering by Tim Dobbs of the Encyclopedia Brunch Podcast. That's all for this week. See you next time on Science sort of.

Music

Ryan: So follow John on Twitter. And you can keep learning about forests and fires and forest fires.

John: Yeah, cool.

Ryan: That should be your tagline, right? Forests and fires and forestfires.

John: I have a tagline?

Ryan: Paleontologist, fire ecologist, PhD candidate.

John: Yeah, that's lame.

Ryan: Out of date. You're not even a candidate anymore. You gotta delete a word.

John: Okay.

Ryan: Yeah. Plus, you don't have a you don't have your majestic beard in your, it’s a very majestic beard. It’s like your beard game is on point.

John: I, that happened by chance and I'm pretty excited about it.

Ryan: It's like, it's thick in the right places.

John: I know, I know.

Ryan: You’ve got a good line of delineation. Like my beard, I can't grow, I can't grow that, what you’ve got going on.

John: I, have you tried?

Ryan: Yeah.

John: Okay. Cuz I thought I didn't have a thick beard and then I just let it grow and it's like oh, it's actually like all those other hipsters. I'm gonna be cool.

Ryan: All those other hipsters. I'll show you my my maximum, like the biggest beard I've ever grown. And the second because my wife and I live apart right now, the second she saw that she was like, nope, get rid of it, kill it with fire. It wasn't good. I don't think it looked good. But I've convinced myself over the years that like it's appropriate to grow even if it's a crappy beard. It's appropriate to grow a beard when you're in Wyoming for winter.

John: Yeah, yeah. I feel like there's some level of dominance displayed by our beards, like...

Ryan: Ya think?

John: I, people treat me differently when I have a good beard. I don't think it's my, I don't think there's, well I hope there's not a bias there, but it seems like...

Ryan: How do they treat you differently? Like what, like an adult?

John: So, I'm like a happy smiley guy.

Ryan: Yeah, I would agree with that.

John: I think men, men don't respect those like happy, smiley goofy guys, but when I have a beard...

Ryan: This is, this is the best I've ever...

John: That's... Ryan: No, gross. Look at it, like, I don't have the nice clear line. It's very scraggly the mustache area is not working.

John: Yeah.

Ryan: Like it's not a good look. It's not a good look, like, uh, uh, no. No, no ,no.

John: Yeah.

Ryan: Yeah, yeah, yeah. I tried to make it work a number of different ways. And then I did like I had fun shaving it off in weird ways. And yeah, it was not good.

John: Men, so I, men at the gym treat me differently. They give me respect whereas you know, me without a beard and 167 pounds. They don't give me respect but with a beard there, they think I'm legit.

Ryan: It's like a testosterone indicator. Yeah, it's, it's just a facade, but hey, they think it's real.

Ryan: What isn't?

John: Yeah, I don’t… ah… too deep. I don't know.