Transcript

Speaker 1: You're tuned in to 90.7 FM, a k a l x Berkeley. My name is Tesla Munson, and this is the graduates, the interview talk show where we speak with UC Berkeley graduate students about their work on campus and around the world. Today I'm joined by Paleo Botanist Jeff Banca from the Department of integrative biology. Welcome Jeff. Hi, thanks. Yeah, not a problem. So I always like to start by actually explaining the term. I used to introduce a person. What, what is a Paleo botanist?

Speaker 2: So a Paleo [00:00:30] botanist is someone who studies long dead green things, usually squashed flat in a rock for quite a few years, basically remains of past plants. So Paleo botanists, uh, basically are interested in plant life of the past and we use a variety of different lines of evidence from the fossil record to living plants to figure out what's going on. Um, in our world. And plants have been around for a really long time, right? Yeah. Uh, we have at least records [00:01:00] of land plants going back to about 510 million years or so. So almost back to the Cambrian explosion.

Speaker 1: And when, just let's give everyone a brief orientation. When did Earth evolve? When did Earth happen? When did we get Earth as a planet?

Speaker 2: Oh, I would say probably several, several billion years ago. I mean, I think it's something like four, four something billion years.

Speaker 1: Okay. And then we get life, right. And then, uh, then when do we get any kind of plan?

Speaker 2: It [00:01:30] all. So any kind of plant. So I guess different people will call different things. Plants. So to a lot of people, green sorts of organisms or lifeforms living in the water are often called plants, but we botanists consider them to be algae, which is is a term that's very used broadly for, for these sorts of aquatic organisms that do photosynthesis. Uh, the first algae come into the fossil [00:02:00] record more than probably 1.2 billion years ago. So there have been life forms that have been using energy from the sun to sort of make sugars and energy for themselves for a very long time. But land plants, um, have not been around quite as long. Some of these sorts of algae type organisms in the ocean eventually developed sorts of traits that allowed them to make the leap out of the water onto land.

Speaker 1: Plants don't like walk around. So [00:02:30] how did they, they didn't actually leap onto land. How did they get there?

Speaker 2: So there's many ways that a plant can move, but they don't move, like you're saying, in the ways that we do, plants can grow, uh, can grow in certain directions depending on whether they're searching for a light or nutrients. But a lot of times they spread their

offspring in the form of spores or seeds ultimately. So these sorts of earliest land plants probably came out of the water at some point. [00:03:00] His spores, they might've been these sorts of algae that live in puddles that dry up at times and eventually over many generations, maybe some of these offspring had at least traits that allowed them to persist in these drier environments.

Speaker 1: So how do you see a plant in the fossil record? I mean, I'm biased. I look at bones and teeth. Those are, for me, that's easy to think about as fossilized. But what about plants? They don't have hard materials like that.

Speaker 2: Yeah, so it really depends on where [00:03:30] we're looking at a plant. So plants have a couple differences from animals. As we all know, just looking at them, it's pretty obvious, but if you look at going down to the cell level, ourselves in most animals, cells have just a single cell membrane and an outer layer that holds all of the sorts of components of the cell organelles. In plant cells, on the other hand have two types of walls. So they're equipped with a whole second wall and we call it a secondary wall. And this secondary wall [00:04:00] in some different types of plants actually is hardened. So unlike our cells, they actually have a rigid structure. And this is really handy for people like me who want to study plants in the past because these hardened secondary cell walls give us material that can fossilize. Well, and that's important because not everything goes into the fossil record as you're saying.

Speaker 2: You know, animals like us, we have bones, we have hardened parts that can be preserved [00:04:30] through time and might be resistant to decay. Under some circumstances, plants are very much the same. It's all kind of luck of the draw where it grows can really affect whether a plant actually makes it to the fossil record. And if a plant has hardened parts, and particularly if it has wood, which is um, made of a special type of cell that's used for conducting water and nutrients through the plant tissue. Many plants in the world though don't have wood. And [00:05:00] so their only reason we see them in the fossil record is often because they just happen to be growing in a swamp or somewhere where they can fall in and not degrade and be buried.

Speaker 1: It's very interesting stuff. So w again, you said like 400 million years ago for the earliest land plants,

Speaker 2: probably all the way back to 500 million

Speaker 1: years ago. So a very, very long time. And have plants changed that much? I know one of the plants you work on still exists today, so [00:05:30] 500 million years and you can still call it the same plant.

Speaker 2: Yeah, so in a sense, so none of the plants that are with us today are exactly like the ones that have been around for a long time. There's a term that's been thrown around called living fossils and it's a, it's a difficult term if you study evolutionary biology because at

any point in our lives, mutations are happening, uh, genes are changing from generation to generation and for animals. This is something we can accept, but it also [00:06:00] is happening for plants. They're modifying their structure. One thing though that we do notice in the plant fossil record is that there are some lineages of plants that have sort of kept the same sort of let's say developmentally equipment over time. If it ain't broke, why fix it? Basically. And some of the plants that I study, I study mostly because they have kept sort of the traits that we see in the fossil record of the present.

Speaker 2: And they might be able to tell us a little more about how those, [00:06:30] their ancestors may have been persisting. That's the like apod correct. Yeah. So, so I study a group called like a pods and they're not really a mainstream sort of plant group like ferns, flowering plants, conifers there. They're also as a group, if you were out looking for them, you might have some difficulty depending on where you are. Like a pods are basically these, um, these plants that split off from all the other plants with what we [00:07:00] call vascular tissue. That is tissues for conducting water in nutrients. Uh, very, very early in the history of life. They split off over 400 million years ago. In fact, and this was a time period when there's sort of division in the plant, tree of life happened that nothing had leaves, roots, seeds, flowers, most of the traits that we would associate with land plants, many either looked like mosses or [00:07:30] their relatives, which are typically low in stature and small and spreading.

Speaker 2: Or they were something like green sticks and tubes that would scramble along the ground. So they were photosynthesizing, they were using the sun's energy to make usable chemical energy and reserves, but they hadn't really developed the sorts of technical machinery that make a lot of plants, plants to us today. And how did you know they were photosynthesizing? [00:08:00] If you're looking at the fossil record, it's difficult. There are some indirect ways you might be able to infer this. So we typically think of plant fossils as being what we call body fossils or trace fossils. Basically an indication of the shape of a plant or indication that may be a root or something that's moving through the ground in a fossil soil. But there are also chemical fossils that we can use to sometimes [00:08:30] get an idea that hey, there was something that was using photosynthesis that was living in this, you know, area or this, this deposit. So there are some people who found chemical markers for early land plants very far back, uh, at least 400 million years ago. And that sort of interpreted using these, these chemicals that these certain byproducts of plant metabolism, we're being left in soils.

Speaker 1: And, but you said there also, [00:09:00] you know, extant are living relatives of the Leica pods or just living a pods. So do you also incorporate the living specimens in your research?

Speaker 2: Yes, I very heavily incorporate living plants in my research, which can be a problem if you're a paleo botanist, uh, because any paleontologist, uh, has to deal with this sort of struggle between what we call the pole, the present, and sort of keeping it real in the past. We have to really be careful about, okay, if we see [00:09:30] maybe a modern

plant doing something, our natural inclination is to assume that an ancient plant in Iraq that looks similar was doing the exact same thing. This may be true and in many cases it seems quite likely. But there are other sorts of scenarios where plants today might not be functioning quite the same as ones in the deep past, or at least, you know, from times, maybe long before the dinosaurs. Do you grow any of these plants yourself? I do [00:10:00] a, it turned out, or at least it, it came from a closet hobby.

Speaker 2: Originally, I started out as a, uh, fisheries major as an undergraduate, but, um, I grew exotic plants, mostly carnivores, and eventually I found the carnivorous plants, uh, were really cool, but they live side by side with these plants that I had read in some textbooks actually were pretty primeval in themselves. And these, these ones ended up being these like, [00:10:30] uh, ponds that I study. They live in environments that are pretty nasty for most plants or at least ones where most plants don't eat to a living very easily. And that's probably partly why they're doing well today is that they've managed to avoid competition through time. But I started growing them all the way, at least back in high school and in college. It really started getting going. And over the years that I was trying to [00:11:00] start growing them, I found that they're really, really difficult to grow and nobody does it apparently. So this weird group of plants that I was starting to get an interest in, I really needed to start exploring how, how do I grow them? And after a while and after trying to kill them for many years, I finally found a soil that worked for me and that then I tried that on every one of these plants I could get my hands [00:11:30] on.

Speaker 1: So that's part of your research, your research method then is actually just, um, how to cultivate or grow these plants in is cultivate the right term. Yeah. Okay. I wasn't sure you know, plants. Yeah, exactly. No, no. If you're just tuning in, you're listening to KLX Berkeley 90.7 FM. My name is Tesla Munson and this is the graduates, the talk show where we speak with Berkeley Grad students about their work. Today I'm joined by Paleo Botanists, Jeff Bank at telling me about Liko pods and some [00:12:00] other, uh, things he's worked on. I know you've also worked in Hawaii a little bit. Can you tell us about that?

Speaker 2: So yes, one of my research projects actually involved me going to Hawaii. So back when I was an undergraduate, I decided that, okay, well some Paleo botanists have actually been using a leaves of flowering plants, uh, in the fossil record to interpret past temperature. Actually, if you look at the shape of a leaf or go out in the forest and pick up leaves [00:12:30] from many of the different trees there, you might notice if you live in a cooler environment that more of the trees in where you are actually have leaves with serrated edges. Uh, whereas if you go to the tropics, you'll find that probably a larger portion of the trees and forest are going to drop leaves that actually have smooth margins or edges, if you will. So just this sort of observation, which was made well over a hundred years ago [00:13:00] can actually give you a really accurate idea of what the temperature mean.

Speaker 2: Annual temperature is in a region. But the problem is that flowering plants only go back about maybe a hundred million years in the fossil record. As far as we can see, they probably were around longer. It's just that they weren't maybe growing in the right place or we don't recognize them quite yet. So we know that there's been some major climatic changes in the distant, distant past, uh, mainly from [00:13:30] ocean sediments and using chemicals, basically isotopes to figure out that there were glaciation events and also warming events. But on land it's a little more dicey if we want to know what's going on in a forest or on a landscape. It's a little harder to tell regionally. So when I was an undergraduate, I was walking through a forest one day and noticed that all the ferns around me in the middle, in the dead of winter, had tooth leaves.

Speaker 2: Basically these [00:14:00] leaves with serrated margins or edges and realize that, well, wait, nobody's looked at this in non-flying plants and being a Paleo botanist, I had known that firms have a fossil record that goes back way, way further than lowering plants, maybe over 300 million years. So I decided, well, if we look at modern ferns and their leaf shape and, and how it responds to temperature, maybe we could figure out whether they do the same thing. So [00:14:30] to make a long story short, I guess I started doing growth chamber experiments when I was in Washington growing ferns under different temperatures. And the spoiler alert was that I didn't find any changes in their leaf shape. So then I said, well, okay, maybe this is a growth chamber problem. I'm in a laboratory anyway. I mean, if I raised myself in a laboratory, I probably wouldn't be quite the same person.

Speaker 2: So I decided, why don't I go out to the field and figure out whether this holds. [00:15:00] So in Hawaii there are some places where you can go up a tropical mountain and a sample. Basically sample leaves across different mean annual temperatures as you go up in elevation. And low and behold, several of the same species of ferns occurred on these mountains along elevation gradients. So I went to Hawaii and I sampled these leaves. Um, and this was some work I did with national geographic a while back and [00:15:30] we basically looked at tree ferns, the sorts of ferns that grow much like palm trees and formed. And we've been trying to compare whether they're showing these changes in the wild and so far our results are inconclusive. We're still plugging away at measures. Uh, but we'll, we'll see.

Speaker 1: So you can tell things from plants, um, of the past besides just what that plant looked like. Obviously you're talking about reconstructing past climates. [00:16:00] What other things can you learn about the past from plants?

Speaker 2: So you can learn a lot of things about the past from plants by just studying, uh, any fragment of a plant you might be able to get information about not just the plant but maybe even the animals that fed on the plants. So some people actually have been studying for their whole careers, basically insect bite marks and chew marks on leaves, which is becoming a really interesting new topic in the field and one that wasn't being

explored recently. [00:16:30] And some things that you can find from that. There's even a, a paper that came out relatively recently where they found that these fungi, that parasitize ants caused these ants to basically become zombies essentially. So ants that get this fungus in them, it controls their brain to make them actually climb to the highest portion of a plant and lock their jaws and bed their jaws into plant tissue.

Speaker 2: And there they die and the fungus emerges from them and [00:17:00] release the spores into the air to infect all these other aunts that might be breathing in air nearby. Well, they actually found what they think are fossil Deathgrip marks from aunts in leaves in Germany, in this lake, in this site called the Messa Lake. So in that case, a single leaf might be giving you information, not just on animals that might eat it, but also Predator prey or parasite interactions. There are other weird stories too like that, but [00:17:30] that's one that has always sort of struck me as, wow, you can get a lot of information out of just a little bit.

Speaker 1: Yeah. Um, although missiles are really unique fossil site, right? It is indeed. Yeah. So excellent preservation. They're much better than you see it. A lot of other fossil sites. So a lot of the work we've been talking is some of your earlier work from the University of Washington. And I want to talk about some of your artistic abilities. And specifically [00:18:00] I know that you got a cover with a reconstruction of a, like a pod and a, again, that was the American Journal of Botany, correct? Yeah. Yeah. So what, what, how do you reconstruct an ancient plant?

Speaker 2: So there's, there's a variety of ways you probably could and it really depends on what kind of dead plant you're dealing with and where in the rocket is. So some plants are preserved just as squashed, you know, black sorts of imprints of a plant. Others are actually preserved [00:18:30] in three dimensions. So sometimes you'll get petrified wood or whole trees, uh, when you have the right conditions. It all depends on what sorts of sediments and chemistry is in the environment that the plants are falling into and being buried. But for, for my work on Leica pods, a lot of these things, we're pretty small in size and they were very delicate. And actually at the site I was working at, which probably is about 375 million years or more old, it's really hard [00:19:00] to find plants that are in good shape to actually reconstruct or get an idea of what they looked like.

Speaker 2: They're basically just fragments, twigs, if you will. We were fortunate when we were working at this site of these new early land plants up in Washington when I was at school working with a former, a UC Berkeley at Graduate Caroline Stromberg. We found fragments of these plants that actually had leaves intact and not just that, but they also had scars where leaves had dropped [00:19:30] off in the front. So we had these plants have been squashed flat in Iraq, but we could tell where the leaves were inserted along the stem and therefore we knew what the leaves looked like. So we sorta were able to sorta cheat and trace those leaf uh, basis or where the leaves had fallen off these stems and make a three dimensional reconstruction of this little thing that looked for all the world. Like a pipe cleaner on acid,

Speaker 1: huh? Pipe cleaner on acid. Nice description [00:20:00] and congratulations on that cover cause that's a huge deal to get the cover of a journal of course. Oh thank you. And you also have other hobbies or I wouldn't call them hobbies per se, but you know, more creative aspects of your biology life. I know that you grow things at home for conservation purposes or in the lab. Can you tell us a little bit about that?

Speaker 2: Yeah, so part of what got me into botany originally was just having a green thumb and trying to grow things. And [00:20:30] ultimately this led me to focus my efforts in space. I mean, I'm now a collector, so I space is really an issue to really focus my time and energy on plants that were really relevant to these fossil ecosystems that I work on and that I hope to work on in the future. And there are also just lineages that are very underrepresented in botanical gardens. So part of what I do is, uh, the horticulture community. Like Paleo Botany is [00:21:00] pretty small and there's not a lot of us around. I mean if, if you talk to kids about what they want to be when they grow up, they want to make money. Being a horticulturalist or a Paleo botanists might not unfortunately be on the top of that list.

Speaker 2: But a lot of people like gardening. So for me, I now work with people from different botanical gardens and when they have really oddball sorts of plants that at least are from lineages, from these ancient time periods that I'm interested in, I try and give [00:21:30] them a hand by uh, taking cuttings of what they have, uh, with permission of course. And usually they, they will send me stuff just as a backup and I grow up backup clonal material for the gardens and just for circulation. We try and distribute cuttings of these plants to whoever, you know, has a good green thumb and really wants to see them persist in the future. And this is a really interesting thing because I, I had been doing most of this over email for years. I [00:22:00] had been sort of contacting gardens I'd never been to. And you know, if you can grow things like the plants I work on like a pods.

Speaker 2: I mean, you know, there's not a lot of people who can do that. So people are very willing to contribute material, which I've been very thankful for. But something that is really scary is that since there are so few of us around, anytime any one of us dies, say of old age or something who has a green thumb for these things and an interest in obscure plants, we actually lose a tremendous [00:22:30] amount of biodiversity that we have in collections, not just for, you know, hobbies. This is also collections available to researchers, biomedical, uh, or applications and possibly saving these species in the future. There's many plant species that are extinct in the wild that only exist in horticulture. And botanical gardens are a very good safeguard for this and we need to continue working with them. But it's very difficult [00:23:00] when many botanical gardens also have to pay the bells like me.

Speaker 2: And you have a limited number of staff support and you usually won't have millions and billions of dollars to watch over these super rare plants. So it can be hard to keep things

alive in any one place. So if you, if you want to make a difference and you're interested in plants, I would suggest getting in touch with botanical gardens every once in a while. And if you want to go into that sort of research, try growing things that [00:23:30] challenge you a little bit and, and get interested in some of the more obscure things. And maybe some day if you've really got your skills down on it, you might be able to help out. Any one person can make an enormous difference, possibly the existence of entire species. Well said. And

Speaker 1: what are some other ways that people who are interested in students who are interested can get involved in botany and Paleo Botany?

Speaker 2: So there's quite a number of ways. If you're interested in plants and also old plants too, which is a bonus. You can try [00:24:00] and see, go out and start emailing is my, my biggest suggestion. Email people who who might be doing things that are of interest to you but also really try and get in touch with and reach out to botanical gardens or greenhouses in, in your area that you know of and see if you can start volunteering. I mean it might be something as simple as, you know, potting up plants for a researcher or something like that. But really getting hands on experience and helping out. [00:24:30] It really makes a difference to, to anyone who wants to work with these. And it might also give you at least, uh, a better sort of foothold to, to maybe go that direction if you want your career to go that way. We also would love both Tesla and I would love to recommend the UCM P e museum of Paleontology here at UC Berkeley and they have an event called fossil coffee, which is on Tuesdays at I believe 1111 o'clock. Yeah. If you're [00:25:00] interested in fossils and ancient life, definitely come to those. And there's so many awesome researchers here at, at UC Berkeley that study all sorts of fossil related subjects that you know you might be able to come into contact with.

Speaker 1: And so you grew a lot of these backup plants for conservation reasons. What other sorts of conservation issues should the general public just sort of be aware of from your field?

Speaker 2: So on, on a broad scheme, when we talk about in danger plants, [00:25:30] we think about, oh maybe there's, you know, a big charismatic animal. A lot of times that's the first thing that springs to mind. But endangered plants also need our help too. And at that, not all of the plants that we see and that are threatened are things that we'd naturally really want to protect. They might seem weedy or undesirable, not pretty, but yet they have such small population sizes, something needs to be done if, if they are to continue. And [00:26:00] as a Paleo botanists, this is really something that hits home for me because I'm not just interested in the plants just for, you know, modern biodiversity, which don't get me wrong, is incredibly important. But you know what? We're seeing is just a blip in the history of life on earth. I mean this is a tiny fraction of the diversity that's ever probably been around.

Speaker 2: The fossil record is a poor sifter. I mean we, we get some indications of what's around but we're not seeing the whole picture. [00:26:30] So anytime that a species disappears

of any sort of organism, animal, plant, uh, we're losing a tip of the branches of the tree of life. And if we want to understand where we came from and how this sort of came to be, that's, that's really crucial information and different species might come from branches, the tree of life that aren't very well represented today. So there's some people here at Berkeley you work on trying to protect or prioritize [00:27:00] protecting groups of plants. I think maybe also animals based on where they fall out on the tree of life and some groups in which have very, very deep histories or at least have looked pretty similar through time. The have very few species, they're really important to pay attention to because sometimes they're, they're not well studied. So I guess I would say to anyone is, you know, before you, uh, play sprays, some herbicide, you know, think twice about [00:27:30] what might be growing in your yard and maybe that weed isn't really, you know, something you want to get rid of. It might actually be a native that is very interesting in its own right. [inaudible]

Speaker 1: no, thank you very much, Jeff. Uh, do you have any last words for the audience? I know you do know,

Speaker 2: well, I guess with a training in botany, uh, we're taught a term called plant blindness and uh, basically I think there's a whole Wikipedia page about this that's pretty good. But as animals [00:28:00] and as mammals, we have sort of a, a gaze on the rest of the, the world in terms of, you know, what's living and what's not. Plants to people who have not spent a lot of time around them or thought about them much are often thought to be greenery. They are indeed, of course living organisms. I'm staying them as a biologist, but they're also extremely responsive and extremely sensitive to the environments that they live in. They're reacting to all sorts [00:28:30] of things, whether we can see it or not, it's just not always on the same timescales as us. So plants, you know, the next time you're walking outside, you know, anywhere you are in the world, uh, maybe except Antarctica or somewhere polar, you know, stop and actually look at a plant and try and make some observations about maybe its forum, just what is it really doing, what's, what's it up to. A lot of times you'll find that plants, they might have simple requirements, but they [00:29:00] have crafty ways of, you know, getting the most out of any situation they're put in. They're kind of like roaches, except they're better. It's hard to kill them. I mean, I have a career still because the mass extinctions really didn't affect most of them very much. So, you know, think about, you know, the long history of the half and maybe how they're perceiving the world we're living in now

Speaker 1: and definitely recognize that they are alive. You can see them move, you can see them eat other things. Um, yes, plants are alive, so [00:29:30] that's a good point to make. Okay. Absolutely. Okay, well that's gonna do it for this episode of the graduates. That's right. You've been tuned into the graduates here on KALX Berkeley 90.7 FM is the interview talk show where we speak with UC Berkeley graduate students about their work here on campus and around the world. Today. I've had the pleasure of being joined by ancient plant Geek, uh, self-proclaimed of course, or Paleo Botanist, a Jeff Bank in the Department of integrative biology. Again, thank you so much, Jeff, for [00:30:00] being

here and, uh, for putting up with all my questions. Thanks Tesla. It's been my pleasure. Yeah, absolutely. And, and yes, I would encourage everyone to just look at the plants that they see around them. There's so many, and they're all so different and interesting and that's one of the amazing things about California of course. So, um, plants, we'll be back two weeks with another episode of the graduates, but until then, stay tuned. You're listening to 90.7 FM k a l ex.