Transcript

Speaker 1: You're tuned in to 90.7 FM, k a l ex Berkeley. My name is Tusla Munson and this is the graduates, the interview talk show where I speak with UC Berkeley students about their work here on campus and around the world. Today I'm joined by ecologists and Evolutionary Biologists, June in limb from the Department of integrated biology here at Berkeley. Welcome June. How are you doing today? Good, good. I'm glad to hear it. So, okay, so you're an ecologist and an evolutionary biologist. Are Those two different things?

Speaker 2: No, [00:00:30] in fact, a lot of 'em, a lot of evolution actually depends a lot on the ecology of individual species and how a species interacts with the world. It's also, uh, strongly tied to its ecology. So while there is this dichotomy between ecology and evolution, they really are two different sides of the same coin.

Speaker 1: Okay. So you get to be both at the same time. Yeah. Sounds good to me. Yeah. And you work in Hawaii, right? Yeah. That's pretty fun, right? Pretty Fun. Pretty Fun. Just [00:01:00] seems pretty, I wish I was in Hawaii right now. So, uh, you know, but are you, do you have any plans, uh, to head back over there soon for research?

Speaker 2: Yeah, I'm actually, I'm heading back out there a next week to collect more of my specimens.

Speaker 1: Okay. And what kind of specimens do you collect generally?

Speaker 2: So I, I study oceanic plants. Um, I study a group of, um, endemic Hawaiian plants called the pepper Romeo. Sounds like Pepperoni, but people make that mistake. Um, the actually closely [00:01:30] related to the black peppers that you, that you, uh, grind onto your evening meals. Um, on Hawaii there is 24 different species of pepper Amiya um, 22 of them are only found on Hawaii and nowhere else in the world. And I'm doing a molecular study to see, uh, where the Hawaiian pepperoni came from when they arrived on Hawaii and how they have diversified across the acapella goal.

Speaker 1: So you said they're [00:02:00] found only in Hawaii, but they didn't necessarily evolve in Hawaii?

Speaker 2: No. So Hawaii is actually a hotspot. Archipelago. So it's formed when you have thick plumes of magma coming from the earth's mantle. And that basically creates these volcanic islands that in the middle of the ocean and as the plate moves across this plume, it creates islands in sequence. And so all of Hawaii is biota. So [00:02:30] it's, it's animals, it's plants, it's marine diversity. Had to have gotten there through long distance

dispersal. So Hawaii is about 4,000 kilometers when the nearest continent. So everything basically had to fly, swim or get blown there.

Speaker 1: Wow. And do you know, uh, when the most recent island formed,

Speaker 2: um, the most recent island, uh, which we call the big island was formed about a million years ago. Some of the youngest lovers on big [00:03:00] island date back to 600, no, actually date back to about 50 years, 40 years. So it's still a very volcanically active island. And there is a, actually a submarine volcano just south east of big island that is just ready to breach in the next 100 thousands of years.

Speaker 1: So there will be a new island that we can like send to her as too soon. That's what you're saying, a hundred thousand years, pretty soon. Pretty soon. Pretty soon. So then some of the plants [00:03:30] and animals must have gotten there before humans got there. If it's the most recent island was a million years ago. I mean I, I'm assuming humans got there much more recently. So then if humans are not carrying them across the ocean, how are plants getting across the ocean?

Speaker 2: I'm one of the, one of the main hypotheses, and it seems pretty, there is a lot of evidence for that is through microwave your boats. So some of these seas, they often have southern mechanisms that allow them to stick onto the feathers of birds. And [00:04:00] as the birds migrate across the globe, they end up dispersing those seeds. Some of them probably arrived from much more different mechanisms, like for example, storms or even jet streams higher up in the atmosphere. Um, and sometimes even through rafting. So when a piece of vegetation gets dislodged from continental areas and just gets driven by, um, oceanic currents towards the island. And these different mechanisms work more predominantly [00:04:30] for different groups of plants and animals. So for some of the more wet, fleshy fruits that some plants actually produce, uh, they are more transported in the gut of birds. For more wind disperse seeds, they probably got their through storms or through circulation patterns like wind circulation patterns. So, you know, there's a great variety of how a different things have gotten there.

Speaker 1: So you mentioned earlier that you study how plants have diversified since they've gotten there. So what do you mean by diversification? [00:05:00] What does that diversity

Speaker 2: [inaudible] is basically the process in which species accumulate. It's quantified as the rate at which species are coming into existence through various, um, speciation mechanisms and the rate at which species go extinct. So it's, it's, it's basically a net rate of how quickly species accumulate on island. And usually that clock starts when the island is formed. And so that's how he studied at verification.

Speaker 1: So it doesn't net, so it's [00:05:30] the rate of accumulation of species, but that doesn't necessarily mean there has to be a lot of morphological differences. Right. So it's not just

necessarily how different everything looks, but how many species there are. And those are two different things, right?

Speaker 2: Yes, that's correct. Um, so some of the, some of the plant species that I look at, they're almost morphologically indistinguishable, but genetically they would be quite distinct.

Speaker 1: And do you do a lot of genetic in your own research?

Speaker 2: Yeah, I sequence [00:06:00] little pots of a plot genome and then look at using that to infer the evolutionary relationships of different species on the island. I also have a more comparative approach where I have different phylogenies. So these are called phylogeny, which are basically an inference for how these different species are related to each other. And using these inferences we can fit sophisticated models of how these species might have dispersed through time when they first got to the islands. [00:06:30] And also how different morphological traits have evolved. So I guess I should go back to the beginning. Have you always been interested in plants? Is that always been your primary focus? That's funny, but the answer is no. So I did my degree at Imperial College, London and I actually have a degree in zoology, which is not plants, which is not plants. Right. The funny thing is, the reason why I was interested in science was really, I call myself [00:07:00] part of the Athens [inaudible] generation.

Speaker 2: So grew it, grew up seeing or these wonderful wildlife documentaries made by the BBC over the past few decades. And so I thought, you know, I really wanted to study animals, but when I was doing my undergraduate I was exposed to a much y the variety of different fields and ecology and evolution. And one of the things that really kept my attention at first was this concept [00:07:30] of community assembly. The idea that the ecological communities that we see today are not random associations of different species, that there is some rhyme and some reason and some processes that actually drive their coexistence in space and time. And so that was how I really moved from an organismal perspective to a more wider community level perspective. Over time I realized [00:08:00] that communities are not isolated entities. You know that the species that interact in one particular space and time actually interact over much larger regional scales.

Speaker 2: You know, one, one may think, you know, a species might actually be in one particular place in one particular year, but if the weather is slightly different or the climate slightly different, it might be found in a different area. And so to understand how these species interact with each other, you have to understand how those processes operate over much [00:08:30] larger scales. And so that's how I kind of got involved in plants because some of the best, some of the best research in studying how different species co-exist happen to be in the plant literature because they have been so well characterized, especially in the UK. And so that's how I originally got into it. But over time I guess I was a little less satisfied with the way that I was thinking these processes that islands started

to become a more [00:09:00] attractive system to actually test some of the ideas of how species actually come together.

Speaker 2: Um, over time, because islands are discreet entities, so they, they're basically a bit of land surrounded by ocean. They change predictably through time. So Oceanic islands such as Hawaii, they have a growth phase and then eventually the road and then they wrote back into the ocean, eventually given you know, a few more meetings of years. So you can see [00:09:30] how easily the landscape changes to time and that has a substantial impact on ecological processes that operate on those islands on. So by actually comparing how these processes operate across the Hawaiian archipelago, you can make some predictions as to how these processes should change through time.

Speaker 1: And is what happens on the Hawaiian archipelago applicable to other islands and other places? Oh yeah. So the cool thing about islands [00:10:00] is that they are many islands around the world and they all have their own

Speaker 2: idiosyncrasies, like how they were form, how old they are, how tall they have been, which continents they have been close to, which will affect potential sources of colonists. So they vary in every way in managing a bowl. And rather than despair that there is so much complexity, we can actually use that variation in different items to s to hopefully get more general picture of how um, evolution [00:10:30] and ecology operates.

Speaker 1: So is it a coincidence that the UK is an island and that's where you studied and now you continue to work on islands?

Speaker 2: I think that's a total coincidence. Um, the UK, um, is very interesting floristic Li, but over the last 20,000 years, um, I think the UK used to be connected to the rest of Europe, but during the glaciations a lot of the plant diversity has been erased by that, um, by glaciation. So I would say that [00:11:00] the UK is relatively more depauperate than most of continental Europe. Um, but it's a very different type of island because the species, what bear to begin with and then they have re invaded from a much less geographically distant source. Um, whereas for islands, you know, they tend to be more idiosyncratic in the types of lineages of plant and animal. The images that actually make it, they're showing Kallquist the famous natural historian of islands. He coined the term disharmony, [00:11:30] which is basically a way of saying that the Biota on islands tends not to be a perfect proportion or subset of its nearest continent.

Speaker 2: It tends to be form of elements from all around the Pacific so far. For example, for Hawaii, they are plant groups that have immigrated. We think from as far as Africa and even Arctic and border regions of temperate north. For my group, for the Pepper Oromia, we hypothesized that they must have come from somewhere in the new tropics even though we [00:12:00] don't know that yet. We will soon. So that makes things really exciting because then you can start looking at, you know, the, the, the row of

chance probability that a particular plot lineage actually gets to the island, but also look at the role of determinism. So how predictable I these patterns given that we are just sampling randomly from all these different continents to build a Biota on Hawaii.

Speaker 1: If you're just tuning in, you're listening to 90.7 FM KLX here in Berkeley. My name is Tesla and this [00:12:30] is the graduates today. I'm joined by joining limb from the Department of integrated biology and he's been telling us about his work, uh, with plants in Hawaii. The, the Non Peperoni group, right? Pepperoni, IOM, am I close? [inaudible] Romeo pepper. Romania. Um, but you did say it is related to pepper, Huh? But is it actually related it, but it is not one of the types of plants that they make pepper out of or is it that will be a separate genus. Okay. Piper typer knows what's so confusing. Why did [00:13:00] they call this one? The pepper one then pepper, Romy diaper.

Speaker 2: Hi. I, you know, I don't know that at the [inaudible] of, of of the genus, but maybe that's something I should actually look into.

Speaker 1: No, you can't know everything. It's okay. June. Huh? So you were in the UK and that's when you really first started to get interested in plants and community assemblages and islands and stuff. How, how did you end up here at Berkeley?

Speaker 2: So it turns out that when I was applying for my graduate school, I really didn't have a good idea of where to look. [00:13:30] I was still thinking about speciation and extinction on and how that plays a role in community assembly across the landscape. But because it was such a broad topic, basically he had no clue and no idea where to start. But in a friend actually saw an ad for a phd studentship with Rosemary SB here at Berkeley looking at community assembly approaches on Hawaii. And that's how I kind of got sucked into this Hawaii as a system. [00:14:00] So professor Jan SB has this immense multi-institutional project undergoing which of which I'm a part of to look at how out the pot communities structure differently across the Hawaiian occupy [inaudible]. So this has involved many feud seasons of going out into the few setting up insect traps, leaving them out for a week.

Speaker 2: And right now we are still in the process of actually identifying the things [00:14:30] that we have found. But the idea is that by sampling communities on different landscapes of different ages, um, that by looking at particular properties of those communities, like for example, how Richardo's communities, are they dominated by a a, a sudden few number of species or are they more, even the oil is abundance more evenly distributed species. We can get a handle of how ecological processes shaped these community level patterns and hopefully [00:15:00] infer that back to what, how those processes might have, um, influenced community assembly throughout the Hawaiian occupy. The goal. The neat thing is, is that the Hawaiian archipelago, because it has been formed in sequence, so I mentioned it, the big guidance of 1 million years old, but if you move further north west, the old island of Hawaii that's almost 5 million years old. And so the landscape has had a much longer period of time for ecological and evolutionary processes [00:15:30] to

operate. And so by comparing communities from odor islands to young guidance, we get a sense of um, how those processes would affect some measure or some metric of the ecosystem that we are looking at. Yeah.

Speaker 1: And are the islands pretty similar in terms of like their typography or just generally the types of ecosystems you might find? Yes and no.

Speaker 2: So part of this project kind of assumes that [inaudible] is like [00:16:00] a 6 million year old version of big island, but really they are idiosyncrasies between the different islands. For example, [inaudible] even at its maximum elevation was never as high as Hawaii's. Today. Maui d during periods of low sea level was actually connected to all the neighboring islands of Molokai. Lanai, coho larvae, Molokini. There are a few more tiny little islands. And that complex was way larger than Kuwaitis [00:16:30] today, but obviously because Maui was more dominated by low then seeing when the sea level rose, a lot of that land mass was actually is now actually something much. So all the islands have very different geologic trajectories even though there is a general pattern of growth followed by, um, subsidence and erosion of the islands. So, and another thing that's different is also soil development. People don't really think about soy as, uh, as something that has to be developed because, you know, we [00:17:00] see it all around us, but remember to Hawaii is found from lava.

Speaker 2: And so there has to be a certain amount of chemical weathering that has to take place before sufficient soil is developed that is amenable to different types of plants. And so on Hawaii, the soil is a very well developed and in fact over the course of 6 million years or 5 million years, I started to lose some, some of its nutrients, whereas on big island, some of its nutrients are still locked in a lava and are not accessible to many of the plants, [00:17:30] um, on particularly on the younger lava flows. And so we also see this transition in ecosystem characteristics of Arnett, krone sequence [inaudible].

Speaker 1: So I think most of us wish we were in Hawaii right now, quite possibly. Can you give us a sense of what it's like working there in terms of what a typical day is like for you in Hawaii? Um, it's beaches and cocktails, right?

Speaker 2: Yeah, yeah, yeah. So we got a sample of some of the biodiversity on the beaches and maybe while snorkeling reality isn't like [00:18:00] that reality of fuel isn't like that. We usually get up at, you know, 5:00 AM in the morning, pack everything into a four wheel drive and then hopefully get to the field site right before sunrise and then work s as much as possible to mitten. That was fall, my community sampling for arthropods, for the plants, you know, they're not gonna run away. So you know, it's, it's a bit more relaxed and I guess a little bit more fun because you can kind of like see the sights a little bit more. Hawaiian forests are really interesting. [00:18:30] Yeah. Unlike any tropical forest that you've ever seen. Um, when you go into a tropical forest, you hear lots of sounds, a lot of insects. The canopy is made up of bazillion different types of species or you go to Hawaii, you really only have one iconic, um, species of tree. I'm known as

Metro city, Ross polymorpho and polymorpho meaning that it has many different mofo types in, um, it's, it's quite ecologically varied across the Hawaiian archipelago. And so it's a very much [00:19:00] more species, poor forest with pretty much a mono specific canopy. So the canopy's only made up of one species with a strange sub canopy of tree ferns and a much more rich under stories. So it's, it's pretty weird. If you have been to the tropical forests in say, Central America or if you have had any hikes in, you know, Southeast Asia.

Speaker 1: So, and is that because it's harder for trees to [00:19:30] get to Hawaii or why is there only one kind of tree?

Speaker 2: Part of it is the isolation. So very few trees, uh, Metro ciders is one of them, but not the only one, but definitely for wet to music. For us it's definitely the dominant. Um, and we think it's mostly the, the isolation 4,000 miles. A 4,000 kilometers is pretty hard to Trevor [inaudible] us is quite a quite a good disperser. It seats a wind dispersed. Yeah. But we are still trying to figure out the genetics of off of that [00:20:00] tree on, on Hawaii.

Speaker 1: So you collect samples, um, and you bring them back here for genetic analysis and you also run a lot of computer modeling, right? So you've got your hand in pretty much every part of the pie, so to speak in that you're working at it from, you know, from end to end.

Speaker 2: Yeah. So I'm a me and my advisor, I've actually developed a model that takes into account the geologic histories of different islands, trying to generalize the trajectory to a time. So [00:20:30] get grow phase. I stay, grow and build lava and grow in height and in habitat complexity and through the inevitable demise into a car at all a few million years later. So we have been trying to characterize their geologic dynamic with the diversification dynamics of different or animal clays. And what we find was that if you include that geology, you actually predict patterns of species diversity on the, on the archipelago better than models that do not take into account that your logic history. [00:21:00] So number one, this suggests that the Biota of Hawaii is intricately tied to the geology, the landscape. Another interesting thing we find is that for many groups they speciate really quickly the moment you get there.

Speaker 2: And if our model is to be believed, which I think it should be believed, they start to decline about about round about 2 million years. So four 15 of this planet animal plates that we looked at, about eight of them [00:21:30] have shown negative diversification rates or negative species accumulation rates, even on islands as young as Maui Nui as Molly, two minute years. So we'd suggest that a lot of these species, even though they look like they're happily trudging along on Hawaiian archipelago, a lot of these lineages are starting to lose species, but this is obviously a timescales that are imperceptible to us. And so I combine a lot of these sorts of, um, mechanistic models with more statistical models to understand [00:22:00] why different species show different types of diversification dynamics on the island and also try to tease apart how they're different

and whether the only factors that drive a slowly radiating lineage versus, uh, uh, rapidly diversifying radiation.

Speaker 1: Did he have any spoilers on, on why they might diversify at different rates or is that still work to work, to come?

Speaker 2: It's work to come. Um, I have some ideas as to how that might be. It's, it's kind of related to [00:22:30] disperse. So, um, one thing that you note for plants on Hawaii is that the lineages that dispose everywhere tend to be particularly species poor, possibly because they disperse everywhere and that prevents any particular population from being genetically distinct enough to become a new species. Those species that disperse very poorly end up being very species poor as well because they end up not getting anywhere. They're when you stick in one spot. Whereas lineages with intermediate levels of dispersal tend to do, [00:23:00] tend to be the most species rich pleads on Hawaii. Um, pepper Romeo one-up is one of them. But the interesting thing about pepper Romeo is that because they're so morphologically diverse, it has been hypothesized that they might have colonized the Hawaiian archipelago more than once. So the species that we see on Hawaii might actually have three or four separate histories.

Speaker 1: It is it, is there any way to tell that from DNA analysis?

Speaker 2: Yeah, but the only way to really do a good test of that is to collect enough pepper [00:23:30] O'Meara from across the Pacific because you know, one particular group of Pepperoni might have been derived from a completely different origins. Say, you know, Central America, whereas another group could have been from a more Pacific species. So the diversity, different biogeographic sauces of different plant lineages on Hawaii is photo compounded that I actually have that complexity within my group. So I think it's going to be pretty exciting when, um, auto is outside.

Speaker 1: Yeah. So it seems like there's a [00:24:00] lot of different directions you could go with your research. [inaudible] yeah. So we're actually, uh, coming up pretty quickly on the end of time, so I definitely want to ask you now and let you get into the soapbox stage here. If there's anything that you would like to say to the public, please, uh, please regale us.

Speaker 2: So I think one of the things that really strike me about plots on oceanic islands is that a lot of them are unique. Yeah. You'll never find them anywhere else in the world. Out of the [00:24:30] 1400, uh, vascular plant species in Hawaii, 90% of them are found nowhere else on earth. There. I estimated 70,000 endemic plant species found on islands alone in the world. That's a quarter of all vascular plants species. In the world. So here you have a quarter of the world's plants species found on only 5% of the world's land surface. But because of human land use change and uh, climate change [00:25:00] and invasive species, up to 50% of them are under threat in Hawaii, the numbers lower

about, um, 33 to 40%. Um, but you know, these, uh, these, uh, endemic species that have evolved in isolation for millions and millions of years, we see plant species on these islands that are so unique that you can't, sometimes you can't even find an analog in continental areas, uh, in terms of their morphology, their fruiting type of just the overall grow form.

Speaker 2: So in some sense these islands [00:25:30] are harbor too, almost like alien type ecosystems. And I think that they are definitely worth conserving. If you are listening from an island right now, you should get in touch with your local conservation groups, figure out how you can save your own native habitats. Hawaii has a very long, uh, history of actually trying to conserve some of its of its land after decades of agricultural extensive vacation and intensification. But I remain hopeful that people connect [00:26:00] to plants in this deeper way. And you know, like I grew up, so I grew up on Singapore, right, which is 90% or I think even higher than that deforested. Right. And so actually getting in touch with or getting a cultural connection with the plants that I found on the island was not necessarily hard, but you had to actively seek it out.

Speaker 2: It wasn't something that was all encompassing. And part of my being, um, I was, I was an [00:26:30] environmentalist when I was in Singapore. And so getting connected to the native Herod, the Natural Heritage of the island was, was fairly straight forward. But I can imagine there are many regions in the world, many islands in world that way then habitants may not have that same connection for the same reason because it's a really been destroyed or the forest at all cleared up. Very few pockets remain and very few people actually seek it out. So besides just conserving it, I would say, [00:27:00] you know, go out and explore your own natural heritage. Um, that's, you know, this is really all we have. And when we lose them, there is, you know, apart from freak evolutionary events where the same plant evolves from a colonist, a few thousand kilometers away, these plants will, you will never see them again.

Speaker 1: And so when you say threat, I mean we talked about how the islands will eventually erode away, but when you say they're under threat, does that mean like in our lifetime?

Speaker 2: Yes. So [00:27:30] these are threats that I impose by just purely the scale of the human enterprise or cities that need to feed those cities. But you know, these natural ecosystems still play a very important role in human wellbeing. Watersheds are a very good example of that. You know, stuff to do with, uh, controlling erosion or pollination services. So there are all of these intangible and in some way, incalculable, [00:28:00] uh, services that natural ecosystems provide that we should definitely think about more when we are considering issues of how best to feed future generations to come.

Speaker 1: And so you mentioned people who live on islands, what they could do, but do you have any suggestions for people in the bay area here who might be interested in environmental ism or conservation? Is there anything they can do to help the islands?

Speaker 2: [00:28:30] Well, one thing that you could help is um, to be a little bit more aware of issues like invasive species. They are really big threat on islands because islands are so insular. You know, these, these plant species have nowhere to go. And so if they get crowded out by say an invasive species that you brought from California or from some place else in the world, they could very easily just get a foot hole in Hawaii and start trashing the native ecosystems. I mean, one of the saddest things when I was [00:29:00] scouting for potential field sites on Hawaii was to see really, really beautiful metro [inaudible] canopy and then hike, you know, through mud and through rain to get there just to see an ocean of invasive ginger. It's, it's the saddest thing. You know, Hawaii's ecosystems are so unique. I mentioned this beautiful sub canopy of tree ferns.

Speaker 2: When you get there, it's just when you get to highly invaded ecosystems, you just see blankets [00:29:30] of invasive gingers from Tibet and some places you find invasive guavas they formed like these very, very dense thickets where no native plants can grow. And it's, it's kind of scary, but a lot of people don't actually realize that they're not meant to be there. So, you know, just being aware of of these things and also whenever they are measures in place at all these different ports of entry regarding the, you know, the movement [00:30:00] of, uh, say, you know, fresh plant material, fruits and so on and so forth. I think everyone should be more aware of why those things exist and obviously hit them.

Speaker 1: So you mean like when you fly to Hawaii and they make sure that you didn't bring any like fresh fruits or plants or anything with you, this is what you're talking about, right? Yes, that's right. Yeah. Well, a very good words of advice. Any last words before we end our time here?

Speaker 2: The next time you go to Hawaii, I think you should go check [00:30:30] out some of the more native type forests and you will see how unique that place really is.

Speaker 1: Awesome. Yeah. Well thank you so much June. Uh, so you've been listening to the graduates here on KLX Berkeley. My name is Tesla Munson today I've been joined by June ng limb from the Department of Integrative biology here at Berkeley. He's an ecologist and evolutionary biologist and he's been telling us about his work in plant biology and diversification and speciation in the Hawaiian archipelago [00:31:00] and also some, some work with arthropod. So that's mostly spiders, right, and kitchens biters and just generally giving us great advice about, you know, conservation and how to really appreciate natural and native forests. Not just in Hawaii but on other islands. And even here in California. Of course we have some great natural forests here and yeah, just be more aware and being appreciative of the things that we have. So thank you again June and we'll be back in another couple of weeks [00:31:30] with another episode of the graduates. Until then, stay tuned. You're listening to k a l x Berkeley.