Written Transcript
On The Line Episode 3.6 “Mountain Pine Beetle”

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Charlie Palmer: Welcome back to you on the line of podcast for today's wild land firefighter. Our topic today, Dendroctonus ponderosae. About the size of a grain of rice, native to forests from Mexico through the United States and up into Canada and even the Yukon. Now, it may be responsible for the largest insect blight that's ever occurred in North America, tens of millions of trees, dead entire ecosystems impacted on a scale, perhaps 10 times larger than any previous infestation. We are of course talking about the Mountain Pine Beetle and our guest today, Dr. Diana Six Professor of Forest Entomology and Pathology at the University of Montana's Frankie college of forestry and conservation and one of the world's foremost experts on this insect that is, as she says about the size of a mouse turd is the reference that she likes to throw out in terms of trying to give you an idea of how big it is. Dr six welcome to the pod.

Diana Six: Hi, it's nice to be here.

Charlie Palmer: It's taken us a while to work through the logistics of making this happen. So I sure appreciate you coming in today.

Diana Six: Yeah, no, it's great to be here. Nice to talk about my favorite insect.

Charlie Palmer: Now, despite the fact that we both work at U of M and that our offices are literally a Stone's throw or a fly cast apart. We don't really know each other.

Diana Six: No, it's, it's sorta like that. I don't even hardly ever interact with the guy in the office next,

Charlie Palmer: So I shouldn't feel bad. (No. Okay.) and then also the usual approach that I like to incorporate with these podcasts is to have a pre-production meeting where whoever's coming on that day, we can talk beforehand about questions that are going to be asked and so on. But we've opted not to do that on this one. So you really have no idea what questions I'm going to ask.

Diana Six: No, I don't.

Charlie Palmer: And you're okay with that. We kind of agreed to that, which is cool. So we thought that might be a fun approach. So thanks for agreeing to do that. But can you tell us and our listeners about this Mountain Pine Beetle?

Diana Six: Oh, I could go on for days as you can imagine, but I won't do that. I think one of the best places to start with this insect is not to go right into the fact that they've killed 70 million acres of trees, but kind of a little bit about what makes

them so fascinating because they are incredibly complex and I think most people think of them as just this little mouse turd looking insect that bores in and kills trees. But there's a whole lot more to it than that. So a beetle, you know, they really are very tiny. In order to kill a tree, they have to have some, some pretty amazing behaviors. Because if you think about it, if you're a little tiny beetle and you're facing a very defensive tree that's going to fight back, you have a pretty big job ahead of you.

Diana Six: And so one of the first things they have to encounter is pitch. So when you stick your knife in a tree, you get all this sticky stuff and it repels you. But you have to realize that if you're a five millimeter long insect, that's a pretty formidable kind of a barrier. So they're actually able to swim in that pitch for hours and maybe even days without accessing new oxygen. There's toxins in that resin, all that beautiful pine smell that we love so much from Christmas trees. Those are all natural insecticides. And so they have to deal with all that stuff. And one of the things they've done is take those tree defenses and taken those chemicals as she's boring into the tree, she'll be eating this resin and she'll convert those tree toxins into a pheromone. So she'll actually use the tree defenses against the tree, release those, and then that draws in thousands of other beetles to help her because she can't do it by herself.

Diana Six: And then if you get enough other beetles to show up, that can actually kill the tree and then they can start to lay their eggs and stuff. But what's really kind of remarkable there, is they've gone through this enormous battle. A lot of them have died to get into this tree and then they can't even feed on the tree without starving to death. And so they bring a nutritional supplement along with them, these blue stain fungi that gather nitrogen and phosphorus to feed them, and that allows them to actually feed on wood. So they do a lot of remarkable things in order to be able to do the stuff they do,

Charlie Palmer: Which is interesting because the pine beetle is the one that gets knocked a lot. Right. That's the one that we talk about, but yet it's a symbiotic relationship with this fungi. Right. That she brings with her as well. Right? Yeah.

Diana Six: And I'm always saying she, because the first attackers on the trees are the females.

Charlie Palmer: Right? That's a specifically, yeah, that's that pronoun is specific. Yeah, yeah. Yeah. So what more can you tell us then about this symbiotic kind of relationship that the pine beetle has as its carrying this fungi then that actually is the one ultimately doing the damage? Is that accurate?

Diana Six: No, no, it's, it's a, that's an old story that just won't go.

Charlie Palmer: Okay. Let's, let's hear the new story. Let's get the facts.

Diana Six: So for many years, people thought that the beetles carried these fungi into the tree and the fungi grew into the tree and clogged up the plumbing, so to speak. And that's what killed the tree. It's not what happens. The beetles actually have killed the tree and are feeding and reproducing before the fungi even start growing. The fungi actually as they grow into the tree are grabbing up nutrients, nitrogen and phosphorus. And then they literally pump it back out to under the bark where the larvae are feeding. And that gets the beetles enough nutrients to actually build a body. And so it's really a nutritional thing, but it's really hard to convince people that, you know, the, the fungi aren't killing the trees. It's, it's, there's all sorts of things when you look closer that indicate that's not happening.

Charlie Palmer: Well that's good cause those facts matter then to make sure that we're accurate in terms of what's happening. So August of 2019 this past summer Nevada Creek and the horsefly fires near Lincoln, Montana. They were part of a complex of fires managed by a type two incident management team. And then, which was one of the days the report came out, it quoted the fires are in steep terrain in dense timber with a heavy load of beetle killed fuels and quote. So what comes to your mind when you hear that?

Diana Six: It comes to mind that a lot of us will go for sort of the intuitive. If you look at a bark beetle killed forest, it looks dry. It looks like fuel. And so you would expect that that would intensify fire. But then stepping back and looking at some of the studies people have done over the last few years, it's not always the case. Quite often beetle kill ends up creating more of a fire break. Right after the beetles have killed trees. You do have lots of red needles on the trees and fuels are dryer. But once those needles fall, basically when a fire hits one of those patches, it drops to the ground because there is no crown. And so beetle kill can actually act as a fire break. It just depends at what stage after the outbreak you're talking about. So for a few years it might be a little more flammable, but after that it actually drops very low.

Diana Six: And there was some concern that a lot of needles on the ground from the trees would create more fine fuels. But they seem to in most places degrade pretty fast. And so you really don't see an intensification of the ground fire either, but it's really complex fires complicated. And so you get different responses in different places. It depends on moisture levels, you know, terrain steep, steep is going to burn. But really the big fires go in a more of because of fire weather and then it doesn't matter if you have beetle kill or green trees cause green trees are very flammable as well. Of course. Right there full of turpines. Yeah. So the, the link between beetles and fire is, is certainly not as strong as people have thought for a long time.

Charlie Palmer: Yeah. There was always this kind of cry that, Oh my God, these beetle-killed forests are just going to be this, these immense standing pockets of fuel that's just going to rage when fire moves through it. Yeah. But not necessarily true.

Diana Six: No. Is, that's the way I felt for a long time. It just, like I say, it's intuitive. It was like, Whoa, this looks really bad. But the Science is does not holding that up.

Charlie Palmer: Okay. Yeah. So this outbreak is because of two triggers. And I learned this because I watched your videos, your YouTube video and some of the national geographic and we've got a really cool big footprint out there in terms of talking about these things. So the outbreaks because of two triggers, one enough trees to attack and then to climate change.

Diana Six: Yeah. The first as a condition really, you know, you have to have the right species of tree. They have to be big enough. The beetles don't go after real small trees, but that alone will not cause an outbreak. You could have lots and lots of dense trees, the right species for centuries and not get an outbreak. To get an outbreak, you have to have a trigger and that is warm and dry. Okay. Here we are in a period of of chronic warming and drying. And so what we've seen is not kind of a normal outbreak where the beetles build up in a droughty warm period, you know, take off, kill a bunch of trees, but then when things sorta return back to normal, they begin to drop out with climate change. We have a warming period that has just continued. And so this, this outbreak has literally kept rolling for more than 20 years, which is probably twice as long as anything in the past. And of course it's killed 10 times more area of trees.

Charlie Palmer: Yeah. Do you see it changing?

Diana Six: Oh yeah. There's a lot of changes. I started working with these about 25 years ago and we had all sorts of roles we could go by, you know, if you wanted to go collect beetles, they flew in the middle of July. That's when you went to get your adult beetles. Now they fly from June to October, and so they're killing trees for a longer period, a more surviving winter as part of the problem. They've moved to new places. So I work a lot in white bark pine, which is now a recommended for listing as endangered. Because white bark pine is up on the tops of mountains and it used to be protected because of the cold. But now the beetles go all the way to the tops, even in harsh places like Yellowstone, Tetons, wind rivers, and they're just wiping these trees out. And as trees have never really had to defend themselves before. So it's not so hard for these beetles to get into those trees. They've moved, you know, across Canada, up to the Yukon, wherever it's warming up, they're moving.

Charlie Palmer: And despite the title of their, this, Dendroctonus ponderosae. That's a misnomer in a sense that it's not limited to just a Ponderosa.

Diana Six: No, no. In fact, that's not the best name. Literally in Latin and Greek, it means destroyer of Ponderosa Pines and it does kill some, but it really likes lodgepole. And now that it's gotten into white bark, it loves white bark cause it doesn't fight back. And in Canada it's moved into the boreal forest and to Jack pine and it's pretty happy there too.

Charlie Palmer: And then there's this belief that it's probably just going to continue across to the Eastern pine forest. Is that accurate?

Diana Six: Yeah. If, if, if it continues to warm, they'll, they'll keep going. I mean, there's nothing you can really do to stop these beetles.

Charlie Palmer: What's that gonna look like?

Diana Six: We don't know. The boreal forest is one of the most important ones we have for a lot of ecosystem functions, carbon sequestration, wildlife. We really don't know because in that forest, it's basically an exotic and exotics change systems dramatically. I can't imagine it's going to be for the good.

Charlie Palmer: Because those systems just are not used to that invader or that exotic. Yeah,

Diana Six: No ecosystems that are used to things that have co-evolved with it often require natural disturbance. That's why our forests here require fire to stay healthy. They require beetle outbreaks to stay healthy, which nobody likes to hear from me, but there are natural disturbance as well, but if you take natural disturbances and change their frequency, their severity, different characteristics, then they become sort of unnatural and so in our forests where this beetle is, normally they're being impacted harder, but in forests where the beetle hasn't been before, it's devastating.

Charlie Palmer: And there are beetles other than the Mountain Pine Beetle and there are infestations in other places throughout the world. So you can get this kind of centric idea of thinking, wow, it's just the West of the United States, or it's just, okay, it's at least confined to this general area. But as I kind of had to try and bring myself up to speed and learn more about it, it was somewhat scary in the sense that you're doing research in Africa, there's impacts and opinion. What can you tell us about this notion that it's not limited to certain geographic areas? In fact, it's really perhaps a worldwide concern.

Diana Six: Yeah, it, it's, it's global. We see it here and we hear about it a lot because this is where we live and it's also been kind of the poster child because it is the biggest one so far. But we've got lots of Ark beetles around the world. We have lots more here. We have Western pine beetle, there's lots more pine beetles. So that's why I'm always careful to say Mountain Pine Beetle. But Western really likes Ponderosa. That's the one that should have been called Dendroctonus ponderosae, I think. And it's building up here and it goes after the big old growth. We have Douglas verb beetle, it's building up. We have Fern graver that's building up. There's lots more waiting in the wings. So as various tree species get more and more stressed because of changes of climate, then these beetles begin to pick them off.

Charlie Palmer: They've been here, but now they've got a better likelihood of success. Yeah, yeah,

Diana Six: Yeah. Changing climate. Yeah. And spruce beetle is going gangbusters in Alaska right now. It's amazing. So we have all these big killers, but we also have what we call secondaries, which are ones that under normal conditions, they're just going off and picking off kind of dead and dying trees. But some of these are actually building up to be big outbreak beetles now, like the pinyon IPS, that's a massive die off that happened. In fact, probably about half of the range of that tree, they'll never recover. So globally there's lots of bark beetles. They're seeing a really big outbreak in Europe, Poland, Germany, a number ofOther countries are having big, big outbreaks of of their tree killer. Siberia is experiencing a huge one, kind of simultaneous with all the fires because of the heat. So there's lots of these beetles and as conditions shift and gets better for the beetles and worse for the trees. We're just going to see more and more.

Charlie Palmer: So through your research you've found that some trees might be genetically better adapted to resisting the Mountain Pine Beetle. What can you inform us about that? This genetics play a or seem to play a very, very large role in which trees survive and which ones don't and, and how the infestations impact that.

Diana Six: Yeah. So as a geneticist as well as an ecologist, I'm always looking for the genetic basis for a lot of things that we see. And so after Mountain Pine Beetle went through some of my favorite white bark pine stands, I was like, wow, you know, I don't have any work left to do at these sites, almost everything's dead. And as I walked around, I started really paying attention to the few trees that survived because the beetles, when they go through white bark at least will kill about 95% of the mature trees. But there's always about five to 7% that are just fine. They don't even have a mistake attack on them. They're just completely ignored by the beetles, which I find really surprising because when these beetles are flying and there's millions of them and they're running out of food, why would they ignore these trees that are right there, right next to the other ones?

Diana Six: And so I started thinking, well, you know, a long shot, but I'm going to see if these things are different. And so we collected needles and extracted DNA and sure enough, they're genetically different from the ones that are susceptible to the beetles. We measured their chemistry, which is how beetles locate the trees. And it's also the defensive compounds. And they have very different chemical profiles. So they make the same chemicals, but they produce different amounts. And so some of the chemicals the beetles use to actually locate the trees, they barely make them. So it's almost like they're hiding in plain view. And then some of the chemicals they use to make their pheromone, they actually make very, so it's almost like the beetles have may have a hard time finding the trees, but even if they do, then they'd have a hard time calling for help.

Diana Six: We don't know for sure, but we're going to definitely be looking at that.

Charlie Palmer: Cloaking device. Y.

Diana Six: Eah. Yes. That's what we were calling it. Cause this, we're all star Trek fans. Yeah. So that's one of the things we looked at their growth rates and they grow

differently. They're actually slower growing than the ones that the beetles killed and we think that might translate to maybe better drought resistance because they don't have as much demand for water, so I think there's a potential to take advantage of what looks like a big natural selection event. Right? The beetles came in killed trees that were struggling, maybe not doing so good in current conditions, new conditions and left behind the ones that maybe have what it takes, so that may be something we can kind of use as an opportunity.

Charlie Palmer: And then thinning has oftentimes been used as a, as a strategy then to try and curb some of the outbreaks. If that's the case or if that's the practice that it could possibly be even more detrimental than it could be effective. Right. If you're culling out some of these genetically resistant trees that have survived the attacks and are the ones that you actually really want to be keeping, it seems the sciences mixed.

Diana Six: The science is very mixed on whether it works with beetles to begin with because once you get an outbreak going, thinning fails. It's only really that effective when beetle populations are fairly low. But as far as thinning, you know the practice that we use is, you know we want trees, certain diameters, we want a certain spacing, certain species composition, that's all really as far as genetics is concerned, cutting blind, we are just going by prescriptions and we don't know if we're removing trees that are susceptible or resistant and that's not an easy one to get around because up until recently we really haven't had the ability to recognize genetic differences in trees all that well. So there are some things I think we can, we can already apply that are pretty simple. So if you look at a forest that's been hit pretty hard and it's going to be salvaged cut, one of the things people do now is not just to take the dead trees, but they take the green ones as well because they get more money at the mill for those and it helps offset the costs of the, of the cut.

Diana Six: But if we leave those green ones behind that are potentially resistant as the seed stock, that could be just a, a really easy approach to try and help these, these forests genetically adapt. I think it's not very far off in the future where we might be able to have handheld sensors that can detect particular chemical profiles that go with resistance and then a manager could use that when he goes out and does marking for, for thinning. And so I think there are some, some things right on the horizon that could be useful for us to start to take advantage of the, the genetic diversity that's out there.

Charlie Palmer: Meaning with the technological advancement, you would have a even a handheld tool that could tell you very quickly this one's resistant, this one's not, we'll leave this one to, to help that manager make decisions.

Diana Six: Yeah. Yeah. I mean they're going to need something simple and cheap, right? I mean, you have to have something like that. And right now the genetic screenings too expensive, too slow, but some people at the university of Georgia are already developing a sensor that can tell the difference between trees that are resistant, susceptible to a disease. And so I don't see any reason

why we couldn't do that with our Pines once we know what profiles are you know, are going to be the best

Charlie Palmer: More research to be done.

Diana Six: Yeah. Yeah. One of the nice things is we've found this resistance also in lodgepole, so not just white bark, and that is one of our more widespread trees we really need to focus on because it's so ecologically and economically important.

Charlie Palmer: So ultimately then through science and some of this genetic identification be in a better position to make on the ground decisions. Is that accurate?

Diana Six: Yeah, I think it'll help a lot. Kind of doing business as usual is not going to help us help our forest adapt to new conditions. Adaptation is genetic. It takes change over time. What we're doing now is mainly short term. You go in and you thin, you try to reduce some of the competition for water, but that's short term. If our trees and our forests are going to continue into the future, they have to be able to genetically adapt. We have to get genotypes out there that can deal with those new conditions. And so I think we really do need to go to a genetic approach.

Charlie Palmer: You are unconventional in some ways. Okay. You like bugs and fungi. You quit high school. Accurate. Yeah. You lived on the streets in California for a period of time. Yup. You eventually went back to school? I did, yeah.

Diana Six: And then I just kept going and I'm still a student. Yeah. Tell, tell us more about that. Yeah, so I, I loved insects and bugs when I was a little kid. I had an insect and a fungus collection, believe it or not when I was a kid, but as I kinda grew up. Yeah. How, why, how, why? I don't know. Just that I just loved him. Yeah, yeah, yeah. And I just collected them. My whole room was full of them. Yeah. I even brought home like baby bugs, like mosquito larvae. They would hatch in the house and I'd get in a lot of trouble. But yeah, I have no idea why I liked him so much. I just did

Charlie Palmer: From an early age. Just something that resonated for you. Yep. All right. Yeah. And then can it continuous on, on the, on the journey then?

Diana Six: Yeah, so I got into, you know, as I got into school and I loved science, but science was always taught in my age to the guys. The science club was closed to girls. I couldn't even go to the science club. And so I just sort of began to drift. I came out of a, a pretty abusive home and so, you know, things just sort of fell apart, didn't have any self confidence. So I ended up getting into drugs and dropped out of high school. Halfway through, went through lots of adventures that almost killed me several times, hitchhiked across the U S all sorts of stuff. After just about dying another time I decided things had to change. And so I went back to school to get my diploma. High school diploma, went back at night

and had two teachers there that really encouraged me to go to college. And I did mainly to make them happy cause I had no idea what college was all about. And then I just fell back in love with biology. You know, I, I entered as a library science major because I liked to read, I had no idea what I should be doing and I had to take a gen ed biology class and was like, Oh, this is it. And then I took an entomology class and it was like, Oh yeah, so, and then I just kept going.

Charlie Palmer: And in the academic world, that means, and state terminal degree PhD.

Diana Six: Yeah. So I got a, I got a degree in microbiology and then decided I didn't want to work in medicine and I thought, wow, maybe I can work with bugs. So I got into agriculture, got a degree in that, decided I didn't want to do that. And then I got into medical and veterinary entomology working with house flies and a fungus that killed him as an alternative to pesticides. And then I decided I didn't want to work in cow or for the rest of my life. And I got offered to a fellowship to work on bark beetles and their fungi and found the love of my life. I just love working on them. They're just so fascinating. And then just kept going.

Charlie Palmer: What was it like then navigating these waters that were not friendly to female?

Diana Six: I was really good student, so it helped me navigate. I didn't feel I had a lot of barriers as a woman when once I got into I was like a straight a student. I was hungry. People recognized that I was good. My barriers were that I was this rough street woman who still wore black leather and dropped the F bomb every other word, maybe every third word. It's a gray word sometimes and not that many useless. My learning to socialize and act like a, a civilized human being and, and not scaring the people I worked with was, was more of a challenge I think. And learning how to just relax and, and operate like an academic instead of some crazy street person, some biker chick.

Charlie Palmer: What have you kept from that world that you still have?

Diana Six: I think I can navigate through most of the world's cities with a lot of knowledge of where I'm, getting into dangerous places and I don't know. Street smart has its place. Yeah.

Charlie Palmer: How about this work in Africa then? You mentioned comfort traveling bringing us up to speed on this species of tree that has your focus in Africa.

Diana Six: Yeah. So, so this tree in Africa is, it's not technically a tree because it's more of a succulent. So it's like a Soro cactus only. It's a euphorbia, but it's so big. It's like 30 feet tall, 300 branches. They're really big succulents and they're just beautiful and they're also extremely toxic. So when we cut one down, we have to have like full moon suits on because if you get it on your skin, it'll lead holes in you, gets in your eyes, it'll blind you. It's a poison arrow tree. So one of the ones that people used to use to poison arrows to, to kill prey, but it started dropping dead a number of years ago, just really fast all across South Africa, up into Zimbabwe

and so forth. And so we started taking a look at it because the government was worried that maybe an exotic insect or disease had gotten in because it was going so fast.

Diana Six: So we surveyed every bacteria, virus, fungus, beetle, everything on it because it gets lots of bark beetles and Ambrosia beetles too. And while they're ultimately killing it, what is leading them to be able to do that is stress. So those sites where it's the worst, we found that it's about two degrees warmer. They're receiving a lot less rain or in some places where they're still getting the same amount of rain, it's coming at the wrong time of year. And so it's one more of the, the big tree die offs that really is being caused by climate change, which is really depressing because it's not something you can go out and try and get a biological control agent to kill an exotic disease or something. What, what can you do about this? Nothing. Yeah. Yeah.

Charlie Palmer: Worst case scenario, things continue. Planet gets hotter, dryer ecosystems change. What's that look like?

Diana Six: Does it look good? And we're going to see a lot of that. Even if we were to do everything we could starting right now, because we've got a lot of carbon up there, stays in the atmosphere, I think about a hundred years. So I think we're gonna see huge changes right here in Montana. I would suspect we're going to lose a huge amount of our forests. We'll get a lot of grasslands fish. I love to fly fish keeping trout, they really hard. It's going to be massive change. Yeah.

Charlie Palmer: Thanks so much for coming on. Final thoughts, just to kind of wrap things up, what would you like to leave a listener with in terms of take home message or thesis kind of from what you've talked about today?

Diana Six: Well, one thing I always like to say is we, we shouldn't blame the beetle because they just doing what they do, right? So if we want to do stuff to keep our forest, we're going to have to, to deal with climate change and work with nature to try and try and keep it kind of plugging along out there. Don't expect that we can thin or replant our way out of this. We're going to have to get a lot more creative. We're going to have to look at genetics. Lots of things that we haven't done before.

Charlie Palmer: All right. Dr. Diana six. Thanks so much for coming on the podcast today. All right. You have been listening to On The Line a podcast for today's wild land firefighters. Again, thanks to Dr. Six, Our guest today, we've got, this is six Mike? We got ideally four more of these to pull off before the year ends. And that's an ambitious goal of for a variety of different reasons. We're going to do our best to make it happen. But thanks again for tuning into on the line and we will catch you next time.

Charlie Palmer: You've been listening to on the line, a podcast for today's wildland firefighter, our audio engineer's Mike Matthews, production assistant Joey Moore, and I'm

your host, Charlie Palmer. Thanks for listening and we hope to connect with you again On The Line.

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