

Podcast Series, Holistic Nature of Us

Episode # 23: Meet Carole Cheah

judithdreyer.com

Hi I'm Judith Dreyer,

Thank you for joining me for this pod cast series "The Holistic Nature of Us".

My intent is to take us, you and I, into a better understanding of the concepts behind our holistic nature and how that ties directly to the holistic nature of the world around us. How can we connect the dots in practical ways that we are nature and nature is in us?

I will be featuring authors and educators, practitioners and others, whose passion for this earth helps us create bridges. We'll see what's trending, what's relevant to our world today, not just for land use, but to connect the dots between nature and ourselves. It's time for practical action and profound inner change so our natural world is valued once again.

And today I am delighted to introduce you to Carole Cheah. She is a research entomologist at Valley Laboratory here at the Connecticut Agricultural Experiment Station. I met her at a Master Gardener symposium. She gave us a talk about the Eastern Hemlock and the woolly adelgid pest that's devastating this particular tree in our forests.

Carole I'm glad to welcome you here today. How are you?

CAROLE: Hi, I'm great. Good morning Judith and good morning to all of your listeners. Thank you so much for inviting me to share my research.

JUDITH: Yes, I'm delighted. So, let's start with the hemlock in general; if you could tell us about the tree species and its role in the forest.

CAROLE: Yes. Well Eastern Hemlock is a very ancient species. We actually in North America have four species native to our continent and the Eastern Hemlock is obviously in the East, sometimes called Canadian Hemlock. The Latin name is *Tsuga Canadensis*. An Eastern Hemlock is a very beautiful evergreen. You've probably seen it a lot. Your listeners probably have even wandered in state parks, forests or trails and been under the shade of this magnificent tree. Eastern Hemlock ecologically is a very important species because ecologists view it as a foundation species. They coined this term because they believe that it's a tree species that so defines the ecosystem that it creates under its mature canopy which defines community structure. And, it affects the kinds of other species that live within it. It modulates the hemlock trees being evergreen. They are long lived and very shade tolerant. It can also affect the soil properties and many other things such as stream temperatures that drain through these hemlock forests. So Eastern Hemlock, (and in forestry) it is not considered a very important commercial species because it hasn't got the characteristics of wood strength that other species do. But it is a very important ecological species and that's what I want to convey to your listeners. They call it a foundation species of great importance. Therefore, if we lose that species or we have dramatic decline of that species it's going to affect a ton of different things that rely on it, so a kind of a ripple effect. Imagine if we removed the species.

JUDITH: Carole can you give us a couple of examples of that ripple effect.

CAROLE: Well, for example there's a lot of wildlife that is dependent on Eastern Hemlock. Now Eastern Hemlock, I'll just preface this by telling you where it likes to grow. It's an evergreen, huge long-lived evergreen. Record size, I think, has been over 160 feet. It can reach 500-600 years. I think the record age is nearly 1,000 years. And in Pennsylvania they call it the "redwood of the East." Hemlock has a number of species that are very strongly associated with it, i.e. they really need the hemlock in order to survive and breed and reproduce. A number of people have done a lot of studies on this and there are several bird species that definitely are strongly dependent on the hemlock. One of the species is the warblers. There's a Blackburnian Warbler, beautiful little bird. I've only see it a couple of times. And the Black Throated Green Warbler which is not threatened because it's very prevalent but where ever you go in a hemlock forest apparently, you can hear these warblers singing in the tops of the trees. So obviously if you lose this tree, you will lose these warblers who will lose

their habitat. There are a bunch of other bird species like the Acadian Flycatcher, which are dependent on the hemlock forest. And then there are also, if you go from the other sphere, you know from the birds, there are also rare salamanders that depend on the very cold waters that these hemlock trees shade. For example, I just found out not too long ago that the Northern Spring Salamander is a threatened species in Connecticut. The Connecticut DEP has designated it as a threatened species because it needs the very cold waters that only hemlock forests can provide. This is a threatened species here. Then there's also our native brook trout which at the current moment are not threatened but they require very clean, very cold waters and once again those waters can only be found when fringed by hemlock trees. You can see that almost, I would say that hemlocks are almost sort of a sentinel species because they create the conditions in which streams and headwaters that fill our reservoirs are pure and clean and cold water. If you lose the protective cover of the hemlocks you can see the cascading affect that could happen all the way down into our reservoirs.

JUDITH: Well that also affects all of us because if we lose the salamander somebody is losing their food, right?

CAROLE: Yes, yes.

JUDITH: And the native trout is still around but it's certainly a species to watch. And then if we lose the bird species we're losing a member of that ecosystem that has a role and a place. So again, looking at a holistic concept, if some part is not working up to par it's going to affect the entire ecosystem. And what we've been concerned about here in the Northeast is what's happening to our Eastern Hemlocks.

You have done tremendous research on the woolly adelgid pest in particular. Could you tell us more about that?

CAROLE: Yes, the hemlock woolly adelgid is very interesting pest. I first started studying this down in Virginia and it is, by no coincidence, that this nonnative pest is an exotic pest. We believe it originated from Japan, and I can go into that in a little bit, but the adelgid is exotic. It's invasive and it's not native to our hemlock trees. And unfortunately, both our native Eastern Hemlock and the other native hemlock, which is called the Carolina Hemlock, which exists in only a very small area in the Southern Appalachians, found in the mountainous areas of the Southern Appalachians,

and both are susceptible to this pest. The woolly adelgid, we believe, many have been accidentally introduced during collections of exotic conifers, especially from Japan. This was thinking before we had the genetic tools. Since then a colleague of mine, Nathan Havill, has done some tremendous research genetically and traced the origin of all the adelgids that we are seeing now on the eastern seaboard from an adelgid that came in from Southern Japan. It was pretty amazing. It was suspected before by Dr. Mark McClure who was my predecessor here at the Connecticut Ag Station, but it has been confirmed since using all these genetic advances. Everything that we have here on the eastern seaboard apparently, according to Nathan's research, has come from southern Japan. And this insect, I guess to describe it to your listeners, is related to aphids but is an ancient lineage. And these adelgids are mostly sessile, so they don't move easily. There's only one stage that moves easily and it's the crawler stage. When they initially hatch out from the eggs, these little specks are sort of reddish-brown and they move around and those are what we call the crawler stage of the nymph and that's the stage that will spread. And when it finds the hemlock stem that it likes, it stops, inserts its feeding mouth part and then it will stay there for the rest of its life. It will go through all of its molting, etc, in place on the hemlock stem spot that it selected. So it doesn't move after that.

JUDITH: And what it does when its there Carole, it eats the needles, correct?

CAROLE: No, actually the adelgid is kind of interesting. It doesn't eat the needles. It's not a strict defoliator like a lot of caterpillars and other insects who actually eat the needles. What it does is it inserts its feeding mouth part and it actually drains, sucks out, the storage cells within the stem. It's a very different kind of damage. It's not something that you will see holes or anything like that on the needles. It's not like that at all. But by draining the storage parenchyma cells in the hemlock. It deprives the hemlock of the ability to put out new growth and we all know how important new growth is to our trees because that's the photosynthetic material that's going to capture the energy from the sun in order for the tree to grow. By hampering the ability of the tree to put out new growth to capture the energy, the woolly adelgid can quickly overwhelm the tree to the point where it can't put out new growth. Studies by Dr. Martin McClure showed that even low densities will actually restrict the amount of new growth that is put out or even just completely stop it all together. And so, you can see that if populations build

up over a tree, and as it spreads throughout the tree, pretty much the whole tree will be affected in a matter of 1-2 years.

JUDITH: That's a very short time, isn't it, to lose trees?

CAROLE: Yes, well tree death doesn't occur in 1 or 2 years. I'm sorry if I gave that impression. It's more that the tree will start to show decline very shortly after it's affected by the adelgid. And it could take 4 years, sometimes it can take much longer than that. And I think that's where your whole concept of how we are all interconnected plays in because hemlocks don't just respond directly to the pest. There are so many other stressors that are affecting our hemlock trees today, whether they're in our gardens or in the mountains, or in a ravine, or around a lake. There are all the climatic stresses that are being compounded even as we speak right now as there are other pests that also move in and take advantage of the hemlock tree when it's in a weakened state, when it's stressed. The woolly adelgid is definitely one of the most serious damaging pests that we've encountered for the Eastern Hemlock. The woolly adelgid is one and there's another very serious exotic pest called the elongated hemlock scale. But prior to that, you know, our hemlocks also did suffer a lot of stress and mortality, but it came from abiotic factors such as drought, extended drought, especially during the summer, obviously when the tree is growing. And there's also another insect that opportunistically attacks the hemlock trees when they're weakened, and it's called the hemlock borer. That is a native insect, but it has adapted to strike when hemlock trees are weakened by drought. So those are the two major elements. There is also another defoliator, a needle defoliator called the hemlock looper that is also native. It will periodically come through and defoliate our hemlock trees too. You can see that the hemlocks manage to survive in spite of all these native stressors but now we have these two exotic species. When you put that on top of all the other stresses you have a situation where our hemlock trees are being threatened now.

JUDITH: It's true. We know that if this is a tree that survives near water or needs water and also has a hard time with severe drought, then when that becomes weakened, as you said right from the beginning, there's this whole chain reaction. It's not just the tree that's weakened. It's everything down the pike that it supports; that it's a part of. Its community completely suffers. And that's the kind of concept or dot I'm trying to connect with these podcasts is that what we do affects everything. We don't live in

isolation. And nature doesn't live in isolation. You bring that out so beautifully in your talks about how important the tree is, and what it affects.

Is there anything else that you want to highlight here?

CAROLE: Yes, Judith you know I mentioned the birds and I mentioned obviously the amphibians, the fish and of course I forgot to mention even there are so many diverse mammal species that really depend on our hemlocks as well. And I know that you know white tailed deer, not exactly our favorites as gardeners, but in the northern New England areas white tailed deer really depend, there have been studies that have shown that they really depend on the cover of hemlock stands for winter protection and for winter survival, which is pretty amazing. We have the black bear. We have a whole list of mammals that folks from the US Forest Service and from wildlife places have documented. There's a Northern Flying Squirrel that is strongly associated with Eastern Hemlock. Let me think of others. Um, a ton of different mammal species that also require the hemlock habitat. You can see it's not just the birds; it's everything as you say. And the one amazing thing about hemlocks that I've learned all these years of studying them is that hemlocks are able to endure very long periods of shade by just not growing. We call it; foresters know this very well; they call it suppression. So you could have a very small hemlock tree and I'm talking really small. A tiny little tree maybe about 3" in diameter and that tree could be 100 years old. Isn't that fascinating Judith?

JUDITH: Oh, that's amazing. You know one of the first tree talks I went to through the Master Gardener Program, we always think that the rings of a tree tell us the age and so you see something that's 4 feet in diameter and you go, "Oh my God, that's got to be 200 years old!" but that's not necessarily true in the forest. They showed us a species of trees that were very small in diameter. I'm talking like 2-3" and they were far older than something that was at least 1-2' in diameter which I find fascinating, how the forest works.

CAROLE: Yeah, yeah. I think it's amazing. And furthermore, the forest is always telling you don't assume the age of the tree by looking at the diameter. It's something I've learned by walking around with foresters who know their trees. They know their forest. And the amazing thing is this: so you have a small tree perhaps in the under story of a hemlock forest. You've got a giant there and then you have a small tree and those trees could

actually be kind of closer in age than you imagine. But the fact is that the larger tree has shaded that little tree and so it endures under those conditions. It just doesn't put on any growth every year. And then say, that large tree gets toppled by a tornado or something, or a woolly adelgid hits it or something and it dies, or it breaks off and suddenly you have all this sunlight pouring in on that little tree. That little tree, as the foresters tell me, is then released. They call it released. That tree will just suddenly activate itself and respond to all those better growing conditions and shoot up, which to me is amazing that it could just kind of stay dormant for so long and then when the right opportunity occurs it can spring up and takes its place in the canopy in the wake of perhaps the death or the breakage of the larger tree that was overshadowing it.

JUDITH: What's interesting about that whole explanation is that I feel, and others feel, that there's a real intelligence in nature. And again, if we look at ourselves as a species we seem to want everything quickly here, now, last week, blah, blah, blah. But yet when we look at the ancient spiritual teachings for ourselves as a species, it's the patience of going with the flow. It's the patience of observing nature. It's the patience of being in the stillness with nature. To watch nature and nature will teach us. To me that's a principle: of staying quiet and dormant for however long it takes until the right timing and the right conditions occur. That's a great teaching from the forest.

CAROLE: Yes, and the hemlocks can teach us so much you know. I mean one of the beauties of my work is that I get to go out into the forest a lot because a lot of my research, I've learnt over the years that you can't just do everything in the lab. You have to have the combination. And not just a field experiment on like a farm or something. You have to go out into the woods, be out there and see what's happening out there. And many times, ideas that I'll have to follow-up on research come from being out there because you're out there, you see the real conditions. You see the real stresses that the trees are subject to in different environments because hemlocks grow over a wide range of environments. Yes, they do like moist conditions. They like cool. That's their optimal. But you can find hemlocks on dry rocky ridges. You sometimes wonder how the heck do they survive out there? And what they do is, I truly believe, is they find crevices and cracks in the rocks and they send their, and although it is typically characterizes the shallow rooted tree, obviously on those cliff edges, etc., they are finding cracks and they send their roots deep down and they're roots

are kept cool by the rocks. Obviously, moisture collects within the rocks from rainwater and whatever, ground water, and that's how they are able to survive. So, they not only can survive in what we call typical cool moist ravines which is where they do the best, but they will find a niche wherever their feet live, and they will try to hang on. But then you throw in something like the hemlock wooly adelgid, you throw in an extended drought which is what we've just gone through in Connecticut for 2 or more years and now the tree that was able to kind of cling to that rather hostile environment is now under some stress that it is overwhelmed.

JUDITH: Yes, today what are the implications? You did mention, if you could sort of summarize for us your research with the weather and how the very cold conditions seem to keep this pest in check.

CAROLE: Yes, I will summarize that. That's been a culmination of more than 15 years of research. And I'll tell you how it first began. So here at the station we were investigating the potential of a little tiny lady beetle that feeds specifically on hemlock wooly adelgid that we brought over from Japan, from Southern Japan which turns out is the exact origin of the wooly adelgid that plagues our Eastern Hemlocks. In order to rear our little beetle we actually had to find adelgids, because that's the only way that we can rear it. We have to rear it on the pest itself. It was the year 2000. It was the January of 2000. We relied heavily on being able to go out in the forest and at that time hemlock wooly adelgid was prevalent throughout the whole state. It was probably one of the peaks of infestation. The adelgid was actually discovered in Connecticut or reported to the station in 1985, so that was the first time that we knew that it was here. But in less than 15 years it was all over the state. So, backtrack to 2000. It was cold, but it wasn't abnormally cold. Then we had this sudden cold drop in temperatures that affected the northern half of the state, in fact the northern 2/3rds of the state. What happens when we went out into the forest to collect food to rear our beetles? We discovered that all the adelgids were dead. It was quite an eye opener, but it also meant we were thrown into a panic. We had no living adelgid to feed our beetles. It was the middle of winter, so we panicked and I just said to an inspector friend of mine, "let's go south. There are very few hemlocks along the coast but maybe we'll find something. Maybe it's a little milder there. Maybe they won't all be dead." And that's actually what we found. We found that along the coast, in coastal pockets where hemlocks still thrived the adelgid mortality was only about 20% where as it was more than 80% over the whole northern 2/3rd of the state. So that dawned on me

that this winter effects on the adelgid. Judith, I forgot to mention earlier is hemlock wooly adelgid is so unusual because it actually feeds during the winter. I mean how many insects do you know feed during the winter? Mostly they go dormant and that's how they're able to survive. The hemlock wooly adelgid has a generation that actually feeds during warmer times of the winter. In Japan they're feeding throughout the winter, probably because it's very mild there. The adelgid was feeding and then this sudden cold abrupt, we know now it was the polar vortex outbreak from the arctic circle, actually killed the adelgid. So that started me looking at this whole power interplay of our winters affects wooly adelgids. Obviously, this is going to be more important up here in the Northeast because we are much closer to the cold outbreaks. But you know occasionally that cold outbreak can extend all the way down even into Virginia and North Carolina. But obviously they don't have it that often so the adelgid populations I found are highly susceptible to what we call now the polar vortex outbreaks. We've had, amazingly enough, four of these events in the last 5 years. And we've never had them so frequent and so regularly and this has drawn my attention to it. We had one in 2014. 2015 was an extended very cold winter with lots of snow, and then 2016 was really the one that proved it all. If everybody recalls it was a very mild winter and then suddenly on Valentine's Day, February 14th, 2016 we had this sudden cold outbreak and it only lasted a few hours. But I live in the northern part of Connecticut and it went down to -20 degrees Fahrenheit and I've not seen that in the years I've lived in Connecticut. It was -22 degrees in the central part of Connecticut and it devastated adelgids all through the state, even down at the shore.

JUDITH: Do you see any kind of positive response amongst the hemlock trees because of this? Are you seeing our hemlock trees not being stressed out as much as they were perhaps 15 years ago?

CAROLE: Well yes. Interestingly enough, so right on the heels of that in 2016, we had that cold kill that killed a lot of adelgids all throughout the state. The highest I've every monitored for mortality statewide was 98%. But it did not kill as heavily the elongated hemlock scale which is another pest that occurs because that pest is dormant during the winter. So, the elongated hemlock scale was affected a little bit, but it didn't really affect it tremendously like it did the adelgid. So that pest remains. So, there's a problem that continues. And then we have this drought. So, Judith it's like unfortunately it did time all together. The drought came in and because

hemlocks are shallow rooted, and the drought was so extensive, you know, it was 11 months in the north region. It was actually over 22 months along the shore, it affects hemlock trees. The hemlocks that looked so great after the adelgid was killed off, they suddenly had drought stress. But there's hope; there's hope. In 2017 when I documented their health. I go out there and I measure all kinds of tree health parameters, so I was very disappointed. In 2016 the trees looked awful. They lost a lot of needles and they looked thin and they looked very stressed. I was quite upset. And then in 2017 we had rain.

JUDITH: Yes, we did.

CAROLE: We had a lot of rain. Rain helps hemlocks recover and that's the one thing I want to convey to your listeners. Many times, you'll see in the literature it's all over. The hemlocks can not recover. Well I'm here to tell you that they can because I've seen it myself in the forest. If there's ample rain and especially if we get these summer rains. I know we don't really want devastating floods, etc., but the rains will save our trees because they give the hemlocks a chance to reflush after the adelgid has been wiped out by cold winters. We're seeing some sort of refoilage and so you can see how everything is connected; the weather, the climate. It's really the climate because if you look at our temperatures over the winters; I've looked at this from using data that's been collected for many many decades, you can see that actually our overall winter temperatures have been warming. You can correlate that with the advance of the adelgid northwards into Northern New England and even into Nova Scotia.

JUDITH: Well that's the part that's hard for us as landowners to really track. We might know it's hotter. We might know it's more of a draught. We might know there's a lot of rain, but we don't really understand because we're not educated about it, how this impacts the quality of our forests. And unfortunately, like you said, we hear the media put out these sensational headlines, which may be originally based on some fact, but they put a spin on it. We get this wrong impression. I really appreciate all the research you've done and your summary of the problem and what's going on out there.

Carole can you give our listeners maybe three tips that they can take away today about this particular issue?

CAROLE: Sure, sure. I'll try to be very practical. I'll tell you what I do. I live in the northern part, so I'm blessed with having more cold winters than somebody who lives along the shore.

1. So that I would say is **just check your trees**. If you've got hemlock trees growing in your landscape at home, or even obviously when you hike you can't do anything about those, check them manually, especially after the winter. If we've had a mild winter, a warm winter that would be the time to think, alright I might need to do some intervention here and I might need to control any insipient wooly adelgid and elongated hemlock scale problems we might have. And you can easily do this. Because the adelgid grows through, develops and feeds during the winter their wooly mass will be most prominent in late winter/early spring because they're about to lay eggs. Turn over the tips of your hemlock branches, the newest growth, the outer most growth. If you see the white wooly balls along the stem or you see flecks on the needles, that would be the scales. Then you'll know you have a slight problem. Now if it's just a few tips here and there and they're fairly low to the ground, you can actually just prune them off. Just take a pruner and take those infested branch tips off. If it's a little bit more than that, you can easily use what we call a dormant oil spray, a horticultural oil spray. And as gardeners, you guys will be familiar with this or even a soap spray. Because what you're doing is you're going to spray the underside and soak the whole branch from the top and the bottom and that will kill the adelgid also, and the scale. It's a double whammy. You get 2 for 1 there. I would say check your hemlocks after winter, especially after a mild winter.

2. If you have a row of hemlocks, a hedge say, and it's alongside a driveway, when you do your snow blowing **don't throw the snow onto the hemlocks**. Throw it away from them because snow is a protective cover and it will actually help the insect pests survive. Throw your snow away from the hemlocks if you can. And the other thing is, if we have a dry spell, and I'm talking not just an abnormally dry spell of 1-2 weeks. I'm talking like you know if we have a

3. month-long drought **try to water your trees if you can**, the base of your hemlocks. And arborists will tell you to mulch the roots of your hemlock. Don't mulch them so deep that you're suffocating them but give them something akin to what they'd have in the forest, all that leaf litter and that will help cool the roots and preserve the moisture that's there. And **don't fertilize with high nitrogen**. Martin McClure's work showed that if you

used high nitrogen, what you're doing, and you'll know this as a gardener, you're actually exacerbating the pest problem because you're actually promoting new growth so that the pests will flourish. Use an organic low nitrogen mineral type fertilizer and to boost your tree after you've controlled with an oil spray or something. Probably that's the best I can give you for homeowner tips, and the best biological control. I forgot to mention biological control is available to the homeowner. This little lady beetle that I've actually worked with all these years is the only one that you can actually purchase from a commercial supplier. The little lady beetle has been proven. We released over 178,000 of these beetles throughout our Connecticut forest and I can tell you, although there are skeptics out there Judith, you can go throughout our states and see hemlocks. And I know a lot of it is due to the winters, but our hemlocks are still here, and I don't that's a coincidence.

JUDITH: No, I don't think so either. You know bugs, just because you put them on one tree doesn't mean it's going to stay there. It's going to go somewhere else.

CAROLE: Yes, yes.

JUDITH: Carole this is great information. Could you leave our listeners with your contact information? You mentioned that you have a new website starting up for monitoring this tree. Could you tell us about that please?

CAROLE: Yes. Everyone is very welcome to contact me if you have more questions. So my e-mail address is Carolee.cheah@CT.gov and I'm developing hemlock wooly adelgid hemlock website actually, which will be posted at our, hopefully posted at our Connecticut Agricultural Experiment Station website, I'm hoping to be able to post information such as the winter effects on the adelgid populations throughout the state and other little tidbits like the performance of the beetles that we've released from our control, links on where to get it, etc. Just general information and actually I'm only one of the scientists who is following on a long history of important research on hemlocks that's been done at this station, way back from the 30s. So, I'm going to try and post links to all the information. It's all tremendous information on growing hemlocks, hemlock variability, all kinds of very useful information. I'm going to put it all there with links so that people don't have to search for it. They'll click on it and get the original publication.

JUDITH: Wonderful. That's great resource information, especially for those of us here in the Northeast, including Nova Scotia, Canada, New York State and Pennsylvania and even probably some of that's helpful to folks in the Appalachian region.

CAROLE: Oh definitely, yes. They've actually started finding, I think they've found adelgid there up near Lake George which is quite worrying. That's a very cold part of the state and with the cold winters. So yeah, in Nova Scotia southern counties they discovered populations of adelgids last August. It's happening. It's occurring, but there are things we can do hopefully, and the more listeners understand this problem and how it's a bigger problem than just the hemlock and the hemlock wooly adelgid.

JUDITH: Right, it is a bigger problem.

CAROLE: I just thank you.

JUDITH: Well I want to thank you again for joining us at the Holistic Nature of Us. I know I'm very inspired by your talk and your very practical advice. I know I want to go outside and check my hemlocks a little more carefully.

Thank you Carolee again for joining us today.

CAROLE: Oh, thank you Judith. Thank you so much.

JUDITH: This is Judith Dreyer, the author of *At the Garden's Gate* book and blog. My book is available through my website as well as this podcast and the transcript of this podcast. Please go to www.judithdreyer.com I'd love you to share and comment. All comments are appreciated. Let's get the word out.

Today I want to end with a quote from Paul Hawkin. He's an environmentalist and author, who reminds us:

"Sustainability, insuring the future life on earth is an infinite game, the endless expression on behalf of all."

Bye everyone and enjoy your day.