TRANSCRIPT

Key Conversations with Phi Beta Kappa

Biologist Victoria Sork on What Trees Teach Us

The UCLA professor shares how the life-changing revelation that she could be a scientist, and work outdoors, led to her research on tree genomes and evolutionary biology. Plus, how she harnesses the teaching power of plants as the director of UCLA's botanical garden.

Fred Lawrence: This podcast was generously funded by two anonymous donors. If you would like to support the podcast in similar ways, please contact Hadley Kelly at hkelly@pbk.org. Thanks for listening.

Lawrence: Hello and welcome to Key Conversations with Phi Beta Kappa. I'm Fred Lawrence, Secretary and CEO of the Phi Beta Kappa Society. Since 2018, we've welcomed leading thinkers, visionaries, and artists to our podcast. These individuals have shaped our collective understanding of some of today's most pressing and consequential matters, in addition to sharing stories with us about their scholarly and personal journeys. Many of our guests are Phi Beta Kappa Visiting Scholars who travel the country to our Phi Beta Kappa chapters where they spend two days on campus and present free public lectures. We invite you to attend. For more information about Visiting Scholar lectures, please visit pbk.org.

Lawrence: Today, it's my pleasure to welcome Dr. Victoria L. Sork, Distinguished Professor in the Department of Ecology and Evolutionary Biology and Distinguished Professor at the Institute of Environment and Sustainability at UCLA. Her research focuses on evolutionary and ecological processes in tree populations with a particular focus on the impact of climate change. She is also the director of UCLA's Mildred E. Mathias Botanical Garden. Welcome, Professor.

Victoria Sork: Thank you very much. I'm happy to be here.

Lawrence: The issues of climate change are front and center for all of us in so many ways and I do want to get to all of those and your research and how it has had a major impact in those areas. Let's start back a little bit with a little bit of your story and your journey that brings you not so very far away to UCLA. You grew up in the Los Angeles area, right?

Sork: That's correct. I did grow up in Los Angeles. I feel like I made a circle around the country and came back home. You know, students come up to me and they say, "Dr. Sork, I'm trying to figure out what I should do when I graduate from college. When did you know what you wanted to do?" And I always say, "Please, my answer will be very discouraging." Because when I was 10 years old, I decided I wanted to become a professor at UCLA, and the only ambivalence I had was whether I would be a mathematician or a scientist. But then again, I loved doing experiments. So I couldn't make up my mind which it would be.

Lawrence: Do you remember experiments that you did at that young age as you were just beginning to think about what science might be and what kind of a scientist you might be?

Sork: Yeah. Well, my first experiment was on a Venus flytrap. And I ordered two Venus flytraps and I also ordered online some growth hormone, gibberellic acid, and my idea was I was going to make a giant monster. So, I sprayed half the gibberellic acid onto one and water onto the other because I believed in controlled experiments. And sadly, neither of them got particularly large. They survived because after all they got water. And so, I was a little bit disappointed at my first experiment. I was not successful. So then, my follow up experiment was to find out to see if there was something wrong with the gibberellic acid. So, I did another experiment where I had grass seed and I divided it in half, my control group which just got sprayed with water and my grass seeds which got sprayed with both water and gibberellic acid. And lo and behold, the ones that were sprayed with gibberellic acid did grow rather tall. So, my first lesson was that gibberellic acid did not work on Venus flytraps.

Lawrence: Now, science of course could mean a lot of different things as you say, including mathematics as well. Was there a point that you remember it really moving directly in the area of evolutionary biology or was that more of a gentle evolution itself to that field of study?

Sork: You know, when I was in high school and early college, I thought that the only way to be a scientist was to wear a white coat and do experiments in a laboratory. So, I very much wanted to fit that stereotype. In my senior year of college, I discovered that one could do science outdoors and that studying nature was another way to become a scientist. So, I would say at that point, as soon as I realized that you could both study nature and be a scientist, that's when I started becoming interested in ecology and evolutionary biology.

Lawrence: Many of us at that time remember encountering Rachel Carson's shattering Silent Spring and that changing our whole way of looking at the world. I wonder if you came to the concern with climate change from the study of ecology or you came to ecology out of a concern with the future of our climate?

Sork: I just loved nature. When I was doing my graduate work, I went to the tropics part of the time I went to the University of Michigan and I studied forests in Michigan, and my first interest was trying to understand how nature worked without thinking about humans at

all. It was maybe years later when I would start going back to study sites that I'd visited as a graduate student and seeing they no longer existed, that I started first becoming aware of the impact of human destruction of habitats and particularly forests and deforestation. So that became my first interest.

Sork: At that point, I started becoming more interested as how are natural populations going to survive fragmentation, how are they going to survive loss of habitat, and became very interested in those kinds of processes of the impact of isolation of populations. So, I went many years studying that kind of phenomenon, and then, it became more and more clear how dramatically climate change was also threatening our ecosystems. And so, it was maybe in the last 15 years that I started switching over from looking at how are populations going to survive fragmentation to how are populations going to be able to adapt to a new climate. So, that is what led me to my current research.

Lawrence: We're going to talk a lot about trees and your path breaking work with respect to trees, but also eye-opening work for many of us with respect to trees. But let me put this in a little bit of temporal perspective here. So, if I have it right, the species that you're talking about have existed for well over a hundred million years, some of them extensively over a hundred million years. Homo sapiens, our species, have existed for something like 300,000 years, probably even less than that depending on exactly what we mean by the full evolution of homo sapiens, so, well less than 1% of the time that trees have existed. Even our evolution ancestors at best gets you to about six million. So, it's vastly different in terms of timeframe. Is it too different to be useful in terms of comparison or can we learn things about the trees that tell us about our own evolution as a species?

Sork: That's a very good question. I actually think that trees are, in terms of how they've evolved, you pointed out how long they've been around. We have conifers and redwoods that evolved well over a hundred million years ago. The angiosperm tree species that I study are more like 60 million years ago. But what's true in both of them is that they've been able to retain genes and keep adapting over these time periods to new environmental conditions very effectively. So, in terms of humans, they're very young, yet have evolved and changed incredibly rapidly. So, I think if anything, what we have is a complete contrast and perhaps it's because humans have evolved so quickly, have learned so quickly that they're able to dominate nature and exploit nature in order to continue their own evolution. So I think of them actually as being completely different from each other.

Lawrence: You've been very involved in what I'll call the tree genome project. Tell us a little bit about that work and what we can learn from that.

Sork: Well, I think what we learned from the Human Genome Project is that understanding the genetic basis of traits gives us tremendous tools at trying to improve human health and improve the treatment of disease and perhaps even prevent disease. We also learned from the Human Genome Project that the genetic basis of traits is a lot more complicated than we ever thought and that the role of the environment, of interacting with the genetics, is incredibly powerful. So we both learned new tools for understanding human health and then we also learned limitations that genetics alone is

complicated and not going to solve everything, that we also need to improve the environments that we live in.

Sork: So, with oaks, and with trees, and other species that we're now being able to use these tools developed for humans and apply them to natural species, we are learning that we can gain incredible knowledge about the evolutionary history of species by looking at the genome. We can look at the genetic basis of traits that have been part of the evolutionary success of trees, and we can also try to develop new tools for how are we going to manage our ecosystem so they can survive the climate change that we're exposing them to.

Lawrence: So let's talk a little bit about how this helps us understand climate change and perhaps gives us some ways, different ways of thinking about it that we might otherwise have had.

Sork: So, it is really helpful to understand why is it any organism is adapted to their environment, and there's a genetic basis of these traits, whether it's traits that allow you to deal with for a tree, traits that allow you to deal with the local climate, traits that allow you to deal with the amount of precipitation you've been exposed to. So, understanding what we call local adaptation, to what extent are trees adapted to the environments that they grow in, underlies the success of a species. So, over time, any species will adapt to its local environment conditions and leads to the expression of, "You bloom where you grow." So, the more adapted you are, the better you're going to bloom and reproduce. When we rapidly change our environment, we now have to deal with genes that have adapted to a different environment. And the question is, are they going to be able to tolerate and grow and do well in the new environments?

Sork: So, being able to study the genetic basis of traits is very, very useful because what we're now doing is what's called assisted gene flow. Assisted gene flow is when you take individual trees that have evolved in let's say warmer climates and then you plant them in a spot where that climate is going to warm up to. Essentially, you're helping the migration of seedlings. Because climate is changing so quickly, how are you going to be able to move, adapt to a climate? You figure trees, let's say their generation time is 300 years. Well, our climate is changing faster in 50 years than it has over the last 5,000 years. So, in that case, the climate is getting warmer. What is a tree going to do?

Sork: And so, we for instance, in California, we see increasing numbers of fires, right? Those fires are then destroying the landscape. And often, we replant and help the forest or the habitat regenerate, restore itself by planting in seedlings. Where do you get the seedlings from? If you get the seedlings from that current environment, well, they're not adapted to future climate, so the forest that you're planting would not be very successful. If you take seedlings from a warmer habitat and you get seedlings that are adapted to warmer conditions and you move them into a site that's going to have those warmer conditions, then the forest that you see in 50 to 100 years will have trees that will actually be adapted to the current. What's a shame is that trees have, over the millennial, adapted to changing climates. It's just that nature doesn't change quite this quickly.

Lawrence: This is a very powerful insight. One of the critiques to the climate change movement, aside from those who question climate change altogether, but let's put that aside, there are those who accept the fact that there is a human impact on the climate, that they say that over the 100 million year plus history of the species, some of the species you're studying, there've been lots of changes. Things used to be warmer then they got colder, now they're getting warmer again. This is just the nature of these things, why do we need to assist the process? The process has gone on for millennia, it'll go on for millennia. But I gather you're saying the process of change has gone on, but this is what my math colleagues would call a second derivative problem, is that it's changing faster than it ever used to change and that creates the need for us to be involved. Have I got that right?

Sork: Yeah, I think that's a good way of putting it. The trees and many natural organisms have a lot of genetic variation. And so, over time, they've been able to evolve in response to climate changes. Sometimes, species have gone down into really small populations, maybe in the southern part of their range. And then, when the climate's warmed up, the populations expanded, they gradually migrated north. So, this process of trees moving north and south or up and down mountains in response to how the atmospheric temperatures were changing has been going on for the millions of years that they've been in existence, and perhaps that is why they're so resilient.

Sork: However, now we've given them a challenge that is not really possible, which is that we're changing the climate faster than the genes, or the seeds, or the pollen can actually move. So, I think the good news is there are ways that we can mitigate that impact if we are able to at least slow down or stop the climate warming that's going on. We're still going to need to help the trees exist in the new temperatures, but if we were able to sort of slow down and cap off the climate warming that we've got, there's ways of accomplishing that. I will go back to why genetics is so useful, which I called 21st century genetics.

Sork: One could say, "Well, let's just go to areas that are warmer and get those seeds that adapt to those warm conditions and put them into the existing climates that are about to change." The problem is, you are assuming that the tree populations right now have adapted to the current temperature conditions. Well, in fact, many trees, many tree species, have not evolved to the current climate. They're still trying to catch up. So, for instance, I just completed a study which indicates that the oak populations that I've studied are actually adapted to climates from 20,000 years ago.

Sork: So, there is a lag effect to adaptation, and the oaks that I'm studying are already lagging. So they're still growing and they're able to reproduce, but they would be reproducing better as they get more and more evolved. Now, however, what is going to happen is the temperatures are warming up fast enough that some of the populations are going to go extinct. They're just not going to be performing very well to grow and produce acorns and regenerate themselves. Others are going to grow but they're going to grow more slowly. So, people will go, "Well, that's okay, they're growing more slowly."

Sork: Well, there is an unfortunate consequence of trees not growing as well as they might under ideal conditions, which is that they're not accumulating carbon from the atmosphere. So, one of the benefits of plants and trees to our atmosphere is they sequester carbon, and the more they sequester carbon, the more they can mitigate the increased carbon that we're putting into the atmosphere. So trees are in fact one of the solutions to helping us bring down the extra carbon that automobiles and factories are putting into the atmosphere. So when we have trees not growing as well, they're also not as effectively helping us get our climate change problem under control.

Lawrence: It's not just a concern about trees for their own sake in that kind of a shall we say a pure or unconnected way, but it actually has an impact on human survival through climate change.

Sork: That's right, and this is the other reason why people are concerned when we have widespread deforestation of, let's say, tropical forests. We're not only losing a lot of interesting and unique tree species, but we're also taking away one of the healthy solutions to keeping our planet healthy.

Lawrence: So we've been talking a lot about trees, the things that grow high, let's go down to the ground and talk a little bit about acorns, not just the acorns that turn into oaks, of course, but also acorns is a source of food for humans, for wildlife, for insects. We've all seen acorns, we see them when we walk in the woods, but we probably don't know a lot about acorns. Tell us a little bit more about this topic.

Sork: What I find rather amazing and amusing is that I seem to have been studying nuts my entire career. I study nuts because we have to collect them if we're going to grow trees to plant. But, of course, I've also studied seed dispersal by animals and how important that plant-animal interaction is for both the trees that need the seeds to be planted, but the animals that eat the acorns. So, one of the interesting parts about oaks is that they have this large, basically food resource that has lots of seed predators. It has lots of insects that feed on it, it has lots of vertebrates. We have squirrels that eat them, we've got chipmunks that eat them, lots of bird species that eat them, bears go nuts when they find a tree with a lot of acorns underneath them, deer eat them.

Sork: So, it's a very, very valuable resource for animal life, and when you think about the diversity of vertebrates, the diversity of insects and even the soil that require oaks, oaks are a very important resource for maintaining a healthy ecosystem and a diverse ecosystem. We call it a keystone resource because it's key to the diversity of that habitat. But you know, acorns have played a really important role in human society. At one point, acorns were the major resource of humans all over the northern hemisphere and in fact we're much more commonly dependent upon than rice, or corn, or wheat.

Lawrence: So, in addition to the research protocols that you've had over the years, you also have this role as the director of the botanical garden at UCLA. Tell us a little bit about that and how is that garden structured and how do you think of the garden as a kind of public educative function, a museum of the outdoors if you will?

Sork: Ever since I was a young assistant professor in St. Louis, when I was affiliated with the Missouri Botanical Garden, I became aware of what an opportunity gardens provide to educate the public about the importance of the environment, the value of other species, the concerns that we should have about how humans are impacting our environment. So, I do think botanical gardens get people a chance to see plants from around the world and talk to them about nature in the environment. I think gardens also are a great opportunity to teach young students about the value of science and get them interested in science. So I appreciate that role. The other part that I realized with the botanical garden is there's so much we can do because it has such a healthy impact on people. It's a place of respite, it's a place where people can go and calm down.

Sork: But I will also tell you another part about botanical gardens and their ability to deliver messages, is that it allows me to basically carry out some of my other values. So, for instance, I have become increasingly aware and feeling responsible to ensure that people are aware that this country that we live in was occupied by indigenous people who were here far before Europeans arrived, and they have a value of nature and ethics of nature, that they were very good stewards for North America, and it always makes me sad when I realize that the species I study was widespread in California and lived here, was used by native peoples, they liked the acorns. They used every part for dyes, for health, for medicine, for toys, for building their housing units. And yet, they didn't cause its extinction, they didn't reduce its biomass. It really was able to persist very well.

Sork: They also used fire to manage it and promote it. So, it wasn't that they were not managing these ecosystems, but they knew how to manage them, and what a wonderful story that tells. In contrast, in 300 years, the species that I study, which is valley oak, has lost 85% of its biomass because Europeans have come in and they've developed, they've chopped it down, they've made ranch lands, they've built suburban neighborhoods, they clear cut it when they don't have to. And so I like to remind people that indigenous people lived in harmony with our environment in California, and I could tell that story through the botanical garden, talk about the importance of native people to our environment, and recently have been partnering with native people to build a garden that recognizes their stewardship, their long-term relationship with the land that UCLA now occupies.

Lawrence: Showing it that way is undoubtedly a more powerful way of teaching than just telling the story. It gives a third dimension to it and a realism to a grounding to it literally and figuratively, doesn't it?

Sork: Yeah. I think that's why, again, with gardens is that people, when they see plants or for instance we just built this basket weaving garden, which is we put a lot of plants in that are native plants to California, they're used by indigenous people for making baskets, and as the plants grow and people see this beautiful garden, it's a nice reminder in a very constructive way of how native people have been able to interact with native plants. It's also a way to give back to native people because the local tribe that lived here, they used all of this land and wood harvest plants. And so, we are going to do is

allow native people to harvest the plants from this garden once they get larger and harvest them in a sustainable way. It'll sort of be a way to keep the garden healthy.

Lawrence: Well, we are so delighted to have you as a Phi Beta Kappa Visiting Scholar. It means you'll have a chance to travel the country for us in an interesting way. As you go to other places, invite them into your garden and the work that you've done and the insights that you've drawn. This is a work that is both local to California but in a sense really is national, global. So, thank you for that and for the insights, for what you'll bring to being a Visiting Scholar with Phi Beta Kappa and to joining us today on Key Conversations.

Sork: Thank you very much for your interest in my work.

Lawrence: This podcast is produced by LWC. Cedric Wilson is lead producer, Paulina Velasco is managing producer. This episode was mixed by Kojin Tashiro. Hadley Kelly is the Phi Beta Kappa producer on our show. Our theme song is Back to Back by Yan Perchuk. To learn more about the work of the Phi Beta Kappa Society and our Visiting Scholar Program, please visit pbk.org. Thanks for listening. I'm Fred Lawrence, until next time.

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