Plant People Season Three Episode Five "Pitcher Plants with Dr. Rob Naczi" Transcript

JENNIFER BERNSTEIN NARRATION: To many, carnivorous plants are some of the most fascinating species in the botanical world. Strange and almost alien in some cases, they deploy all sorts of clever tricks to capture their insect prey from hair-triggered jaws that snap shut to long, sticky tendrils that mire bugs in a natural glue.

But, while they might come off as exotic, carnivorous plants are more commonplace than you might think. Many are native to the United States, and some even grow in the New York region, like the pitcher plant. Welcome to Plant People. I'm Jennifer Bernstein, CEO and The Williams C. Steere Senior President at the New York Botanical Garden. Today, we're joined by NYBG's own Rob Naczi, our curator of North American botany with a passion for pitcher plants, to dig into these hungry oddities of the plant world.

JENNIFER BERNSTEIN: Welcome, Rob. Welcome to Plant People.

ROB NACZI: Well, thank you, Jennifer.

JENNIFER: So glad that you're here and I'm very excited to have this conversation about pitcher plants. So to start us off, what are pitcher plants and how did you first become interested in them?

ROB: Well, first of all, pitcher plants are flowering plants and they're green plants, but they are carnivorous, as you mentioned, so they're a group of plants that are able to trap, digest, and absorb nutrients from animal prey, mostly insects, but not restricted to that, right?

Because they also catch a lot of slugs and spiders and other crawling creatures. But in pitcher plants, we actually have three very different families. So here in North America and also in northern South America,

we have the Western Hemisphere pitcher plants. In Southeast Asia, we have the Nepenthes pitcher plants, and then in southwestern Australia we have the Cephalotus pitcher plants.

JENNIFER: Okay.

ROB: Now, how I got interested in short, it's because when I was in high school I really got interested in plants. I had a wonderful science teacher and he encouraged me and I wanted to learn more about them. And once I learned about carnivorous plants, I was hooked, especially with pitcher plants. And then what really helped was when I was 15, my dad took me to the New Jersey Pine Barrens and a wonderful local naturalist, Annie Carter took us to a population of pitcher plants, and that did it for me.

JENNIFER: Tell us what it looks like. How would I recognize a pitcher plant if I encountered one out in the wild?

ROB: Well, it would strike you as being very, very different than any other plant you've seen because. The first thing you would notice is a tubular structure, and this is why they're called pitcher plants, because they resemble pitchers like water pitchers.

And so some of these pitchers are low growing and others are very tall and trumpet-shaped, but they tend to flare out at their far end. So, they're...where their mouth is they're wider than at the base.

So, they taper down to a very narrow base. They're all green, but with a bold pattern usually of strikingly red stripes and veins.

And also some of them have quite a bit of white on them. A white region and others have white spots. The leaves are also a little bit tough. They're quite durable because once these leaves are produced, they

usually last for most of the season, so they tend to be a little bit, not quite leathery, but tending to be almost leathery.

JENNIFER: Yeah, they're definitely distinct. Once you've seen one, you'll always be able to recognize them from there.

Generally, what kind of environments are pitcher plants found in and how do we think that they evolved carnivory?

ROB: Well, I'm so glad you asked about that because for me, that's one of the fascinating things about pitcher plants particularly, but about all carnivorous plants. So all carnivorous plants have something in common, and it's their habitats. Their habitats, first of all, are nutrient poor.

These nutrients are necessary for plant life, but what happens is when some plants live in those nutrient poor environments, they still have to acquire the nutrients, but they're not able to do it from the soil.

So instead, some plants have evolved to be carnivorous so that they can acquire nitrogen, phosphorus, and other necessary nutrients by carnivory. By trapping and digesting animals...

JENNIFER: Is it a particular type of nutrient poor environment? A desert or a wet environment, or where would you find them?

ROB: It's not only nutrient poor, but it's wet and it's almost always sunny.

JENNIFER: Hmm. Because I would imagine in a wet environment you do have a lot of insects hanging around...

ROB: In most of them, yes you do. And people might wonder, what are some examples of these? Well, one word that comes to mind at least a

botanist, is bog and well, what is a bog? A bog. People get bogged down in a bog. A bog is a place that's a wetland where the substrate tends to be very soft and squishy, and it's often made up of a particular group of mosses that live there called the peat mosses.

And the peat mosses build their own environment. They eventually build peat, and peat is almost completely devoid of nutrients. So, that's one typical environment for carnivorous plants. Another one are sandy, almost pure sand environments that are wet. Like in the southeastern United States, we find wet pine lands like in the longleaf pine belt from North Carolina, south and west to all the way to Eastern Texas.

JENNIFER: So can you explain, sort of step by step, what happens from the moment that an insect lands on the pitcher to when the plant gets its nutrients, how does it attract the insects and why is the pitcher plant such an effective trap?

ROB: They are indeed very, very effective so that most animals, especially insects that are attracted and enter a pitcher, never leave.

So, how it happens is, first of all, insects...well take a fly for example. Flies are attracted from a distance by colors. Most of our pitcher plants are very brightly and boldly patterned. They're attracted by these colors, but also by aromas because the plants release fragrances, most of them attractive to certain groups of insects. And then getting closer these plants secrete nectar on the exterior of their pitchers.

The pitchers are the traps. They're actually modified leaves. So, the insect will sense the nectar when it's very close and it will land. And the nectar glands, those organs that secrete the nectar, are most abundant in the vicinity of the mouth of the trap.

So as the fly probes around, moves closer and closer to the denser concentration of nectar, it gets to the mouth. And then right around the

mouth there are a lot of slippery surfaces and the flies tend to fall in. Also, other parts of the plant have stiff downward pointing hairs that tend to coax the fly into the pitcher.

Well, some pitcher plants have their mouth open to the sky and they collect rainwater inside. Others actually have their hood covering the mouth, but either way, once the insect falls in, it can be in a pool of water or it can be inside a tight, moist space and it's very difficult for it to maneuver within that, within that space. It's very difficult for it to escape.

Inside there are more stiff downward-pointing hairs. And also these plants that live in the Western Hemisphere, they secrete a very powerful tranquilizing agent. It's quite potent and it tends to immobilize the insects much faster than if the insect had, let's say, fallen into a little puddle of water.

So, within a matter of seconds to minutes, the insect stops struggling and eventually it suffocates or drowns within the pitcher, and then it gets digested. Now some pitcher plants, like the Southeastern Asian Nepenthes pitcher plants, they have powerful enzymes inside that do much of the digestion. But in our Western Hemisphere pitcher plants, it's mostly bacteria that do the digesting.

And then the last step, the plants have within their pitchers, specialized glands that absorb the breakdown products. The nitrogen and the phosphorus, and the other nutrients from these decomposing insects.

JENNIFER: Fascinating. So, they kind of look like a sort of a long test tube.

ROB: They do.

JENNIFER: And the insect falls in and then it can't get out because it's too slippery or there's a lid or they're trapped there. That's right. It's amazing. So, I know that some plants have different needs throughout the year as seasons come and go. So, can you talk a little bit about what the annual life cycle of a pitcher plant looks like?

ROB: Sure. And I'll talk about the Western Hemisphere pitcher plants, the ones that grow around here and throughout eastern and northern North America. So, as I mentioned, these are flowering plants and our pitcher plants tend to bloom early in the year. So, if you live in Florida, you would see them blooming as early as late February, early March.

And then as you move northward, the blooming season goes all the way to mid-June if you're in Canada. So, along with the blooming, the blooms tend to come out as the young pitchers are developing or just prior to new pitcher formation. But once the blooms form, pollination can occur, new pitchers are produced and it takes a little while for the pitchers to harden up.

When they're young, they're very tender. So, the pitchers harden up and then they're fully formed and mature and they're ready for trapping. And most pitcher plants will produce new pitchers throughout the season. Sometimes there are mainly two flushes, a spring flush and a late summer flush. And then others will just produce pitchers continuously throughout the growing season.

And then as we approach autumn and winter the production of pitchers slows down. The individual pitchers become less metabolically active, and the whole plant is preparing itself for winter, at which time it becomes dormant.

And in the north, this sounds a little counterintuitive, but in the north, the pitchers tend to be evergreen.

And in the deep south not so much, but both ways. We find that the overwintering activity is by the underground stem, the rhizome, and then that rhizome has buds that form late in the fall so that by the time spring comes along, new pitchers can begin forming to complete the cycle.

JENNIFER: So, it's time for eating season again...

ROB: Absolutely.

JENNIFER: Okay.

ROB: The plants do not trap during the winter. They're dormant at that time.

JENNIFER: So, what ecological factors are key to the survival of the pitcher plants and what are the main threats to their wellbeing?

ROB: Most of them are fire dependent. Most live in the southeastern United States, and they live in habitats that originally burned on a regular basis. Typically every three to five years.

And what the burning does is it sets succession back, meaning that it keeps the habitats open and sunny. In the absence of fire, the forest tends to grow up shade...the pitcher plants and the pitcher plants cannot tolerate shading indefinitely. So, periodic fire is absolutely necessary, and that is one aspect of the habitat that had been overlooked for a long time.

So, one of the threats is indeed fire suppression, but even more serious is outright habitat destruction.

JENNIFER: Yeah. And have we encroached in their habitats to the degree that there are certain populations that have gone extinct? Like where are they thriving best these days?

ROB: Yes. It's really sad, especially for me to talk about this because I've been studying pitcher plants long enough that I've seen many habitats that have been destroyed.

So the most species rich area, the richest area for pitcher plants in all of North America, is on the Gulf Coast. The tough thing for these plants is that historically the number of habitats, the number of populations known for these plants was greatest nearest the coast.

Well, of course, resort development is where is the biggest competitor. So, places like Panama City, Destin, Pensacola. These are areas where we like to live, and I'm certainly not against development and recreation, but these activities and development that ensues from them has greatly reduced the number of pitcher plant populations.

JENNIFER: So in addition to the sort of inherent value of all species, what are the ecological services or ecosystem services that a pitcher plant is providing? I assume part of it is controlling insect populations, but you tell me.

ROB: It is, and it's amazing how little we still know about pitcher plants. So, that matter you just mentioned about controlling insect populations...you know, there's never actually been a study of that?

JENNIFER: Oh, that's interesting.

ROB: Local control of insect populations. But one ecosystem service that I like to talk about, and I find it absolutely fascinating, is the fact that a set of insects and mites actually lives within pitchers. So most insects and mites, when they enter a pitcher, as we've discussed, they're

devoured, but there's actually a set that has circumvented all of that trapping and digestion. And instead, they thrive only inside pitchers.

And this is actually a quite diverse set of organisms. Many of the species are yet to be described to science. They're unknown at this point.

So, there is a whole micro ecosystem that thrives inside pitchers. And that supports the larger ecosystem. So, for example, there are flies that are fairly sizable, house fly size and larger that breed inside these pitchers, and they in turn feed birds that live in the local habitats with the pitchers.

JENNIFER: So I'm interested, is there a horticultural interest in pitcher plants? Can you pick them up at your local garden center? And if so, are there conservation issues associated with that as there are with many other desirable plants?

ROB: Yes. Pitcher plants are hugely popular in horticulture. So, a lot of people breed them. One of the things that makes them so attractive is they can be hybridized. And so a lot of people breed them looking for new and more interesting forms and colors and shapes.

As a result, we do have some conservation threats. All of the pitcher plant species are commercially available.

But despite that fact many people persist in poaching directly from the wild, and unfortunately, there is a thriving black market for pitcher plants. I myself have encountered poachers and also the results of poaching on numerous occasions. I returned to populations for my research and I discovered there are fewer plants and instead there are holes in the ground.

So, we can love these plants, but we're loving them too much. We're loving them to death, especially when we do engage in illegal activities like poaching.

But, I'd rather talk about the positives. One thing about the horticultural interest in pitcher plants is, as I say, they're immensely popular and they bring people together. And so there are conferences, some international, some local, some on a very local basis, and many of them are very well attended. And whenever I go to these meets, there's a tremendous amount of energy in the air.

JENNIFER: I bet it's a fun crowd. These pitcher plant people. I want to go to one of those conferences.

ROB: Definitely, you would enjoy it. It’s very fun.

JENNIFER: I'm interested, from your perspective, someone who has spent a lot of time looking at these plans, what are the big unanswered questions in this area of pitcher plant research, and what kind of research is being focused on today?

ROB: So, back to those three different genera of the Western Hemisphere pitcher plants. The pitcher plant family is called the Sarraceniaceae. So the Sarraceniaceae has these three genera...imagine their geography.

So, these three areas are completely separate from each other. We call this a disjunction or a disjunct distribution pattern. So, Darlingtonia, Sarracenia, Heliamphora... They're many, many, many miles apart from each other.

So, one of the biggest questions is: How did this come to be? So, there are two leading hypotheses. One is that the ancestral picture plants were widespread throughout this entire area, and that subsequent climate

changes, mountain buildings desertification... that they fragmented the original continuous range.

The other hypothesis is long distance dispersal. Somehow the seeds or plants were able to be transported over a great distance and established new populations and new regions. So that's one question: How did we get these disjunctions?

JENNIFER: And do you answer that through genomic research? How do you address that?

ROB: Can I talk about a very unconventional way that we're addressing that?

JENNIFER: Yes!

ROB: Yes. So, this question of the biogeography and the achievement of the current distribution pattern of Sarraceniaceae has been one of the longstanding questions for the family since the beginning of scientific research into the family. We have had several attempts to crack this nut using different sets of data.

Most recently molecular biology, DNA-based studies, and they have not succeeded in answering the question. So, recognizing this...quite a while ago, I began focusing on some of these mites that live inside the pitchers. And what attracted me to them is the mites are highly host specific so that almost every different species of pitcher plant has its own mite.

Well, what I discovered about the biology of these mites is the mites live in fully aquatic situations in the water filled pitchers, or at least in very wet environments in those pitchers that don't fill with rainwater, but are still quite wet inside. And I became very interested in the host specificity and its causes, and so I studied how these mites are dispersed

and why they are limited to certain species of plants, and what I discovered is that most of the dispersal is of the mites leaving one pitcher in which they developed and entering the new developing pitchers within the same plant.

Yet that cannot explain all of the pattern that we see. So, there has to be a bit of a longer range dispersal. And what I found with that is that on occasion, the mites attach to the flies and the flies move them around from plant to plant.

However, that is a very risky proposition.

JENNIFER: Yeah, those flies get caught.

ROB: The flies can get caught. But even more serious is the mites tend to dry up. They desiccate within just a couple of hours or maybe even less of leaving the pitchers. So they develop within these pitchers in a very wet environment.

And when they leave, they're exposed to drier climates, lower humidities, and they tend to dry up. So unless the dispersal happens very quickly, the mites die. So, that basic biology of the mites helps support the hypothesis of what we call vicariance, meaning that we had a once continuous distribution that has subsequently been fragmented by various environmental processes.

JENNIFER: Fascinating. So, how can listeners who are interested in this topic, participate in pitcher plant conservation? You mentioned the societies... Maybe there's cultivation. I don’t know if there's citizen science efforts... How can listeners get involved?

ROB: Wow. That's a great question and I love it. I would say the first thing is: get to know pitcher plants better. And so one of the questions that arises is: where?

Where can I see them? Well, certainly a place like New York Botanical Garden... it's a wonderful place.

JENNIFER: Yeah. Come here.

ROB: Come here and you can see them in our Conservatory, where you can see them in our Native Plant Garden...

JENNIFER: And the Children's Garden.

ROB: You don't have to go far, but let's say you are an adventurous soul and you really do want to see them in their natural haunts.

Well, again, you don't have to go terribly far. Many places in New York state, for example, have pitcher plants in the wild, all the way from county parks to state parks, to state forests to national wildlife refuges and so on. Get in touch with local botanical societies. Look on the internet. Where can I find pitcher plants nearby?

Go out and look at them. Another wonderful place, to see pitcher plants in the wild and it's relatively easy to see them because there are a number of populations and they're relatively large is in the New Jersey Pine Barrens, and there are a number of preserves there where people are welcome to go and look at pitcher plants up close.

JENNIFER: And leave them alone.

ROB: And, and leave them alone, or, well, you could touch them, but don't, don't dig them up.

JENNIFER: That's wonderful. You know, Rob, I can't, get through this whole conversation even though it's not about pitcher plants without asking you about the Northeastern flora that you've been working on. Could you just say a word about that?

ROB: Yes. I lead an effort to produce a new floristic manual for the northeastern United States and adjacent Canada that is part of a long lineage of such floristic manuals that the Garden has produced since its earliest days since its founding.

And the manual is primarily for identification, but it also is a go-to reference for the geographic distributions, the conservation status, the appearance, the names, the habitats and so forth. It's a wonderful resource and we're working hard on it. It's a very ambitious project. We estimate that by the time we finish, we will have covered 5,300 species.

JENNIFER: It's amazing. And these floristic manuals are the ways in which over time we understand our changing biodiversity.
So, they're really important reference material for researchers and for the general public. So, I applaud you on your long-standing efforts on the manual.

ROB: Thank you, Jennifer. And thank you so much for your support. You have helped us so much already and I know you will continue.

JENNIFER: Well, it's a joy to work with you. It's been so fun to talk about the pitcher plants. I do hope folks will come and see them in person here at NYBG or on public lands near you. It's great to be able to interact with these amazing species. So thank you for being here, Rob.

ROB: Thank you, Jennifer.

JENNIFER NARRATION: To learn more about Rob's work in North American botany, check out the links in our show notes. And the next time you stop by NYBG, remember that strange and fascinating plants like the abundant pitcher plants in our Native Plant Garden Conservatory and Children's Garden grow closer to home than you might think.

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