EPISODE 222 TRANSCRIPT

Jamie

Welcome to Two Bees in a Podcast brought to you by the Honey Bee Research Extension Laboratory at the University of Florida's Institute of Food and Agricultural Sciences. It is our goal to advance the understanding of honey bees and beekeeping, grow the beekeeping community and improve the health of honey bees everywhere.

In this podcast, you'll hear research updates, beekeeping management practices discussed and advice on beekeeping from our resident experts, beekeepers, scientists and other program guests. Join us for today's program. And thank you for listening to Two Bees in a Podcast.

Hello everyone, and welcome to another episode of Two Bees in a Podcast. Today, we are joined by Dr. Michelle Flenniken, who is a professor in the Department of Plant Sciences and Plant Pathology at Montana State University. Michelle is an expert, a world expert on honey bee viruses. So, that's going to be the topic of this episode. Michelle, thank you so much for joining us on Two Bees in a Podcast.

Dr. Michelle Flenniken

Thanks for having me.

Jamie

We are super excited. You know, you're in Montana, we're in Florida. It's hot here. I bet your weather's perfect up there. How is the weather today in Montana?

Dr. Michelle Flenniken

It is great. We had a nice light rain yesterday clearing out, we had a little bit of smoke due to wildfires, but that's cleared out now and it's a beautiful fall day. Although, fall in Montana is very short. It'll last couple weeks, and then we will have snow.

Jamie

Well, snow is not something we ever have here, so I'm a little bit envious. Okay, Michelle, we're going to just start the way that we always start. Since we've got listeners from around the world interested in knowing about you, as well as, specifically, how did you get into the honey bee world? We'd love to hear your introduction to honey bees story.

Dr. Michelle Flenniken

As you mentioned, I'm currently a professor at Montana State University here in Bozeman, Montana, where research in my lab focuses on understanding the impacts of pathogens,

particularly viruses, on honey bee colony health, but by training a microbiologist and virologist. And I got my PhD from Montana State University in 2006, and then after leaving at MSU, I did a postdoc, a postdoctoral research experience at the University of California in San Francisco, where I worked with two virologists, Dr. Raul Andino, a polio virus expert, and Dr. Joe DeRisi, a pioneer in virus discovery.

And in 2008, I was working on a mammalian virus project when news really started to highlight the high levels of honey bee colony deaths in the US, and I wondered about the potential role of viruses in those losses. So, I emailed other UC scientists at UC Davis, including Dr. Eric Mussen, who told me about funding that would allow me to investigate honey bee viruses and learn more about their immune responses.

So, I jumped on that opportunity and applied. About the same time, Christi Heintz, who was the executive director of Project Apis, a nonprofit organization that supports bee research, was getting in touch with Dr. Joe DeRisi about viruses and honey bees as well. So, I joined that project too.

So, my initial jump into honey bee virology, if you will, was to team up with commercial beekeeping operations where we took samples from colonies over the course of the next year, not the year with high losses, and determine what viruses they had.

And part of that study, we discovered the Lake Sinai virus family. And then I did my own research on learning more about the honey bee immune system. And that's when we kind of investigated specific pathways that are important that bees have evolved to fend off their viruses.

Amy

Michelle, we've been doing this podcast for five years now. Jamie, how is it that this is the first time we've had you on the podcast?

Jamie

I know, Michelle, you're so knowledgeable about this stuff, and it's our oversight, Michelle. We'll do better in the future.

Amy

Seriously.

Dr. Michelle Flenniken

Thanks for having me now.

Amy

No, we're really excited to have you. You know, viruses, it's what we talk about on this podcast. I mean, that's the number one, you know, issue that beekeepers deal with is Varroa and the viruses that it transmits. And so I'm super excited. I think that we could probably go on for a while with this episode, but we'll try to keep it short. So, let's talk about viral impacts. Can you give us just a little bit of background on viruses as a whole and then, you know, viruses related to honey bees?

Dr. Michelle Flenniken

Yeah. So, viruses infect all types of organisms. I think we can relate with that having lived through the SARS Coronavirus 2 pandemic. But honey bees are also infected by viruses and by many different viruses. It's actually common to detect multiple viruses within a single colony and even a single bee.

And as I mentioned before, part of my research in my lab studies how bees naturally defend themselves against viruses. But, of course, we also appreciate that viruses are still a big problem. They're associated with colony losses. And when we talk about viruses, we talk about viruses by their genome.

So, viruses are categorized by what type of nucleic acid makes up their genome. So, I think we can appreciate that our genomes are made of double-stranded DNA. So, humans and honey bees genetic blueprint is double-stranded DNA, but most of the viruses that infect honey bees have single-stranded RNA genomes, and they're in this family called the Picornaviridae and Pico RNA. That's where Picornaviridae comes from, just means small RNA viruses. And the viruses are really small.

They're about 30 nanometers in diameter and they look like really tiny soccer balls under a transmission electron microscope. They're so small that about 3000 of them could line up across a single human hair.

So, we can't use microscopy to detect them, and we use what's called molecular biology tools to detect them. And that means we detect their RNA, and we quantify their RNA to determine which viruses are in any given sample. And the most common honey bee viruses are black queen cell virus, deformed wing virus, sacbrood virus, and members of the Lake Sinai virus group.

And some of these virus infections are associated with morphological symptoms like deformed wing virus. I think beekeepers and scientists and everyone can relate that this virus causes wing deformity, but there's some details there to understand. Deformed wing virus will cause morphological symptoms of deformed wings only if it infects the bee during larva or pupil stage. Deformed wing virus infections that are acquired as an adult honey bee, so after her wings are already developed, won't give that morphological system.

But we know from our studies and others that that seemingly healthy bee could have over a billion deformed wing virus copies circulating in her. So, efforts in my lab are also working on figuring out what is the cost or the negative impacts of these virus infections that we really can't see with our eyes.

Jamie

So, you've mentioned sacbrood virus, black queen cell virus, deformed wing virus, and you said the Lake Sinai viruses. And so, gosh, there's so many things to talk about in the virus aspect. You know, I get asked questions about viruses a lot. I think about these viruses you mentioned, you know, we're all aware of even other viruses that honey bees get. And so, I know it's really difficult, maybe, at this stage to categorize what you would consider maybe the biggest viral threats to honey bees. But I'm going to ask you anyway, if you have to look across the viral, you know, pathosphere out there, which ones are the biggest threats to honey bees, and maybe why?

Dr. Michelle Flenniken

Yeah, that's a great question. And I'm just going to back up a little bit because, as you mentioned, there are a lot of different viruses that infect bees including black queen cell virus, deformed wing, sacbrood virus. Those are some we've all heard of.

There's about 20 or so well-characterized honey bee infecting viruses, and there are many more that are continued to be discovered by what's called high throughput sequencing efforts.

So, the list is growing. But that's important to know the list of honey bee viruses so we can better associate particular viruses or speeds of virus with either colony health or individual bee health. But you did ask, what are the biggest viral threats to honey bees?

And I think throughout literature, throughout the world, studies throughout the world kind of points to a few most important players at this time. But it's important to recognize that there's no one specific virus. It's really actually a suite of viruses and other factors that can be associated with poor colony health or colony death.

And sometimes that suite of viruses or particular viruses varies, but does include Lake Sinai virus 2, Israeli acute paralysis virus, and probably most prominently, deformed wing virus. And so those have been associated with poor colony health and over winter colony losses the most and probably are the most impactful.

Most recently, we experienced high colony losses in the US averaging probably about 62% according to the USDA and Project Apis most recent report. And the USDA, Jay Evans, Judy Chen and Zach Lamas and others recently described there was strain of acute bee paralysis virus that was associated with those losses, and they also saw a lot of deformed wing virus as well in those studies. And so, I would say to sum up, deformed wing, acute bee paralysis virus, and

Israeli acute paralysis virus are probably the biggest threats, but we can't rule the others out either.

Amy

So, Michelle, I'm glad you were talking about the number of viruses that we have and how we're constantly finding more because I think, you know, when Jamie and I are giving talks to beekeepers out there, that's always a question that I get, at least, you know, people always ask like, well, how many viruses are there out there that bees can get? And I'm like, the answer is really, we don't know, right? And so, I don't know if that's an appropriate answer, but that's usually what we say.

Dr. Michelle Flenniken

Yeah. And when you think about that, we don't know the extent of bee viruses. We have many fewer bee virologists, I have to say that slow, or people who study bees, like, viruses like me, than we do people studying human viruses.

And I think we can all appreciate that we just discovered the, you know, the SARS Coronavirus 2 during the pandemic. And so, viruses are kind of a fast-evolving pathogen. We're going to continue to discover new viruses or different viral variants throughout time. And that's natural and common in most systems. We just have to better understand the role of these viruses in honey bee colony health. And can we tip the balance to the honey bee side, augmenting their immune systems to combat these viral infections?

Amy

Definitely. So, when you're talking about, you know, the role of these viruses, sometimes we'll get reports back and sometimes they'll say, there are viral loads versus the virus is there or it's not. It's either there or it's absent. Can you discuss the difference between viral loads versus what it means to just have the presence there?

Dr. Michelle Flenniken

Yeah, that's a very good question. So, the difference between viral loads versus presence. So, I'll start with presence, and the difference is really important. As I mentioned before, to detect and quantify viruses, scientists use molecular tools to detect viral RNA, and we can see if it's there or not using a reaction called polymerase chain reaction, or PCR.

And that's really a yes/no test. Do you see that particular virus, like deformed wing virus, in the sample? And since honey bees are commonly infected with multiple viruses, this yes/no answer isn't that informative.

I would say we use it in our lab to determine, is it there, and if it's there, we need to go further. And going farther means to quantify the virus load. And to do that, we use a technique called quantitative PCR or qPCR for short. And that allows scientists to determine the relative abundance of viruses in a particular sample.

And this information is far more informative to associate particular colony level phenotypes, like low population levels, for example, with particular viruses. Viral load is very important to do that. And interestingly, if your listeners want to learn more, Montana State has a Pollinator Health Center, and on that resource page, we made videos to describe how we do PCR and quantitative PCR and how those techniques really work in the lab. And again, as I mentioned before, these techniques are the same techniques that are used to determine the presence and absence and loads of human viruses. So, they're very readily used techniques in our field as well as all of virology.

Jamie

Michelle, this is fantastic information. I wish we could make this podcast go on for two hours because I've got so many questions for you, but this one's kind of a low-hanging fruit. You've already mentioned that a bee or colonies themselves can have multiple viruses. That's good. And you know, if you're a biologist, you know Kingdom, phylum, class, order, family, genus, species. But viruses kind of march to a different drum, right? So, there's complexes, there's groups of viruses. You've spit out a lot of virus names. So, 2 questions for you. What does this virus complex idea mean? Number one. And number two, talk about coinfection with multiple viruses at a time.

Dr. Michelle Flenniken

Yeah. So, honey bees, as we've talked about, are frequently infected by multiple viruses. And so I think about it as that and just that. Maybe we see particular suites of viruses in any given sample cohort, but in general, it's good to just examine which viruses that are there and how many of them.

I think that, you know, one of our papers that I think about when I get this question all the time is a publication in PLOS ONE that talks about and has graphical illustrations of viruses in any given colony. And then, in that particular study, we found black queen cell virus was pretty prevalent throughout the year.

Deformed wing virus was more abundant later in the beekeeping season. And that's, for us, during the late summer or fall, in Montana. And that's because, as we know, Varroa destructor mites play an important role in transmitting deformed wing virus and other viruses, while others, like Lake Sinai virus 2, were more prevalent in the spring.

So, that also points to another thing is that the mites, while an important vector or transmitter of bee viruses, don't govern the overall patterns of all bee viruses in a colony. And you can certainly have viruses in your colonies, and you do, even if you keep your mites low.

And so, we're really trying to better understand the seasonality, and what I'd say, the epidemiology of bee viruses to better understand the impacts of single viruses, but more commonly, multiple virus infections at the colony, individual bee, and cellular levels.

Amy

So, Michelle, you know, a team and I here at the University of Florida just put together this pest and disease field guide. I feel like I really should have had you review some of it because we were looking at some of the viruses and trying to describe some of the clinical signs that beekeepers can find that are associated with different viruses.

So, Israeli acute paralysis virus, deformed wing virus, as you had mentioned earlier, chronic bee paralysis virus, black queen cell virus, and sacbrood. And I was wondering if you could share, you know, some of the clinical signs that beekeepers would see if they went into an apiary, looked through frames. What are they looking for exactly?

Dr. Michelle Flenniken

Yeah. So, that's a great question. So, I would say, overall, you know, maybe low colony population number would be associated with multiple viral infections because you're having individuals die and you, of course, need enough healthy individuals for the super organism to thrive.

The easiest one is deformed wings because you can see bees emerging as adults with wing deformities. And then I think beekeepers often call those the crawlers that are out in front of the colony because the rest of the bees will take those bees, kind of drag them out of the colony, and they can't fly back to the colony.

So, they'll, unfortunately for them, they will die in front of the colony. So, you can see bees with wing deformity in front of the colony. The others are more subtle, but bees that have the word paralysis or paralytic virus in their names, they can be associated with strange movements on the colonies.

Sometimes those bees appear kind of greasy and shiny, especially a chronic bee paralysis virus causes this kind of shiny cuticle on the outside. Their hairs are off, and they move in weird ways and kind of fall over and things. But we all appreciate, as beekeepers, that when you're looking in a box of 30,000 bees and looking at all those frames, it's sometimes hard to see those outliers.

On the other hand, sometimes it's not. Your eye is drawn to those and so you could look for those. If you have brood symptoms, looking for those sac-like forms that are due to sacbrood virus, you might be able to pull those out. They'll look different than the bacterial infections. Black queen cell virus.

I know some queen producers especially see that where the queen larvae is blackened. But again, as I mentioned before, a lot of these viruses appear asymptomatic but are in high levels in the colonies. I often get approached by beekeepers who get some report back about their mites and viruses.

And they've done a good job keeping mites down and they've been told that then in turn, they should not have viruses coming back in their tests, and they often do.

So, while controlling the mite population in your colony can help reduce the viral transmission, especially for those like deformed wing that are transmitted or really hand-in-hand with this vector of Varroa destructor, mites don't govern the virus populations as a whole, so beekeepers will still have viruses in their colony even if they keep their mites down.

Jamie

So, Michelle, you've mentioned multiple times throughout this interview about different research projects and different research themes that you've covered in your lab. You don't have to get into specifics with your current and ongoing projects, but I am curious if you could outline some of the broad themes that you and your team study regarding viruses.

Dr. Michelle Flenniken

Yeah. So, overall, my lab at Montana State University, the focus of our work is understanding the impacts of viruses on honey bees at the colony, individual bee, and cellular levels with the ultimate goal of, the better we understand the system and the viral impacts on bees, then we can develop strategies to mitigate virus associated losses.

So, I'll tell you about our research just a little bit more in terms of our federal funding, because our research relies on federal taxpayer dollars to support these projects. We're funded by the USDA to further investigate the potential role of using immune stimulating molecules.

We're investigating thyme oil so you can plant thyme in your gardens that we think that's good for bees, and its role in potentially stimulating the immune pathways that bees have evolved to defend themselves against viruses. Another small molecule we're further investigating is double-stranded RNA or synthetic mimic.

So, that's a really applied project, I would say, but the implications of that work are further down the road. And in a more basic science or fundamental project is funded by the National Science

Foundation. And the goal of the National Science Foundation is to better understand the fundamentals of biology.

You can make this analogy. If you don't understand how a car works, it's hard to fix the car. So, I think we're still learning about what are the impacts of viruses on bees. I've mentioned a couple times now that a lot of these seemingly asymptomatic infections are maybe problematic to bees, but we can't tell.

And so, the National Science Foundation has funded us to investigate that, and we're doing that using, actually, flight as a proxy for individual bee health. So, we've infected bees with viruses in the lab and we look at flight performance. This work has recently been described in Science Advances, and we publish all Open Access articles so your listeners can always check out our work.

But in a nutshell, we thought that high levels of virus infection would impair flight, and that was true for deformed wing virus. But surprisingly, there was a twist that sacbrood virus seemed to stimulate this octopamine pathway and increase the energy of the bee, while sacbrood virus infections aren't overall good for bees because we know they kill brood.

It's interesting to see that different viruses have different impacts on individuals, and we really do need to understand those fundamentals before we can develop strategies to mitigate virus associated honey bee colony losses.

Amy

Michelle, my mind is blown. So many follow-up questions on everything you just said. I'm like, does this mean we should be giving them sacbrood? They're going to be stronger in flight?

Dr. Michelle Flenniken

No, no, no.

Amy

No, I'm totally kidding. But it is really great. I feel like Jamie and I could go through your literature and, you know, we could highlight like every single one of your projects and do a whole episode on that. So, yeah, I'm excited to continue following you and reviewing your work. And thank you for having them Open Access as well. So, I know, Michelle, that our listeners are probably wondering at this point, you know, there's so many viruses out there, aware of some of the clinical sites associated with some of the viruses. What should a beekeeper do at this point? You know, what does a beekeeper do with this information and what should they do to control the viruses in their colonies?

Dr. Michelle Flenniken

Great. That's an important question. So, unfortunately, beekeepers really can't control the viruses in their colonies at this point, but they can be vigilant about monitoring the mite levels in their colonies and administering anti-mite treatments. The Honey Bee Health Coalition has an excellent guide that's accessible online via Montana State's Pollinator Health Center resource and lots of other sources that describe several anti-mite treatments or miticides that include organic options.

So, it's important to control your mites, and as I mentioned before, while you control your mites, I would say you reduce your viral loads, but you won't stop viral infections that way. But you can certainly help your colonies. Nutrition is another important aspect. I'm sure we can all appreciate that if we have better nutrition or more competence in fending off any type of pathogen, and that includes viruses.

So, beekeepers can situate their colonies in suitable environments or provide nutrient supplementations like pollen patties or protein patties throughout the year as needed. Though more research is needed in this area to figure out, you know, what are the best food sources.

I think adequate nutrition is important. Small little details you can do if you do have a sick colony and multiple colonies in your bee yard is that you can reduce transmission by, you know, putting your hive tool in the smoker and then letting it cool off so then you're not physically transmitting any of those viruses.

And again, there's been several studies to show that, it's kind of tied to nutrition and transmission, that bees need a lot of floral resources we can appreciate. And if there's more floral resources in the environment, then they have a more diverse diet and repertoire.

But that also means that there's less pathogen or virus sharing on floral resources. And that's an important aspect since bee viruses – we call them honey bee viruses because we discovered them in honey bees but many of the viruses that we've talked about today can also infect other insects, including bumble bees and mining bees. And so, if we have broader floral resources in the area, we will also reduce viral transmission in general.

Jamie

Michelle, that's all fantastic information. I really appreciate your work. You're so articulate and clear about this virus issue, which can be complex, and so I appreciate your background and appreciate what you were able to do. And thank you so much again for joining us on the podcast today.

Dr. Michelle Flenniken

Thank you for having me. It's great to talk with you and I'm glad that you're getting good information out to anybody that cares about bees. We know that they need our help right now.

Stump the Chump

It's everybody's favorite game show, Stump the Chump.

Amy

All right. Welcome back to the question-and-answer segment. This is the third of the three oxalic acid series. We're actually going to ask 4 questions this time, Cameron, so I hope you're ready for it.

Dr. Cameron Jack

Okay, I am ready now. I've had a couple of warm up times, like now I'm ready.

Amy

Exactly. OK, so for the first question, does one get better coverage? So, does someone get better coverage when using oxalic acid vapor by treating from the top or the bottom of a colony? So, does it matter if you're trading from top or bottom and has this been looked at?

Dr. Cameron Jack

Yeah, I don't know anybody that's like looked at this too carefully, and I can't imagine it really mattering. We mostly just treat from the bottom. But if you think about it, I mean, you're blowing in kind of this hot gas that's coming in as it’s vaporizing and you know, we know that warm air rises, right?

So, the hot gas is going to kind of rise up and kind of fill that space. I feel like if you were to do it from the top, it's still going to come in and rise, but it's going to probably just hit the roof and then like circle through. It kind of wouldn't matter so much.

So, I wouldn't make an effort to change whether or not I was doing the top or the bottom. I would probably just say the bottom is probably easier. And so, I'd probably continue with that with my own treatment. As long as it's sealed up properly, I don't think it would really matter whether it was from the top or the bottom.

Jamie

So, Cameron, this next question I think is very relevant when we think about oxalic acid. You and Amy and I live in Florida. You know, one of the things that's here is heat. It's always hot. At least, it feels like it's always hot to me. But there are folks all around the world listening to this podcast, and they have different ambient temperatures, and they may treat in summer or fall or spring or winter and their version of those seasons might be very different from the same versions of our season. So, this question from a questioner says, do you think ambient temperature matters to how effective OA is when applied through a vapor?

And I guess some of the motivation behind their question is, you know, the volume of OA. Do you think you'd have to treat with more or less OA depending on how hot or cold it is outside the hive when you're doing the treatment?

Dr. Cameron Jack

Yeah. So, this is one question that I have been asked a lot, I think, over the last few years. And I don't know that I have an amazing answer for it other than I have never noticed ambient temperature ever making any kind of difference.

I mean, if you think about it, your bees are actually pretty good keeping the temperature pretty consistent inside their hive, right? Like, there's definitely waves inside their hive. I mean, they're not always at exactly 33°C, but they will keep it relatively warm even when it's cold outside, right?

So, they're pretty good at keeping that temperature steady. And so, I don't think it really makes much of a difference what the ambient temperature is when you're planning to use a vapor anyways. I mean, dribble, that could matter in a sense that you're opening up the lid and you're trickling it on and it's going to take a minute or so to apply the treatment.

And then that could have, you know, impacts on your honey bees, potentially. But, really, with OA vapor, I can't imagine it making much of a difference at all. And I've certainly never seen it. And we've applied it at different times of the year and different seasons, different temperatures. We get a good drop, you know, every time we do it.

Amy

All right. So, the third question we have today is that if you vaporized every five days for five cycles in a row with capped brood, are you going against what the label says to do? This person is using 2 grams each time. So, what are your thoughts on this?

Dr. Cameron Jack

So, I'm going to speak from the perspective of a researcher that is in the United States and knowing that we have a couple of different OA treatments that you are allowed to vaporize including Api-Bioxal and then Mike's EZ-OX tablets, right?

Nowhere in the label does it even really specify in either of those products how many days and how many cycles, right? So, what you described to me as like every five days for five cycles, that sounds like a totally reasonable thing to do.

We have research. This is something that Jamie and I have a paper on is like basically how often we should be applying these OA vapor treatments. And we have seen that there can be issues if you apply them too frequently.

I guess, I shouldn't say issues in terms of honey bee health issues, at least, we did not see that, but we didn't see that it was not nearly as effective as giving it five to seven days. So, five to seven days as kind of your intervals seem to really be the sweet spot.

You want to give the mites enough time to kind of emerge out with the bodies of the bees. They're going to hang out on the workers' bodies for a period of time before they enter back down into the brood cells. So, you do want to give them that, and then you do need to give it like four or five cycles in a row when you have a lot of capped brood and that will help clear it up.

So, I think that this treatment program that somebody has just described here, five days, five cycles in a row, that can really be a great thing, and it's certainly not against the label.

Jamie

All right, Cameron, you have been on three times. This is your third time. We usually ask three questions in a series. This is a bonus question, which means this is your tenth and final question about oxalic acid here on the third consecutive segment that we have had in this series of oxalic acid. Are you ready?

Dr. Cameron Jack

OK, I'm ready.

Amy

I feel like we're playing like a… like we're playing some sort of game.

Dr. Cameron Jack

Like, Who Wants to Be a Millionaire?

Amy

Yeah, like, Who Wants to Be a Millionaire? I was going to say Jeopardy!

Dr. Cameron Jack

And that's our final answer. Well, if I can have a chance to win some money at this, then that will be a pleasant surprise.

Jamie

Let me know if you need to phone a friend. All right. OK, this listener posed the question about an OA tablet. Is there such thing as an OA tablet? What is it and how is it used?

Dr. Cameron Jack

Okay, so, yes, there are OA tablets. So, in fact, I just mentioned in the last question that there's a product called EZ-OX tablets, right? And so that is, in the United States anyway, this is legal treatment. I know that Canada has some people selling tablets, and I know that there are other countries, certainly throughout Europe, where people are producing OA tablets, basically packing them really tight.

And so, they make it really easy for you to just drop in the tablets. There's a little bit of inert ingredients in there because they have to, sometimes, they use something to help bind it together a little bit easier to make it packed nice and tight and stay dry and things like that.

But I mean, most, they're still like 97% oxalic acid, right? So, they're still quite pure oxalic acid and they're usually packed into like a one-gram tablet. So, then that's really great. If you were vaporizing with four grams, then you would just drop in four tablets. Makes it really easy for just dosing things correctly. I'm all for it. I think it's great. So, yes, OA tablets are a real thing, and yes, they are just fine and just as easy and safe to use as anything else.

Amy

Awesome. Thank you so much, Cameron, for coming the past three Q&A's, the past three Q&A's to be our chump. I hope that our listeners take some of this information and send us some follow-up questions. This was a lot of fun. I enjoyed doing the Q&A with both of you guys.

Dr. Cameron Jack

Well, good. Thanks for inviting me to be the chump. That's something that I should be more used to, but it's always still a little bit hard in the hot seat here. But it was fun. So, thanks for inviting me to be a part of this series.

Amy

Sounds good. Listeners, don't forget to send us an e-mail or send us a message on one of our social media pages if you have any follow-up questions.

Hey everyone, thanks for listening today. We would like to give an extra special thank you to our podcast coordinator, Jeffrey Carmichael. Without his hard work, Two Bees in a Podcast would not be possible.

Jamie

Visit the UF/IFAS Honey Bee Research and Extension Laboratory's website, UFhoneybee.com, for additional information and resources for today's episode. Email any questions that you want answered on air to honeybee@ifas.ufl.edu. You can also submit questions to us on X, Instagram, or Facebook @UFhoneybeelab. Don't forget to follow us while you're visiting our social media sites. Thank you for listening to Two Bees in a Podcast.