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SPEAKERS

Honey Bee, Jamie, Guest, Amy, Stump The Chump

Jamie 00:05
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, and welcome to this episode of Two Bees in a Podcast. We've got a great episode for you today. First, we'll be interviewing Dr. Jeff Harris from Mississippi State University. He is an expert on the Varroa sensitive hygiene traits. We're going to talk about queens who have those characteristics and how they can be a benefit to you and your beekeeping operations. Amy and I will follow that with a discussion on overwintering colonies and different climates. And of course, what Two Bees in a Podcast would be complete without our famous question and answer segment?

Honey Bee 01:19
For more information about this podcast, check out our website at UFHoneyBee.com.

Jamie 01:29
Amy, do you know what we've been talking a whole lot about recently?

Amy 01:33
Bees?

Jamie 01:34
Well, bees, of course. It's a podcast about bees so surely we're doing that. But what else? What specifically about bees? I feel like we've talked a lot about this recently.

Amy 01:41
Yeah, I mean, we've talked a lot about colony losses and why colonies are dying off. And I think the top thing is Varroa.

Jamie 01:49
Right. And we've talked a lot about queen quality and nutrition.

Amy 01:53
We talked about queens, yeah.

Jamie 01:54
To me, I feel like we've camped a lot on queens, right? We've had a lot of interviews with individuals talking about different aspects of queens mating biology, queen clinic at NC State, some other things. And today, we're continuing in that theme or continuing with this idea of producing queens that we actually want to be in our colonies and that, in turn, produce bees that are productive and tolerant of diseases and pests. So it's really an honor for me today to welcome our guest who's an expert on queen production. That's Dr. Jeff Harris. He's an Associate xEtension Research Professor in the Biochemistry, Molecular Biology, Entomology and Plant Pathology Department at Mississippi State University. Jeff, thank you so much for joining us on Two Bees in a Podcast.

Guest 02:38
Oh, thank you for having me, Jamie. Good morning. How are you?

Jamie 02:41
I'm doing well. Again, I'm really excited to have you because, I think, from your time at the Baton Rouge bee lab, the USDA lab there, as well as your time at Mississippi State, you've been doing a lot of work with queens. And I think it's this really hot-button issue that we're going to talk about today, specifically Varroa sensitive hygiene. But before we get into that topic, Jeff, what we really like to do is allow our guests, yourself included, tell the listeners just a little bit about how you ended up in bees and bee research in the first place before, again, we kind of tunnel down into the production of queens, but queens specifically with this VSH trait. So how did you get into bees, Jeff?

Guest 03:18
Sure. Well, it's kind of funny. It goes back to being five years old. I had an uncle who's a hillbilly in Virginia, and he kept bees in log gums. And when I was five years old, he took me down to his hives, had me on his hip, neither one of us on a bale, he lifted the tin lid off of his log gum hive and took his pocket knife out and cut me a sliver of honey, and I've been in love with bees and honey ever since. So I always was fascinated with them from that, and he entertained that. Every time I visited his farm, we would go look at the bees. And then when I was eight years old, I had learned from him how to catch swarms. He told me about how to do it. I saw him do it once and there was a swarm about a quarter mile from my home, and I went ahead and caught it. I cut the tree branch off, and I walked it home.

Amy 04:07
You were eight.

Guest 04:07
I walked in down my driveway. My dad said, "Mom looked out the kitchen window and fainted." And dad was smiling in the driveway when I came up. He said, "Son, whatcha got there?" And he knew what I

had. I said, "I got some bees, and where am I gonna put them?" He said, "Well, hang on," and he went made me a box and we hived them and that's how I got started.

Jamie 04:29
That's our crazy story. Jeff, in my time knowing you and and kind of working around you and reading about you, I'm not surprised that your introduction to bees was that way. I mean, you seem like one of those people who didn't get in it necessarily at the beginning from an academic perspective, but got into it because you like bees and that's kind of the way that I fell into it as well. So that's a neat story. Where did you grow up? Where did all this happen?

Guest 04:51
So my uncle was in Virginia, but my dad was military so we were Air Force, we moved all over the place. So that particular hiving occurred in Alabama. I consider that home now, Alabama.

Jamie 05:04
That's cool.

Amy 05:05
That's so fun. So Jeff, I feel like after this podcast gets released, after this segment gets released, I know people are going to start commenting and asking more and more questions. So I already know that we're going to have you come back to answer all the questions that people have, but something that has been coming into our inboxes are people asking about Varroa sensitive hygiene. And so I was wondering if you could tell me what that is.

Guest 05:31
Okay, so, Varroa sensitive hygiene is an acronym given to a complex colony behavior. It's really just a form of hygiene. So let's just back up and talk about what hygiene is. Hygiene is basically nest-cleaning behavior. It's often used in reference to the removal of dead or sick brood. And of course, Marla Spivak is well known for, we call it general hygiene, but basically, she has bred bees that are very good at removing dead brood, freeze-kill brood, and that kind of thing. And we call that general hygiene. This is really kind of a subset of that behavior, in the sense that the bees that are doing the removing of the sick brood, they're targeting brood that's been infected or infested, I'm sorry, by Varroa mites. So we found that they had a particular bias toward mite-infested brood and so we call it Varroa sensitive hygiene, VSH.

Jamie 06:22
So it's an amazing story, I think, because as you mentioned, Marla Spivak had been working on hygienic behavior at the University of Minnesota and I know others have before... her as an example. But didn't this kind of start off as a -- if I'm not mistaking my acronyms -- SMR, suppressed mite reproduction is kind of what you guys thought it was initially? So SMR and then it became VSH. Could you tell us a little bit of the story about how you discovered this trait, how it's now known as VSH, even though it kind of went through a few iterations?

Guest 06:51

Yes. So what I should do first is also credit my mentor because I was a student and a postdoc. And really, the person who started this research I should give credit to is Dr. John Harbo. He was my mentor at USDA when I first joined the lab, and what he did, and this is when I joined him, gosh, it was a long time ago. But when we first did is simply select a variety of queens and set them up in standardized field trials just to measure how well they grew mite populations in rather short periods of time, three months for example. And then what we decided we would do is select from those whether or not we knew they had a genetic quality or not, we would select those that grew the lowest mite populations in a three-month period as breeder queens for the next generation. And after a few iterations of that, we were making quite good success versus controls that weren't selected on actually keep mites down. And then what we started to do is look at qualities of the bees and qualities of the mites population just to see if we can find anything that could correlate with why these mite populations were lower. And what we noticed was in the colonies that had the fewest mites after a few years of breeding, we found that, basically, the mites in these colonies were not reproducing very well. A lot of them weren't laying eggs, and even those that did, they were laying their eggs not on schedule, they were kind of late. We called that suppressed mite reproduction. We didn't know what we were looking at. We thought, here's kind of my naive thought, we thought maybe there was some kind of -- I'm going to be crude here -- but like a birth control something in either the diet, something in the body of the bees that was affecting mite reproduction. We thought it was something sort of located in the immature honey bee that the mite was feeding on. But we didn't know what it was, we just knew that the main character we saw the correlated with low mite growth was this idea that mites aren't reproducing well, and we call it suppressed mite reproduction. Well, a few years went by, and then we discovered that the suppress mite reproduction was actually caused by this hygienic behavior. And here's how it worked.: Basically, our bees were focusing on and removing, with bias, mites that produced families. They smelled those and remove those and they left behind mites that didn't lay eggs. And, see, every population of animals has some individuals that reproduce and don't lay eggs and they're non-reproductive. In Varroa mites, it's roughly 15 to 20% of all the mites who tried to raise a family aren't successful. Well if our bees are removing all the ones that do lay eggs, it gives you an impression that the mite reproduction is being interrupted. That's how the two are linked, but it took us many years to figure out that it was the hygiene making it look like mite reproduction was being inhibited and it really wasn't. It was just what was left in the comb after the mite hygiene was done. So that's how the complicated story goes.

Amy 09:55
Wow, I'm so amazed right now. I don't even know where to ask or where to go with this. I'm like, wow.

Jamie 10:02
I think the cool thing about that story is it's an example of you see something that you think you understand, and then, no, it's even more complex and more remarkable than the first time around. I mean, when I first heard about the transition from SMR to VSH, I think I was still a postdoc at the University of Georgia. And I remember going, "Holy moly, bees are remarkable." It's just remarkable that within in a cell, they can determine, from outside the cell, the worker bees can determine within a cell if the mite is reproducing or not, and selectively remove only those mites that are reproducing. And that mite is in a cell that is surrounded by six other capped cells. So how is the signal so strong in that one capped cell that the bee could distinguish it radiating from that one cell and not the six neighboring cells? I mean, it's incredible what they're capable of doing.

Amy 10:53
Yeah, that's amazing.

Guest 10:54
Well, essentially, you mentioned that because after we kind of understood that it was hygiene causing this phenomena overall, I was just like you. I said, "Oh, gosh, there must be an odor emitting being emitted from that cell." So actually teamed up with some people from CMAB, the USDA lab there next to you to try and identify similar chemicals that might be coming out of those cells. And of course, we assumed it was probably a volatile coming through the cap. And it turns out, I've spent about two years looking for volatiles, building an apparatus to collect the airspace above infected combs versus not, and we couldn't find anything that would basically correlate.

Jamie 11:33
Incredible.

Amy 11:34
What is it?

Guest 11:35
Well, it turns out, so what else other people have been looking, and we were looking in the airspace and it turns out, it looks like it's more a contact chemo reception that the bees have to touch their antenna to the cap. And so it's not a volatile. So tells you the rabbit holes you can go down. You can spend a lot of time looking.

Jamie 11:55
Yeah. Research. Why isn't everybody a scientist?

Amy 11:58
Wow. My mind is blown right now. I had no idea. So how do you select for VSH? How do you select for that in bees? How do you select for that with your queens?

Guest 12:12
There are two ways you can do this. And I tend to do the hard one. And actually, as I get older, I am less patient with it. You can actually directly select for the ability of bees to remove mites from brood. And just to give you an idea, what you do is you basically take the inoculated comb, that you know the infestation rate, you know how many mites per 100 brood cells are in that comb, and you give it to a colony of bees that you're trying to select and see if they have this ability, and you remove that comb in five to seven days, and you actually measure the decrease in the infestation rate of that comb. And that gives you an idea. And the really good ones will remove more than 90% of the mites in a comb in a five-day period. And so it's quite dramatic. You can see that change, but it's very difficult because it's time consuming because you're making a baseline measurement of the comb, you're putting it in colonies, then you have to make another measurement. And so it's just very time consuming. And that's what I do. Now, what John Harbo and some Europeans do is simpler. I told you that we called it suppressed mite reproduction because what we saw in the comb was an elevated expression or remnants of the mites that were left, basically didn't lay eggs. And so you can measure that. So what

you can do is what John Harbo does. He basically, after he puts a queen in a colony that he wants to test, he lets her brood turnover, let the colony become her offspring. So maybe that's a month and a half, two months after he puts her in. And then he makes sure the colony has had mites introduced and he'll wait a certain period of time after mites go in, and he'll simply take out a comb and measure the reproductive rate of the mites. And he looks for those colonies that have the lowest mite populations, and the highest level of mites that don't lay eggs. And the Europeans do a shorter version of that. But basically, they're measuring how infertile the mites are. And it's easier and quicker. And that's kind of what they do. So there's two ways to do it. Neither one of them are easy for the average beekeeper, though I'll say. Sure. I was about to ask, do you have grad students who work for you? Yes, yes, I do. Yeah. Yeah.

Amy 13:53
Do you put them work to have them do that?

Jamie 14:15
That's what they're there for.

Guest 14:31
Yeah.

Jamie 14:32
All right. So these stories of how these things are discovered are always amazing to me, but at the end of the day, Jeff, it's getting it into the hands of the beekeepers. The Baton Rouge lab in Louisiana, where you were once a partner at, now, Mississippi State, you guys work really hard to try to get these traits into populations. So before we talk about strategies for beekeepers using it, my first question is if you have a quote, good VSH queen, what level of protection is that capable of providing the colonies headed by queens of that type?

Guest 15:07
Okay, s this is a difficult question to answer because one of the problems we have with any of these stocks is how do you certify and know what you have? So, as researchers, we knew. For example, if I had up a purebred VSH queen in my hands, I actually saw my populations decrease in those colonies. The pure inbred, 100% expression of VSH behavior, the highest level we could get it, we actually lost mites in these colonies, okay? But we cannot practically deliver that kind of purebred queen to everybody. It's difficult to breed that way. So what we tried to do to release it to the general public is say, "Okay, let's make daughters from that purebred queen, and let them mate with any drone out there and see what level of protection that gives and we'll deliver it to the public that way," is what we decided to do. And what we found is those queens, those daughters mated with any other drone would be half VSH. They would be half of the pure line. And what we decided to do -- we did many, many tests to see how their resistance was compared to unselected commercial stock that you can get from anywhere. These are early experiments, but these are the ones I remember the most because I was Head of Bees. But a good example would be if you put these half VSH queens in colonies versus unselected controls, at the end of the experiment, the average mite population -- we would start with between one and 500 mites per colony at the start, and then three months later, we would measure the mite population, the total mite population in these colonies -- the unselected controls would have between

3600 and 4000 mites in a colony at that time, and then the ones that were half VSH would have 800 to 1200 mites in the colony. So it's at least a third less mites in the colony than the unselected controls. Now, is that enough to complete the protect your colonies from mites? No. And so you still had to practice IPM. And that was the model we used to deliver it to the public because we knew that inbreeding, I mean, the problem with purebred lines of anything and delivering that to the American public or any beekeeping public is that inbreeding is an issue. So this was the model we took. It wasn't the best. We weren't delivering the highest level of mite resistance we could just because of the way we were breeding the stock. And there are different approaches, now, that people are trying and even John Harbo has got a smaller group getting together, and they're trying different models now. But that's kind of where we were. So what I'm trying to say is if you have a purebred VSH breeder in your hand, and you know it is purebred because you it from John Harbo or some other reputable breeder who knows what they're doing in their selection, then you can expect a really high level of resistance from that queen, but her daughters are going to give you half that. Half of that's pretty good but it's not enough to fully protect your colony. That's the best answer I could probably give.

Amy 18:12
Yeah, that's a pretty good answer. I think that's really interesting. And it makes me think of a couple of questions, actually. So one of the questions that we get a lot is, so you had kind of mentioned John Harbo but how do people find these VSH queens? I mean, where do they find it? And how much do they cost? And how long do they survive? So those are my three questions for you.

Guest 18:36
Okay, so, the model when I left USDA, Dr. Bob Danka, who just retired this month, he was left in control of the breeding project. And what he was doing was he was basically transferring pure VSH lines to VP Queens, Adam Finkelstein in South Carolina, now. And so there was a technology transfer agreement or MOU with them. And basically, the bee lab was sending stock to him, and then he was basically crossing and producing queens and releasing it to the public. And so that was the model they were using, but I was never sure of what kind of selection was being done at VP Queens. So this is one of the problems. John Harbo, he's retired, but he's still in Baton Rouge, and he's still actively selecting for the VSH trait in his own bees. And I've actually bought some of his and tested against mine and they're the highest expression of VSH that I've seen out there. And the thing is, he sells them as inseminated queens to pure VSH breeders. And then, of course, what he's expecting people to do is to sell the outcrossed queen, the daughters, as as a commercial product to the industry. However, John's recently organizing, there's a lot of excitement among a small group of people who really want to select this trait the way we did it and do it as a collective group and exchange material and kind of create, excuse me, a semi-closed breeding population and try and create, not an inbred, a less inbred purebred stock that can be delivered as a purebred stock. So it's sort of a cooperative breeding group. This is actually their first season of forming. So they're just getting their feet under him. What they're trying to do is model themselves after a European group that basically is doing the same thing on a larger scale in Europe, and having lots of success with it. And so John's tried to do it on a smaller scale where he knows the people and knows that things are going to be done, people are going to be trained and try and operate and select the same way. So now, you ask about survivorship. So if your purebred queen is an AI queen, AI queens don't live as long or perform as well, often they don't know. Some people make better AI queens than others. For example, John Harbo, some of his queens, I've had them for three or four years. And I'm lucky to get one or two years out of my AI queens. So it depends on where you get them

from. But if it's a purebred VSH, that's produced by AI, it's not going to live as long as other queens. Cost, it just depends on who sells them. They're not terribly expensive as breeder queens go, I think John's selling up for $250+, maybe, I don't remember the exact price, so it's not terrible. Now, the outcrossed queens are just like any other queen, as far as I know. I think the prices are on par with other queens. So if you buy something that's half VSH, and you know it's half VSH, it's probably in that -- what? I don't know what the price is anymore. $30 to $35 range per queen, and those who are expected to live as long as any commercial queen, depending on the producer. And I forgot, did I answer all three questions?

Amy 21:58
You did answer all three questions. Yeah, I'm impressed. I mean, would you recommend that all beekeepers use queen selected for this trait?

Guest 22:10
Okay, so this question was actually the hardest for me to think about. And this is why. There are a couple of issues. One is, we have a lot of people out there, and I see this among scientists, too. It's not just beekeepers. A lot of people, unfortunately, VSH is an acronym for a behavior, and even non-resistant bees, like stock that we know will grow a lot of mites and die for them, they actually had bees in the colony that will try and do VSH behavior. It's just they don't have enough of the bees to do it to be resistant. So we have scientists who refer to VSH behavior as being any level of expression of VSH. John Harbo and I, I'm not going to speak for John, he'll get mad at me, but we really think that VSH, the way we're using it to identify a stock, refer to highly select the stock, it's known to be expressing at a certain level. And unfortunately, it's incumbent us probably to define what that is and to make it clear, because I see a lot of research out there where I see people doing experimental behavioral studies on VSH bees that are expressing the behavior at one sixth the level that I had in my pure lines. And it kind of aggravates me, because it's like, well, it's just not at the same par that we produced. So unfortunately, if I said, "Yeah, I think all beekeepers ought to be using queens that are selected for this trait," we really do risk inbreeding in our whole industry. And we don't want to do that. Until we have a more robust closed population breeding program that avoids inbreeding, has a lot of genetic variability and in selecting for this trait, has a track record of avoiding inbreeding and keeping genetic variability high at the same time selecting for this trait, I can't really recommend that everybody use queens that are highly selected for this trait. I really would say I do highly recommend people use queens that are outcrossed anything else. So, the original model, I do think that would be fine because we still had a lot of genetic variability in the system because these outcrossed queens are mating to other drones. So the reason I resist saying, "Yeah, everybody should use highly selected VSH stock from John Harbo," is we don't want everybody to have the same genetic bottleneck. And that's the problem with breeding in general. And so I just would like to see, I think, our original model is good, and we ought to work toward like a Brother Adam approach to producing a general stock that's liked by everybody and has this trait in its selection category and the breeding is designed such to avoid inbreeding. And then I'd feel more comfortable about saying, "Yeah, everybody should have one." So that's kind of where I am.

Jamie 24:59
So Jeff, you really raised so many interesting points I really want to follow but I know we're gonna get short on time. But I do want to say, I guess, a couple of things. That Brother Adam approach you mentioned is pretty fascinating, the book Buckfast Bee. And people still want to get a hold of that, or

variations thereof all the time. When I was a postdoc at the University of Georgia, I actually did a research project on Russian queens that we were purchasing from an individual who's part of the Russian Queen Breeders Association. Of course, you all know that has its roots at the Baton Rouge Lab as well. And we found clear differences between using the Russian bees, at that location. I'm not necessarily endorsing them for everybody everywhere. Just saying in that study, under those circumstances, they had significantly lower Varroa populations, needed treating significantly less, produced more honey, had more survival, just on and on and on. Alright, so that's a success story for you guys. You've got VSH, you've got all of these things coming out of labs, like the one you were at, the one you're at now. You mentioned John Harbo and others. I just sometimes wonder why our industry doesn't adopt these types of queens with these types of traits more often. I understand your comment about how some of these are highly inbred lines. But I feel like if there was more industry-wide adoption of things like the bees with VSH trait or Marla Spivak's more hygienic bees, or the Russian bees or something like that, that we all would be in a better place. So I guess my question to you, because I know you've had to struggle with this given you've been in queen production, what do you feel are some impediments to the adoption of the selected stocks for the industry? Why don't more beekeepers use them?

Guest 26:39
Well, I think one of the first issues is, basically, the selection methods are fairly difficult. They're not difficult, they're tedious. They require microscopy, examining brood, measuring mites, and a lot of beekeepers and queen breeders, I should say, just aren't set up to do those kinds of measurements. They don't have the staff to do it. That's the thing, I got to thinking the other day, we work at a USDA Honey Bee Lab. You've got to realize millions of dollars are being thrown at that lab and you're paying research scientists and their supporting research teams. The technicians that we use are the some of the best around and you forget that not everybody has that, so it is so much more difficult to actually select. So that's one. And therefore, it's also difficult to quantify the level of resistance you're getting in from somebody. So someone says, "Hey, I've got a pure VSH queen." Well, how do you know? How do you know? There's no stock certification process or screening. But I think beyond that, I hope we're not running out too much time, but what I did want to say is we mentioned Brother Adam, and what I'd like to do is mention this risk to bee breeding program that started about four years ago, maybe five years ago, now, in Europe. These are sort of remnants of some of Brother Adam's network of breeders in Europe. And they basically came to the Baton Rouge Bee Lab and asked John Harbo and Bob Danke and myself, "How can we select your trait in our bees?" They had already had -- these guys had been selecting for a Buckfast-like stock that they love for 25-30 years, and they've set up a network of breeders. And they do this selection scheme and crossing scheme with instrumental insemination, where they avoid inbreeding. They've got records that go back years, they can generate pedigrees that go back 18 years or whatever, and they know what they're doing to avoid inbreeding, they've produce a stock that is loved. It's incredibly non-variant. I mean, colony size and everything about them are what beekeepers like in that part of Europe. And they said, "All we want to do is add your trait to our selection? How do we do it?" And so we kind of told them John Harbo's method of selection of measuring reproduction in mites, and they went back and added it to their program, and they're now really getting VSH elevated in a stock that already existed, and was already in a breeding program, and being delivered to people who liked it. And it is because they had a cooperative of at least 300 people or 300 queen breeders involved in this network. And they're disciplined, and they all select the same way and the crossing is controlled. The queens of a certain year -- the source of those queens are

known and the drone sources are known from within the group and everybody sticks to the same plan. And that's what you need in the United States. And I asked the Europeans, I said, "Why can't we do that in America?" He says, "Oh, you're too much Maverick. You guys want to do things on your own." And so I guess what I'm trying to say is there is a cultural element here, and there is some truth to that. I mean, you know beekeepers, we're rugged individualists. I'm not saying that people don't cooperate, but that's part of the impediment is we need cooperating networks of people who are sophisticated enough, in the sense of breeding, to avoid the inbreeding issues and to produce stocks that people like and have a broad genetic variability that can be used throughout the United States. And we just don't have that network. I mean, certainly people have been thinking about that kind of thing for a few years now and little groups have been developing to sort of select for bees that do well in a certain region. And so it's starting, but we just don't have that established network like they had with the Brother Adam network. I think we can get there, but it will require that kind of cooperation. It's one of those things that's got to evolve if people really want it. And, frankly, I'll say one last thing, our commercial beekeeping industry is really reliant on chemicals. And until that reliance sways, it's too easy for them to just stick to the chemicals, and frankly, not concentrate too much on breeding. And I hate to say it that bluntly. But that's really the reliance on chemicals, therapeutics to control mites is one of the reasons that stock adoption, especially in the commercial industry, is not a primary focus, let's say.

Jamie 31:12
I think that's all well said.

Amy 31:16
Jeff, I think your cat agrees.

Guest 31:19
I'm so sorry. She's a 20 year old cat and I live alone. And she's like, "Why is he talking to the computer?"

Amy 31:26
I love it. I love it.

Jamie 31:27
It's really okay. It's okay.

Guest 31:29
She wants her attention.

Jamie 31:30
Not a problem. It adds spice to the interview. This has actually been one of my favorite interviews that we've done so far on Two Bees in a Podcast because I've learned so much. There are so many more questions I want to ask you. But I better stop now. But it's really a fascinating story. And I hope our industry in the next decade or two decades really does begin to realize the importance of the investment of improved stock. One of the answers that I usually give people to that last question, why do not enough people use these stocks, because, frankly, this sounds negative and I don't intend it to be negative, but these days, you can sell every queen you produce. Why work extra hard to produce

amazing queens when you can just sell whatever comes out. Right? I don't mean that in a negative way at all, but what I'm saying is, we as a consumer need to demand movement towards some of these kinds of things. But you're right, we're so heavily reliant on chemical controls, and it's a problem in that regard. But I really appreciate you joining us on this podcast. I think our listeners going to love it. I love the fact that you brought in research from overseas because we have European listeners as well. And they're going to be, I suppose, probably making fun of us on this side of the pond as we talk about struggling with these issues. So thank you for joining us on this podcast episode. You're welcome. Thanks for having me. Absolutely. Everybody, that was Dr. Jeff Harris, the Associate Extension and Research Professor in the Department of Biochemistry, Molecular Biology, Entomology and Plant Pathology at Mississippi State University.

Amy 33:12
So in this segment, Jamie and I wanted to talk a little bit about, I guess, different climates within Florida and within the United States, and I guess around the world. I mean, we have listeners from all over the world listening in, we have received specific emails about climate, even North Florida versus South Florida is different. And so Jamie and I wanted to talk a little bit about management of the different climates, just different factors that go into beekeeping in different areas of the world. So I guess, Jamie, the first thing I do want to talk about is what are the biggest differences? I know that when I lived in Virginia, we had something called snow. And we don't know really have that here.

Jamie 33:52
I don't know what that is.

Amy 33:53
Have you seen that before?

Jamie 33:54
It's funny. I've lived in Florida for 14 years and, actually, it has snowed at least two or three times but I'm telling you it was so light. It maybe melted three inches above the ground. So it never really did but I have seen it and I'm from Georgia and I saw it every three years or so.

Amy 34:10
That's fair. That's fair. People always make fun of me. They're like, "It doesn't snow in Florida." But it does. It freezes here in North Florida. It does.

Jamie 34:16
It does. We get frost all the time. And I tell you, the whole concept of winter is a really interesting one when we talk about overwintering bees. So we're recording this podcast literally the last day of August here in 2020. And so winter is still a good long time away from us in Florida. And I was giving a talk last week using Zoom to a beekeeping club in Pennsylvania. And one of the interesting things is they were asking me a lot of very specific overwintering and cold climate questions. And the reason I'm saying this is because I've only ever lived in warm climates, being from Georgia, working in Florida, doing a PhD in South Africa. So I really only know overwintering from the warm climate perspective.

Amy 35:00

So what did you tell them? That's what you told them?

Jamie 35:02
I told them they need to ask somebody who lives up where they are. But I gave it my best, I gave it my best shot. But, I travel a lot. And so I hear, especially if you think about in the US, at least, there are a lot of beekeepers who will hold their state meetings in the winter because there's less for them to do. So I'm up in winter a lot with a lot of Northern beekeeping clubs where the beekeepers are talking about overwintering. So you do start to pick out these trends. And I think the obvious difference between colder and a warmer climate is the temperature. And I know that's such a stupid statement to lead. That's the obvious thing. Of course, it's colder in cold climates and warmer in warm climates. But that temperature really affects absolutely everything else that you're going to see. In fact, everything that I've kind of scribbled out as notes as we talk about is something that's brought on or impacted by temperature. So let's just kind of start from the beginning. Where we are in Florida, we don't really start getting freezing temperatures until Thanksgiving or later. And for those of you listening overseas, that's usually the fourth or so week in November or later. And I remember, I think I've seen a frost in Florida as early as mid-November but really, it's December that I usually see those, whereas a lot of our northern climate beekeepers in the US and around the world are starting to get below freezing temperatures even as early as September. So that cold, there's a lot of environmental triggers that will stimulate bees to get ready for winter shortening day length, cooling temperatures, etc. And in a colder climate, bees are making preparations earlier, say July, August, September to get ready for the upcoming winter, whereas in warmer climates that may be delayed, August, September, October, November, even, to get ready for winter. In colder climates, the first thing that I really want to point out is food. Honey bees are really remarkable among all the bees, especially this western honey bee with which we work, because it forms a cluster to keep its core colony temperature warm. And that temperature is somewhere in the neighborhood of the low 90 degrees or the mid 30s in Celsius, lower 90s in Fahrenheit. And the reason this is important is it takes honey bee colonies quite a lot of honey to be able to generate the heat that is necessary for them to survive winter. So if you're in a northern climate and you have six months of winter, you may need 100 pounds or more of honey in that hive for the bees to be able to heat the colony in order to keep it alive. Whereas if you're in a warmer climate, you can get away with 50 pounds of honey because there won't be many cold temperature nights. So one of the obvious differences in northern versus southern beekeeping or cooler versus warmer climate beekeeping is that those beekeepers who overwinter in cooler climates, their bees are going to have to have a lot of honey to survive for 5, 6, 7 months of winter sometimes. So that's the very first thing to think about.

Amy 38:06
I mean, I didn't feed throughout the winter time. So you basically just take the feeder off and leave them the honey stores to see if they survive throughout the winter, right?

Jamie 38:15
Amy, everybody's different in that regard. A lot of, especially hobbyist beekeepers -- let me back up. The way that I was taught is my mentor would tell me -- my standard colony size is a deep brood box and a medium super of honey. And that first medium super of honey, my mentor would call a winter super. In fact, he encouraged me to paint the letter W on all of my winter supers so that I would never be tempted to go in and extract that honey. That honey is always for the bees. But commercial

beekeepers recognize that honey is more valuable than sugar. So they'll extract all the honey and then they'll feed back sugar for the bees to fill up that winter super. So you mentioned leaving a super for the bees. Yeah, you need to leave at least a medium super for the bees, but commercial beekeepers might have to feed for the bees to have that super, whereas hobbyists might elect to leave on that first super so whatever the bees store is honey in spring or summer, you don't touch that in that first super, no matter how pretty it is. That's what I remember my mentor telling me. It doesn't matter how good that honey looks in that food super, you don't touch it. That's what the bees need. So, yeah, they've got to have at least that to survive winter.

Amy 39:30
Sure. As far as the Bee Informed Partnership's survey, one of the factors that go into decline is that week in fall, right? So I guess I would assume that this would be one of those factors that goes into that.

Jamie 39:43
Absolutely. If you read the surveys, the results from the BIP, the Bee Informed Partnership surveys, they talk about nutrition, or they will often use the word starvation in their surveys. When they use the word starvation, that basically means beekeepers are saying that their colonies don't have enough food when they're trying to survive winter, and that's important. They need, at least in pounds, somewhere between 75 to 100 pounds of honey to basically power what is a 40 to 50 watt light bulb of energy throughout winter. And so if they are, quote, starving, it means that we as beekeepers didn't allow the colonies to carry enough honey into winter. So food reserves are incredibly important. And in the south, especially where we are in Florida, we get some nectar flow, some late nectar flows right before winter, and some early nectar flows as early as February. So I don't really have to have a lot of honey on my colonies in winter. If you were further in southern Florida, you may need even less honey still. But you get the flip problem in a warmer climate. The bees tend to be active. So they also have a demand for food. So you can't leave nothing on them. They have to have something to go through the winter because their energy output is so high just because of activity.

Amy 41:01
Sure. So just as far as activity goes, what about some of the pests and pathogens that we look at throughout the nation in different climates? I mean, I guess we all have Varroa, we all have small hive beetle, but how does that change in the different climates that we have?

Jamie 41:18
Yeah, the way to think about it is the warmer the climate, the longer the warm season, the cooler the climate, the more truncated the warm season. And the reason I bring that up is if you're in North Dakota, as an example, and you're coming out on winter in April, again, as an example, and again, we're using temperature-based winter, not seasonal-based winter. Winter is technically over somewhere in the 20s of March, but if you're in a cold climate, you may still have freezing temperatures through April. So as a result, if you're a Varroa living in a colony in North Dakota, you basically have May to August to do your thing. That's when the populations can grow really quickly. So as a result, there's a lot of effort in these colder climates to get the rural populations under control, say, by July, so that those winter bees that are being produced by the time August and September roll around, the colonies are fit and ready to go through winter. Whereas, where we live in Florida, at least in northern

Florida, we have warm temperatures from February until November. If you're in southern Florida, you never have cold temperatures. And so you've basically got ever-present, ever-taxing Varroa populations. Varroa is a year-round problem. And that's intimately tied to another thing, whereas, in the northern climates, your queens may shut down and you get no brood production through winter. In warmer climates, your bees will carry brood through winter. I have brood in my colonies year-round, and I'm in North Florida. Imagine what the South Floridians have or the southern Texans have, or the Southern Californians, or people in the Mediterranean, or if you live in Africa and keep bees. You can have brood production year-round, so you've got this ever-present taxing population of Varroa. And the other catch with brood production is if there's brood production through the season as well, you've got a high demand for pollen, a high demand for food. Pests can be a greater problem for warmer climates, pollen, brood production, there's just a lot that goes into the impact of climate on your beekeeping operation. Just another example, you're talking about pests and pathogens, small hive beetles. We have huge beetle problems throughout all of the production season, March through October, whereas our northern colleagues might only have beetle problems for a few months of the year. So there's just really a lot to think about with regard to pests and pathogens and the differences that you'll see, depending on whether you're managing bees in warm or cold climates.

Amy 43:45
Yeah, it's funny. So UF, I don't know if our listeners know this, but the University of Florida actually has the number one Entomology Department -- is it in the world? Or is it in the country?

Jamie 43:54
Well, the survey says it's in the world. We are the highest-ranked Entomology Department on Planet Earth.

Amy 43:59
That's pretty cool.

Jamie 44:00
According to one survey. But, of course, it's the survey we think matters.

Amy 44:03
Exactly. Well, it's funny because I always kind of joke around with people. I'm like, well, part of me feels like, definitely, I'm biased, and I do think that we have the best Entomology Department. But the other reason is that we have so many insects here. I mean, in Florida, we have so many. I guess we've got to decide, we've got to look at other surveys. I've heard of that.

Jamie 44:23
That's the thing is we have a lot of entomologists in Florida, just here in Gainesville. We have our UF Entomology Lab, the USDA has an entomology lab, the Florida Department of Ag has an entomology lab, and the Florida Museum of Natural History has an entomology lab. But the reason there's such a high density of entomologists in Florida is because there's a warm climate and there's lots of critters year-round. So that really exemplifies the same problem we have in our bee world. If beetles are a problem in northern climates, they're doubly a problem in southern climates. If Varroa are problems in northern climates, they're doubly a problem. So what you tend to see in warmer climates is higher pest

pressures throughout winter, and in colder climates you see higher food-related issues, right? They need a lot of food, and the catch-22 with food as well is a colony can have a lot of food around it but if it's super cold, the bees only consume what's right around them. And if it's superduper cold, and the bees can't break cluster and shift that cluster over or up a little bit to get to the food that's right around them, they can starve to death with food one inch away from them simply because it's so cold that they can't access it. And in colder climates, too, in winter, you have an added problem of moisture. Beekeepers in colder climates tend to want to wrap their colonies. Yeah, you get this moisture buildup under the lid. And then, as bees generate heat, as they consume honey, they create moisture, and you get this moisture that accumulates under the lid of colonies that can rain down on the bees. And moisture and cold are not friends. So you can get all these problems. In colder climates, bees have a buildup of Nosema, as an example. They're unable to defecate easily, or there's forced defecation in hives, which is really not a good thing. Whereas our bees in southern climates might be able to defecate through winter, they can go on their cleansing flights as they leave their hives to do that, in colder climates, the bees are just kind of holding it. And when they hold it, you get these Nosema build-ups. So there are just a lot of different things that can happen depending on if it's warmer or cold where you keep your bees.

Amy 46:26
Yeah, that's fair. So another question I have, some of my friends up north, whenever they see a feral colony, they'll just catch them and keep them. And here in the southern climates, we have African-derived honey bees. So I assume that has to do with the climate here versus up north.

Jamie 46:45
Absolutely. I mean, the reason African bees are where they are in the United States, and that would be southern Florida and the southwestern US from Southern California all the way to Texas, the reason the bees are where they are is because they don't overwinter well. They're not good at thermoregulating. So African bees really can't survive, at least the African bee we're talking about, really can't survive cold, harsh winters. So even if they're moved up into these cooler climates throughout the year, just by virtue of moving bees, they don't usually survive the winter there because they just don't cluster well. They freeze out.

Amy 47:20
Sure. All right. So what else with the climates?

Jamie 47:22
Yeah, another thing to think about, too, is what I call time shifting. We had that question recently that maybe even brought on this discussion that we're having.

Amy 47:32
You mean bees can't tell the difference between daylight savings or not?

Jamie 47:36
They don't wear watches. But in all seriousness, a lot of what northern beekeepers go through with their colonies, southern beekeepers also go through with their colonies and vice versa. It's just a considerably truncated season. So again, I go back to this idea, we also have freezing temperatures,

we get down into the teens every year in northern Florida. It's just that we have that risk spread out over about three to six weeks. That doesn't mean we're going to have three to six weeks solid cold temperature, but it just means that within three to six weeks, we'll go below freezing with some regularity. But if I say that to someone in the Dakotas or someone in Germany, they're going to chuckle because they're going to have three to six months of potential exposure. So it's just shifting that time. Our bees, quote, come out of winter in the end of January and February. Bees in northern climates might not come out of winter until April, and I've even heard early May. It's funny, Amy, because it even affects bee researchers. Essentially, we can do projects nearly year-round where I live in Florida. But when I did a sabbatical in Germany for six months, I was purposely there in fall and winter. And there was just not much that you could do outside of the lab during those months. Simply, the weather was not conducive to it. So not only does it affect beekeepers and bee colonies, it affects bee scientists as well. So food, pests and pathogens shifts, just literally how you prepare bees for the cold weather, managing bees, you really shouldn't go into colonies if it's temperatures below 55 degrees Fahrenheit. That's somewhere -- I have to do this reverse -- so it's somewhere around --

Amy 49:20
I'll let you do the math.

Jamie 49:21
Yeah, somewhere around 10 to 15 degrees Celsius.

Amy 49:25
And is that just like one day? So 55 degrees one day and then I could go out into them the next day? Or do we have to wait a certain amount of days?

Jamie 49:32
No, it's temperatures below that. So even if the temperatures are above 55 degrees today but are going to get freezing tonight, you can go with them at 55. It's funny, when I was a postdoc at the University of Georgia, we had a collaborative project with a colleague at Clemson University, and some colonies that were on a sampling schedule had to be sampled. And it was in the 30s one day and I was scraping ice. It had iced the night before. In Clemson, I was scraping two inches of ice off of the top of colonies and then working those colonies in the 30s and 40s, which for those of you who don't use Fahrenheit, that's somewhere in the five to 10 degrees Celsius range. And I was working those colonies pretty invasively and put them all back together and the bees survived just fine. A lot of what the books say, it's hard to know with certainty what's true, but, in reality, you shouldn't be going into colonies with regularity and for long lengths of time if the temperatures are below about 55 or 60 degrees. Basically, the rule of thumb is, if you see bees flying in and out of the hive, it's fair that you will be able to go into that hive and work that colony. But again, the cooler it is, the less time you want to spend in there.

Amy 50:42
Sure. I'm just cracking up. I bet you the rest of the world is just laughing at us right now.

Jamie 50:46
Oh, absolutely.

Amy 50:46
Us thinking that this is cold, and just a tiny bit of ice for a day or two, we're just little wusses over here.

Jamie 50:54
Well, bees can get cold no matter where they are. If you manage them appropriately, then there won't be any differences. Honestly, the key differences that I see between what I do in Florida and what someone does, say, in Maine, is mainly when to control diseases and pests, how much food to ensure the colony has, and how much time you leave them alone. So like where I keep bees here, I just don't go into my colonies from right after Thanksgiving until sometime in late January, usually, whereas in the colder climates, you may avoid going into your colonies altogether for four to six months, which is why northern beekeepers really have that anxiety. They don't go into their colonies, it's too cold to see bees flying, so you're not exactly sure how well they're doing. And it's kind of the great unknown until spring rolls back around.

Amy 51:45
But then you feel really good when they come out strong and they just start reproducing.

Jamie 51:51
Yep. Well, bees have been surviving in cold climate before there have been humans that worry about surviving in cold climate. So it's possible for them to do it. And as beekeepers, we're just trying to manage in a way that helps them out as much as possible.

Amy 52:04
Yeah, so this segment actually came from a couple of questions that we had from our audience. So I would definitely encourage our listeners to continue emailing us or write to us on our social media pages, just letting us know what different topics you all want to hear about. We could go pretty broad. We could, I think, we can go pretty specific. Depends on the topic. But keep the questions coming. Jamie and I really enjoy discussing all of these segments with you all.

Jamie 52:30
I obviously love our Florida beekeepers, we're here focused in Florida. But if you're outside of Florida or outside the US, we'd love to hear from you as well, because we want to make sure this podcast is relevant to all beekeepers as far as we can. So if you're in Australia and the UK or Germany, or Thailand, wherever you are listening to us, make sure you put some questions on our social media accounts, suggest us some individuals who we can interview. We absolutely want to make this podcast about you, the beekeepers. Amy and I aren't doing this for ourselves. We want to make --

Amy 53:02
You know what's funny too? I would just love to hear everyone's experience of the coldest climate they've kept bees and maybe some horror stories or something like that, because those are fun.

Jamie 53:12
Amy, I've got some colleagues from the Scandinavian countries and they talk about keeping bees in those countries. And it's really different to the way we have to think about it. Insulation and food, those are the two keys.

Stump The Chump 53:27
It's everybody's favorite game show, Stump The Chump.

Amy 53:41
Okay, it is that question and answer time. Jamie, three questions as always.

Jamie 53:46
All right, I'm ready. Let's do it.

Amy 53:47
Great. Okay, so the first question, this person was wondering if there's been any research on combining two or more different chemical treatments at the same time to treat Varroa? I'll just stop the question there.

Jamie 54:01
Yeah, I'm seeing that question. And there's basically a lot of variations based on that. But I think your question summarizes the multiple questions really well. So, historically, when we think about Varroa, we think about putting a thing into colonies, Apistan, ApiVar, just whatever you elect to do, whatever legal product you elect to do. But as the questioner points out, there are a lot of other ag commodities out there where it's routine to co-treat. You administer an insecticide and a fungicide at the same time on a particular crop, as an example. So that brought up a question, is it okay to put multiple compounds in a colony at the same time? So the question specifically was, though, has anybody looked at it? It's interesting because Dr. Humberto Boncristiani in our lab has started looking at that. He did a little bit of a pilot study earlier this year, late last year, I forget, where he generated some pilot data to look at cross treating colonies, I will tell you the labels are fuzzy because all the labels that I have read are written under the assumption that this is the compound going into colonies. I don't usually see language that says you can or you can't treat at the same time. So I would say we need to do more research to answer that question. We need to make sure we follow the label and that we're sticking to the law. But we can look into this for this particular questioner and see what's the case. But I will tell you that we are also interested in this question. I think one of the problems we're going to have, though, is while research may someday show that co-treating or treating at the same time with two different things may work, the question is, how do you dose it appropriately? Right? Apistan mites, I forget what it says exactly, but it might be two strips per brood box. Well, if you're treating with a second thing simultaneously, do you cut that down? Or do you still fully treat? Well, if you fully treat and now they've got two full treatments at the same time, so I would caution you not to engage in this activity until there's enough data, number one, being generated to support this, and number two, that the question regarding label permission of this is addressed in the first place. Because even if it works, if the label prohibits it, it wouldn't be legal to do. So this is a very interesting question. And I do think that there should be a call to arms for researchers to look at this question to see if it's possible to do it. But one of the last things I'll say about this is we kind of have a problem in our industry that we have such so few options in the first place. We don't have a lot of things that we could use simultaneously. And so if you're using them at the same time, multiple times a year, you run into different problems. So it's a great question. We're beginning to look at that here in our own lab. And I think others will as well around the world, but we still got a ways to go before we can make recommendations on this.

Amy 56:52
Yeah. And I was gonna say, we always recommend rotating treatments, right? Rotating active ingredients so that the mites can't build resistance, but what would happen? Who knows? I have no idea. I'm just throwing that out there.

Jamie 57:05
Yeah, absolutely. I think when it comes down to Varroa control, and I'll say this a thousand times, the Honey Bee Health Coalition has produced an amazing guide on Varroa control. So I would argue that you should always start there. If you Google "Honey Bee Health Coalition Varroa," you'll find that document. That should always be the starting place for making Varroa treatment decisions as far as I'm concerned.

Amy 57:25
Alright. So the second question we have is a person asking about selling a daughter from one, I guess, from a non-local queen. So I assume that this person has purchased a queen from elsewhere, and then, they start to raise more queens. And so if that daughter has survived the season, does that mean she has been adapted to this colony?

Jamie 57:48
So you are asking the question that I'm struggling with, and you and I, I think we've already talked about this in one of the other segments so let me just kind of paraphrase my feelings. And I know this is going to get us some hate mail. But there is a huge local bee movement at the moment, locally adapted bees, and I think we even talked about it with one of our recent --

Amy 58:06
I think we did, yeah.

Jamie 58:09
I know in Europe, there's a huge push for locally adapted bees. Honey bees are native there, too. So they've got a wild population of honey bees. And you can see bees that are truly locally adapted. So there's this big push towards a locally adapted. Anytime I'm in northern states in the US, a lot of northern beekeepers will complain that they have to purchase their queens from southern states that are locally adapted for southern climates. But, to me, to be adapted to a climate takes time. I'm not a geneticist so people are going to point out why I'm wrong in so many different ways. But, a lot of people will say, "I've kept my bees here for five years, they're locally adapted." Well, I've been in Florida for 14 years, and I wouldn't say that I'm locally adapted, right? So I don't know, if that's enough. To me, the benefit of selection is selection moves faster than it would otherwise move on its own. And so while I believe in the possibility of local adaptation for bees, I don't believe most of the people who think they're accomplishing it are doing the right thing in order to ensure that they're accomplishing it. And I think about this specific question. This specific question is, essentially, "I bought a queen from somewhere else. She survived here this season. So if I produce from her, will her offspring be locally adapted?" The answer's no. I mean, the queen is not locally adapted because she survived here. You could buy queens from all over the US and they all survive in your backyard for a season. So really, to me, the way that local adaptation works is you bring that in and you quit bringing in new queens and you run

that system for five years, 10 years, and then you start producing offspring from those individuals because you're able to say, "I've got successive generations of bees that have survived here under this climate, or these conditions, etc." And one of the issues that I struggle with, with this particular topic in general, is that bees are moved around the country so frequently, all over the place, that while you may never move your bees in your backyard, you're still getting a lot of genetic influence from bees that are coming in from the outside. So I still feel that we're a little early in this discussion. I think the answer for this particular question, if I purchased the queen this year, can I graph from her daughters because they're all locally adapted? I mean, that's no. But is it possible to do? I think it is. I think it requires multiple seasons and special strategy to do that. In fact, I think, Amy, what we ought to do is bring in someone who considers themself an expert on this topic, and we talk about what it actually takes for something to be truly considered locally adapted.

Amy 1:00:44
Yeah. That's a great idea. We'll get someone on that. All right. So the third question is, are there more than one type of Varroa?

Jamie 1:00:52
Yes. There is more than one type of Varroa. At the end of the day, it's an interesting story. Prior to 2000, we thought we had Varroa, the genus, jacobsoni, that's the species, we thought we had Varroa jacobsoni in the US, and for that matter, in other parts of the world, but what Anderson and Truman were able to show is that we, in fact, have a new species of Varroa species called Varroa destructor. So there's multiple species of Varroa. All of them, or most of them, occur exclusively in Southeast Asia. I believe jacobsoni has been spread outside of its native range, but I know destructor has because that's the one that we have around the world that we complain so much about. Even within Varroa destructor, there's multiple strains, or haplotypes of Varroa destructor for that matter, the other Varroa species, as well. So yeah, there's more than one type. But the one that we actually are having a problem with is Varroa destructor, that species specifically.

Amy 1:01:54
Just really quickly, do they look the same?

Jamie 1:01:55
They look very similar. There happens to be a couple of guides online for the different Varroa species. You can Google species of Varroa and look up some image choices, and there are usually some side-by-side comparisons. But they look very similar, but the strains are indistinguishable. So like within Varroa destructor, it would be difficult to know if you've got this haplotype or that haplotype if you're not doing some sort of genetic research. But you can distinguish morphometrically between destructor and jacobsoni. But it would still require probably someone very familiar with mite taxonomy to be able to identify that in the field quickly.

Amy 1:02:34
Yeah, and I think one of our episodes from the very beginning when we had interviewed Dr. Cameron Jack, he was kind of talking to us about the history of Varroa. I would encourage our listeners to go back and take a listen to some of the other segments that we've already posted and released. So there we have it, our three questions. We'll have you guys listen in for next time. Hi, everyone. Thank you so

much for listening to this week's episode of Two Bees in a Podcast. We would like to give an extra special thank you to our audio engineer James Weaver, and to our podcast coordinator, Jacqueline Aenlle. Without their hard work, Two Bees in a Podcast would not be possible.

Jamie 1:03:16
For more information and additional resources for today's episode, don't forget to visit the UF/IFAS Honey Bee Research Extension Laboratory's website ufhoneybee.com Do you have questions you want answered on air? If so, email them to honeybee@ifas.ufl.edu or message us on Twitter, Instagram or Facebook @UFhoneybeelab. While there don't forget to follow us. Thank you for listening to Two Bees in a Podcast!