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SPEAKERS

Serra Sowers, Jamie, Dr. Cameron Jack, Guest, Amy, Stump The Chump

Jamie 00:10

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.

Amy 00:43

Hi, everyone, welcome to this segment of Two Bees in a Podcast. Today, Dr. Cameron Jack and I are going to be interviewing Eli Powell with the Department of Integrative Biology at the University of Texas in Austin, Texas. He just released a paper called "Field realistic tylosin exposure impacts honey bee microbiota and pathogen susceptibility." So I'm really excited to discuss this topic with him, especially because beekeepers are working a lot more with veterinarians on something that's called the veterinary feed directive. And so I feel like this research really ties in with the health of honey bees and antibiotics. And so thank you so much, Eli, for joining us today.

Guest 01:35

Hey, it's a real honor to be here. I'm excited to talk about the research and to talk about honey bees.

Amy 01:42

Well, awesome. So before we go into the actual topic and your paper, we like to share with our audience who they're kind of speaking to. And so if you wouldn't mind, could you just tell us a little bit about yourself and how you got into this research? And just about your interest in honey bees in general?

Guest 01:58

Sure, yeah. Well, first thing out of the gate, what I have to say is that I mostly studied bacteria. But these bacteria happen to live in honey bees. So I work with bees a lot, and I'm really honored to have done a lot of work with honey bees. so as to give you a little history lesson here, mostly because my research has kind of been built on the research of the team around me. So I work in the lab of Dr. Nancy Moran and have worked with her since 2010. She's a really amazing individual, if anybody's familiar with her work. So she's this pioneer of studying symbiosis between bacteria and insects. Most of her work has been done in aphids and other sap-feeding insects. So this is kind of cool, because sap-eating insects live on this material in plants that has virtually no nutrition in it. And they use the bacteria that live inside these aphids in order to convert this really nutrient-poor substrate into something that they can live off of. So, Nancy, at some point, had a graduate student named Vince Martinson, who's at the University of New Mexico now, who got really interested in bee gut bacteria. And this was back just a little before 2007, so, when all of the colony collapse disorder stuff started coming to the fore. And simultaneously, there was this sort of revolution in how we do a lot of scientific stuff. So we call it the revolution in metagenomics, or in molecular biology. So we were able to use DNA from bacteria to look at things that we couldn't culture, like on Petri dishes. We could just see or take a peek inside of a bacterial community and see all the individual species that were in there. In 2007, Vince and Nancy and some other people like Diane Cox Foster wrote this paper for the Journal Science about colony collapse disorder and if there were any bacterial signs of that. One of the interesting things that they found back then that some other folks had sort of uncovered was that there's this really small group of bacterial species that live in the guts of honey bees all over the world. So that was kind of like this springboard for Nancy to get this grant from the National Science Foundation. And that's when I joined the lab. And so yeah, it's been pretty cool. So it's been an adventure ever since. And honey bees have become a bigger part of the lab but Nancy's lab looks into all kinds of different symbiotic associations between bacteria and insects. So it's pretty cool.

Dr. Cameron Jack 05:08
Yeah, it's super cool. Thanks for giving us some of the background, Eli. With this recent paper out of Nancy's lab and you're the lead author on this paper about tylosin and how it affects the gut microbiota of bees. So I guess the very first thing to maybe even think about is, can you just tell us a little bit about what tylosin is and why some beekeepers are going to be using this in the colony?

Guest 05:42
Sure. Yeah. So tylosin tartrate, it's an anti-biotic in this class of antibiotics called macrolides, and they basically just shut down the system in bacteria. They call it bacteria static. They kind of put bacteria into this limbo state. And the brand name that it's sold to beekeepers under is Tylan. And it's been used in veterinary applications for years and years, but, I believe it was in 2005, the FDA approved it for use in beehives. And the big reason that beekeepers use antibiotics in general and tylosin specifically is because of this really nasty bacteria called Paenibacillus larvae, which causes this disease called American foulbrood. And this bacteria is what we call gram-positive bacteria. So these bacteria have this really heavy-duty, super durable, very big cell wall. And they're like the tanks of the bacterial world. So they form these really nasty spores, and the spores can actually stick around for decades, like 20-30 years, maybe more. And young larval bees get it, they die, they get super-infected, and they become these reservoirs for spores, and the spores are super infectious and can move from one beehive to another. So the disease, when you get a bad infestation, can wreck a whole apiary. And really, the only

way to deal with this when you get a bad infestation is to incinerate your hives. And then, trying to clean your equipment can be very expensive, because they have to irradiate it or use these really harsh chemical treatments. Anyway, it's a very scary thing for beekeepers to deal with and to worry about getting American foulbrood. So up until pretty recently, and even still, a lot of beekeepers use tetracycline oxytetracycline to treat hives, which is also super common in agriculture. I think it's been used to treat American foulbrood, probably, since the 1970s. As with human medicine, evolution is really tricky. And something that's a tool one day becomes a real liability the next so we see this in human medicine where we get these drug-resistant bacteria. Same thing happens with veterinary applications or out in the environment where we're basically taking antibiotics and putting them out into the world. And so, tetracycline was used for decades, but then Paenibacillus larvae started getting resistant to it. And so the FDA approved these other antibiotics, tylosin and lincomycin. But a few years ago, the FDA started getting really worried about these things just being spread out in the world and causing antibiotic resistance. That's really when they started the veterinary feed directive. And so basically, they wanted folks in agriculture to have to talk to a veterinarian and learn how to properly use antibiotics and to use them to treat a specific problem. But even so, I think there's still, and has traditionally been, a history of folks just trying to use antibiotics in a preventative way prior to actually having a problem. So anyway, long story short, beekeepers are really scared of American foulbrood, and that's totally understandable, and the use of antibiotics is a way to treat that or to attempt to prevent it.

Amy 09:40
Yeah, I still feel like there's a lot of research that needs to go into it for sure. It's funny, Cameron and Eli, I said tylosin and you guys are like tylosin and so now I'm feeling like I've been saying it wrong this whole time. Can someone correct me? What is it?

Guest 09:56
I think it's a tomato, tomato thing.

Amy 09:58
Okay, All right. All right. Well, I'm really glad that you brought up American foulbrood because that's the whole reason for the use of the chemical. And so here in the state of Florida, if you have American foulbrood, it's required to burn them, I think, like, right there, right then because you don't want to spread it. And then, of course, to be able to use the same beekeeping equipment that's been used in that colony, I'm not quite sure what the recommendation on that is. So we're talking about your study. And so I'm just wondering, I guess, tell us what you were actually looking at and what you were testing.

Guest 10:38
Okay. Yeah. So, some previous studies out of our lab and others had done some research with tetracycline and looked at how it impacted the bee gut microbiota. If anyone's interested in that stuff, Dr. Casey Raymond who's at the University of North Carolina looked at how tetracycline affected the gut microbiota and found that there were these big impacts. Now, she used some really high levels of the antibiotic. And so we wanted to look at, if you treated actual hives, like out in the environment with a field-realistic dose of tylosin, what would that do to the microbiome? And then how would that effect be helped? So there's this whole community of bacteria in the gut, and we wanted to see if beneficial

members of the microbiome got knocked out, or totally eliminated, did they come back later? And then we also wanted to see if bees were more susceptible to infection because American foulbrood and Paenibacillus aren't the only bad actors out there. Again, I'm going to use the analogy of human health. There are these opportunistic pathogens that are just kind of out there all the time that, like, with people, if we get sick, or our immune system gets knocked down, somehow, sometimes this thing that's just residing in our gut, making happy living in there takes over and we get really, really sick. So the same thing happens with bees. So we wanted to check that out and see what kind of impacts those were. That would be like a state that we call dysbiosis where this gut community that's usually in this homeostatic equilibrium gets knocked out all out of whack. And then the other thing we wanted to kind of look at was this idea behind using a probiotic mixture to kind of rebuild the community that was there before and to see if that helped bees deal with this opportunistic pathogen. So yeah, that's the basic premise of the study there.

Dr. Cameron Jack 13:00
Well, Eli, I mean, you touched a little bit on this, but I'm curious more about this idea of the entire gut microbiota. Can you tell us why do we want to worry about the entire gut microbiota of honey bees specifically?

Guest 13:17
Yeah, well, bees are really an interesting species in this regard. Some insects can't live at all without the microbes that are in their guts. I mentioned aphids earlier. But bees, we can't actually raise them in the lab without bacteria in their guts. And this is because they pick it up in the hive from adults when they emerge from brood frame. They're just trucking around, and there are nurses, there are bacteria all over the frames, and they pick it up. And some of this is an area for more investigation, but there may be an unintentional kind of communication of bacteria at some point, and a lot of insects do that. So anyway, like I said, we can raise young bees in the lab without bacteria and raise them with bacteria. And so this has allowed us to compare and contrast bees with and without microbes and put them in a bunch of different scenarios to see what this microbiota does. And so what we've discovered is that the bee gut microbiome is really important to helping bees do things, for example, develop correctly by stimulating these genes related to aging and transitioning from being nurse bees to foraging, as well as a lot of these bacteria break down complex components and the outer coat of pollen and odd chemicals that are in nectar, even sugars that are in nectar that are toxic to bees. And there's some compelling research that they help bees get detoxified from environmental contaminants. So we're still in the early stages of figuring out the complicated relationship between bees and their gut bacteria. Some other things to think about with the bee gut microbiome is that, in science, we often use these things called model systems where you take like a complex problem, and you use a system to break it down into something really simple. If people who were studying the human brain want to look at gene pathways in the human brain, they'll often study things like fruit flies or nematodes. The honey bees are an interesting species because they have this microbiome that is the same between bees all over the world, even some other honey bees have the same bacterial members like the Eastern honey bee, Apis cerana, has really a closely related microbiome to Apis mellifera. It's this small community of a few bacterial species, whereas the human gut has dozens or even hundreds of different species or strains in them. So it's a way to look at how does the microbiome, in general, kind of interact? What are the essential parts to a microbiome? How do they interact with host tissues, things like that? So there's

that other layer that, by studying the honey bee microbiome, we can understand more complex ideas about microbiomes in general.

Amy 13:53
That is so crazy.

Guest 15:01
Yeah, it's so cool, and so interesting. I can't imagine how difficult it would be to just disentangle all the effects of all these different bacteria in the gut and see, to know what they're contributing to the overall health. It's got to be so complicated and well beyond my abilities. Yeah, and luckily, I mean, it's a real active area of research. There are quite a few labs looking into it now. It's an expanding area of research. So it's really cool to be involved in something where you get to see new science all the time. So it's fun.

Amy 17:16
Yeah, I also know that they're doing a lot of research on fungicides and the effects on the honey bee gut. So I feel like there's just so much to examine with the honey bee gut. So that's pretty cool. Did you say that you're able to raise them in the lab with or without this gut microbiome? And in that case, does that mean that in nature, I mean, if they're just in their colonies outside, they're born without that gut microbiome? Did I understand that correctly?

Guest 17:45
Yeah. I mean, young bees acquire it very quickly and have a normal large population of bacteria in their guts within three days after they emerge. But yeah, that moment that they emerge from the cell, they don't have a gut microbiome.

Amy 18:04
That is so cool. I'm nerding out,

Guest 18:08
When we work with these bees in the lab we'll actually open up the capped brood cells and use little forceps to pull the young bees out and put them into these Tupperware bins and put those in an incubator to emerge.

Amy 18:23
Very cool. So what were some of the main results that you found from your study?

Guest 18:28
Okay, well, basically, the biggest impact we found was that a couple of really important microbes in the gut get knocked way down during and then immediately after treatment. And so the two bacteria, one of them has got kind of a funny name, Snodgrassella alvi, and it's named after a famous entomologist whose last name was Snodgrass. That's like the perfect name for somebody who studies bugs. Anyway, this bacteria lives in the ilium, which is kind of, if you look at the bee gut, it's basically just this long tube and there's this mid-gut section where the bee gets most of its nutrients from, but not a lot of

bacteria live in there. I guess upstream from that is the crop, which a lot of people will be familiar with because that's when foragers go out and get nectar, they put it into the crop and bring it back to the hive and then put it into the honey cells. Or when nurses are feeding young bees, they'll have nectar or honey in their crop and be able to feed the young bees with that. And then you got the mid-gut, and then the area where there's a lot of bacteria is this part called the ilium and then the rectum. The ilium is this really small, short tube that has these really complicated invaginations are crevices in them that there's this thick biofilm of bacteria that live inside there. And then the rectum is where all of the pollen grains wind up down the road and just kind of sit there. There's this whole other community of bacteria that live in that rectal compartment. So Snodgrassella lives in that biofilm that's inside the ilium, which is kind of like our, I guess you'd say, small intestine. It's a really interesting bacteria because it forms this biofilm, which is kind of a barrier for pathogens to make it into the hemolymph of the bee. There's some other research that says it kind of has this special relationship with the bee that it helps to activate immune genes and a bunch of other things. Another bacteria that the tylosin treatment knocked way down was Bifidobacterium. And that's one of the species that lives in the far end of the gut, the rectum. And it helps break down parts of the outer coat of pollen. So when a bee consumes pollen, most of its raw protein and stuff is absorbed in in the mid-gut, so way upstream of where it meets bacteria. But then once it goes downstream into the rectum, and is sitting in there, these other bacteria go to work on it, and start to break it down. So Bifidobacterium, some folks might recognize the name because humans have Bifidobacterium in their guts, and you can actually buy probiotics of Bifidobacterium. That's the part of the human microbiome that breaks down complex fibers and produces these short-chain fatty acids that are really important for all kinds of things in human biology. Same kind of deal with bees. So anyway, we showed that the total numbers of these bacteria were depleted, as well as within each one of those species like Snodgrassella or Bifidobacterium, there's a whole constellation of these strains. And each one of these strains of, say, Bifidobacterium have a little different toolkit to do different things at a molecular level. So we found that both the total numbers of Snodgrassella and Bifidobacterium were knocked down as well as the number of strains. And then we showed that the bacteria, after treatment, come back about a month after the treatment. But we showed that in that interval, like post-treatment, bees from treated hives are more susceptible to dying when they get challenged with an opportunistic pathogen. So we used this stuff called Serratia, which is a really common microbe in beehives, and even in bee guts. I mean, bees carry this bacteria around all the time. And usually, it's not a problem. But like I said, when that microbiome gets upset and gets dysbiotic, then it can become a problem. So yeah, we showed that you disrupt the bacterial community, and then when you give bees Serratia, it can be a real problem, and they can die sooner. And then the other interesting thing that we looked into was that we took these bees that had been from hives that had been treated with tylosin, and then we gave a portion of them a probiotic cocktail of some of those bee species, or bee gut microbiome species that had been cultivated on Petri dishes. So basically, an artificial community of bacteria. And then we found that bees that got that cocktail were less susceptible to dying. Anyway, it remains to be seen just how much the benefits of this particular probiotic idea might help. But it's kind of a unique idea. Most probiotics that beekeepers have access to right now are not from the bee gut. They're, basically, from fermented human foods, things like that. So they're industrially produced mostly for human or livestock consumption, so may have some kind of benefit for bee immunity, but they don't live in bees, they don't have any kind of long-term impact on helping the bee gut microbiome. So yeah, that's in a nutshell what our study uncovered.

Dr. Cameron Jack 24:51
Yeah, really, really cool. So, let me see if I can kind of summarize this a little bit. So basically, you've got tylosin that's knocking down a couple of key bacteria that are in the gut. And when that happens, if those bees are challenged with another bacteria, I mean, they don't survive as well. But by feeding this probiotic, some kind of cocktail probiotics may support gut health and may help them kind of return to strength. Did I get that okay?

Guest 25:27
Yeah, that's correct. And I don't want to oversell the idea of the probiotic. This is a real active area of investigation, and the jury's still out on probiotics with bees in general. And this is kind of a new idea, too. But yeah, in this study, which, anytime you're looking at a scientific study, it's very controlled and kind of buttoned down in a number of different ways. So, in our study that is true, yes.

Dr. Cameron Jack 26:04
So I mean, this leads me to my next question, then. I was just thinking, if you had all the research funding in the world, what's the next step? What's the next research that you think needs to be done? Are you going to focus more on the probiotics? Are you going to maybe work to maybe learn more of the impacts of tylosin or other antibiotics? I mean, just curious, obviously, if we had millions of dollars to do whatever research we want, we could answer a lot of questions. But just curious, where does this research project take you next?

Guest 26:38
Well, I think it's interesting to look at probiotics. So one thing we are actually studying in the lab right now is, and this is completely within the lab, we have looked at ways in which we can genetically alter some of those bacteria to help the bees' immunity and things like that. Currently, you can't put genetically modified organisms out in the environment, which is probably good. But someday, I actually think that kind of technology might really help do things like help bees deal with the whole myriad of viruses that they encounter, parasites, all kinds of things like that. So I think that's really interesting stuff like, basically, how you can help the microbiome to administer living vaccines, or buttress the bees' own immunity, things like that. But yeah, in the near term, we have folks who are looking into things like how a lot of other common agrochemicals affect the bee gut microbiome and bee health. So we've got a guy in the lab, Eric Mota, who's looked a lot at glyphosate, which is the major component in Roundup, which is the most common herbicide currently used, and has found that it has some impacts on the bee gut microbiome. And then, looking at things like diet supplementation that is used in apiculture, and stuff like that. So yeah, there's no shortage of things to study out there.

Amy 28:33
Yeah, I can't wait to hear when you all have some publishable papers to be able to read some of the findings that you get from the research that you have. So I have the million dollar question to ask you. And that is, what recommendations do you have for beekeepers regarding the application of tylosin?

Guest 28:56
Well, I would just kind of point to the veterinary feed directive because that's a document that, I think, comes out of some good science and some good concern about how we don't create superbugs in the

future. So I do recommend that beekeepers use antibiotics to treat specific outbreaks and not to use them in any kind of prophylactic or preventative way. And I don't know, with these kinds of things, I hate to wag fingers at people, it's not really my style. But there's a chance that you may be opening your hives up to some harm over the long run, as well as just contributing to antibiotic resistance in the environment. It's also important to note that antibiotics kill active Paenibacillus but they don't actually kill the spores of the bacteria. So sometimes this treatment is kind of a mask or you might be treating your current outbreak, but you might be opening things up to a worse one down the line because like I said, these spores can stick around for decades. So because I brought up probiotic treatment, really the jury's still out on probiotic treatment either with these kind of reconstructed bee gut microbiome communities or with the more common, commercially available probiotics with things from yogurt and sauerkraut and stuff like that. There are a bunch of studies that come out all the time, some look super positive, and some say that the addition of these probiotics is totally neutral. So if you want to give probiotics to your bees, it's probably not going to harm them. But it might not do anything positive either. So it might be kind of a waste of money. So anyway, I would urge people to support the science because most of this research is paid for with your tax dollars. So try to empower scientists to go out and answer these questions and figure out good ways of helping bees and beekeepers.

Amy 31:33
Yeah, absolutely. I think if they are going to be using the antibiotics to make sure that they rotate active ingredients. That would kind of minimize the resistance of that bacteria. Now, I do have one more question. I'm sorry, this episode is just going to last forever because I have so many questions. Let's say there's one colony that has American foulbrood, would you recommend treating just that colony? Let's say that there's a colony of, let's say there are 20 of them that are all nearby and in one location, would you recommend just treating that one colony or all of them?

Guest 32:13
Geez, I don't know. This is like one of those questions where you got the train, and it's going to either go off the bridge, and you gotta pull a lever and the train goes one way or the other. I don't know. I'm probably not the one to answer that question. But it's interesting to think about.

Dr. Cameron Jack 32:36
I mean, just as you mentioned, Eli, I mean, treating a colony that already is infected with American foulbrood doesn't get rid of the spores. And so, I mean, there doesn't seem to be a lot to do in that situation besides, remove that colony as fast as you can from that apiary, get it out. It's tough. It really is tough. I mean, as a beekeeper myself, too, I feel this. This is hard, and you want to protect your bees, and so you might get that antibiotic and be treating them. But then, there are side effects, and it's costly to just treat prophylactically, and there are other problems. So it's just a tricky situation that I don't think has an easy answer.

Amy 33:28
I think that's totally fair. All right, Eli, is there anything else that you wanted to share with our audience before we finish up the segment?

Guest 33:37

No, I just wanted to thank you all for your interest in our research, and being involved in the beekeeping community and working with such spectacular creatures has been a real honor. I had to work out at our field hives in the Texas Hill Country last week, and it was such a beautiful fall day, I couldn't believe that I was getting paid to be out there. So yeah, it's a real honor and a really fun thing to do research on. So yeah, thank you.

Amy 34:10
Very cool. Well, thank you so much. We have the best job in the world, guys. Just wanted to let you know that. Alright, everyone. So that was Eli Powell with the Department of Integrative Biology at the University of Texas in Austin, Texas, and he was speaking to us about field-realistic tylosin exposure impacts, honey bee microbiota, and pathogen susceptibility. Thank you so much for listening to this episode of Two Bees in a Podcast. Welcome to the Five Minute Management. And actually, in this Five Minute Management, we're going to talk about how we're going to manage the Five Minute Management. So I don't know if that just broke everyone's brain or not, but it kind of did mind. So, Jamie, let me take a step back. So right now we are recording in January of 2022. We've had the podcast since 2020. And so our episodes looked a little bit different in 2020. In 2021, we added the Five Minute Management. And so at the end of the year, we usually put out a survey to our listeners just asking them what they liked, what they didn't like, and what they want us to change. And so I thought that we could take this opportunity to just discuss maybe what we plan on doing moving forward with a Five Minute Management or whether we're going to have that at all. So, did you want to add any input as far as what you see or envision us doing for the rest of 2022?

Jamie 36:03
Yeah, I mean, this is a really good lead-in to some of our vision. First of all, what I will say is this podcast is not about us, right? It's not about me, it's not about you, Amy, right? It's not really even about the guests that we have on. This podcast in general, Two Bees in a Podcast, in general, is about you, our listeners. Amy and I, and our team here at the University of Florida, we want to make a podcast that you use. We want to talk about things you want to hear. We want to talk about management strategies that you end up using. So it's very important to us both, Amy and myself, it's important to us that you provide feedback. And when you provide feedback, either through our social media channels, or through direct emails to either Amy or myself, or through the yearly surveys, we use that feedback to change our podcasts. And one of the things that Amy just mentioned, Amy, you're spot on, we've we've been taking big management issues, for example, recently, producing queens, rearing queens, and we've split them up over multiple Five Minute Management segments over multiple episodes. But based on feedback, you guys have really enjoyed the management segments. So rather than making them small segments of every episode, what we'll do is we'll sprinkle entire management episodes among our episode list. So we might interview a scientist this week, we might interview a beekeeper next week, and the next week, it might be just me and Amy talking about how to feed bees, right? And so we're trying to do this because we want to make sure our podcast is as useful to you but also as delightful and entertaining to you as possible. So thanks for the feedback. And please let us know how we can make it better. But like we said in the future, we're trying to take those smaller segments and combine them into just larger episodes where we spend a lot of time talking about various aspects of managing honey bee colonies.

Stump The Chump 38:08
It's everybody's favorite game show, Stump the Chump.

Amy 38:20
Welcome to this segment of Two Bees in a Podcast. We are back at our question and answer segment. And, Jamie, we've got three questions here. The first one is that this person was interested in knowing what organ or what part of the body insects used to interpret pheromones and then understand it as communication. Are there other insects that use pheromones to communicate with each other?

Jamie 38:45
Absolutely. I believe all the insects do. I hate to make such a broad statement. But if all don't, then 99.999% of them do. Smell is very important in insects in general. And of course, the same is true for honey bees. And so bees don't have noses, and neither do the other insects. But the organ, the appendage that they use to detect smells would be the antenna. So they have two antennas, one on either side of the top of their head, and they use these to detect pheromones. If you look closely at an antenna under a microscope, maybe even a scanning electron microscope, you'll notice that there are a couple of features on the standard antenna. They often have, especially a honey bee antenna, they have these little spikes that are for tactile stimulus, so they touch things and can feel things. So it's like the finger part of their antenna. And they also have these little recessed pits that are the chemosensors or the chemical sensors, in that case, the things that pick up the pheromones. So honey bees communicate to one another using pheromones. Pheromones are chemicals that produce a scent that bees can detect, and these chemicals are secreted by glands. In this case, exocrine glands, glands that secrete these chemicals outside of the body. So one bee might be producing this pheromone that the other bee can detect using her antenna. And we also know that chemical signatures can be passed among bees by licking. We know that bees will lick the queen, for example, and they'll pass her pheromones on to other bees through these secretions that they will mix with the food as they're passing on to other bees through this process called prophylaxis. Principally, pheromones are detected through antenna.

Amy 40:42
That's pretty cool.

Jamie 40:43
It is cool. Bugs are cool.

Amy 40:45
Bugs are pretty cool. Alright, so the second question. So actually, the second topic is a bunch of questions. And so I'll just go ahead and read it. If you miss any of them, I'll let you know. But the second question is about brood breaks. And so this person is asking if they're an effective integrated pest management strategy for Varroa, and I guess, maybe, we should take one step back to even discuss what brood breaks are and why people do them. And then of course, when should we try to do a brood break? Or what are some of the potential drawbacks?

Jamie 41:18

Yeah, so in the strictest sense, a brood break, and I hate to use the two words in their own definition, it's a break in the presence of brood in the hive. Now, for people who live in colder areas of the temperate world, that will occur mostly throughout winter. It's a natural brood break. The queen will curtail her egg-laying in mid to late fall. She won't lay through winter and you get this natural break in the brood cycle. The brood is not dead. It's just not there. They're not producing any. Maybe there's no pollen coming in. Maybe it's cold, they don't want to produce brood during the cold season. Now, the link that brood breaks have to Varroa is that Varroa must reproduce in capped brood cells. So when there is a natural brood break in the hive, Varroa are unable to reproduce. This basic biological observation led some beekeepers and scientists to say well, if Varroa can't reproduce when there's no brood in the hive, maybe creating a broodless period in the hive will be a good strategy for reducing Varroa populations. And it is, at certain times of the year and under certain management scenarios. Years ago, I'm going to put a date on it, I hate to put a date on it, but I'm just going to guess and say it was about 10 years ago, I met an Italian researcher who was looking at brood breaks in Italian beekeeping operations. And what they discovered is that a lot of commercial beekeepers were using brood breaks. What they would do is, in summer, like June and July, the periods of the year that I would think that brood breaks would be stressful for bees, they were causing brood breaks in their hives and they were doing this by caging the queen for somewhere between 21 and 28 days. And with the queen caged, that period the existing brood in the hive would make its way through all of its developmental stages. So by day 28 there'd be no brood left in the nest. Technically, by day 21, there'd be no worker brood, and by day 24 there'd be no drone brood but if you give it a few extra days to include a cushion, by 28 days later, there'd be no brood in the nest. And with no brood in the nest, there's no Varroa reproducing, and all the Varroa, then, would be on the adult bees and they would be vulnerable to treatment. So the Italian commercial beekeepers were creating, basically, a one-month brood break, and then they were treating with oxalic acid right at the time that they would release the queen from the queen cage. Again, this idea is that all of the mites were on the adult bees, so they are incredibly vulnerable to any treatment that you would put in the midst. So Dr. Cameron Jack here from the University of Florida, as part of his original PhD research, was testing this very issue if he could create a brood break by caging a queen, would he be able to treat the colonies during the brood break period? And would it be okay? In his research project, and again, I want to throw out this caveat that research, only answers questions relevant to how the project was done, where it was done, and when it was done. So I don't want you to take anything I say here as an overarching statement saying that brood breaks don't work, but I will just tell you for Dr. Jack at the time of the year he tested it, which I believe was August, September, where he tested it was here in North Central Florida, on what he tested following the pattern he tested, it wasn't very impactful for us. We didn't really see a significant improvement in colony health with regard to Varroa. In fact, the brood break via caging queens was somewhat detrimental to the hives. He had the reverse effect, which is where it was stressful to the bees. I don't know if it was related to caging the queen for 28 days, but nevertheless, there was a bit of a problem. That said, I certainly do believe that brood breaks can be accomplished, can be done right and done well certain times of the year in certain places. And in fact, for many hobbyist beekeepers brood breaks might provide a reasonable control management for them. I say many hobbyist beekeepers because obviously, anything that requires you to go and find a queen and cage her for X amount of time is going to be a lot of work that a commercial beekeeper would have to do. And so it may not be advantageous for them, even though, again, I first heard about this through commercial beekeepers in Italy doing it. Nevertheless, it could be a lot of work. And again, there are variations of brood breaks. You don't always have to cage the queen. You can take out all of the brood from the hive and use it for something else, maybe to start new nucs or something like that, and only have adult bees left in the nest. That's an immediate brood break. And so there are other ways to implement this strategy. And it can be done well and it can work. I just will point out that the listener asked about some potential drawbacks. And we did see, in one of our studies, a potential drawback. I do think it can be used effectively. But more research needs to be done and it's almost always coupled with a treatment of some sort once there's no longer brood in the nest.

Amy 46:32
So I guess that I was just thinking about the queen being caged. What does she do? She just hangs out for 28 days when she's caged?

Jamie 46:39
That's it. It's almost like when you purchase a queen and they come to you in the mail in a cage, it's that pattern. She's just hanging out in a queen cage waiting to be released. As you imagine, there could be some drawbacks to that from the queen's perspective. Maybe by the time she's come out she's she's damaged in some ways, maybe she doesn't survive, whatever the case. But again, I'll stress there are other ways that you can create brood breaks and you get a natural brood break, anyway, for most folks keeping Apis mellifera and that occurs during winter. So winter can be a good time to use treatments like, at least here in the US, formic acid, oxalic acid, things that may not work as well when there's lots of brood in the hive, but certainly could work reasonably well when you get that natural brood break.

Amy 47:20
Yeah, absolutely. And I was going to say we usually recommend using the Honey Bee Health Coalition. Their website has a really great Varroa resource where you can kind of go through a bunch of different questions to figure out what treatment to use during different times of year depending on what your colonies look like. So I hope our listeners visit Honey Bee Health Coalition and are able to kind of go through their website to look at some of the Varroa stuff. Alright, so for the third question, Jamie, this is your specialty, small hive beetle. It's small hive beetle larva. So this person's asking about small hive beetle pupa. And if it falls to the ground, and they finish their growth and they develop in the soil, can their development be interrupted by having the beehive sitting on something other than dirt? We get this call all the time and people say, "If I get a huge slab of concrete, how far do I need to make this?" And it just makes me think back to your PhD story. And I'm going to let you tell that.

Jamie 48:22
Yeah, it's funny because I think I've probably answered this question already a lot on this podcast. I think we get it a lot. And I think we've even had small hive beetle segments where I've discussed it and we still get it because anytime I give a talk on small hive beetles, this question comes up. I tell you if I had a dollar, it's like one of those things, if I had $1 every time I were asked this question, I'd be a multimillionaire, probably. I understand the motivation behind the question. It's real simple biology of small hive beetles. The adults go into hives, the females lay eggs in the hives, the larvae come out of these eggs and eat in the hive but they don't pupate in the hive. The larvae come out right when the sun starts to set. They come out over nighttime, crawl until they find suitable soil, go into that soil, and

pupate in the soil. So long story short, part of the small hive beetle life cycle occurs in the soil around the hives that they develop in. Right? So when beekeepers hear that, even when scientists hear that, they go, "Gosh, if they come out, all I have to do is put something under my hive. Maybe rocks, maybe cardboard, maybe carpet, maybe concrete, all I have to do is put something under my hives so when the larvae come out of hives, they can't go into the soil and pupate and they die." The problem with that is, of course, Amy, to the story you referenced, and I'll tell a story again. If you've heard it before on the podcast, I apologize but it's certainly one of those things that folks ask about a lot. When I did my PhD in South Africa at Rhodes University, I was rearing small hive beetles for the purpose of having them around so I could do research on them, and I can't remember, it was 15-20 years ago now, but I believe it was the second story of the building where we had our rearing lab, in a closet. I kept them in a closet. I remember I would always get to work early, usually before the faculty members and other students would arrive. And I would walk into the building up the first flight of stairs, up the second flight of stairs, and go and see how my larval rearing program is going. And I remember one morning, walking up the stairs and not really looking down until I got to the floor where the rearing program was, but then I looked down, and I saw small hive beetle larvae everywhere. They had crawled out of the rearing program, out of the closet out of the lab, and were walking down the halls of the building where we had our rearing program. So I panicked. I walked down the stairs, and I saw them walking down the stairs.

Amy 48:30
Were they taking the elevator too?

Jamie 49:53
I hadn't noticed that yet. They weren't able to push the buttons. But for sure, when I walked down to the next floor, I saw them on the next floor. I had missed them coming in because I wasn't thinking about looking down. And then when I looked down, they were going down those stairs as well. So within one night, they had probably crawled, I don't know, just guessing, 20 to upwards of 50 meters. So what I discovered, number one, they can crawl great distances away from the hive all in one evening to find suitable soil in which to pupate. So while I think it is possible to put hives on something that would prohibit larvae from reaching the soil, it's really not feasible in most circumstances, because the larvae can crawl 20, 30, 40 meters, potentially, in a nighttime to find soil in which they can pupate. So it's a great, great, great idea. But biologically, the larvae are just too good of crawlers. And so a lot of people, they will take the next approach, which is, "Well, maybe I can put some sort of trap under the hive, something that the larvae come out of a hive, fall into, and can't escape." And that is a much more feasible option, at the moment, than putting something under. They just can't eventually get to the end to get to the soil. In fact, some colleagues of mine and I published a paper recently, I think in the last year or two, about trapping larvae coming out of hives, and we can link that in the show notes for today. But as far as locating hives on something, it would have to be a big concrete slab in order to be able to beat the larvae. But good question nevertheless, certainly one that comes up quite a bit.

Amy 52:26
Yeah, that one's a good one. We receive that one all the time. So all right, well, there we have it, our question and answer segment. Don't forget to send us questions on our social media pages, Facebook, Instagram, and Twitter, or send us an email.

Serra Sowers 52:45
Thank you for listening to Two Bees in a Podcast. For more information and resources on today's episode, check out the Honey Bee Research Lab website at UFhoneybee.com. If you have questions you want answered on air, email them to us at honeybee@ifas.ufl.edu or message us on social media at UF honey bee lab on Instagram, Facebook and Twitter. This episode was hosted by Jamie Ellis and Amy Vu. This podcast is produced and edited by Amy Vu and Serra Sowers. Thanks for listening and see you next week.