Episode 87 Mixdown PROOFED

Mon, Apr 04, 2022 10:02AM • 52:11

SUMMARY KEYWORDS

bees, pesticides, colonies, combs, enzyme, beekeepers, insecticides, micro particles, queen, honey bees, fed, good, pollen, scott, question, gut, honey, james, research, beekeeping

SPEAKERS

Guest, Amy, Jamie, Stump The Chump, Guest 2

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. Hello, everyone, and welcome to another segment of Two Bees in a Podcast. I am very excited to be joined by our two guests today. Our two guests have just published a paper entitled "Pollen-inspired enzymatic microparticles to reduce organophosphate toxicity in managed pollinators." And those two individuals, of course, are Dr. Scott McCart -- Scott is an assistant professor in the Department of Entomology from the College of Agriculture and Life Sciences at Cornell University in New York -- and James Webb, who is the founder of Beemmunity. He did part of his master's work on this very topic while at Cornell in Dr. Minglin Ma's lab in biological environmental engineering. And they're here to talk about this new research they found to detoxify organophosphate compounds in honey bees. Scott and James, thank you so much for joining us to talk about this.

Guest 01:50

Thanks very much for having us, Jamie and Amy.

Guest 2 01:53

Thanks, Jamie. Excited to be here.

Jamie 01:55

Well, great. So guys, we've got two of you, you worked together to publish this manuscript. For all you listeners out there, we're going to absolutely make sure and link in our show notes to the manuscript we're referencing as well as to Beemmunity, the company that James has. You guys work together to address a very important topic in honey bees. But before we get there and talk about that, we just want to introduce our listeners to you both. So Scott, James, if you don't mind, could you tell us a little bit about yourselves and how you got interested in studying honey bees in the first place? Maybe, Scott, we'll start with you. And then James, you can add your story as well.

Guest 02:31
Sure, yeah. So I can start. I've always been interested in insects. I was one of those children who used to play with bugs in the backyard all the time growing up. But formally studying bees, that happened in graduate school for me. Let's see, so I guess I've been doing bees since 2006. However many years that is. I'm getting too old to do the math. But yeah, now, currently, I'm helping to run the Dyce Lab for Honey Bee Studies up here in New York with my collaborator in crime, Emma Walters. She's our honey bee extension associate here.

Guest 2 03:07
Great. And yeah, I can take over. I guess pretty recently I got into honey bee research. It kind of started whilst I was doing my master's degree at Cornell. Before that, I did have some entomology experience. I used to work at a company which was developing the production of insect protein for animal feeds. We were using black soldier flies then. So a bit different. But yeah, when I got going at Cornell, I was looking for a project to hopefully do some good. And luckily, my professor kind of liked this idea of detoxification for bees, so yeah, I got started on that. And I like to think I know a little bit more now than what I did back then.

Amy 03:48
That's awesome. So I remember, Dr. McArt, I had reached out to you earlier this year and asked if you wanted to be on our podcast. And I remember you telling us "Well, we're actually in the middle of a project right now. Once that becomes published, then we can talk about it." So I'm excited to say that once we found that you had published the paper, we reached out to you, and we're so happy that the both of you, Scott and James, are able to join us today. And so as Jamie mentioned earlier, you guys published a paper on the ability of enzymatic microparticles to reduce organophosphate toxicity and manage pollinators. It seems like a mouthful to say, I guess. And so can we just start from the very beginning? Can you describe what organophosphates are? And what do they have to do with pollinators?

Guest 04:37
Sure, so I can start with this. So organophosphates are one type of insecticide that are out there. So an insecticide is a type of pesticide that specifically targets insects and organophosphates happened to be one of them. Other types of insecticides that listeners might be aware of are the neonicotinoid insecticides. So those have been in the news a lot lately. Organophosphates are an older chemistry. So they've been developed for much longer than the newer neonicotinoids. But that doesn't mean they're still not in use. So some organophosphates that listeners might be aware of, so chlorpyrifos is one that was just banned in the United States. So that one's been receiving some media attention, but before that, it was used in quite a few cropping systems. And then most beekeepers will be aware of coumaphos. So coumaphos is actually an organophosphate insecticide that has been used as a miticide within colonies. So there's several, there's at least a couple dozen organophosphates that are still used in the United States. But it's a class of insecticide.

Amy 05:46
So you had mentioned coumaphos, and I feel like the beekeepers, especially the ones in the United States, are quite familiar with it. So let's talk a little bit about documented impacts. So what kind of impacts are there on pollinators? And we can talk just about honey bees or pollinators in general, whatever you'd like to talk about.

Guest 06:04
Sure. I can take that question, too. So there have been documented bee kills from organophosphates. Like any chemical insecticide, especially synthetic chemical insecticides, there can be risk if they're used inappropriately, or if they remain in the environment for these non-target organisms, such as bees. Chlorpyrifos has been linked to some acute bee kills. Phosmet is another one. So the trade name for that is oftentimes Imidan. That's one of the main products that's used. But Phosmet has been linked to some acute bee kills. And then I think an important part about a lot of these organophosphates is that many of them, actually most of them are systemic insecticides. So similar to neonicotinoids, they can sort of be incorporated into plant tissues. Unfortunately, that also gets into pollen and nectar. So not only does it provide good protection against your crop pests that are eating the leaves or the flowers, or whatever else that we're trying to protect against, but they also get into pollen and nectar. And then the other thing that's a problem, because of their systemic activity, they're oftentimes very water-soluble. So they can leach around in soils and sometimes stay in soils for many, many years. So if they're in the soils and they're systemic, they can be taken up by plant roots, incorporated into the tissue, again, into the pollen and nectar. It's this whole cycle of, we just can't get this stuff out of the environment, and therefore, it can impact non-target organisms.

Amy 07:42
People are always saying, "Well, pesticides killed my bees." And when we're talking about pesticide, especially insecticides, well, yeah, sometimes they will kill bees, right? Bees are insects, and we're talking about insecticides. And so, I always think that's kind of interesting when I'm talking to a non-beekeeping audience.

Guest 08:00
Sure, yeah. I think it's important to point out that what gets in the news a lot is the acute bee kills that happen. Those are pretty rare. It's pretty rare that I get a call from a beekeeper and say, "Listen, my bees died and we think it's pesticides." And I should know this because we run a residue lab in my lab, and the whole Bee Informed Partnership sends their samples to my lab to look at pesticides, and I have a lot of beekeepers who contact me. But it really is fairly rare that we get these acute bee kills. What's much more common is the sub-lethal levels of exposure that occur in the environment and organophosphates because they're systemic insecticides, they're environmentally persistent, and they're hydrophilic, so they're water-loving, they can sort of move around in groundwater and in soils, leaching through things. Oftentimes, organophosphates are at sub-lethal effect levels that might affect bees or other insects.

Jamie 09:02
Yeah, it's funny that you had mentioned things like chlorpyrifos and others. Those are things that show up in residue tests a lot. And so those are things that have been kind of on my lands radar for a while

as well. So, guys, you came together, you've established that organophosphates can be harmful to bees in general, but honey bees specifically, but in your research, this paper that we're referencing, you suggest that it's possible to make them less toxic or less harmful in some way to bees, detoxify them or something. Could you give us a bit of a background of the research, how it came about, what your motivations and ideas for the projects were that ultimately led to what we're discussing today?

Guest 2 09:42
Sure, I guess I can take that question. So I guess it really came about with just a very fresh set of eyes on the pesticide problem. I was actually just looking for a way to apply a group project that we had going in our biomaterials lab. So let's try and find the problem and come up with a solution for it. And yeah, I thought, "Well, bees are always in the news. There's a clear, public urge of excitement for trying to save the bees, let's see if we can do something there." Yeah, I basically thought about this idea with a very fresh set of eyes, not really fully understanding the problem, I think. When I started to learn more about it, I thought, "Well, maybe we can think about, essentially, cleaning the bees from the pesticides within them," and my professor at the time liked the idea enough to try and pursue it. I approached Scott because, obviously, he had the expertise that we would need to kind of steer the ship in the right direction. And we managed to come up with a few different designs, which managed to successfully detoxify those pesticides. I guess what the detoxify part means is really breaking down those pesticides, in this case organophosphates, into parts or constituent parts, which aren't as toxic as the organophosphate in its complete form.

Guest 11:08
So what I can add to that, that's a great description, James, what I can add to that, is I remember distinctly when James got in touch with me, we had this wonderful meeting out in the back of the Dyce Lab. There were bees flying around, and it was just a beautiful sunny day. And I remember James said, "Yeah, we've developed something that we think we can make bees immune to pesticides by feeding them this vehicle," and I thought, "Oh, my God, who is this guy? This has about a 1% chance of working." I thought, "There's absolutely zero, just not any chance that this is going to work." But as we were talking, he started becoming much more and more convincing, telling me about these microparticles, some of the other research that the lab had done. And I thought, okay, I left this meeting after 45 minutes or something like that. And I thought, "All right, well, it's not a 1% chance this is going to work, but maybe it's like a 5% chance now." Let's just say I'm very happy to have been proven wrong.

Jamie 12:11
It's funny when you say that, Scott. I've often heard similar things. And James, aren't you happy he took a shot and a chance at this? So it sounds like you guys did some neat stuff.

Guest 2 12:22
No, yeah, I'm very grateful. I mean, both professors, Minglin and Scott that I worked with, I guess they have a knack for vision and taking a chance on it. So yeah, I mean, I really had no clue where it was going either at the time, to be honest. When you're kind of young, and I guess in the lab, you're just seeing what can happen. So yeah, it was a good time.

Amy 12:48
All right, so now you're getting our audience super excited about what you're actually talking about. Tell us about the designs, tell us about your experimental design, how you conducted your study. James, I'm so glad you convinced Scott to let you move forward with this project. But what did your design look like?

Guest 2 13:08
Sure. So first off, we kind of identified this enzyme, which we knew in previous research. It's shown to have the ability of breaking down these organophosphate pesticides. And we thought organophosphate pesticides were quite a good place to start because they're pretty well used. I think, at one point 30% of insecticides, or around that number were organophosphates. And so we thought, okay, well, this enzyme is a proven way of breaking these things down. If we can get that into a bee, then maybe it can have a positive impact. The only issue is when you throw a lot of enzymes into the acidic gastric tract, or an environment in which it's not normally used to, it can become denatured, etc, and not functional anymore. And so we needed to somehow provide a vehicle to deliver that enzyme in a way that it could stay in the bees' gut for long enough that it could do its job and break down those organophosphates. This is again, from very, very fresh eyes, not fully understanding bee entomology or anything, we thought, "Okay, if we could maybe mimic the food that bees eat and keep the enzyme safe in that vehicle, if you like, then maybe the enzyme could stay stable long enough to do its job. And so we created these microparticles, which could withstand the acidity in the gut tract of the bee. And we encapsulated the enzyme with that microparticle. It's a simple calcium carbonate microparticle, so, upon meeting acid, it will essentially create a very slight basic environment around the periphery of the microparticle and that basically allows the enzyme to do its job. We found that when we actually fed these microparticles in sugar syrup at the same time as exposing these bees orally to organophosphates, the bees managed to survive because the enzyme successfully broke the pesticide down. If we just fed the enzyme on its own without the microparticle, the bees showed some improvement in health. But typically they they wouldn't do anywhere near as well as the microparticle-loaded enzymes.

Jamie 15:29
Oh, there are like a thousand questions I want to ask you.

Guest 2 15:31
Sorry.

Jamie 15:34
No, it's okay. What I'm thinking is, the scientist is kicking in now, not the extension specialist. So you've got these groups of bees, correct me if I'm wrong, I want to make sure I understand the experimental design, so you've got these groups of bees. One group just received the organophosphate. I'm assuming it probably died during the study. And then another group would have received the microencapsulated enzyme, and then another group received both. And you saw some clear differences between treatment groups, correct me if I'm wrong, set the stage better if I've messed something up, so let me know kind of how you did it and specifically, what you found. Like what fold differences in survival were you seeing, things like that?

Guest 2 16:16
Oh, yeah, there you go. So essentially, as you said it, we took different groups, ones which we would just expose to pesticides, organophosphates, and ones which we would also treat with microparticles, as well as exposing them, of course. And inevitably, the ones that weren't treated, they would all die. And it would depend on the dosage as to how fast they would die. But, typically, we try to do these experiments quite fast with many repetitions. So we'd give them quite a high dose, and they would die within 24 hours. And then the ones that we treated, I think off the top of my head, around 80% would survive relative to ones which all died in 24 hours. And so we tried this out with different forms of organophosphate. So we tried it with malathion and peroxone, which is a kind of cousin of parathion, which I think is commonly used. But the reason we tried different pesticides is because some of those pesticides within the organophosphate family have different structures, which are actually broken down in different ways by the same enzyme. So I don't know if it's getting too technical.

Jamie 17:29
No, it's not at all. Keep going.

Guest 2 17:31
Okay. So there'll be different rates in which these pesticides can be cleaved by the enzyme, because of the linkages or the linkage in the malathion and a different one in others. So that's why we had to make sure we covered a decent breadth of pesticides. And so yeah, I think there was a very clear, conclusive difference that showed that actually feeding these things would improve the survival rate.

Jamie 17:59
So let me ask a couple follow-up questions, then, kind of thinking still about this. So when you provided the product, this microencapsulated enzyme that you have, you fed that in advance of the organophosphate exposure? Or shortly after the organophosphate exposure? Like, what's the timeline associated with that?

Guest 2 18:22
So, simultaneously, we provide a pollen ball, which was contaminated with a known concentration of pesticide. And then at the same time, we would have a test tube of syrup, which contained the microparticles.

Jamie 18:37
This is fascinating, and you got prolonged protection? You had mentioned a little earlier that the microparticle was necessary in order to maintain the integrity of the enzyme. So do you have any information on, "they get a single dose of this microparticle encapsulated enzyme, and therefore, they're protected X amount of days, or hours," or what?

Guest 2 18:58
So yeah, so we looked at how the microparticles traveled within the gut, which was quite an interesting thing to look at. So we tagged the microparticles with a fluorescent tag. And then we would dissect the guts out and see at what point or how far the microparticles got down the gut tract after however many

hours of feeding. And so we found that after 12 hours, the microparticles were still in the gut tract, whereas if you kind of just left the enzyme to be fed on its own, that would kind of disappear and be mashed up by the gut quite quickly. So yeah, up to 12 hours after that, the microparticles would probably just essentially dissolve in the gut tract and be gone after that. So it's definitely not something that is going to provide a vaccine for people in this day and age, but yeah, it provides a safe net during that day where the bee might be exposed.

Jamie 20:01
So I do want to ask them one more follow-up question, then I'll yield the floor because it sounds like a lot of this information is going to be in the manuscript you guys have published. Like I said, we'll make sure and link that in the show notes. But but I've had discussions with others before kind of thinking similarly or protectively, etc., with bees. So where in the bee does the enzyme do its work, such that if an organophosphate is taken into the mouth of the bee, the bee is okay until the point that the organophosphate gets where it needs to do its damage? Does that question make sense? I know that's a weird question. Where do the two meet? In some case, is it too late, or you always got good protection?

Guest 2 20:47
Well, Scott may be able to correct me on this, but it was our understanding that a lot of the absorption into the hemolymph of any kind of nutrients and/or neurotoxins would take place in the midgut. So after the honey crop, you'd get the midgut would extract any pollen into that part of the digestive tract. And so it was our thinking that if we managed to get the enzyme into that section, as those solids were being broken down and absorbed, we could simultaneously meet it with this with this enzyme, which could break them down into non-toxic components, which may be absorbed into the hemolymph. But they wouldn't be able to do their job of providing a neurotoxic effect. So, yeah, in the midgut.

Guest 21:39
Yeah. And all I can add is that, sure, a pesticide, especially a water-soluble pesticide can certainly even be a contact exposure on the outside of the bee. You can still have some absorption and toxicity can result from that. But the vast majority of absorption happens in the midgut. So it's sort of analogous to our small intestine for humans, where that's where a lot of the nutrients are being absorbed, the toxins are being absorbed, etc. So, if that's where the microparticle's working, that's the best place for it to be working.

Jamie 22:15
That's absolutely fascinating. I love science, don't you, Amy?

Amy 22:19
I love science. And I love communicating science. I just have two final questions for you. I guess the first one is, what real research needs to be done next? And then, if there is a resulting product, how can these enzyme-loaded microparticles be used by beekeepers? That's like the million-dollar question. Right?

Guest 2 22:43

Right. These are juicy questions.

Amy 22:45
I like how Scott is just laughing. He's like, "Yeah, okay. Thanks for asking that question."

Guest 22:51
I'll let James go first. But, I've been having lots of fun discussions with folks. In fact, some people are not very happy about this technology. I have to talk about that, too.

Guest 2 23:02
Yeah, that's a whole nother topic. Yeah, so future research, I guess, the eminent thing that we've been trying to work on is how can this be applied to multiple different pesticides, whether it might be a fungicide or herbicide. These are also things that are kind of known to have negative impacts on bees. We've developed a follow-on design, which we can talk about very briefly if you want, but a follow-on design. The idea is it can actually absorb, selectively, all these different types of pesticides, which are out there, which form this cocktail, which is sort of known to be especially detrimental, right? The cocktail of all these different types can form these synergistic effects and detrimentally impact bees. So yeah, definitely looking at how we can expand the plethora of pesticides we can address. And then I guess, also looking at how we can increase the time in which these things are functional within the bee. So 12 hours, obviously, is a good start, but it's not enough if we're trying to make this a really practical solution for beekeepers. I have a quick comment, I guess, on how we can use this for beekeepers, and how it might turn into something that they might use routinely. We've been working on this for the best part of a year now as a company, and how can we create a product which beekeepers can seamlessly integrate into their beekeeping practices? And I think there are there all sorts of situations in which a beekeeper might want to use this, but we've kind of landed on trying to just put it into their routine feeds. So they're not really having to specifically worry about when a pesticide exposure might happen, because that's obviously extremely hard to predict. But if they can just put it into their feed in a way that was cheap and economical for them, that might be a good solution. So we're working on, basically, advancing your typical bee feed, whether that might be a, essentially, polymer patty, and trying to get it into bees in that way. There are probably follow-up questions, but I'll let Scott go.

Guest 25:20
Yeah, no, what I can say too, is that from our lab, we find bees are commonly exposed to pesticides. So almost always, almost every single sample that we take from a bee colony is going to have a pesticide residue in it, but generally, fairly low levels of those pesticides, except during pollination. So just to put in some numbers here, we just published a paper on blueberry pollination in Michigan, and on average, honey bees are exposed to 35 different pesticides simultaneously when they're doing blueberry pollination. Here in New York, in New York Apple, 17 different pesticides simultaneously are coming back in with the pollen. That's what's in the freshly collected bee bread that they have in their hives, right? So there are a lot of pesticides. I think one important next step is not just targeting organophosphates here, but other pesticides as well. But also, you have to think about what are the major pesticides? What are the ones that are really risky? And what are the ones that you want to take out? Oftentimes, it still is organophosphates. So chlorpyrifos is one of them, malathion, which is one of the ones that James studied here is oftentimes one, and phosmet is another one. So those are three

organophosphates that we oftentimes see at fairly high levels during pollination. Why are those exposures coming in during pollination? It probably has something to do with the fact that they're systemic insecticides. So they're just in the environment. No grower that I know is spraying those during pollination, but they're just in the environment. So bees are coming into contact with them. So anyway, regarding pesticide exposure, I think that's a definite way to go. But I guess what I want to talk a little bit about too is, great, so we are providing immunity to one managed pollinator, honey bees, and that is obviously helping, well, it could help beekeepers, especially during these high-risk pollination events when bees are oftentimes exposed to pesticides. But what does that mean for the sustainability of cropping systems? Does this mean that okay, any grower should just now say, "Oh, great, we've made bees immune to pesticides so we can just spray willy-nilly?" Well, clearly, that's not the message we want to send, right? But how do you not send that message? How do you say, "Alright, this is a good technology, this can help beekeepers." But how do you make it so it doesn't provide the incentive to not really consider what you're doing in this whole cropping system to avoid exposure to other non-target organisms, organisms that may not be able to be fed this particular technology? And that is a very interesting question. I think it's sort of a philosophical question, on the one hand, but also maybe a practical question. Could we potentially develop feeders or something along those lines, use our knowledge of chemical ecology to attract particular beneficial insects to these particular feeders where you make bees or predators or ladybugs or whatever immune to pesticides or not? So practical question, but also philosophical, like, do we even want to do that? Is this sort of like the next step in making a cropping system even further from an actual natural system? And is that something we want to do or not? I don't know, I don't have the answers to that. But I do think there are some really interesting questions that this technology brings up.

Amy 28:57
Well, geez, I thought you were going to have the answer for us. Sounds very complex. I mean, I think that our ag system is just very complicated. And I'll just kind of leave it at that.

Guest 2 29:11
Yeah, I think from our side, just to add to Scott's comments, I think that it's definitely not a final solution, that we need for preventing insect deaths forever. I think, obviously, the ultimate solution has to be safer alternatives in what we spray. But until that point, it might be a good idea to start trying to save some of those insect lives until we do reach that utopia. But I think if this is going to be used, it does need to be used with a great deal of education around what this is actually doing and making sure that it's very clear that this is not providing a safe space for all beneficial insects. We're never going to be able to save all beneficial insects, we're only going to be able to save the few that we might be able to treat. So, it is a useful tool, but it's definitely one which needs some good information disseminated around.

Jamie 30:16
So, guys, that's just very, very exciting. I really can't wait to see where this goes. I really appreciate, James, you and Scott both joining us here on this episode of Two Bees in a Podcast.

Guest 30:27
Thanks very much.

Jamie 30:29
Absolutely. Everyone, for your benefit, make sure you check out the show notes so that you can see the link to the manuscript. Also, please visit the website of Dr. Scott McCarty again, he's an assistant professor in the Department of Entomology at the College of Agriculture and Life Sciences at Cornell, and James Webb, who's the founder of Beemmunity who did a lot of this work while he was a master's student at Cornell. Thank you again for listening to this segment of Two Bees in a Podcast.

Amy 31:24
We are on our second Five Minute Management of the year. We are looking at queen rearing and the types of colonies that you need to rear great queens. Jamie, hold on, I need to get my timer out. And let me know when you're ready. And I'll go ahead and push start.

Jamie 31:41
I'm ready. But I can guarantee you I'm going to bust wide open the five minutes because there's a few things we have to discuss here.

Amy 31:47
Okay, I'll give you six minutes.

Jamie 31:49
Oh, gosh. Thanks.

Amy 31:51
You're welcome.

Jamie 31:53
Alright, gosh, I'm so scared to start because that was going to take a while but I want to make sure and get this out. First of all, there are lots of ways to produce queens. So I'm going to really just kind of go over the types of colonies one would use in a standard commercial queen breeding operation. Generally speaking, there are four types of colonies. I mean, you could argue that there are actually five types of colonies because that fifth type of colony is the colony that holds the queen who's producing the offspring that you want to make queens out of in the first place. But assuming that colony is not in the mix at the moment, once you have grafted these queens and are ready to go, you're going to need four colonies, four types of colonies to get them through to maturity. They are starter colonies, builder colonies, mating nucs, and drone source colonies. So starter colonies, builder colonies, mating nucs, and drone source colonies. So starter colonies, like the name implies, are colonies that begin the queen production process. So we're going to be talking about grafting in a future Five Minute Management. But grafting is essentially the process of taking super young female larvae and putting them into a human-made queen cup. And what you're doing is wanting to put that queen cup into a colony that is queenless so that they'll want to make a queen in the first place, but that is also absolutely slammed with young nurse bees. These are the bees that make the royal jelly necessary to feed developing larval queens. So the way to do this is you really need a lot of nurse bees, number one, but number two, you've got to give them a lot of open brood in the starter colonies to keep them

producing a lot of brood food or royal jelly in the first place. So a starter colony, for example, maybe a five-frame nuc where there's honey against one wall of the box, pollen against the other, and then two frames. So frames, let's think about it another way. There are five frames. So frame 1, 2, 3, 4, 5. Frame one is honey. Frame five is pollen. Frames two and four are open frames of capped brood. Again, just to make sure the nurse bees in there are cranking out the brood food. The middle frame, frame three is where you're going to put your grafted cells. So with all these young nurse bees in queenless colonies cranking out the brood food, they're going to be ready to start taking those larvae you grafted and push them toward becoming a queen. Now again, these started colonies need to be very strong, they can deplete their resources quickly. So a lot of folks like to feed these starter colonies. And typically these grafted cells are left in starter colonies the first 18 to 24 hours before they're moved on to the next step. So again, you start them in these queenless nurse bee-rich environments prior to moving them to the second type of colony, the builder colony. Now, the builder colony is the one that finishes the queen cell. And think of it this way, imagine having two deep boxes absolutely slammed with bees. In the bottommost box, you've got the queen from that hive, a lot of sealed brood and a lot of drone comb, so a functioning hive. Then you have a queen excluder on top of that box so that the queen can't go upstairs. And in that second box, the uppermost box, again, frames one through 10, frames one and two might be honey and pollen, frames nine and 10 might be honey and pollen. The rest of the frames, that would be three through eight, are all uncapped brood, again, to force a lot of nurse bees up into that uppermost box. And in the very centermost frame would be the frame where you move your queen cups. So it's almost like a starter colony placed on top of a functioning colony that has a queen but you want to keep that queen separated from where you're producing queen cells in that uppermost box. Essentially, what you want is a super strong colony full of a lot of nurse bees. But it's so strong that the queen's pheromone is a little bit diluted so that they want to continue that queen production process. It's almost like you're trying to get them to make swarm cells. They think they're making swarm cells, but they're really queen cells that, once they're capped, move to the third type of colony, which, of course, would be the mating nuc. So a mating nuc is usually a small, much smaller, dimensionally, box that's absolutely full of bees. You've got honey and drone comb in that mating nuc, and you'll pluck off one of those queen cells that's right from your builder colonies and place it into a mating nuc. You'll have one cell per mating nuc. That's the hive in which the queen is going to emerge from her cell, and from which she is going to go out to mate. Well, if she's going to go out to mate, you must have the fourth type of colony, which is the drone source colony. If you think back to the last podcast episode, I told you you've got to select two main types of colonies. One, this queen stock and two, the drone stock. So the drone stock colonies will be full-sized colonies managed normally in the mating apiary and also sited at apiaries around the mating apiary, these apiaries being half a mile to a mile away from the mating apiary so that you're saturating the area with the drones that you selected. Now, you want to coerce these drone source colonies to produce more drones than they otherwise would. So at least one, but at best, two frames in the brood box of every one of these drone source colonies will be drone foundation frames on which the worker bees build drone combs so that the colony produces a disproportionate number of drones. So to summarize what's way over five minutes, starter colonies to begin those queen cells, builder colonies to finish them out, mating colonies to move those cells into when they're ready for the queen to emerge, and drone source colonies to provide enough drones for those virgin queens that you'll be producing. So how bad did I do, Amy? I know I went way over.

Amy 38:27

You didn't do that bad. I mean, honestly, I stopped the timer but I was still listening to you and still learning so I think we're good. I think everyone will forgive you.

Jamie 38:35
I think you're just trying to make me feel better.

Amy 38:38
Well, next week we are going to be releasing a Five Minute Management on queen rearing. Specifically, we're going to be talking about grafting and so I'm pretty excited for that one. But Jamie, that's okay. We could have a Five, Seven, Ten Minute Management.

Jamie 38:53
Oh good, good, good.

Stump The Chump 39:01
It's everybody's favorite game show, Stump the Chump.

Amy 39:13
Welcome to the question and answer segment. Jamie, our first question for today. Someone has asked about something called torpor. And so they've heard that honey bees go into a state of torpor or hibernation in the wintertime. Can you explain what this is and what's going on?

Jamie 39:31
Yeah, it's interesting. I hadn't heard the word torpor in a very, very, very long time. When I think about having worked with honey bees, I think about the state of conditions that they go into during winter. I often liken it to hibernation. So hibernation can be a type of torpor, but it's not the exclusive type of torpor. So, essentially, it means slowing down one's responsiveness or physiological function during a specific time of year. So imagine, for example, how bears, they eat a lot in spring, summer, and early fall to store up a lot of fat. And if they live in an area that gets very cold, they'll hibernate all winter. Why would they do that? Why would honey bee colonies likewise go into this state of torpor or hibernation through winter? Well, if you think about it, hibernation, torpor, usually, these things are brought on when an organ is often brought on, at least, when an organism relies on resource availability to maintain its activity. Therefore, when the resources aren't available, it behooves them to slow that activity significantly, so there won't be such a great demand for the resources. Let's just use bears as our first example. Bears eat berries, fish, depending on the type of bear it is, it might eat roots, it might eat all kinds of things that are often readily available in spring, summer, early fall. But if the rivers freeze and the lakes freeze, they perhaps can't get to fish. We know the plants are in their state of torpor through winter. So there are no berries and fruits, vegetables, nuts, and these things available to bears. So bears then invest heavily when resources are available in putting on a lot of weight. And then throughout winter, that weight, in the way of fat, creates the energy and therefore, the heat necessary to keep the bear alive at a reduced metabolic rate, so that they can survive a resource-poor time of year. Well, honey bee colonies are exactly the same. Honey bees use nectar, they convert it to honey and honey is their energy source. Well, nectarivorous plants aren't available in much of the temperate world for late fall and winter. Now, we live in Florida, we've got nectarivorous plants available a lot of

the year. But even in Florida, there's a period of time that's, for example, up here in North Central Florida, where the University of Florida is, it's December, January, and February, there are not enough resources available to honey bee colonies. If these colonies were active through these months, they would burn out of their reserves. So what they do, like bears, is they will store up lots of honey in anticipation of the resource-poor time of year. They'll go collect a lot of honey, put it in their combs, and they essentially become a hibernating animal throughout winter. They slowly work through their energy reserves, maintain the basic activities of life, create heat, stay alive, reduce their metabolic activity, etc., and slowly go through that. Honey is essentially the fat stored by the colony, the beast. And just like bears use their fat to stay alive and stay warm, honey bees use their fat in the way of honey to stay warm and stay alive throughout winter so that they're ready to meet the world head-on when late winter and spring come around.

Amy 43:12
Gosh, bees are so cool. It's just amazing what they're capable of doing just to survive, right? So it's kind of funny also because I think I called it tarpor, and I meant torpor.

Jamie 43:26
It's okay, it's a hard word. It's really hard for me, especially given my southern drawl.

Amy 43:33
So, while you're kind of explaining that first question, or while you're answering that first question, that kind of took me to the second question that we have. And that's whether bees forage if there's nothing to find. So this person was asking and basically saying that it was mid-November, they're in Maine, it's really cold. The bees are kind of coming and going, but there's nothing really out there for them. So are they out foraging? Are they just being optimistic? What are they looking for?

Jamie 44:04
So the first question they asked is really important. Do they forage when there's nothing to find, or essentially, nothing available? The answer is no. So if there's truly nothing available in the environment, no nectar, no pollen, and they are still flying, then they are not foraging, at least for nectar and pollen. So why might they be flying? Well, there are a couple of other reasons bees might fly even at the time of year you suggest. Number one, they simply could be defecating. Bees like to leave the hive to defecate. When all goes well, they prefer to leave the hive to defecate, so maybe they're just taking what people call a cleansing flight. Number two, bees can be taking orientation flights, where it's a new cohort of bees that are finally ready to go out into the field, and they're just simply flying around the nest trying to figure out where their nest is in the greater the landscape. And in this case, these orientation flights will ultimately cease and lead to no foraging at all if there's no forage available in the environment, right? So defecation, we've got orientation flights. Bees can also fly to collect rosins, perhaps they need propolis. They'll make propolis from these rosins, or tree saps, or sticky substances from plants. So maybe they're out there collecting rosins. They can also go out and collect water. It's unlikely if it's really as cold as you suggest in Maine that they're out there collecting water. Water is used to cool nests, and less so or not at all really to heat nests. It's possible that they could be collecting water, some suggest to dilute sugars, in some cases, depending on what you're feeding them in the way of solid food versus liquid. And then, of course, there is some evidence that high pathogen

loads can drive bees to fly when they otherwise wouldn't be. And this might be a way to facilitate the spread of those pathogens between colonies. It's unlikely that to me, it's much more likely that they're taking cleansing flights, maybe orientation flights, but there are a lot of reasons that could fly even in the absence of a true forage.

Amy 46:05
Yeah, I remember when I first became a beekeeper, and it was winter. And I remember on the first warmish day in that winter, there were a bunch of dead bees out front. But then there were also bees that were just coming in and out of the entrance. And I'm like, "What is going on?" But, I mean, they were just doing their cleansing flight, even though it was still winter, there was still snow, it was just a little bit of a warmer day. So that's pretty neat. Alright, so the third question we have, this person is asking what they need to do with frames from a terminated colony. So basically, you've got your hive, you've got frames with honey pollen, brood, and what are you supposed to do with this? So how do you, I guess, store it? Do you store it inside? Can you store it in your office? What would this look like?

Jamie 46:50
We get these types of questions a lot. And what this tells me is this is normal, first of all, because colonies die. If you have 10 colonies, 1, 2, 3, or 4 are going to die throughout the year. So you're going to be left with hives where the combs are perfectly good. They may even have honey and pollen, and you don't want them to go to waste. So there's a bit of a decision tree that I'm going to walk you down to tell you what I would do with the combs. Number one, do you have a good grasp of why the colony was terminated in the first place? For example, if they died to Varroa or small hive beetles or chill or starvation, then the combs are instantly reusable. If you've got some honey and combs that you want to give to another colony, just do it. If you have some pollen in combs you want to give to another colony, then do it. If you don't have a need for those combs instantly, then you could store them. My favorite way to do that is in a freezer. You can leave them in their box and move that box to another strong colony, a colony that's sufficiently strong enough to cover and protect those combs from wax moths or small hive beetles. So there are quite a few things you can do. You can reuse the combs instantly, you can store them, etc. However, there are some instances where folks don't know what killed the bees, or they do know and are worried about future use. For example, if you have reason to believe that it was a pesticide exposure to kill the bees, I would get rid of the combs, right? I wouldn't want to reuse them and expose the next round of bees to those pesticides. If it was American foulbrood that was leading to the weak colony that ultimately led to your terminating that colony, I wouldn't reuse the combs. I'd burn the combs and discard the combs because I wouldn't want to move that over to another colony. So what if it was something like a virus disease or European foulbrood or chalkbrood? Well, there are split thoughts about this. Some folks like to put those combs into storage for a set period of time two or three months, in hopes that the pathogen loads will decrease naturally and you can use the comb safely. There's some research that suggests using the combs instantly doesn't do anything at all negative to the colony to which you move those combs. To be honest, there's not really great research out there at the moment on what the best strategy is. I know we've talked on the podcast before about methods of sterilizing combs and how we all wish we had them, but we currently don't. So maybe a good way for me to talk about it, Amy, is what would I do if I had combs that weren't pesticide exposure related deaths or weren't Varroa or small hive beetles but might have been a virus or might have been Nosema or something like that? I would probably put the combs into storage for two months, protect them the

way that I would have the other way, freeze them, something like that, and then use them next spring when making new colonies, and I wouldn't really worry too much about it. There are lots of ways to store comb. I mentioned freezing. We talked about this, I know, before in other podcasts, but a lot of folks don't have access to freezers. There are some chemical methods to store combs to protect them from wax moths using para-dichlorobenzene or wax moth crystals. There are ways you can do it to increase light and airflow through combs, but you really want to protect those combs because they really are gold. It takes bees' energy to make those combs. And that's why I really prefer freezing and some of these other methods. We have a document on protecting combs from wax moths and that document lists a lot of good pointers on how to protect combs in general. So we'll make sure and link that document in the show notes and make it related to this specific question so folks can find out more information.

Amy 50:23
Yeah, absolutely. It's definitely super helpful. I just had this question, actually, the other day. And it was simply because they were pulling their honey super off their colony because they wanted to treat. And so there were like, "What do I do with this? Where do I put it? I don't have a freezer. So where do I put it?" It's like, "Well talk to Jamie Ellis and he'll provide you resources."

Jamie 50:47
Well, that's why I want to make sure we link to that document. Again, it's written from a controlling wax moths and stored comb perspective. But really the recommendations on storing the comb in that document are relevant regardless of what reason you're storing combs.

Amy 51:02
Absolutely. All right, everyone, let us know if you have any other questions. We would love to hear from you. Hey, everyone, thanks for listening. Today, we'd like to give an extra special thank you to our podcast coordinator, Lauren Goldstein, and to our audio engineer, James Weaver. Without their hard work Two Bees in a Podcast would not be possible.

Jamie 51:34
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!