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SPEAKERS

Jamie, Stump The Chump, Serra Sowers, Guest, Amy

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 00:46
Hello, everybody. Welcome to this segment of Two Bees in a Podcast. Today I'm excited to be joined by Dr. Garett Slater, who is a postdoctoral research associate with the USDA ARS at the Honey Bee Breeding, Genetics and Physiology Research Laboratory out of Baton Rouge, Louisiana. However, he is calling from Indiana, is that right, Garett?

Guest 01:06
That's correct. Yeah. Thank you for having me.

Amy 01:08
Yeah, we're excited to have you. But before the episode, before we started recording, I was just talking about how I had seen you, I feel like, in the past couple of months, I've seen you everywhere that I've been, all the conferences, you've been a speaker, and you've been talking about drones and their contributions to queen failure. And so we wanted to bring you on to the podcast today to talk to you about drones and their contribution. And we'll get into that. But before we do that, can you tell our audience just a little bit about yourself and how you got into honey bees and honey bee research?

Guest 01:40

Yeah, so I'm originally from the southwest corner of North Dakota. There's not much in North Dakota. But what there is, is there's a lot of beekeepers and so I grew up in this beekeeping family. My uncle actually managed 10,000 to 15,000 colonies. So I've really been around beekeeping my entire life, especially from sort of a commercial beekeeping perspective. And from there, I decided to really focus on research rather than actually keeping bees. One of the major drivers of my deciding to focus on research was I remember this day in 2006 when we were preparing colonies for almonds and we found that 80% were dead. And it was just one of those perplexing things where we really didn't know why. And so from there, I really decided to focus on research and trying to identify solutions for beekeepers. From there, I went to do my master's degree at North Dakota State University, focusing on pre-nutrition. And then I took a kind of a two-year sabbatical with the Bee Informed Partnership where we sampled beekeepers from across the Midwest include North Dakota, Minnesota, Wisconsin, and Indiana. And then from there, I decided to pursue a PhD. So I did my PhD at Purdue University under Dr. Brock Harpur. I really focus my research on drones and queen quality. So now I'm currently a postdoc at the USDA ARS in Baton Rouge. And the labs really focus on breeding and genetics. It's really up my alley, I'm really interested in breeding. So it's really a perfect situation for me.

Jamie 03:10
Yeah, I think Garett, just like what Amy said, I keep hearing your name all over the place. You've been giving a lot of talks about queens, drone quality, things like that, and that's really what we want to chat with you about today. Kind of as a preamble to that, our listeners in the podcast have heard me kind of ramble on about this for a while, the Bee Informed Partnership data, when you look at it, every year beekeepers, through the Bee Informed Partnership data, report that queen quality is a really big deal for them. And we've talked about queens in a lot of different ways on our podcast. We've had a lot of different folks talking about and this is really relevant around the world. When I travel around the world, beekeepers really everywhere are talking about queen quality. You and your research, you've really kind of taken a slightly different angle. Yes, you're looking at queen quality, but you're looking specifically from the angle of how drones might impact queen quality. I think that that's a really interesting thing. I think it'd be very beneficial to our beekeepers to hear about that. So let's just kind of start from the beginning. Let's talk about drones. I'm assuming there are some certain traits associated with high-quality drones. What are those traits?

Guest 04:16
Yeah, yeah. So first off, I mean, one reason I really got interested in drones was, I mean, it's something that's really under study in the first place. And we're starting to realize that they are huge contributors to queen failure. A lot of ways we're seeing that, queen fillers are being linked to more drone traits rather than queen traits altogether. And so when you think about high-quality drones, I really tried to split this into sort of three major categories of traits. One is the sperm production so the sperm related traits. Two is sexual maturity, and then three is mating behavior altogether. Now, for sperm production, honey bee drones are really unique in this way. Sperm is only produced during a two-day span during development. So if you've ever opened up a colony, we have drones developing when the drones are really large and right before they're capoed, that is when sperm is produced. And then once your capped, that's the second stage of sperm production. And so it only occurs during this two-day period, whereas in most insects or closely related taxus, sperm is really produced continuing throughout life.

And so sperm production is really important to its sexual maturity. Sexual maturity is not really tied to sperm production because sperm is being produced during development. Sex maturity is more tied to this kind of maturation of the sperm and sperm getting ready during mating. This occurs during the first 10 days of the drone lifespan where they're kind of in the middle colony being taken care of by other workers, they're really kind of in this teenage stage because they really depend on workers for everything. And then once drones reach sexual maturity, they go into the outskirts of colonies, they start feeding on this high-sugar diet, and they go on these constant mating flights. And they do this until they either mate or they die trying. And so yeah, when I think about high-quality drones, I really split these sort of three major categories, sperm production, sexual maturity, and mating behavior.

Amy 06:08
I had no idea that sperm was produced during that two-day period. I feel like if there was anything new that I learned in this podcast, that would probably be it. So thank you for sharing that with us.

Guest 06:18
It's a very sensitive stage too because it only occurs in like two days. And if something happens during that stage, it can really cause irreparable damage to the drones, right? So it's not like they can ever produce sperm ever again, it only occurs during this two-day period. So that's why if anything happens during that time point, it can cause really irrepairable damage to the drones.

Amy 06:39
Yeah, absolutely. So I mean, just the things that can happen within the colony, but also environmental factors, I assume that there are environmental factors that are also associated with drones and colony health in general. And so we started talking about high-quality drones, but what other factors can cause, I guess, poor drones or anything that can happen during that production?

Guest 07:05
Yes, so there are a ton of different environmental factors that are associated with poor-quality drones. There's been a lot of great research on that. I mean, we can split that apart to pesticides. So we know certain pesticides can cause poor drones and poor sperm quality, such as neonicotinoids and fungicides. There are certain acaricides that can cause poor drones such as chemical parasites, even organic miticide treatments can cause poor drones. Poor nutrition is a huge driver of poor drones. So really, any of these environmental factors that are associated with low-quality health can impact drones. Probably, the major driver of poor drones is Varroa and the virus is a transmit, and so like I said, if sperm is only produced during development, I mean, these drones are just basically maintenance for mites. During this stage, this is when the mites are feeding on the fat body of the drones and you're transmitting viruses, and this can really damage drone quality and drone sperm altogether. So really, all these environmental factors combined can cause poor drones. So there's not really one that has the biggest effect, but they all kind of combined have a huge effect on drones.

Jamie 08:10
Gosh, I'm listening to you talk about this. I can almost anticipate the answer to the next question as we link that quality of drone to queen-related failure. So I'm going to ask you just that - queen failure is a

leading driver of colony losses, so how do drones contribute to that? Before you talk specifically about the role maybe drones play, could you tell our listeners what you consider queen failure? Is it just the death of a queen? What is that umbrella of queen failure? And then how do poor-quality drones contribute to that?

Guest 08:42
Yeah, that's an excellent question. For me, queen failure, I'm going to kind of do from a survey's perspective, when we survey beekeepers, when they call a queen failure, they're seeing that these queens are being replaced at a really high rate. I think it's been recently showing that 50 or 60% of queens are failing or being replaced within six months, and that's a really high rate, especially comparing that to historical estimates where queens should be reproducing for two to three years. I mean, I've heard a lot of different stories from old-time beekeepers saying, "Well, I had this queen that survived and reproduced for two or three years and now, I'm purchasing this queen or raising my own queen and it's failing within six months." So that's a huge problem because queens are really important to not only colony health but colony survival overall. So your second question was how do drones actually contribute to queen failure? So we think about the importance of a queen, we can think about not only your contribution to a colony and her egg-laying rate and all these different traits related to fertility, well, there are queen aspects to that, like her actual egg production. But in order for her to actually lay eggs, there has to be sort of a sperm component, right? The sperm has to fertilize eggs. Now, if queens are mating with poor-quality drones, whether those drones are producing sperm that's 50% dead or not enough sperm, that can impact her egg-laying rates, which can impact the quality of the offspring she produces. Drones have a huge, huge role in a lot of these queen traits. And let's say the queen mates poorly with these drones, if she runs out of sperm faster, or if a lot of the sperm is dead, then it's likely that the workers are going to sense that she's a low-quality queen, or the queen is unable to lay fertilized eggs anymore, and then the colony will just replace the queen. There are lots of factors that contribute to queen failure but drones are really important because they really contribute the sperm to the queen traits.

Amy 10:49
So, Garett, you're really looking at the other half, right? So the queens, they mate with drones, and the drones, they have to be high quality. I know that you were talking about high-quality drones having good sperm production, being at sexual maturity, and their mating behavior. And so you've done research with drones, and you've looked at key genes associated with these high-quality drones. Why did you do that? I guess I'm gonna ask that. Why did you do that? How can you use this, how do we breed better drones? How do we have more high-quality drones?

Guest 11:28
That's a good question. When you think about poor drone quality, I think there's a lot of research showing that there are environmental factors that cause poor drones. I outlined that beforehand where we think about poor nutrition, pesticides, miticide treatments, pests, and pathogens. We know a lot of these environmental factors that cause poor drones. Now, what I was really interested in was, what are the genetic factors that cause high-quality versus low-quality drones? And the reason I'm interested in genetics is because if we can identify certain genes or gene networks that cause a high-quality versus

a poor-quality drone, we can use this in breeding a selection program. And so at the USDA Baton Rouge, we're really interested in breeding selection for a wide range of traits, including including improving stocks. So one thing we want to do is improve drone quality and queen quality. And so my goal was, okay, we have these three major traits that are important for drone traits: sperm production, section, maturity, and mating behavior. What genes are actually associated with those traits? And how can you use this to improve breeding selection for drone quality and, hopefully, queen quality altogether?

Jamie 12:35
So Grrett, honey bee breeding has been focused on selection for Varroa defense and colony production for a very long time. Could this selection have a negative impact on drone fertility?

Guest 12:48
Yeah, so one thing that I guess beekeepers and queen producers and queen breeders have been focused on are these Varroa defense behaviors and honey production, for example. There's nothing wrong with that, right? It's something that's really important for beekeepers and bees. Varroa is really the number one driver of colony losses and production is really important from a business perspective. But one thing that we're starting to see is that if you breed for some of these traits, this could actually have a negative impact on drone fertility. If you take a step back and look at this from other industries, for example, if you breed for production, or some of these other traits, this usually has a negative impact on male fertility. And so one reason that we're seeing these different stocks produce low-quality drones may be because beekeepers are selecting for some of these traits, and it's having a negative impact on male fertility, or even queen fertility. There's nothing wrong with selecting for these traits, it's something that we need to consider. And so for me, as a researcher, how can we not only breed and select for some of these traits that are really important for the industry but also breed and select for improved male fertility and drone fertility? So trying to understand the genetic drivers of these traits and how they contribute to these together, how we can select multiple traits at the same time is really, really an important next step.

Amy 14:09
Yeah. So kind of bringing that back to what you were talking about with your genetics and breeding for high-quality drones, what can be done? What do you recommend being done to address the issue with drone quality? Maybe elaborate a little bit more on, again, just selecting for those high-quality drones.

Guest 14:27
So one thing we want to do at the USDA is really breed for colonies that produce high-quality drones. And so one thing I want to do is, now we have a candidate, so for my PhD research, we found we have these genes, and these genes are associated with these high-quality drone traits: sperm production, sexual maturity, and some of these flight traits that we looked at. And next question is, okay, how can we actually integrate this into our breeding program? So, we already have these Varroa resistant stocks. Now, how do we also improve drone fertility altogether? One thing we want to do is kind of pre-screen drones. So we actually have a closed breeding program at the USDA ARS where we select drones from one colony and then inseminate them from a queen from another colony so we can kind of

perpetuate this trait of interest. Now, what we might do now is actually pre-screen drones for some of these genes. And so instead of just kind of randomly choosing drones from these colonies, we want to look at the genes in these drones and say, okay, these drones not only have a trait of interest, such as maybe VSH, or some of the Russian breeding program traits, but also have these high-quality drone traits. And so by pre-screening, we can not only select for Varroa defense behaviors, but also some of these high-quality drone traits. And so that's something that we're interested in doing is integrating some of these genes that are found into the current breeding programs to really improve this trait.

Amy 15:48
So I have a really super silly question about drones. How do you collect semen from drones, like for insemination?

Guest 15:58
Yeah, that's a really good question. Once drones reach sexual maturity, they're usually the ones that are flying, and so if you ever want to do this once your colonies are producing drones, you just collect drones are flying back into the colony, and you just take them and you just squeeze their thorax. And once you squeeze their thorax, the endophallus, which is kind of this clear structure will pop out. From there, they have brown solution at the end of the endophallus. From there, you just use a pipette and just pipette the sperm up and then you can use that for your insemination program. So there's some really good videos on it on YouTube.

Jamie 16:36
There are videos about everything. I'm not surprised. I'm not surprised that someone has filmed that and put it on YouTube.

Guest 16:42
Yeah, I'm trying to describe it. But there's probably a better video online.

Jamie 16:46
I completely get what you mean, Garett. I want to circle the wagons back a little bit because when you mentioned a little bit earlier, this idea about there are three things that you think about with high-quality drones, sperm production, sexual maturity and mating behavior, I think about all that you're saying here, how when they are developing is when they produce the sperm, just general sexual maturity after emerging, the ability to get to and from DCAs, drone congregation areas. I think about this idea of selecting drones or selecting drones with all of these great traits. But how do you ensure proper development in the colony? So, you can select drones to have these traits, but if they're nutritionally starved, or exposed to pesticides while they're developing, or whatever, all of that can still crumble on itself. So, what type of colony maintenance is necessary? Once you have the drone stock selected, what type of colony maintenance is necessary to ensure that the drones have the best chance of being really good when they finally reach sexual maturity?

Guest 17:55

Jamie, that's a really excellent question because we have to make sure that the environmental factors are really the best to make sure that these drones are high quality. We can really start with really high-quality nutrition. We can make sure that the colonies are well-fed, they have a good diversity of protein sources and sugar sources, and so nutrition is probably the most important one. Second are these miticide treatments. If you are raising queens, and you want to produce high-quality drones for these queens, making sure that you're limiting the acaricide use until after the queens are fully mated. We know that a lot of these synthetic acaricides such as Amitraz can really impact drones. We know even organic treatments, such as oxalic acid and formic acid can impact drones. And so just kind of being aware of those things and how they impact drones is really important. And probably the most important one is Varroa maintenance, right? Drones are these mite magnets. If you've ever put a drone comb to a colony, and you guys know this, the mites are attracted to the drones. If you have a really high mite population, that's going to impact your drones, not only are the queens that your drones are mating with, but also, they're going to be mating with queens from your neighbors, for example. And so making sure that Varroa is managed is probably one of the most important things.

Jamie 19:19
I was just sitting here listening to you talk about that. So my mind's going, you got this kind of catch-22. You've got to control the Varroa in the colonies to ensure high-quality drones while they're developing, but then you have to use acaricides to do that. And I'm wondering, you mentioned thymol, I think thymol and oxalic acid specifically, but I wonder what some of these other Varroa-cides, Amitraz or things like that, what impacts they might have even when used at label rates, or maybe they have no impact at all if they're used at label rates, and they're completely safe for developing drones. But I'm curious, how do you control Varroa in the context of trying to reduce pesticide exposure to drones?

Guest 19:55
No, that's an excellent question because we know that not only the acaricides impact drones, but also the mites impact drones. So you have to not only treat to control your Varroa, but we also know they impact drones. So I really think that there are some non-invasive or non-chemical methods for controlling these Varroa, such as drone brood removals, maybe using that type of method or, integrating a brood array to some extent. But I think when you think about this, I think the most important thing is to think about this from when your queens are actually mating with the drones. And so this would be really more the springtime. Maybe using more organic treatments in the spring when your queens are mating to make sure you have high-quality drones. Now, obviously, you can't just limit yourself to that throughout the whole season. Even your beekeeping practice and where you're located, but you can't just not use chemical treatments at all. I don't want to say that, but but you want to try to control Varroa to the best of your ability. Think about that way.

Jamie 21:01
So Garett, you mentioned it again, sperm production, sexual maturity and mating behavior are all ways that you can gauge the quality of a drone. So I want to get to that mating behavior. I had a master's student here years ago who would find DCAs in Florida, and we were looking at the proportion of drones that were European-derived honey bees versus African-derived honey bee. So I know the difficulty with finding DCAs and working drones at DCAs but my mind is sitting here saying, "Well, if

there's something that's impacting sperm quality or sexual maturity in a drone, might that something also keep drones from ever finding drone congregation areas in the first place?" In other words, if they show up at the DCAs, haven't they already been de facto selected to be good-quality drones? Or do you find that a lot of drones at DCAs are also poor-quality drones? Just because they made it to a DCA doesn't mean that they're sexually mature or have a high mobile sperm count? So can you talk a little bit about that whole mating behavior occurrence at DCAs and what we know so far?

Guest 22:05
So, first off, one thing I've always been interested in is we have these traits of interest, we have like sperm production and sexual maturity, but what's happening at these actual drone congregation areas? Now, for my PhD research, I never had a chance to really find these DCAs and look at what's happening these the DCAs. But one thing I am finding is that there are these wide variety of traits. We know that some drones produce low-quality sperm, some drones reach sex maturity earlier, but they are initiating flight at age seven to age 10. And so even though they are producing low-quality sperm, they are going to these drone congregation areas. I think one reason for that is that drones have such a limited lifespan or sort of a limited time period in order to mate that even if they are producing kind of low-quality ejaculates, or they're not fully sexually mature quite yet, it improves their chance to actually pass their genetics to the next generation. I'm sure they might change mating behavior based on their quality. We know that around age 14, that's when drones really maximize their quality. We know once they reach that time period that they're gonna be flying more often just to really maximize sperm production. But even if their sperm is low-quality, and they haven't fully reached sex maturity quite yet, they might still be going to these congregation areas just to really maximize their chance to really pass their genetics to the next generation.

Amy 23:31
So Garett, you've given this talk, you've given talks on drones and their relationship to queen quality many, many times. But, I'm interested to hear what are your most common questions or feedback from your audience when you give this talk?

Guest 23:48
It's kind of hard for me to display my actual research, my plots and everything. But one thing I found was I had some drones that haven't reached a certain maturity at age 20, even though they should be mature and producing high-quality sperm at age 10 to 14. And so one question I always get is, well, if these drones aren't reaching sexual maturity by age 20, what happens after this timespan? Well, it's possible that these drones may never reach sexual maturity, or it's possible that they may delay sexual maturity an extra week, for example. And so that's one common question I always get. Another question I get is, can the workers actually gauge drone quality? That's something that I'm really interested in. So that's something I'm actually finding is that if we have drones that are low-quality, that workers actually give them different behaviors, right? Or give them more care, give them more food supplements to make sure that they are higher quality, or they may stay in the colony longer because of that. So those are probably two common questions I get. Another question I usually get is, I guess, as a beekeeper, what what can you do to improve drone quality in your operation? One thing, it's tough for me to really explain because I've identified these genes, and they're associated with these three major

drone traits. Now, from a breeding perspective at the university and at the ARS, we're focused on using that in our breeding and selection program. Now, for an everyday beekeeper, I mean, what can you do? I mean, one thing I really try to stress is, in the spring, whether you're raising your queens or you're buying virgin queens or you're buying queen cells, making sure that the drones are of high-quality as you can. So that means making sure that they have the right nutrition, making sure to limit parasite treatments to the best of your ability, limiting exposure to some of these pesticides, that's probably the best you can really do. I mean, one thing we want to do is breed for better drones, but there are things that you can do as a sort of everyday beekeeper.

Amy 25:55
Yeah, absolutely. Well, I'm super excited that you were able to join us today. And I'm just wondering, I know that you'll be around the honey bee research world for a while, so tell us maybe about some of your future plans.

Guest 26:08
Yeah, so right now I'm a postdoc. I'm really looking for a full-time position. So what I want to do is run my own lab, kind of what Jamie has. I want to have a lab that's really focused on genetics and breeding. How can we use some of this new genomic technology to breed for better bees, whether that's breeding for bees that are tolerant or resistant to Varroa and viruses, or whether there are bees that have high drone quality? What I want to do is have my own lab where I really focus on genomics and breeding.

Amy 26:43
Very cool. Well, is there anything else that you wanted to share with our audience?

Guest 26:47
No. I think the one thing I want to share is that when you think about drones, I just want you to think that they are really important for colony health, even though a lot of people really forget about the drones. They are really important not only for queen fertility, but also overall colony health. So never forget about the drones.

Amy 27:02
The drones are just as important. Right?

Guest 27:04
Exactly.

Amy 27:05
All right. Well, thank you so much, Garett, for being with us today.

Guest 27:09
Thank you for having me.

Amy 27:18
Well, I'm excited about Garett doing talks everywhere. He's really focused on drones. I feel like a lot of times, Jamie, we focus on pests and diseases, queen quality, and of course, there's that other piece of queen quality, right? You've got to have nice high-quality drones to be able to have good queen quality.

Jamie 27:37
I listened to Garett's interview, Amy, and the whole time I kept thinking of how bad of a rap drones have gotten, historically. And when I think about that, even I've said it probably in lectures in the past, "Oh, drones aren't that important. Workers kick them out, all they do is mate with the queen." But gosh, they may not contribute, really, any work to the nest, but they are half of the DNA of the workers in that nest. And that's incredibly important. I mean, you could argue queens also don't do much in the nest, they just simply lay eggs. But the workers are the physical manifestation of the genes that the queens and the drones carry. You hear people talk about selecting for queens, wanting to have all of these traits, our queens are failing, well, that queen failure according to Garett, and actually, frankly, others I've seen, Dave Tarpy gives a really interesting talk about this, that queen failure can be due to running out of semen, receiving poor-quality semen, mating with drones that are sterile, whatever, there are thousands of things. And you've got this issue that's exacerbated when the drones themselves are not high quality. So they're incredibly important, which should, of course, have come at no surprise to us, but they're incredibly important and how their quality is exhibited affects the success of that colony.

Amy 29:00
I feel like there's going to be a lot more drone research coming out here pretty soon. I have a feeling.

Jamie 29:06
It seems imminent because there's so much focus on queens, there is so much focused on behaviors of workers, and I know people have kind of been dancing around the drone issue for a very long time. I've got scientists/colleagues who would say, "Well, we've known drones are important the whole time." But honestly, if you think about drone contributions to the colony, and how they may play a role in this queen loss or poor queen quality issue, then you have to know that people are really going to begin exploring this like hardcore straight on to make sure that we, as a scientific community and a beekeeping community, address this very important issue.

Amy 29:39
Yep, absolutely agree.

Stump The Chump 29:44
It's everybody's favorite game show, Stump The Chump.

Amy 29:54
Alright, welcome back to the question and answer time. Jamie, we've got so many questions that come in, and we decided for this episode to pull some questions, because we thought they were pretty interesting, from the article that you write in the American Bee Journal. Right? Is it The American Bee Journal? American Bee Journal.

Jamie 30:13
It's American Bee Journal, but the column I write is The Classroom. And it's funny because that's where beekeepers ask questions of me, and I have to answer them, but I do it with writing. And on this, I'm being stumped as the chump, but I answer them verbally. I feel like I do a better job of answering them written style than I do orally, but we'll see. We'll see how I do today.

Amy 30:36
The pressure is on. Alright, so the first question, and this is funny, I mean, we eat lunch together every day. I think a lot of people know this, not just you and I, but the entire lab here. This was a question you asked all of us. And it was really fun to hear the responses that people had. But the question is, what is the best time to requeen?

Jamie 30:58
So just as a little bit of background for our listeners here, I'm stumped way more often than not. I have to do research to answer the questions that you ask, that is true here as well as for me writing for the American Bee Journal. And so I get these questions that I look up for research, for some sort of scientific answer because I want to support what I say with more than just anecdote. I want to look at a research paper study where this was investigated. I couldn't find anything at all about what the best time of year to requeen was. So I just, like you said, Amy, asked at lunch, and we got multiple answers. So I harken back to another listener who said, "Well, I know all you're gonna say is it depends." So here I am saying it depends yet again. So I've become very self-conscious about saying it depends. But nevertheless, I would argue from a management perspective, it is probably best to requeen as early in the year as possible, immediately after winter. And so let me just say why. First, I believe having young queens that are very productive going into the major nectar flow is a good thing. Number one, that reduces their swarming tendency, doesn't eliminate it, you can still get swarms from colonies headed by young queens, but it reduces the swarming tendency. And also, generally speaking, younger queens are more productive than older queens. They just simply lay more eggs because they're younger. If you do this well enough in advance of the major nectar flow, then hopefully you can maximize your colony's population, and be ready for the nectar flow. So for example, if your major nectar flow starts in mid-April, and you can requeen at the end of February, you get all of March and half of April for that new queen to be laying eggs, six weeks of brood production, maybe they're ready to go. So to me, that's like the best time of year from a management perspective because you're maximizing colony populations. The downside is, Amy, that's also the most difficult time of year to get queens for two primary reasons. Number one, it's hard for breeders to predictably produce queens that time of year because you never know how bad the late winter weather is. And that all dictates whether or not colonies are producing drones, whether they're producing queens, whether they're back into their normal routine or if they're still tight in their winter clusters. So it's low queen availability that time of year. Now, the second reason, which is maybe an even more important reason, is that commercial beekeepers who have thousands upon thousands of colonies often get on the queen order list last year for queens that are coming out as early as possible this year. So even when queens can be produced, they're often spoken for by other beekeepers, usually commercial beekeepers. So while it may be best from a management perspective to do it at the very end of winter or the very beginning of spring as possible, from a practical standpoint,

it's not always easy. So let me walk you through the rest of the year and give you some pros and cons of the rest of time. I don't like requeening during the major nectar flow. So if I can't requeen early in spring, I might try, again, let's use April 15 as another example, I might try to requeen as late as mid-March, but after that I just move forward with the queen that I have. So I don't like to requeen during the major nectar flow unless there's a reason to requeen like, she's dead, dying or poorly performing in some way. Because I just don't like to mess with the system while the bees are supposed to be maximally productive. So right after the major nectar flow can be a good time of year to requeen for a couple of reasons. Number one, the queens are more available. Number two, you've got a lot of bees in your colony, so a lot of beekeepers with nothing to do, a lot of beekeeper use this time to make splits. You've got a lot of bees with nothing to do, their nectar flow is over, why not purchase queens and requeen the parental colony as well as use a second queen to split that colony? I don't hear about a lot of requeening taking place in the middle of summer. That seems to be a lull period for a lot of beekeepers. But you can get a lot of late summer and/or super early fall requeening depending on where you live. And the advantage of that is queens tend to be very available, the demand for them is lowest that time of year. They often go on sale that time of year. You often can get a discount on queens that you purchase that time of year, and you can get the strong young queens who produce a lot of offspring who, hopefully, can carry your colonies through winter more successfully. And when they get out of winter, those queens aren't still aren't so old. They're only six to eight months old when they're coming out of winter, which is still better than having a one-year-old or two-year-old queen. So it's kind of the average, the best of both worlds. You get a young-ish queen coming out of winter, but you also get a lot of good strong production going into fall so that you have a critical mass of bees. So a lot of people will do it for those reasons. So, really, it kind of depends on what your goals are. But honestly, most commercial beekeepers are very strategic about when they requeen, they know when they're going to do it for very defined management practice, and a lot of hobbyists just do it kind of reactionary, right? They do it in reaction to a dead queen, a failing queen, a swarm or whatever.

Amy 31:34
Yes, we did. Yeah, when you had asked the question, my immediate response was just, "When you're able to get a queen. The earliest you're able to get a queen." Done, finished.

Jamie 36:52
Exactly.

Amy 36:54
Okay, thank you for that. So for the second question that we have, so someone is asking about Bt corn pollen, and is that bad for bees? So, Bt is the bacteria Bacillus thuringiensis. Try to spell that out. I don't know, I should submit myself into a spelling bee.

Jamie 37:14
Please don't make me.

Amy 37:16
But anyway, back to the corn pollen. Is it bad for bees?

Jamie 37:22
Okay. When I was asked this question, it's an important question, I'm glad I got asked this question, but it's a little difficult to answer because it's one of those questions that really has three answers. Let me explain to you what I mean by that. The questioner was asking it from the perspective, really, does the Bt part of Bt corn pollen harm bees? And let me explain what I mean. Amy, you're spot on. Bacillus thuringiensis is a bacterium that produces a toxin that depending on the strain of Bt, the toxin can be toxic to different groups of insects. There are Bt strains whose toxins work well against beetles, there are Bt strains whose toxins work well against moths, as an example.

Amy 38:19
Right. And the reason why they have Bt corn is because of the pests that the corn growers have, right? And so isn't that part of Bt and why that's in there?

Jamie 38:29
That's exactly where I'm heading. So essentially, when scientists discovered this, they isolated the gene from this bacterium that produces the toxin, and they can put that gene into corn. So the corn itself, in its genome, expresses this toxin. So when moths, caterpillars or beetles or whatever, are eating the corn, they will die because they are exposed to the toxin that was otherwise present -- that was otherwise derived from the gene that came from Bacillus thuringiensis. Now, for purposes of full disclosure, that's what makes corn, in this particular example, a genetically modified organism or a GMO. As you know, and I'm about to step in it here, but GMOs are an incredibly hot-button issue. Some people aren't concerned about them at all. Some people are afraid that they're going to be eaten by corn stalks at nighttime because GMOs just really produced that level of anxiety in the general public. So I'm not going to wage that battle right now, except to say that Bt corn protects the corn while it's developing from things that you would otherwise have to put a pesticide on to kill. Now, a lot of folks have speculated Bt could be bad for bees. I have seen study after study after study where people have looked at the impacts of Bt on bees or looked more appropriately for impacts of Bt own bees and could not find any. I specifically found a study where they collected pollen from Bt corn and fed it to bees and could not get a response. I looked at another study where they isolated the compound itself, the actual toxin and fed it directly to bees, and it would not kill them. So I do not think there is any evidence at all that Bt corn pollen, from the Bt perspective, is bad for bees. And when that question is asked, that's how they usually mean it. Now, there's two other ways that it can be understood as well. And I'll be much quicker with this. Number one, you could just ask yourself is corn pollen good for bees at all? Is corn pollen a high-quality pollen that we should be collecting? People are working on that right now. But even if it turned out to be bad for bees, it's not because it's got Bt, it would just be because corn pollen is not good for bees, like pine pollen is not good for bees. So it has nothing at all to do with the Bt, it just has to do with the fact that it's corn pollen. So the third way people will usually try to implicate GMOs as well, it might not be the GMO part, but it's the fact that a lot of GMO crops are grown from seeds that are dipped in systemic insecticides to protect the young plant. If you've ever bought corn seeds from the seed store, you'll notice that a lot of corn seeds have this kind of purplish, pinkish dust on the seed. Well, that is a pesticide that when you plant the corn, and the corn grows, it helps that it protects the young seedling from damage from insects. So a lot of people looked at that, the potential impacts of

corn dusts, these things that have added to these seeds to protect the bees looking at pesticide impacts on bees, even if that has overwhelming evidence, which it doesn't, but even if it were to have overwhelming evidence that it was bad for bees, again, it wouldn't be because of the Bt. It would be because of the pesticides. So the answer to the question is the Bt part of Bt corn pollen, there's no evidence that it harms bees. So from the GMO perspective, Bt corn is okay for bees. Now, this might incite a lot of people, but I'm just pointing out what the research says.

Amy 38:30
Sounds good. Alright. So for the third question we have, the person's asking, do immature honey bees killed by American foulbrood fluoresce? So I am reading this and I assume it's just one of those things where if they do fluoresce, maybe that's a way to identify American foulbrood? I'm not sure. So what are your thoughts? Have you ever tried this?

Jamie 42:50
Amy, that's exactly why people ask me the question.

Amy 42:53
I believe it.

Jamie 42:53
Yeah. It's funny, I mean, when you get asked questions, you learn so much. So when I give presentations, I give presentations to bee clubs all around the world, they're asking me about stuff I'm talking about and studying. So I usually know the answer. But when I get questions like for our podcasts or for the American Bee Journal or just a question --

Amy 43:13
It's a free for all.

Jamie 43:14
It's a free for all, and it's stuff that's often way outside of my knowledge. You don't know everything and so I have to do a lot of work. Well, I've known about and read about and seen American foulbrood for decades now and never heard that if an immature honey bee dies from American foulbrood that it fluoresces so I looked it up. Guess what? It fluoresces.

Amy 43:37
No way. Seriously?

Jamie 43:38
It does. It does. And so let me talk a little bit about this to help our listeners understand what I mean. American foulbrood is a bacterium. Well, it's a condition produced by a bacterium called Bacillus larva. That's the name of the bacterium. So larvae will eat this bacterium, and it will kill them and often, no, not always, it often kills them in the capped stages of their development. But before they start pupating, it can kill later stages and earlier stages, I'm just making a generalization here. But if it's killing that kind

of just freshly capped stage of bee, those grubs are still larvae. They're technically called pre-pupi. But they are a larva before it started to pupate. And what happens is when they die, they will sink to the bottom of a cell and form what we call scales. So anytime we talk about identifying American foulbrood in colonies, we refer to American foulbrood scales. You can look in the cells and look for scales, look for scales, look for scales. Bees have a hard time removing these scales. So scales are a telltale sign that the equipment that you're buying or the colony you're buying, has, or at least has had, an active American foulbrood infestation. So the questioner said, well do these things fluoresce? And I'm like, well, I don't know. Well, fluoresce means that when you look at these things under a certain wavelength of light, they will glow. Well, I looked it up, and sure enough, if you look at combs with a black light, the scales that are formed when an old larvae or pre-pupa die from American foulbrood, they will fluoresce, they will glow, as if you are like walking through a black lit room and are wearing a white outfit. You guys all know that experience. And so my hesitation about saying that you can use this for a definitive diagnostic characteristic is that other things in hives fluoresce. For example, certain types of pollen will fluoresce under black light. I know this with certainty because we had a master's student years ago, Emily Nordyke, who was looking at tracing pollen substitutes in hives, and in order to pick dyes that she wanted to use, she had to see if other things in the hive fluoresce, and sure enough, certain pollens that bees bring in will fluoresce. So my point is American foulbrood scales are larvae that form scales after being killed by the Paenibacillus larvae will fluoresce, but it's not diagnostic because other things will as well. So really, when you're trying to confirm that you have American foulbrood, you need to look for a number of characteristics that collectively suggest it, the scales, the sunken perforated cappings, that old ropey test which everybody's familiar. But in my search for the answer to this question, I found a really good document on American foulbrood written by scientists at Penn State University, and they actually have an image in that document of an American foulbrood-killed individual fluorescing when a black light is held over it. It's a really great picture. So maybe we can link to that document in the show notes so you folks out there can have a look at that picture produced by Penn State scientists.

Amy 46:56
Can I tell you something?

Jamie 46:57
Please do.

Amy 46:58
So we are working on a veterinarian grant. It's a USDA NIFA veterinarian grant, and I'm working with Dr. Meghan Milbrath at Michigan State University, Katie Lee at the University of Minnesota, and Dr. Juliana Rangel at Texas A&M. We are working with vets to teach them about foulbrood and we've got UV lights in their kits that we give to all the veterinarians, so I kind of actually knew the answer to that, but I was gonna let you respond anyway.

Jamie 47:25
Dadgummit, Amy, you knew the answer before me and you just let me stumble?

Amy 47:30

No, I'm just kidding. But yeah, I mean, you're absolutely right. There are lots of other different clinical signs that you look for in foulbrood. But, it's kind of fun to see the larva under blacklight.

Jamie 47:42
Hey, Amy, and here's some free education for our listeners, what you just said is brilliant. You said the words clinical signs. Honey bee colonies don't actually have symptoms. Symptoms have to be communicated by the sick individual. So only humans can have symptoms. Colonies cannot have symptoms of American foulbrood, they can only have clinical signs. The same is true for viruses and other bacterial diseases and fungal diseases. So clinical signs is the correct way, just like you did, Amy, to refer to conditions that we associate with these diseases and pests that we have. So there you go, folks, clinical signs.

Amy 48:27
All right, everybody, and now you know you can go out, buy your UV light. Thank you so much for all of your questions. Keep them coming. Don't forget to send us a message on Facebook, Instagram, or Twitter, or send us an email honeybee@ifas.ufl.edu.

Serra Sowers 48:42
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.