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

Jamie 00:05
Welcome to Two bees in a Podcast brought to you by the Honey Bee Research and 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. In this episode of Two Bees in a Podcast, we are going to be speaking with Keith Delaplane, who is a professor at the University of Georgia. He'll be here talking to us about queen mating behavior. That segment will be followed by a segment [in which] Amy and I are discussing the label. Have you ever wondered how to interpret pesticide labels; what they mean and if you should follow them? We'll be talking all about that in a segment called The Label is the Law, and of course, we'll be finishing today's podcast with our famous question and answer segment. Thanks guys for joining us on this segment of Two Bees in a Podcast. As far as I'm concerned, we have a very special guest with us today to talk about some of the things that he's been up to at his institution. He's special because [of] many reasons. He's done a lot to accomplish things professionally for honey bees and for beekeepers around the world. But I also have known him for a very long time. I worked as an undergraduate in his laboratory for four years when I was pursuing my undergraduate degree at the University of Georgia, and then I came back to his lab and served as a postdoc in his lab for a couple years after I got my PhD. He was in my wedding and most people who [went] to my wedding can remember the bagpipes. Everybody says, who is that guy who played the bagpipes? Absolutely, Amy, and I'm talking about none other than Dr. Keith Delaplane, professor of entomology, Walter B. Hill fellow from the Department of Entomology at the University of Georgia. Dr. Delaplane, thank you so much for joining us on this podcast.

Guest 02:17
Well, thank you, Jamie. And I always say there's no event that a set of bagpipes can't make better.

Amy 02:23

That is so funny. You know what? Dr. Delaplane I think your name has been brought up in probably 75% of our podcasts now.

Jamie 02:33
That's our point of reference, right?

Guest 02:35
Is that a good sign or a bad sign?

Jamie 02:37
The funny thing is people at my wedding don't even remember me being there; they all remember the bagpipes playing. Doctor Delaplane I don't know if you know, but Amanda now we've been married for just about 18 and a half years now. So that was some time ago.

Guest 02:53
Oh, Mercy.

Jamie 02:54
It's crazy. Time flies. All right. I've known you for some time now, I guess 20 plus years and I'm curious if you could tell the listeners a little bit about yourself: how you got into bees and beekeeping and how you found yourself at the University of Georgia?

Guest 03:08
Well, I consider myself very fortunate that I was able to follow a boyhood hobby into graduate school and ultimately a faculty position here at the University of Georgia. I come from a farming family in Indiana. My family grew corn and soybeans and hogs, and my father grew up knowing about honey bees because his dad kept them. My dad did not have any interest himself. But for my 13th birthday, he thought it was a good idea for me to keep bees, and so I got a beginner's kit. I think now in hindsight, it was a portent of things to come that the package bees in that beginner's kit came from Georgia. It was a sign where I was heading. I started off with 2 hives and they grew to 4, to 8, to 16. And I think the most I ever kept when I was growing up at home was 50, which is quite a bit for a young kid. I enjoyed it very much. Then I was able to follow my interest in bees into graduate school and I moved from Indiana to Baton Rouge, Louisiana, to attend graduate school at LSU under the direction of Dr. John Harboe, who was a honey bee breeder and scientist at the USDA bee lab in Baton Rouge. At that time, it was one of the few graduate research programs in the country. After six years in Baton Rouge, then I took up my post here at UGA in January of 1990. It's been a good career, not only working with the bees, the most fascinating animal there is, but with all of their beekeepers too, which are at least equally as fascinating people. And so, here after 30 years, I'm grateful for that life trajectory.

Amy 04:57
That's amazing. I feel like we need to have you on to talk about the history of everything that you've seen throughout your career. But we'll have to save that for another day. We'll have to have you back on again.

Guest 05:07
We can do that.

Amy 05:08
Yeah, that's fair. We actually have been talking a lot in our podcast, some of our segments have been about queens. And I know when we had reached out to you said that you wanted to speak on queens a little bit in some of their mating habits. That's what our segment is going to be about today. Of course, we'll have to bring you on again for another topic. But let's go ahead and start talking about honey bee queens. Can you talk to us about the process of what happens after a queen emerges from her cell?

Guest 05:34
It's pretty chaotic at first, because these young virgins that emerge, and there's usually always more than one, it's a messy ordeal. These young virgins do carry, each of them, a particular signature of queen pheromone, but it is not at very high levels yet. It doesn't reach its full levels of pheromone until after she has mated and begun laying eggs and functioning as a normal queen. So there's a lot of chaos. Different queens are trying to jockey for control of the colony, so to speak. Different workers don't really know where to give their allegiance. There is outright fratricide going on, because queens do not abide other queens and so there will be queens going from cell to cell trying to abort their sisters before they can emerge. It is not a hierarchical process, one that is organized and managed and strategized. It is very chaotic. There's many different factors that go into play of which queen wins. It could very much simply be a matter of whoever emerges first has, probably, a statistical chance of succeeding in the end. Ultimately, she will kill her rivals, she will fly and mate in the air on the wing, come back, and hopefully, resume the queenship of that colony. It's kind of wild and wooly. It's fraught with error and as any longtime beekeeper knows, a re-queening event could very well go sour, and the colony simply fails to re-queen itself. This is where a beekeeper has to be vigilant. Note when that happens, step in and try to salvage the situation by introducing a new queen.

Amy 07:33
I feel like whenever we talk about bee biology, people are always so interested in the politics of bees and the queen. It's just a story that we tell about how this all happens. I feel like this is everyone's favorite topic. As soon as you start talking about queens and their mating, it's like that's what really pulls them in to start thinking about honey bees in general. What do you guys think?

Guest 08:00
It's true, you can't beat sex. Anytime you talk about sex, people's eyes are open wide, their ears are going to open.

Jamie 08:07
I was going to mention something similar. I think my comment was going to be a little bit more diplomatic for sure. I was going to say that sex definitely intrigues people, but Delaplane, you probably said it better.

Guest 08:19

Well it is it is fun to say, but it's also true. To think about it in the history of life on this planet. Sex has been one of the great success stories. It's a testimony to how genetic recombination and various forms is adaptive. Organisms that have a lot of allelic diversity in their genomes tend to be more vigorous than those that are more narrow. There's many good reasons why we're interested in sex. It certainly is with honey bees as well.

Jamie 08:50
That certainly leads me to my next question, and you'd mentioned that once the virgin queen emerges and disposes of her competition, she has to mate. Can you tell us a little bit about how that mating happens? The mating behaviors that queens and droves exhibit?

Guest 09:06
Yeah it too, is featured with a lot of chaos. The virgin queens are programmatic. After about a week of age, they have amassed enough strength and maturity and nutrition that they can start taking mating bouts and mating flights. This is one of the best examples of where the entire species, the honey bee Apis mellifera, has gone to extraordinary lengths to create genetic diversity in the nests. The honey bee queen multiply mates and we call that term polyandry, poly means many, andry means males, polyandry. The opposite of that is practiced by many ants and termites, polygyny and that is many females. A very large and spacious subterranean ant colony, for example, may have numerous little queens and queenlettes, if we may, scattered across the realm. Polygyny is what we call that. Well, that doesn't work with the Western honey bee that lives in a relatively small nest about the size of a couple basketballs. There's not enough space for a colony to endure numerous competing queens. So the strategy the genus Apis has adopted is one queen mating with many males. You see how the two strategies end up at the same place, whether you have multiple queens, or if you have one queen with multiple mates. Either way, you end up with a social colony that is genetically diverse. I think that's an important theme. Why I have been interested so much in polyandry in the last few years, is that the strategy that Apis mellifera uses to employ genetics is a strategy of diversity. Whether the queen mates multiply or not dictates how much genetic diversity is in her daughters, and colonies that are more genetically narrow, do not perform as well ecologically as those with whom their queens have mated with many males. Getting back to your question about how does this mating occur? One way it happens is the queen's multiple mating habit. Well, that is only possible if the drones cooperate, and they do, they're quite happy to cooperate. This is where we have that fascinating behavior called the drone congregation areas. Drones tend to cluster together, they tend to fly out on a good, warm, sunny afternoon, and they end up forming like rivers in the sky, avenues, highways in the sky where drones from multiple colonies converge, and they start flying in circuits around the landscape. These circuits tend to be very long lasting year after year, and beekeepers who live long lives notice this, that these drone congregation areas tend to be constant. This has been for a while a mystery of biology because we have no transgenerational learning. When a drone dies in fall, he's dead, and there's no way for him to transmit the knowledge of the drone congregation area route to next year's drones. Yet, that route persists year after year. How does this happen? Well, it probably happens because of the landscape features, which tend to be permanent, year after year. A drone flies out, he sees a light window in the horizon. He follows that dip in the horizon where the trees stop, and he flies in that direction, because that's where the light is. He goes through that light window and oh gosh, look, here's the edge of a forest. Well, here's a strong visual. Let's just follow this edge of the forest. Oh, look, the edge of the

forest comes to another edge along this river. Okay, let's follow this river. Oh, look, it comes back and encounters a cliff. Okay, we'll follow the cliff, and before he knows that he's gone a circle and he's back where he started from. This is probably the best explanation of why drone congregation areas persist year after year. Although...

Amy 13:42
I always kind of joke around and call it the dude bee bar.

Guest 13:48
You're not far off, because they're kind of like teenage boys cruising on the strip on a Saturday night, and just like the teenage boys, they probably have one thing on their mind. So you're not far.

Jamie 14:01
Basketball?

Guest 14:04
Basketball, Game Boy.

Jamie 14:05
It's not basketball? I'm sorry.

Guest 14:12
Yeah, you get all these guys from all these different colonies. There was an interesting study done back in the 1970s in Germany, and they were able to show that an average drone congregation area contained males from over 200 colonies. So yes, it is the guys coming together and cruisin' the strip. It's these drone congregation areas that these virgin queens find. It's very easy, in some way, to copulate with many of them in very fast order. You have this elaborate behavior of the queens native promiscuity that is co-opted with the drone's drone congregation areas to result in queens mating with many, many males. Polyandry.

Amy 15:03
That is interesting, you're talking about many males? I do get this question pretty often: people always ask me, how many drones do queens actually mate with? I've heard between 10 and I don't know, 25? Are there more? Is there less? Is there an average of how many drones queens usually mate with?

Guest 15:25
Yes, there is, there's actually quite a bit of literature on this. A good review was performed about 10 years ago, by David Tarpey, who's our colleague at North Carolina State University. David found a species average in the literature for Apis mellifera at 12. Twelve males tends to be a pretty robust average for what Apis mellifera mates with. She is by no means the champion in this respect. The Asian giant honey bee Apis dorsata, has a species average of over 25. So with many bees, the Western honey bee that we know is kind of in the middle of the pack, as far as the genus goes. The numbers do range widely. The highest number to my knowledge, again, comes from Dave Tarpey's lab, one of his students published a number of 77 males, that was recovered in one female, and it kind of

gets to the center of my research interest is: Why does the queen mate with so many males? The literature in the last 10 years or so, has shown a really strong relationship between the number of males that a queen mates with and the ecologic vigor of her colony. Basically, the more the better. This I find interesting, from an evolutionary point of view, but also from the point of view of beekeepers as we try to use genetics in our bees to solve the big health problems that we're facing today. And I think polyandry has been under studied, and we should pay a lot more attention to it in practical beekeeping.

Amy 17:19
So when you say more is better, what do you mean by better? What is that? What does that look like? What does that mean?

Guest 17:24
Well, good question. I did a sabbatical six or seven years ago now with a colleague, Giles Budge at the National Bee Unit in York, England. We were trying to get an answer to that question, what are the upper limits? What are the constraints? In our design, we used instrumental insemination, and yes, we can do this, we can instrumentally inseminate queen bees.

Amy 17:54
That's another topic we'll have to talk about. Yeah, exactly.

Guest 17:59
And a good one, a good one to cover, but we inseminated queens with the semen of either 15 drones, or 30, or 60. We doubled it in double increments. Then we took those queens and established them in colonies, and we made several measures of colony strength, and we found pretty consistently that the 30 and 60 group outperformed the queens that had only been mated with 15. This raises at least as many questions as it answers, if the species average is in fact 12 as I said earlier, then we have to ask, well, then why do they stop at 12? If you get better performance at 30 or 60? What is to constrain them? This has been what we have been working on in the years since I have come back.

Amy 18:58
So what's the answer to that?

Guest 19:00
Answer? I knew you were gonna ask that.

Amy 19:04
You can't leave us hanging.

Guest 19:07
Well, let's think about it. Evolution is a cost and benefit; [there's] a tension between the two, and it is not entirely risk free for a queen to practice limitless mating. For one thing, just as there is with human populations, in invertebrate populations, we also have sexually transmitted diseases. We do know for example, that deformed wing virus is transmissible in drone semen. So that creates one constraint; it may not be adaptive for a queen to just mate infinitely. Another constraint is environmental: birds. Birds

are serious predators. Navigation and flying, queens are very bad fliers. A normal queen will only fly two, three, at most, maybe four episodes in her entire life. So these insects are very vulnerable to bird predation. So this creates a strong counterweight to whatever adaption benefits there may be for a queen from a genetic diversity perspective. So evolution is all about optimizing these constraints, and this is probably why the genus, or the honey bee, has landed at about 12 as a satisfactory compromise between those two extremes. We have to ask ourselves, though, okay, well, just because we can say that, can we in fact, show that? And if 'genetic diversity' and put quote marks around those two words, 'genetic diversity', if that's as important as we all think it is, then how in fact, can we measure it? Well, this is stuff that geneticists can do, and Ben Oldroyd, who is one of our distinguished colleagues from the University of Sydney, in Australia, has shown that a queen captures 90% of the genes in her mating population within her first six matings, six! By her sixth mating, she has captured almost all of the alleles that are out there in her mating population, but yet the species average is 12. Why do they do this? Why do they exactly double the number of matings that is necessary to acquire most of the alleles in their population? This is a big mystery. We think we have a good answer to this. There are some characters that are adapted to the colony only if they are rare. Now that seems odd until a beekeeper stops and thinks about it, and Jamie and others who have worked in Varroa resistance, we have a really good example: Varroa sensitive hygiene. I think any of my beekeepers out there listening who have used Varroa sensitive hygiene queens, you got to have a question, why does this character disappear? You spend a lot of money, you buy a Varroa sensitive hygiene queen, and you fill all of your colonies with these VSH queens, and they might do pretty well for a year or so, but that trait vanishes, that trait tends to erode in the population. You got to scratch your head and say, oh, why does it go away? If this character is so valuable, if it gives honey bees resistance to Varroa mites? Why in the world is that character recessive? Why is it rare? Well, this is a perfect example of that rare allele model that I'm talking about. There was a group in Germany who proposed this and said there are certain traits that are only beneficial when they are rare, because they are so potent, that if they were dominant, that they would overwhelm the entire colony with one behavior and the colony would not be any good at anything else. I have an example. It is possible with Varroa sensitive hygiene, to get over expression of this character so that the worker bees actually abort all of their brood, not just the brood that has mites, all of it, they go crazy. They can't stop pulling out brood. Well, this is too much of a good thing, and so Varroa sensitive hygiene is an example of one of these rare alleles that's only beneficial in very small doses. It's kind of like Tabasco sauce, a little bit is what you want. You don't want to have some rice with your Tabasco sauce you want it the other way around, and VSH is one of these characters. Our latest research has shown that these characters express under conditions of polyandry. Even though queen may capture everything she needs genetically within her first six matings, she has to go beyond that. To capture these, I call them the brass rings. Those really extra special characters like Varroa sensitive hygiene, she has to go above and beyond the the 90% plateau to capture those. That is kind of our best understanding of why queens mate at such extraordinary numbers as 77, for example, that are outrageously beyond what the mathematics of genetics would say they need to.

Jamie 24:53
That's just pretty fascinating. I was fortunate to be able to work with Nico and Gudrun Koerniger and Larry Conner to write a book, Mating Biology of Honey Bees, and I just became fascinated with how this whole process happens and how complicated it is and how they pull it off. The benefits, as you note of polyandry, but there's other questions and other issues that they face as well, because queens

should not mate with their brothers, right? Inbreeding is bad, even in the bee world, but when they go out on these mating flights, if there's a low density of colonies in the area, it's possible that there's potentially a lot of drones at those DCAs that are related to the queen. Do queens mate with drones from the colonies from which they originate? And if not, how do they prevent inbreeding?

Guest 25:43
Excellent point. And I think the answer is they most certainly do. The answer is yes, they do mate with very near kin, potentially even brothers. It could not be a son, because a queen would not have lifespan enough to produce mature sons to fly out and mate with her, but it's most probable, almost absolutely certain, that she does mate with brothers, and I would argue that this is probably yet another adaptive character for polyandry. You can kind of think about it this way, yeah sure, I get a few bad matings, but if I mate with enough others, then it'll just sort of cancel out and it won't matter. I think that is another explanation for the evolution of polyandry. I think it's probably safe to say too, and I'm parroting a comment by Rob Page on this, that it may not even be a product of natural selection. Rob Page and Dave Tarpey have put forth the idea that it may be a completely stochastic random event, which when you think about it, is not entirely out of the question. I mean, with the drone congregation area that I described earlier, we're not talking about an orderly affair here. I mean, this is mass chaos, and pandemonium, and a queen has conceivably no control over which of those males she's mating with nor how rapidly she mates with them. And the outcome just may simply be an outcome of chaos. I tend to not believe that. I do not believe that, and the reason is, because we have been able to show colony adaptive benefit at extremely high levels of polyandry. I personally do not believe that scenario. But it is out there, and people are talking about it.

Amy 27:47
That's interesting. I'm going to assume you are talking a little bit about artificially inseminated queens and what you're doing for your research. And of course, we're talking about queens that mate in the wild, I would assume that there are differences. But can you talk a little bit about maybe the differences in queen quality? Or what kind of outcome if there is a difference? And what are the differences between the two?

Guest 28:10
Yeah, that's a good question. Instrumental insemination is a tool that I strongly believe in. I encourage beekeepers to consider learning it. I encourage beekeeping clubs to invest in it. I acknowledge that it is daunting, that to an individual, the idea of learning the skill and buying the equipment is intimidating. I mean, we are talking probably in the neighborhood of $1,500 to $2,000 investment. And that does not cover whatever training the individual may need to get.

Amy 28:51
We all have that to throw around.

Guest 28:52
Sure. Yeah. Well, some people do, some clubs do.

Jamie 28:58

Stimulus checks. Everybody should learn about instrumental insemination device.

Guest 29:04
That is right. Stimulus in more ways than one, right?

Jamie 29:08
There you go. You said it, not me.

Guest 29:11
You're leaving all those juicy comments to me.

Jamie 29:13
You know, I work for the state and I'm not allowed to say certain things.

Guest 29:16
Bring in the out of state guy to say this stuff.

Jamie 29:18
You're the one who gets in trouble, not me.

Guest 29:21
I think clubs do buy equipment for their members like honey extractors and I think this falls right into that kind of line. I can see some of the more larger and active clubs buying an insemination device and even paying for some of their members to get the training. Certainly, queen producers and breeders should have the skill under their belt, and it is the only way to guarantee targeted matings in the honey bee. There is no other game in town. It is the only way to control mating in the honey bee and so for this reason it's highly valuable. Back to your question though, Amy, the differences between the two. There do seem to be some differences. I think there is a great deal of handler skill that expresses itself. If you're clunky with the queens, if you don't really know what you're doing, the outcome will show it It's a thing where a lot of practice helps. You cannot be too tender and gentle with the queens. The queens need lots of attention by workers and nurse bees before and after the procedure. Sanitation is extremely important. When we're inseminating queens, it's kind of like COVID-19, we're constantly sanitizing every surface we touch in between the queens to eliminate-

Amy 30:58
Do you give her an epidural?

Guest 31:01
We do, of sorts, and that's a big blast of CO_2 in the face; carbon dioxide narcotizes insects. It knocks them out. We don't really know if they're unconscious or feeling pain. I mean, quite frankly, we don't know that. But it does anesthetize them so that they're immobile. Otherwise, their muscles tense up, and we would not be able to inseminate them under the microscope as we do. But there do seem to be performance problems. Instrumentally inseminated queens generally do not do very well as production queens. They're fantastic for breeders to have a well mated mother that can produce daughters and

then those daughters are then open-mated. That's normal. In the US queen production industry, most queen breeders will buy an instrumentally inseminated queen mother, and then they will rear daughter queens from that mother, but those daughters themselves are just open mated, and it's hopeful that they'll mate with the good drones when they do that. Zero control in other words, but that is nonetheless, the industry standard that we have right now. Sue Kobe, Joe latchaw, other individuals who are out there that do this a lot tell me that they can produce inseminated queens that are every bit as good as naturally mated queens, and I believe them. I think they probably can. I'm not that good. I inseminate maybe 100 queens a year, and that's nothing compared to what they do. So there are some performance problems, but keep in mind, what are we doing it for? We're doing it usually to get a mother from whom we graft queens. It's a technology that's out there. It's an innovative technology. There's a purpose engineering, a new firm up in Indiana that's producing some very nice insemination devices, and I encourage beekeepers to check it out and learn it. It's not that hard to learn. Getting good at it may be hard, but learning it is not that hard.

Jamie 33:17
Dr. Delaplane, this has been really fascinating talking about all the queens, the queen mating, and all of the research that you guys have been doing, but I don't really want to end this interview until you have an opportunity to briefly discuss what you guys do at the University of Georgia. I mean, UGA is a land grant institution, you guys have responsibility in teaching, research, and extension. So you've shared a little bit about your research, but can you give us a just highlight of some of the other programs that you have going on at UGA? Our listeners are definitely going to want to visit your website. We'll make sure to link everything you've said in our show notes today, but they might want to hear it on the air as well.

Guest 33:51
Sure. Well, I think I kind of mirror what many of my peer labs across the country including yours, Jamie, the kinds of activities that we do. In colleges of agriculture, we are somewhat unique in that we have clients, we have a client citizenship. And that, in our case, is beekeepers, crop growers, anyone who's interested in pollination and pollinators and pollinator conservation. These are our clientele groups, and we try to address their interests through research and through continuing education and in the classroom teaching. We wear those three missions with some tension, because you cannot do 100% of any one of them, though at times it feels like it. We try to do research that is addressing big issue questions of the biology and the evolution of honey bees, like we've talked about in this podcast, why do queens multiply mate? But then I always feel in the back of my mind that my work is not really finished until I have translated that research into something that is useful for beekeepers, and again, in the case of polyandry, a perfect example, I really should not leave it just at that, I should instead try to take that knowledge about polyandry, and use it for improving queens genetically for the good of beekeeping and beekeepers. We, for example, are looking at how does polyandry interact with Varroa sensitive hygiene traits. How does it interact with grooming traits? How does it interact with Russian traits? How does it interact with other characters that honey bees are selected for? I think the whole realm of genetic selection has not interfaced well with polyandry, and that's what we are trying to do. In the biggest sense, we take our research, we take our scholarship, and we try to translate it and deliver it to beekeepers, and those who are interested in it. One of our biggest events of the year is the Young Harris Beekeeping Institute, which is similar to the college that you've initiated, Jamie, in Florida. We have it every May, unless COVID comes around and interrupts our plans as it did this year. We have it

every May at Young Harris College which is in the extreme north of Georgia up in the cool mountains, and it's a very popular event. It's a tourist destination, and I certainly encourage your listeners to check out the Young Harris Beekeeping Institute. Come there and hear beekeepers from all around the world talking about science and the practice of beekeeping. So that's it. That's what we do in a nutshell. I like to think that I do all of it well, but sometimes it's hard. You know, you do extension a little more this month, and then a little more research that month and you have many people clamoring for your attention, but it's exhilarating, and you meet a lot of wonderful people along the way.

Jamie 37:10
Well said Dr. Delaplane, thank you so much for joining us.

Guest 37:14
My Pleasure, Thank you, and I hope to do it again.

Jamie 37:16
Absolutely. Everyone, that was Dr. Keith Delaplane, Professor of Entomology and Walter B. Hill fellow in the Department of Entomology from the University of Georgia. Fortunately, Amy, no old Jamie stories came out.

Amy 37:28
That's a different segment.

Jamie 37:32
Fortunately, we survived this segment without anything embarrassing to report on me. But it was a great study.

Amy 37:38
You were worried the whole time, weren't you?

Jamie 37:39
I was, a little bit. I was pretty squeaky clean, though. So there's not much you can talk about. Anyway, Dr. Delaplane, thank you for joining us. We look forward to having you back.

Guest 37:50
Okay, my pleasure. Thanks for having me.

Honey Bee 37:59
For more information about this podcast, check out our website at UFhoneybee.com.

Amy 38:11
Alright, so Jamie and I are gonna be talking in this segment about something that we always say over and over and over and over. Jamie, do you know what I'm about to say?

Jamie 38:21

Get away from me.

Amy 38:23
Do you say that to me often?

Jamie 38:26
We didn't necessarily say we say it to each other. We might use those phrases a lot.

Amy 38:32
Okay, well --

Jamie 38:33
I do know what you're going to say because we talked about this pre-show, am I supposed to act surprised?

Amy 38:39
I know. I just wanted to know what you were gonna say which, that was pretty funny. Okay, so we always say The Label's the Law. And that's not just us. We didn't make that up. I learned that through the extension world, I've learned that just by speaking to researchers, industry, everyone knows this. The label is the law. We wanted to talk a little bit about that today, what that means, and to be quite honest, I hate reading labels. I feel like they're so complicated and complex and even adding fertilizer is like just a headache.

Jamie 39:20
Let's start a little bit from the beginning. Let's just make the point that we're talking about pesticide labels here, right? Amy, you are 100% right. If you are going to do pesticide education, your administrators, your bosses, your teachers, whoever introduced you to this topic, they're going to preach to you maybe a zillion times over. The label is the law. The label is the law. We just all know that. We know it. We hear it. We hear it. We know it. I've heard my colleagues at UF say it, and I've heard my colleagues around the world say it, it's just what people say. What it simply means is, is that the label that is included with or on the pesticide product that you use, is literally a legally binding document. You are supposed to follow that label. Failure to follow the label is to break the law, the label is the law. Neither you nor I are pesticide specialists. The University of Florida has a pesticide office here, actually, to help us deal with a lot of these issues. In fact, in the show notes for this particular segment, we'll make sure and link the pesticide office because they have written a bunch of documents about pesticide labeling, understanding the label, the label is the law. There's documents explaining every part of the label, but it's important to know that the beginning premise of using any pesticide is, the label is the law, whatever you put into your colonies, you've got to follow the label. If you are putting things into your colonies that aren't labeled for use in colonies, you're breaking the law. This is a very strong statement. The label is the law.

Amy 40:59

Yeah, so I guess I'd like to take a look from the outside in. Just starting from the beginning, what is a pesticide? A pesticide has different categories, right? We have like fungicides, and we have insecticides. Can you start with that?

Jamie 41:16
That's exactly right. We tend to use this umbrella term pesticide, and it's any product or compound used to control a pest. And so insects can be pest, rodents can be pest, fungal pathogens can be pests. Plants can even be pests. We have these terms, these categorical terms for the types of pesticides. Insecticides are used against insects. Rodenticides are used against rodents. Fungicides against fungi, herbicide, yeah, fungi. Depends on where you are in the world, you want to fun-jee, fun-gee, I'm a fun guy.

Amy 41:59
I had a feeling you were gonna say that.

Jamie 42:02
There's a fungus among us, which is always true, because there's always fungi around. Fungi, funji, however you want to say it. I'm an equal opportunity speaker here. However, it can be said, I'll try to say it. All of these things have their own cides, right, and insecticide, rodenticide, fungicides, etc. These things are things that are designed to control those particular [pests]. Oftentimes control can mean death. When you're putting out an herbicide, you're usually trying to kill the plant that you're spraying. When you're putting out an insecticide, you're trying to kill the insect, for which you're putting out the insecticide. All of these products that you will use to control these pests will have a label. The label will physically be on the bottle or the packet. The labels are also usually downloadable online, the label is composed of federally mandated sections, there are things that have to be on labels, the active ingredients, the inert ingredients, the safety comments, the environmental hazards, the directions for use, all of these things have to be on the label. The label, of course, that's the instructions for us. If we elect to use compounds, even the things that we put in bee colonies, they all have labels, and you were mentioning early, Amy, that a lot of labels can be difficult to understand. They certainly can be. A lot of labels, in the bee world, we're relatively fortunate, you take a product like Apivar, it's Amitraz, that's essentially impregnated into plastic strips. It's real simple, because you follow the label, the label says put so many strips in so many boxes, whatever. But a lot of these things are calculation, you'll get a vial of dust, and you've got to weigh out that dust and mix it in so many gallons or liters of water, and then so much of that we put out per acre or hectare, and it's very complicated. Usually people who are putting out pesticides for a living will have to get pesticide use licenses, and they'll have to go through lots of training, they'll have to take continuing education units to keep those licenses etc. They can be complicated labels, and you really should ask for help if you don't understand a label,

Amy 44:23
I mean, more is not necessarily better.

Jamie 44:25
That's right. Humans have this mindset, we'll see a roach in the kitchen and this treatment might say, put one gram of this compound out and that'll kill your roach, well if one gram works 100 grams will

work 100 times better, but to use that product in a way that's inconsistent with a label is a violation of a label. You're breaking the law. This sets a bigger stage for I think that's something important to hear. You and I, Amy, work for the University of Florida, it's a land grant institution, it's a state institution, it's a very public position. We've got colleagues around the US who work for land grants, we've got colleagues around the world who work for university equivalents or other agencies. We at the University of Florida are often encouraged not to give specific recommendations regarding the use of a compound. Again, I'll pick on Apivar, that the amitraz compound that we use to control Varroa, it would not benefit me and you to talk about whether I think you put two strips in per box, etc. because labels change. And if I've told people, you've got to put two strips in a box, and now it's three strips in a box, or one strip or colony or whatever, you know that I'm making recommendations that are contrary to the label. That's why you will often hear people Amy, like you and like me and our colleagues around the world not make very specific statements about how to use a compound. Instead, we say you should consider using this compound and follow the label. When we were talking about segments and things that we wanted to discuss with our audience, at first I was thinking maybe we should go through each label and read it and try to figure it out and kind of tweeze through. You make fun of me every time I say a word, but I just want you to notice that I'm calmly letting you say the word.

Amy 46:30
Everyone knows what I mean. Going through the label and really trying to understand it, but then the more we started talking about it, the more complex that that was going to be because we want people to be able to listen to our podcast later, look at a label and not say, wow, they were totally wrong. Because honestly, we might be sometimes just because things change so quickly.

Jamie 46:50
Plus, there's enough compounds out there that I've quit even trying to memorize the label. What I usually do for recommendations sake is I'll say, if you're trying to control Varroa, these products are available, make sure you follow the label if you elect to use them, and the questions I much prefer to answer well, what's the efficacy of these products? If I'm going to use it, what kind of knockdown can I expect, but the thing is, to me, is that labels don't just tell you how to use it, it tells you safety that you're supposed to use, a lot of people ignore the fact, people love to use it oxalic acid, for example. But if you look at the label, it talks about all this protection equipment that you're supposed to wear. Again, I'm not going to get into detail with it specifically, but there's a lot of compounds for which you're supposed to wear gloves or goggles or respirators and not like these little grass cutting respirators you'll put on your face to keep the dust out, like legit respirators that have to be leak tested, and all these things, and that stuff's called personal protective equipment in the biz, we call it PPE. You're supposed to be wearing PPE when you use a lot of these compounds. It's safety for you. It's safety for the bees, and it's even things like withdrawal periods, a lot of these things have to be out of hives so long before you super those hives for honey production, or a lot of them can't be used during honey flows. All of this is specified on the label. It's there in black and white, what you can and can't do when you should and shouldn't use it, how long it can stay in, etc. And again, it's simple things people say, Oh, it says stay in 56 days, well, if 56 days is good, 112 days is better, but the reason it's 56 days is because research has shown it's useful up until that point, but afterwards, it loses its efficiency or so far. All of these things even disposal, you shouldn't take the strips out of hive and just throw them on the ground to let Earth

swallow it. Even disposal for these things and disposal for the packaging is included on the label, how you're supposed to handle all of this stuff.

Amy 47:51
Yeah, so what advice do you have for the common folk like me?

Jamie 48:57
Great question. What I always tell people is that if you run into label related issues, at least in the United States, we have a fantastic team of county extension agents around the country who live in the counties where you are. A lot of these men and women have been trained to read labels to interpret labels and to even teach pesticide related courses. So if you're in the US, of course I am, I would check with my county extension agent. I live in Alachua County, Florida, I would go to the Alachua County Extension Agent say hey, I'm struggling to understand this label, can you help me interpret? And they would help. They'd either be able to answer themselves or they'd be able to help me find someone who could answer. Now, if you're outside the US and you're listening to this. I would start, since this is a beekeeping podcast, I would start with your local, regional, state, provincial, or national scientist related to bees or beekeeping. I would say to them, look, I'm trying to apply this, to try to get this result, I've run into a hiccup, I don't really understand the mixing instructions on this label, can you help me understand? And I think your scientist and your bee professionals, etc, they'd be able to help you interpret that label. But it is important to interpret it correctly and use it correctly, because at least in the US, failure to do so, and you're violating a law.

Amy 49:19
Sure. Yeah. I feel like it can just seem kind of daunting at first, when you're first reading, it seems like there's so much going on. I mean, it just seems like there are a lot of different steps.

Jamie 50:41
You are so right. And the crazy thing is, is I happen to know a mess load about pesticides, we do a lot of tox work in the lab, and it's very common for me to purchase compounds to use around my property for whatever reason, and me to struggle understanding how I'm supposed to use a product. Yeah, labels for use directions for use, how much you're supposed to put out, how much you're supposed to mix, all that stuff can be confusing. That's why it's helpful to have those resources that we've mentioned.

Amy 51:09
Yeah. So go find help.

Jamie 51:11
I will tell you though, Amy, as well, is I can't stress enough that our own pesticide office here at the University of Florida has produced so many good resources, we'll make sure to link that again in the show notes so that you listeners can get to that, but there's a few things that I want to point out. A lot of people, we could go on for days, but a lot of people, I'll use Varroa as an example, are afraid to use any insecticide, or miticide, or whatever, in honey bee colonies, and a good example is Varroa, because Varroa is a mite that you have to control with a miticide in an insect colony. A lot of people are anxious

about using some of the Varroa treatments in honey bee hives because they're worried about the impact of those on colonies, but you've got to know that labels were developed in a way to maximize the impact on the target organism, but minimize the impact on the non target organism. Following the label means that you are maximizing the impact on Varroa while minimizing the impact on bees. In other words, it's safe to use. What I would tell people is that even labels that are used on orchards or fruit and vegetable crops that honey bees are visiting. Those things are developed, believe it or not, with honey bees in mind. A lot of times the bee kills that we get are not because a particular compound is harmful for bees, but it's because it was applied inconsistent with the label. If it had just been applied according to label, the bees would have been safe in a particular instance, but it was mis applied, and so as a result, you get collateral damage, pollinators might be killed, etc. That's why as beekeepers, we need to work with growers, etc, to make sure they are following the labels, because the labels for those compounds, the things that will be used around our beehives, were developed in a way to maximize the impact on the target organism, but minimize the impact on things such as bees.

Amy 53:20
Yeah. And I mean, that's the same with residential areas. I mean, not just growers, but your neighbors in a residential area if you live in an urban area.

Jamie 53:28
Well, it's funny. Yeah, I'm glad you brought that up. People often want to blame beekeepers on pesticides, and if it's pesticides, they want to blame those on ag settings, but in most instances that I'm aware of, the Ag appliers are specialists in reading and interpreting labels. If you talk to a lot of the toxicologists or some of the big manufacturers out there, they will argue that some of the most rampant misuse and failure to follow label is actually the homeowner and not ag, because ag has long histories of trying to do this right, and interpreting labels appropriately. You're right. It's a good point. Yeah.

Amy 54:05
And we're not trying to point fingers so don't email us angry because we're just here to share the knowledge.

Jamie 54:12
I think one thing that's important to come out of this too though, Amy is if something's not labeled for use in bee colonies, we should not be using it in bee colonies. This might be throwing fuel on the fire, but part of our Varroa issue today is related to misuse of the compounds that we've had available to us, as well as bringing in compounds that aren't labeled for use in hives. That should be a no-no, our industry should have never have done that, but we have and here we are, and it's led to a lot of the Varroa related issues we have. We now have a mite that's somewhat difficult to control. We have limited options. There's potentially off label use, and even if that's the crazy thing, and I hate to point out this specific example because we might get hate mail, but Amitraz is labeled for use in colonies as a "Apivar", but it's not labeled for use in colonies as other products. So even if the active ingredient, in this case amitraz, is allowed to be used in colonies, it's only allowed to be used in colonies, under certain formulations, in this case, apivar, and not in others, where you go and buy a big tank of Amitraz and mix it yourself, even though that's Amitraz. That's not a label use, and that's illegal. So that's an issue that we have to address. As beekeepers, we have to be honest with ourselves and try to address

this. I know a lot of beekeepers feel pushed into a corner, because there's so few things available for use against Varroa but I would argue we need to spend our energies trying to find new things, and not our energies into developing. Yeah, new ways of using compounds in ways that are violations of the label.

Amy 54:19
Well, I feel like there are two things that come to mind when you're talking is one, we definitely have to have someone on the podcast that works with labeling, and I would love to understand the process a little bit more, because I don't really understand the process to begin with. It'd be kind of cool to have someone, we'll try to find someone to come and talk to us about that process. But two, I think that this is a really good opportunity for collaboration. There's so many different entities that can come together. Beekeepers, the EPA, research universities, and Land Grant Universities, other institutions that just think that there's a really great opportunity for collaboration for a lot of this applied science.

Jamie 56:41
Absolutely. I agree completely. It's funny that all this conversation was just born out of having a comment early on to us about understanding the label, I think you even got an email recently about a label of a product that was difficult to understand. And there's just so much to know about labels, number one, like we said early on, the label's the law, failure to follow the law. Number two, labels have everything you need to know about that product, how to use it, how to dispose of it. The Personal Protective Equipment and on, and on, and on. Number three, the labels are developed in a way, like I said, to maximize the impact on the target organism, but minimize collateral damage. Number four, using the same active ingredient, a different way is a violation of label. If it doesn't have honey bees on it as an example, you shouldn't use it in or around honey bees. There's so much to know about this topic. That's why Amy, we spent a lot of time talking about it, in our bee colleges and things like that, and our master beekeeper program, we make sure to have modules on understanding labels. In fact, I remember narrating a whole module on understanding pesticide labels and dealt with all of these issues. We'll make sure and get some good links in the show notes so that our listeners can have some good resources to go back to visit when they're struggling with this particular issue.

Amy 57:59
Yeah, and I would also encourage our listeners to go back and listen to our previous podcasts. I think we interviewed Judy Wu-Smart. Dr. Wu-Smart had helped us and spoke to us a little bit about pesticides as well. So, again, this isn't the first and won't be the last time we talk about this, but we thought it was important enough to bring it into a segment.

Stump The Chump 58:21
It's everybody's favorite game show, Stump The Chump.

Amy 58:34
Hey, Jamie,

Jamie 58:35
Hey, Amy.

Amy 58:36
I have a joke.

Jamie 58:38
Oh, no. You didn't even tell me behind the scenes about what's going on. All right.

Amy 58:44
What do mold, honey bee larva, and honey moisture content, what do those have in common?

Jamie 58:51
I don't know. Tell me.

Amy 58:52
They're gonna be on this question and answer segment.

Jamie 58:54
Oh, you're so smart. I chuckled.

Amy 58:58
Okay. Thank you. I hope the audience did too. They probably just feel bad, but I'm not going to question why everyone else chuckled. Alright, so the first question we have for question and answer is, is there a way to control mold in a hive and how can someone prevent it?

Jamie 59:15
That's an interesting question. I don't think I've ever been asked that question before. Usually, I see mold under a couple of scenarios. Number one, there's almost always a ventilation problem. Maybe the entrance is restricted. Maybe there's no upper entrance, etcetera, oftentimes, colonies that are stored fully in the shade are colonies that are in low lying areas where a lot of cool moist air settles. Those colonies will often have mold inside the nest. I will also say that when a colony is too small to occupy the nest and its entirety, in other words, you've got more boxes or more supers on the hive than the colony can adequately cover. I will sometimes see mold in those combs that are unprotected by bees. If you think about how to keep colonies from having mold, you just do the reverse of everything that I just said. That leads to it. Number one, you don't keep your hives in a low lying areas where cool moist air will accumulate. You make sure that the colonies get some sun throughout the day, that they're not fully in shade. Also, you want to make sure that they're adequately ventilated. The way that I do that, of course, I have the colony and just the hive entrance where the colony can access. But at the very top, my covers have a notch cut in the inner cover so that air can escape a little bit through the top. Of course, I use the outer and inner cover system, a lot of beekeepers use migratory lids. But you can always crack the migratory lid just a little bit to allow some airflow. If the bees gum it up with propolis, you can open up again, I even had a colleague who would put a small block of wood under his lid, if he had the telescoping lid, he'd do that just to make sure there was adequate airflow out of the nest to vent that moisture, that sets up the condition for mold. And of course, the last way is to make sure that your colony is strong, and that it occupies the entire nest. If you have frames that are unprotected by bees, if

you have supers that don't have bees in it, you just take that off, because where there's bees, there's usually no mold problem. All of those things can really go a long way helping to remedy this situation.

Amy 59:19
Yeah, so just not providing them the environment that they need to grow.

Jamie 1:01:25
Right. That's exactly right.

Amy 1:01:26
Great. All right. The second question we have is how can you tell the difference between wax moth and small hive beetle larva?

Jamie 1:01:34
That is also a really good question. And it's a little tricky to explain, unless you're an entomologist. Before I start, I will tell you that people have battled with this question for a long time. So there's a lot of really good web resources. If you just Google wax moth larvae versus small hive beetle larvae, you're going to get a lot of images that show them side by side, and it's going to point out some of the features that are more obvious. So let's just start at the beginning. If you're working your way from the oldest of larvae, to the youngest of larvae, it's pretty easy to tell a wax moth larvae from a small hive beetle larvae, because they're so much bigger. Now of course, the real problem lies when they're both small. Wax moth larvae also start small and so they will progress through the same sizes that small hive beetle larvae will progress to except small hive beetle stop and wax moth larvae keep growing. So the better question is, when they are the same size, how can you tell the difference between the two? There's two key differences.

Amy 1:02:38
You ask them.

Jamie 1:02:41
Well, are you a beetle? Of course they'll volunteer that information. No. In all seriousness, small hive beetle larvae have spikes on their various body segments, they run down the back of that beetle larvae. If you Google a picture of a small hive beetle larvae, you'll see those spikes protruding out of the top of the larvae from every body segment. The other thing that helps is that both of them, both wax moths and small hive beetle larvae have six legs that are essentially the rudimentary legs that will become the legs on the adult insects. And those legs are towards the front of the body, just behind the head. They're on the segments that will be the thoracic segments when these individuals turn into adults, but that's where it stops for small hive beetles. Small hive beetles have no more leglike appendages further down the body. On the other hand, wax moths have what we call pro legs. This is very common in moth larvae, the things that we call caterpillars, they'll have this second set of legs somewhere midway to the body and further down the body. Essentially, they both have those three pairs of legs towards the front of the body, but the beetle larvae have no more legs, and the wax moth larvae have multiple pairs of pro legs or rudimentary type legs further down the body.

Amy 1:04:07
That is so cool. I would encourage all of our beekeepers when they see the larvae to look at the legs.

Jamie 1:04:12
That's right. Again, to get a good idea of this, just Google wax moth larvae versus small hive beetle larvae, and you'll see very clear direct comparisons between the two.

Amy 1:04:23
That's awesome. Alright, so for our last question, how do you deal with high honey moisture content?

Jamie 1:04:30
Amy, I'm going to assume that the individual asking that question is asking about moisture content after the honey is extracted. Let me just make a couple quick statements. We want the moisture content of honey to be somewhere between 15.5% and to 18.5%, that's kind of the ideal moisture range for honey. Now nectar, the bees collect this sugar water, this nectar, from flowers, [and] bring it back to the hive. They put it into cells and when they bring it back to the hive it's somewhere around 70% or 80% moisture, so a lot of that water has to be evaporated in order to condense the sugars, essentially, evaporate off of the water, so that you've got a more sugar-like substance and that special range is between 15.5 to 18.5. If honey is below 15.5 water, it's prone to granulation, it's prone to coming out of solution, and you'll get the solid sugar being made as a result. If it's above 18.5 percent water, it's prone to fermentation. You really want to have it in that range. How do we make sure that happens? Well, number one, bees tend to cap the honey, when it is within that range. The first thing you should do is avoid extracting frames that have a large percentage of uncapped nectar. The general rule of thumb is, you want 80% of a frame or more to be capped, before you extract that honey. That way, you're hoping that the bees are essentially telling you that this is ready.

Amy 1:06:02
Yeah. And that's on both sides, right?

Jamie 1:06:03
Exactly. Yeah, exactly. Some people will take a super and they'll go well, you know, I've got five frames that are fully capped on both sides. And these other frames aren't, but don't worry, the five frames that are fully - no, that that will not work, you need, every frame that you extract has to be at least 80% or more capped on both sides. Assuming that doesn't happen, a lot of beekeepers will actually take their supers off. And if it's not capped enough, they'll keep it in a small room where they run a fan, a heater, and a dehumidifier to draw off some of that moisture over a couple of days or a week, and they'll use a refractometer, which is a little device that you can use to measure the moisture content in the honey. So they'll check the honey that's uncapped to make sure it's dropped below that moisture content and then they will extract it. So essentially they're drying off their honey. Once honey is mass extracted, and physically in a tank, it is much harder to evaporate off the moisture to dry it off, as it were. I know some beekeepers who put bubblers in the honey to dry it off and while they're kind of bubbling through these settling tanks, they'll heat it and they'll have dehumidifiers in the room. I know of at least one equipment manufacturer who actually makes a dehumidifier. You can hook a hose into a drum of honey, the honey will be pulled through this dehumidifier machine and out the other end comes honey that's a few

percentage points lower in moisture. The real key to it is not trying to solve the problem once it's extracted, it's trying to address the problem before you ever have it in the first place, and that's by making sure that you extract fully cappped or nearly fully capped frames of honey. Or if they're not making sure that you try to dry it for a few days or a week, the only catch to drying it for a few days or a week is you're leaving frames of honey unprotected, available for small hive beetles. You're going to have to make sure that small hive beetles are not a problem while your honey is drying. But you really want to address these issues before you get it extracted because it's easier to deal with them at that point. One key thing that people do is once you learn your honey flows. Let me give you an example of what I'm about to say, Amy, imagine that your honey flow is four weeks, and it's going really well and honey is coming in you put super and super and super in. And you know it lasts about four weeks and in about week three, you've got two supers on that hive bees haven't quite moved into yet. Rather than saying I hope this last week is great and they're going to move up into it, take off those two supers, so that the bees will use that last week of incoming nectar to fill the available cells and cap it off. The worst case scenario is that they move in those upper to supers, start putting a little bit nectar in there, and then the honey flow stops and they've got no nectar to finish filling that, capping it and all that stuff, and you end up with a lot of uncapped stuff that's not quite ready to be extracted. A lot of beekeepers try to force their bees down into fewer supers as that honey flow wanes just to make sure that those supers are fully capped prior to harvesting. That's great. All right. So there we have it. What do the three mold, hive beetle larva, and honey moisture content have in common? Yeah, we now know. No, you're welcome. All right. Thank you listeners. And if you have any comments, questions, of course, feel free to email us contact us on our social media. Let us know if you like some of the content. If you have suggestions for other content materials, let us know we'd be happy to hear from you. Absolutely. And guys, don't forget to go to your favorite podcast app and rate us. Rating us is a way that we can help spread the news to other beekeepers and make it available to as many people as possible. So thank you for listening to Two Bees in a Podcast.

Amy 1:09:52
Hi, everyone. Thank you so much for listening to this week's episode of Two Bees in a Podcast. We would like to give an extra special thank you to our audio engineer James Weaver, and to our podcast coordinator, Jacqueline Allenje. Without their hard work, Two Bees in a Podcast would not be possible.

Jamie 1:10:10
For more information and additional resources for today's episode, don't forget to visit the UF IFAS Honey Bee Research and 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.