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SPEAKERS

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

Jamie 00:10
Welcome to Two Bees in a Podcast brought to you by the Honey Bee Research Extension Laboratory at the University of Florida's Institute of Food and Agricultural Sciences. It is our goal to advance the understanding of honey bees and beekeeping, grow the beekeeping community and improve the health of honey bees everywhere. In this podcast, you'll hear research updates, beekeeping management practices discussed and advice on beekeeping from our resident experts, beekeepers, scientists and other program guests. Join us for today's program. And thank you for listening to Two Bees in a Podcast. Hello, everyone, and welcome to another episode of Two Bees in a Podcast. In this episode, we're joined by Dr. Christian Pirk, who's a professor in the Department of Zoology and Entomology at the University of Pretoria in South Africa, and he'll be discussing with us the nutritional needs of honey bees. In our Five Minute Management segment, we'll be talking about bottling honey, and we'll finish today's episode with our question and answer segment. Hello, everyone, and welcome to another segment of Two Bees in a Podcast. It is my absolute distinct pleasure to be able to introduce to you Professor Christian Pirk. And I'm so excited about interviewing Christian because he and I go way back. We were actually PhD students in the same lab at Rhodes University in Grahamstown, South Africa, I don't know, 15 or 16 years ago. And now, Professor Pirk is a member of the Social Insects Research Group in the Zoology and Entomology Department at the University of Pretoria. He has a really big program, does a lot of amazing work there in South Africa. And it's just my pleasure, Christian, to be able to welcome you to this segment. So thank you so much for joining us on this episode of Two Bees in a Podcast.

Guest 02:29
It's great to be here. It's a great honor to join your program and answer your questions.

Jamie 02:36
Well, good. When Amy and I were talking about, Christian, what in the world to discuss with you, I was like, "Well, gosh, Amy, he's done so much research since I was with him as a PhD student." I remember you, at the time, were working on policing behavior, and now you're kind of in a broader

group, behavioral chemical ecology, evolutionary ecology of social insects. So you really do so much different work with honey bees. But the topic we'll be discussing today is balanced diet in bees and how they're able to balance their diet. But Christian, before we get there, our listeners love to hear our guests talk about how they got into bee research in the first place. So can you tell us a little bit about how you found yourself where you are? How you started working with honey bees? What got you where you are, what you're doing now?

Guest 03:23
That's a really fascinating question because, more or less by accident, it all started with combining that I studied mathematics and biology. And game theory allowed to combine mathematics and biology when it came to social insects. So I started my masters with ants and then decided to travel the world, wanted to visit somebody in South Africa. And the plan was to go to Australia, South America and then back to Europe and then start working. But then I got hooked up with the amazing bees, which we have in South Africa. And I decided to do my PhD there. And the German government decided to fund it. So that's where I got stuck to South African bees. And I have to say, the climate is much, much better than Europe, or much, much better than Germany.

Jamie 04:17
Everywhere has its perks, I'll tell you, Christian, but I get what you're saying. It is very nice in South Africa, that is for sure.

Amy 04:25
I almost made a joke, Jamie, with the 'perks.'

Jamie 04:27
Yeah, I heard it when I said it, but it was too late. I couldn't pull it back. So, yeah, it was too late.

Guest 04:32
It comes quite often, so it's fine. No, but I mean, the bees are just fascinating. Yeah, I mean, you have problems with them in the southern parts of the States, I'm pretty sure, but I mean, if you keep in mind that the subspecies I'm living with, so to say, is the one which you term "killer bees" in the southern States, it's quite a biological nice experiment in terms of biological invasion but yeah.

Jamie 05:05
Well, how long have you been at Pretoria?

Guest 05:09
Since 2005. 16 years? I mean, the original plan was three years. Three years is now much, much longer. And it's, I think, it's a nice place to do honey bee research. I'm pretty sure Florida is a nice place as well.

Jamie 05:32

It is nice. Yeah, when I visited you some years ago, I was very envious. You guys really do have some super cool bees, the ecology and the native bee, honey bee biology there is just really amazing, and I've been watching your program with envy, for sure.

Amy 05:47
Jamie keeps talking about how he wants to go back to South Africa to do more research. So I'm sure you all will connect here pretty soon.

Guest 05:54
Oh, no, no, definitely. I mean, there are links, as well, I mean, in terms of invasion biology, in terms of, I mean, Jamie probably talked about my small hive bee already. So that's definitely a topic. But I think that there are, definitely, quite interesting questions. And I would actually, from a chemical ecology point, I would really like to know how that bottleneck because I mean, originally, it was, what? 150 queens which went to South America, or two hundred queens? I think 150 survived. The majority of them were actually from an area probably five Ks away from where I'm sitting now. So most of them are pretty local, in my terms, so it would be nice to see how the chemical profiles actually have changed, developed, improved, you name it.

Jamie 06:48
I hear a project collaboration coming on, Christian, so be careful what you wish for.

Guest 06:53
Always. Always. I mean, just comparing the genetics would be already quite fascinating as well. But yeah, no, I think there's a lot of interesting questions out there, especially if we look in the invasion biology, but yeah,

Amy 07:09
Yeah, we should definitely bring you on again to discuss invasion biology. And so I feel like Jamie had already mentioned earlier that there were so many different topics that we could discuss with you. And we landed on honey bee nutrition. And so we wanted to talk to you today about honey bee nutrition and a balanced diet and honey bees. And could you, I guess, just describe to our listeners what this balance is? What does that mean? And what do honey bees need to have a balanced diet?

Guest 07:41
Yeah, I mean, it's one of the focuses, we are doing research on. And I mean, it started to look at, actually, doing my PhD topics. How do you become a laying worker? Let me phrase it like that. How do you get the resources to actually become a reproductive dominant individual? I mean, there's food, which plays a role. The queen gets royal jelly, mainly. The workers, not so much. And how is that actually triggered? So we looked into, what's the effect of macronutrients? So that is mainly, say, sugar and proteins. So how many potatoes do you have to eat and how many steaks do you have to eat, so to say, to actually have a balanced diet? And that is more or less the approach we started with looking in bees as well. How much pollen do you have to collect to get the proteins? How much nectar do you have to collect to actually have the energy and a really sufficient diet? And we did quite a lot of

experiments and looked at what happens if you give them too much protein. There was some work done in the US as well. If you feed them 100% proteins, they all die. So we looked at a ratio, which is optimal. And we came to some ideas. And obviously, there is some kind of optimal ratio between sugar and protein which you should feed to your bees. However, I mean, it all depends on what the bees are actually doing. Just imagine. I mean, there's a lot of different tasks within a colony. You have to feed the queen as a worker, you might have to feed larvae as well, you might have to feed drones, which are present in the colony, or you just have to make sure that you have enough energy to forage or to defend the colony. If you look at the different tasks, if you have to feed the queen or the larvae, you have to produce a lot of protein-rich royal jelly. So you actually have to digest quite a lot of proteins first to actually produce it. Whereas, as a forager, you just have to, I put that in inverted commas, you just have to fly to the flowers, collect pollen and nectar and come back. So it's not so much proteins which you actually need, and you might receive it from other workers anyway. So depending on what task you're actually doing, it depends as well what kind of nutritional requirements you have. Just compare that to somebody like me sitting in front of the desks and working the whole day compared to somebody who's digging trenches outside in the sun. All kinds of different requirements when it comes to food in general. And it's more or less the same in bees, obviously, or we assume that it's the same in bees obviously, and we actually started looking into it, what's the optimal rate ratio? And we first started with giving them a fixed ratio and see what's actually happening, looking at parameters. We did that mainly in cages. So there was no queen present. So how does it affect the physiology and their behavior? And then the next step was suddenly, do they actually care, does it matter? I mean, if you think about the colony of, Jamie, correct me, I don't know what the sizes are in the US, but I mean, our colonies are what? Peak around 20, 30, 40,000 individuals?

Jamie 11:14
Yep, that's about the same here, yep.

Guest 11:18
Does it matter what kind of food you're actually collecting? And how does it actually affect you? And we thought, okay, let's give them a choice. And in that case, we had to realize quite quickly, that they actually care. So they actually regulate depending on what they need. So I think what was fascinating then as well, if we just look at protein and sugar, we came up with a ratio of one to seven. So one part protein to seven parts sugar. We quickly realized that other things are playing a role as well. And that is still an ongoing field of our research. Other groups in Israel and in the UK as well jumped in, or not jumped in, but started working, looking into that one as well, in terms of amino acids. And just circling back, I mean, the point is, you have so many different tasks. You have to take care of the queen, you have to take care of your one or four day old larvae, or older larvae of your nest mates, that all requires different degrees of proteins and sugars as well. So it's not something that they can just collect everything which is around them. So they actually have to make an active choice to ensure that the colony is healthy in the long run. I always have the example with potatoes and steak. If you always eat it only steak, some people do, I'm not disputing that, but on average, you'd say the whole only steak diet would probably not be as balanced as perhaps, adding something like veggies or potatoes or starch to the diet as well. And that is more or less the same when we look at honey bees, which has quite a lot of implications when you think about how you use your colonies for pollination services. If we

look into the South African example as a comparison, I mean 90% of our colonies are wild. So if you think about a balanced diet, they might be affected by land transformation, changes within the biodiversity. So conserving the right foraging areas for wild bees in South Africa could be quite beneficial. On the other hand, if it becomes more monocultures it might be not as beneficial. And unlike the US, as I said, 90% of all colonies are wild. And so it's not like that beekeeper who can actually intervene and give them a supplementary, which is possible to give. Okay, that was a long monologue on my side.

Jamie 14:07
No, that's that's actually okay, Christian, because one of the things that you said is something I absolutely want to drill down in just a little bit. So you've made a lot of wonderful comments, and honestly, when I teach honey bee nutrition to students, I have never thought about it the way that you just described it, right? So if worker honey bees are progressing through a series of tasks as they age, it makes sense now that you talk about it that there would be varying nutritional requirements. I've always taught it very simply, which is the young nurse bees need pollen, the older bees need carbohydrates, but that misses a lot of cohorts of bees. And you said something that was really interesting that I want to ask you more about, this idea that bees possibly can determine nutritional deficits. And I think about that like this: If you've got a colony that's got all of these different types of pollen available in the environment, are they just randomly collecting pollen because it's there? Or is there evidence, Christian, that they're making decisions regarding the quality of pollen on which they are foraging?

Guest 15:15
I think you're jumping a little bit ahead. I think that's still three or four years away to answer that question.

Jamie 15:21
Well, maybe we need to do that project.

Guest 15:25
That as well. What I can tell you from cage experiments is that they're definitely balancing. So if you give them the choice between protein and sugar, doesn't matter which ratio, they always honing in on more or less a similar ratio they have. And that is, as well found from Newcastle and Israel where they did experiments with sugar and amino acids, so already broken down protein so to say. And they find something similar, that they're actually regulating the intake. So if that translates into the fact that they pick certain pollen over other pollen when they're actually foraging, I think we have to mark a lot of bees to see what they're bringing back. And we have to have a lot of artificial intelligence, actually, to record it at the moment to make sure that we can actually identify it. But my educated guess, or wild guess, would be that they can, because for one reason, there was a study from 1947. She did her work during the war, I think. And she looked at pollen intake of different colonies within the same apiary. And apparently, it was a mess, in terms of diversity. They all were collecting different things. I tried to pin down to see if we can identify what the ratio is between sugar and protein in these different pollens. But what is it now? 70 years later. That didn't really work. So I would assume just looking at the diversity of

what the colonies are bringing in, they're regulating as well. But that's a guess. I have to admit that is something.

Amy 17:15
Yeah, I'm really actually glad we're talking about this, because I had this very question yesterday where somebody emailed me, and they were asking me, can honeybees identify a quality protein source? The foragers, can they identify that? And can they choose that? Or is it that they go out and forage for whatever they they can forage for, and then bring it back into the colony, and the bees inside the colonies are actually deciding if it's a high quality protein or not? What are your thoughts on that?

Guest 17:47
I take the fence-sitting one. Both? I think there's different levels of decision making, I think the foragers to make a decision of what she is collecting. Obviously, if she doesn't find the right stuff at one stage, she probably gets too depressed, if I want to phrase it like that and collects whatever she can find. But then, obviously, ultimately, the decision is made in the colony, how quickly is a pollen taken up by the other workers? So I think you have different feedback loops. You have the individual decision on the forager side. So she is probably doing some kind of decision based on, and that's an educated guess again, based on her previous experience, how quickly did a certain pollen get unloaded? Was it fast? Okay. Therefore, it might be something which the colony needs. Or was too slow? So perhaps, I shouldn't bring it back and then gets the feedback again, when it comes back into the colony? I hope that answers your question.

Amy 18:51
Yeah. Wouldn't it just be easier if we could just ask them?

Guest 18:55
Yes, it would be. It would be. It would be. But luckily, we know the dance language to a certain degree. So we could actually design an experiment, I'm pretty sure, that we could ask them. I mean, you could probably link it to how extensively she is actually dancing. I haven't really thought about that because I wasn't really too much into dance language, but I'm just putting it out there. Perhaps that might work to answer a question. I'm not sure.

Jamie 19:28
So Christian, one of the things that I'm thinking about while you're talking, when bees go collect pollen, how important do you think the conversion of pollen to bee bread is to the nutritional needs of honey bees? Do you think that that is a necessary step, and they derive more nutrition from bee bread than they do just from pure pollen, just collected from the field?

Guest 19:50
I mean, it started doing foraging. So yes, I would think that the bee bread is already a step further. I mean, if you look at it, it was done by two colleagues of mine from the University of Pretoria as well, where they looked at fresh pollen and bee bread pollen, and you could actually identify that the sugar to protein ratio exchanges, doing collection and bringing them back, and if you look at sugars, for

example, bringing back nectar, they actually evaporate more water already by flying back to the colony. So they're actually improving, already, the product they're bringing back. So yes, I think the conversion to bee bread is pretty important, because it probably links it closer to the ratio, which the nurse bees probably need.

Amy 20:41
So with all this said, we have a lot of beekeepers here that manage their honey bees, and they feed sugar water, some use protein patties, and we were still not quite sure what we should be recommending. What does this mean for beekeepers as far as this ratio? What do you recommend that beekeepers do in their management?

Guest 21:04
It's probably the same what we're doing to get our bees through the winter here. It's all depending on how you want to use your colonies. I mean, if you want to just get them through the cold days, so to say, I mean, it's probably enough in terms of the bare minimum, so to say, it's enough to feed sugar to get them through the winter, in terms of the colony is not dying. If you want to have them already picking up in terms of size and numbers, you probably want to start feeding proteins before because then they would start with... earlier. So it's a tricky question, to be honest. It all depends what's flowering in the surrounding as well, which allows them to actually balance the diet. I think if you have a colony and sunflowers, for example, that's lower proteins, so you would actually have to add some proteins to it as well. And I know from people doing pollination on sunflowers in South Africa, for example, they have to build up the colonies afterwards because of their pollination jump. But since they only get mainly sugar, the colonies don't really thrive as much as they would if they get on a more permanent protein-rich diet. So, unfortunately, there is not one solution to all the colonies, if I want to phrase it like that. So you would have to see where do you want to have your colonies? And what is the aim in the next 2, 3, 4 weeks? Do you want to build them up for pollination going somewhere? Then you probably have to add more proteins. If it's your observation hive who you keep in your living room because it's so much fun, it's perfect enough to just feed them sugar so they can heat the colony and make sure that they're there when outside is picking up again.

Jamie 23:02
Do beekeepers in South Africa feed pollen supplements or protein supplements to their colonies as part of any management practice?

Guest 23:10
Yes, it's quite popular. Everyone has their own mixture as well to a certain degree.

Jamie 23:15
Yeah, it's interesting that you said that, Christian, because I was kind of leading to this next talk. So you know what, when I travel around the world and see beekeepers doing this, as you might guess, we have a number of protein patties available commercially here in the US, and we've done some nutritional supplement work. And it always gets me into trouble because every time I talk about our nutritional work, almost every time we feed colonies pollen patties, we cannot find significant

measurable impacts on the colonies. And to me, nutrition work from a management standpoint is a great opportunity in the honey bee world, because I'm not overly convinced that we're always getting the benefit we think we're getting when we feed pollen supplementation. So a lot of folks will fuss at me and tell me, "Well that's not the case, we feed our pollen patties to colonies and the colonies look better." But it's usually they feed it to all their colonies. So you don't really know what would have happened if they didn't feed it to colonies. And so I see this as a little bit of a controversial area of research, and I'm curious given that you work with nutrition and you've looked at protein to carb ratios, etc., and now you're telling me that South African beekeepers do feed pollen subs, what is your general feeling about the benefit of feeding bees pollen subs and do you think there's room for improvement? Do you see yourself studying that in the future, etc.?

Guest 24:42
I mean the nutrition work I did with with Sue Nicholson, also a retired professor at the department, and Jerry Wright, who was at Newcastle, she is now at Cambridge -- Oxford, Oxford, sorry. And they actually had a project already putting together a new formula, so to say. And that was actually picked up, if I'm not mistaken, by a company in Belgium, which sees the commercial benefits, actually, there. So I think there's still a lot of potential because, again, there's not one size fits at all. I think it depends on the local conditions to a certain degree as well as what they want, or what the bees wants, let me phrase it like that. So that feeling is we're at the beginning, because we're talking about two macronutrients. So we're talking about proteins and sugar. So we have minerals as well, which play a role, fatty acids, if I want to phrase, or lipids might play a role as well. So if we looking at the nutritional space, we have more than two parameters. So despite the fact that the first paper on protein to carbohydrate ratio was in 2010, I think we're only at the beginning to fully understand the nutritional requirements of bees. And I agree with you, we have to have more controlled experiments in that way, because there will be a lot of colonies which are happy with your random patty, so to say, which you put together with soya and you name it, or mud powder, and it might work, but you don't know how the colony might last for the next three years. So if we think about it, in terms of what is a healthy diet for honey bees, or for your honeybee colony, I think we are only at the beginning.

Jamie 26:10
I completely agree, Christian. I really do. I feel like there's a, I call it an opportunity. There's a really big opportunity right now in honey bee nutrition work from both the basic research side, understanding what bees need and when they need it, like what you've been doing, but also from the applied side, seeing how to improve diets over the long term. Well, there you have it, everybody. There's a lot of opportunity to continue research on honey bee nutrition. Dr. Pirk, I'm so grateful that you joined us today and shared your insight on honey bee nutrition as well as some of the projects that you've been up to. So thank you so much for joining us on Two Bees in a Podcast.

Guest 27:21
Thank you for having me. It was very fun.

Jamie 27:24

Everyone, that was Professor Christian Pirk, who's a member of the Social Insects Research Group in the Zoology and Entomology Department at the University of Pretoria. There, he is a specialist on behavioral, chemical and evolutionary ecology of social insects, specifically, the honey bee. Thank you for listening to this segment of Two Bees in a Podcast.

Guest 2 28:00
For more information about this podcast, check out our website at UF honey bee.com.

Amy 28:23
Welcome back to our Five Minute Management, and today, we are going to discuss the fourth segment of our honey series. And so the first one, we talked about making honey. The second segment, we talked about harvesting honey, and the third, we talked about processing honey. Today, Jamie, we are going to be talking about bottling honey. And I feel like there are probably a million different ways to do that. So you have five minutes to talk about bottling honey.

Jamie 28:51
Yeah, Amy the pressure is on. So this is, of the four things we've talked about with regard to honey, from all the way from the hive all the way to the bottle to the consumer, this is the one that you need to pay most attention to. And the reason for that is there are specific bottling laws across the US, and wherever you're listening from, the same is possibly true for you. In Florida, as an example, places where bottling honey is being conducted, if you're going to sell commercially and are making over a certain amount of money, you have to bottle in inspected licensed kitchens. So what I'm starting off telling you is you need to find what your local laws, rules and regulations are about bottling honey and what you're able to sell based on where you bottle, etc. So nothing that I say that follows is as important as you checking your local rules, regulations, laws regarding bottling. And if for some reason I say something that's inconsistent with your particular state or location's, rules, regulations, etc, you need to default to the rules under which you are being governed. So with that out of the way, from this point forward, you've got to remember you are taking honey, that's a pristine product that bees made, and you're putting it in some sort of package that you ultimately hope a consumer buys. So there's some art to it, right? You want to choose nice packages, but there's also cleanliness and human health and safety part to it, and that you're doing a good job while you're bottling that honey, and you're keeping the consumer and the customer in mind. So just to start a little bit, kind of from the beginning, you've got some decisions to make big bottles, small bottles, round bottle, square bottles, glass bottle, plastic bottle, all of that stuff that's ultimately up to you. And if you've got that marketing, you can take honey, put it in a bottle and make sure that the consumer is going to want to buy it. I mean, the bees have done their part. They're going to make the honey itself look worth purchasing to the consumer. Now, you as the beekeeper owe it to the bees to make sure that you do your part to do the same. In prepping to bottle, remember cleanliness, cleanliness, cleanliness. Default to your local rules and regulations. But when in doubt, make sure the place where you're bottling is clean. Wipe everything down with a 10% bleach solution. Make sure your hands are washed all the time, frequently. Make sure everything you use has been washed with warm soapy water, including the bottles themselves. A lot of folks like to throw bottles in the dishwasher to be cleaned before you bottle. And I cannot say enough, because honey is a food product, it's important to maintain certain sanitary practices. Like, a lot of folks for

example, like to pull their hair back, wear a hat, wear a hairnet or anything while you're bottling. You want to make sure no stray contaminants are going to get into the honey. Another thing you need to know is that honey, when it is warm, can expand. A lot of folks like to fill the honey jars all the way to the tip top. But if you do that and it gets warm, the honey might actually leak from under the lid. You want to leave about a quarter inch of space between the top of the honey, where the honey is filled to, and the top of the bottle. And almost every jar I have ever seen has a natural fill ring towards the top to which you're supposed to fill that bottle just to make sure that if it expands, you've got enough space. And also, if you go to the fill ring, you're actually putting the amount in that bottle that the label says is in there. There are, of course, automatic bottling processes or automatic fillers that will measure this out for you. But if you're doing it by hand, you want to make sure and get to the fill ring and not even a micrometer above that. Once you've got the honey in the bottle and you've got that honey up to the fill ring and you make sure there's no stickiness on the outside, etc., you want to make sure and put on the lid. Now, a lot of lids these days come with safety seals, which might not be necessary, but it gives the customer that added assurance that you're taking this food product seriously. So the safety seal might be embedded under the lid of that bottle so that when you screw that lid on, it naturally seals. A lot of folks will buy stickers that kind of go from the bottle across the top of the lid, just to add that customer satisfaction and reinforce the idea that you're taking their health and safety seriously. So you've made sure you're following the rules and regulations, you made sure your bottles are clean, that you yourself are being hygienic through this process, you've made sure the bottles are appropriately filled, now what do you do until they reach the consumer? Well, you've got to remember a few things. Honey can crystallize, it can ferment, so back to the previous episode, we wanted to make sure and try to deal with that, it's all about how you extract and process and harvest your honey. Well, now you've got it bottled, you want to keep it kind of in a cool dry location and in boxes that block out sunlight. You don't want direct sun exposure. You don't want too much heat. Usually, somewhere around 60 degrees to room temperature, 80 degrees Fahrenheit, are just really good temperatures to store honey. If you do all of that, you're going to have a pristine product that you can sell direct to consumer. Of course, I could go on for days about making it look pretty like labeling, but labeling is going to do -- you're going to have to follow local label laws, number one, but number two, you're going to also have to add that touch of art and uniqueness to it to make that bottle just want to jump off of the table that you're selling it from into the hands of the consumer.

Amy 34:47
All right, well you went a little bit past five minutes, but that's okay, because I feel like bottling is super important. And honestly, every time I go to a grocery store or anytime I go anywhere, and I see a bottle of honey, I immediately grab it. I don't know if you do the same thing, Jamie. But I feel like every time I see a jar of honey, I want to look at how the person bottled it, how the beekeeper bottled it and what their label looks like. I think those are super fun to do, especially when I'm traveling.

Stump The Chump 35:20
It's everybody's favorite game show, Stump the Chump.

Amy 35:25

Welcome to the question and answer segment. Jamie, the first question I have for you, this one, actually, I receive pretty often, and I receive this question a lot from non-beekeepers as well. And the question is someone's wondering, what's the process? And how is it possible for an unfertilized honey bee egg to develop into a drone? So what is that process? And does that work for other animals? And why would it work? Why would it not work? I don't know.

Jamie 36:09
Okay. Yeah. So alright, these are all great questions. Alright, so let me just kind of start from the beginning. I'm not going to go into super thick detail. Number one, because even though I know a cursory answer to this, there's a lot to know about this, and I don't even understand all of the science related to it. But I'll mention some terms, you can look it up and find out more about it because it's just it really is an interesting process. So let's start with this idea of parthenogenesis. Parthenogenesis is essentially the ability of an unfertilized egg to develop normally, ultimately, and into an adult organism. So the reason this question is being asked is because we all think about just humans, right? It takes a sperm from a man, an egg from a female to fuse to form a cell that will ultimately become me, you and all the other humans here on planet Earth, right? And the same is true for mammals. And the same is true for birds. And some people start thinking, this is broadly how life happens, at least animal life happens. Well, in parthenogenesis, you don't need the contribution from the male. Alright, so then the question is, why don't you need the contribution from a male? Because things have to have two sets of chromosomes to develop normally, right, at least two sets to develop normally. And so the process from creating an individual from a single individual, I'm oversimplifying it, but this is the way that I'm explaining this, it's called parthenogenesis. So you can look up parthenogenesis. There's lots of different forms of parthenogenesis. Arrhenotoky is when the unfertilized individual becomes a male. Thelytoky is when the unfertilized individual becomes a female. So honey bees are able to produce adults, both via arrhenotoky and via thelytoky. So let's start at the top. When a queen bee lays an egg, she can allow that egg to be fertilized from semen that she stored. If it's fertilized, it develops the way we all expected them to develop, with a mom and a dad. So out comes a female offspring. We know that females in honey bees results from fertilized eggs. Now, the queen can also elect not to fertilize that egg. She can withhold semen from that egg while she's laying it. This egg is the one that can still be an adult, and the vast majority of the time, it results in a male honey bee, drones. Drones are produced from unfertilized eggs through arrhenotokous male-producing parthenogenesis. Alright, and how that happens is actually quite straightforward. In the process of animals, creating sex cells, right, meiosis, germ cells, the eggs and the sperm, there is a point in the meiotic cell division where, when we think about meiosis, we think about a cell splitting in half and half of the chromosomes going one way and half of the chromosomes going the other way, producing a haploid individual, a haploid egg that needs to be joined with a haploid sperm and a haploid sperm and a haploid egg produces a diploid individual, mom and dad produced individual. But in parthenogenesis, that haploid egg, even though in meiosis split to make it half the chromosomes there is a stage in meiosis where the chromosomes don't split into two eggs, but where half of the chromosomes move to the edge of the nucleus and form what we call a polar body. So the egg is functionally haploid. The only chromosomes that will be used are half of them. But it also has that polar body off to the side that, for lack of a better purpose, can reanimate, come back and fuse and then you've got this diploid individual resulting from a single adult. Well, in arrhenotoky, in this haploid situation, you get males. In thelytoky, that polar body reactivates,

comes back down, fuses with the nucleus and you get a diploid individual. So it produces a female. In honey bees, this haploid process produces drones, and also, there is a specific subspecies of honey bee, the cape honey bee, that in through thelytoky, this polar body reactivates, comes back down, fuses with the chromosomes that are already there in the nucleus and produces a diploid individual and because it's a diploid individual, we get females. So we get arrhenotokous parthenogenesis and thelytokous parthenogenesis, and I know I'm glossing it over at a very, 1000 foot level. But if you look up arrhenotoky, or you look up parthenogenesis, or you look up thelytoky, Wikipedia has really good explanation pages for all three of those. But that, in a nutshell, is sort of how it happens. And the second part of the question was, well, why don't organisms do this? Other organisms do do this. Other insects can do this, birds, some bird species can do this. Fish can do this. It's very common, for example, for people to only put a female fish in the tank, but all of a sudden she gives birth when there's no other fish, male fish in the tank. Well, that happened through parthenogenesis. It's actually when you move down the organizational level of animals, you increase the chances that parthenogenesis can happen. I'll just throw it out there, it's conceivably possible, even for mammals to reproduce through parthenogenesis, but we have a lot of mechanisms in place to stop that. So for sure, a lot of the lower organisms do it with some regularity, not just honey bees.

Amy 42:21
That's very interesting. I feel like I need to go back to my high school biology notes just to remind myself about cells. So I will say that this is my favorite honey bee party fact, is that a drone has no father but has a grandfather. I feel like that's just a simple way of explaining that they do come from an unfertilized egg because they don't have a dad but their mom, the queen, she's got a dad. So there you go. So for the second question that we have, this person is wondering how they know if their hive is queened right or if they have a laying worker? So the question really is, you know, do queens ever lay multiple eggs? I mean, do queens ever try to trick us into thinking that we have workers and laying workers in the colony?

Jamie 43:11
So these are good questions. And we're going to start kind of backwards. What is a laying worker? Laying workers are workers whose ovaries have developed in the absence of a queen, and then they start laying eggs. Laying worker, right? So when a queen dies, and a colony becomes hopelessly queenless, they've tried to produce a queen and they failed, some workers ovaries can develop, they can begin to lay eggs, and there are kind of two telltale signs that your colonies are headed by laying workers. Number one, you'll get multiple eggs per cell. Workers, for some reason, don't have the shut off valve. When they go and start laying eggs, they will often lay multiple eggs per cell, including on the sidewalls of the cell, they'll lay eggs in stored pollen cells, etc. The second telltale sign of laying workers is the exclusive production of drones. Workers cannot mate. Therefore, they cannot fertilize the eggs that they lay. Therefore, their eggs are unfertilized and result in drones. It's funny. This is a great segue question straight from the parthenogenesis question because for almost all subspecies of honey bees, Apis mellifera, they will lay unfertilized eggs that can't mate and through arrhenotoky, they become drones. But there is that cape honey bee I mentioned in the previous question that when they lay eggs, they can't fertilized the eggs but their eggs, through thelytoky, become females, but that's the exception rather than the rule. Now, queens can lay multiple eggs per cell and there are some conditions that can

lead to queens exclusively producing drones. However, when queens lay multiple eggs per cell, it's usually queens that have just started laying, and it all seems to work itself out in the end, usually a month or so later queens are only laying one egg per cell. The second telltale sign that it's a queen is that you're producing worker offspring, that not everything she produces is a drone. Now, some people will say, "Well, my queens are drone layers, they're producing mostly drones." Well, if they're producing any workers at all, it's not a laying worker, right? So you can have failing queens produce a proportionately high number of drones, but they usually still produce worker offspring. And even if a queen is exclusively producing only drones, they are still usually only laying one egg per cell. So when you see multiple eggs per cell, and exclusively drone brood, laying workers. When you see one egg per cell, and at least some worker offspring, it's usually a laying queen. Again, with the caveat that queens can lay multiple eggs per cell right after they mate and start laying eggs for the first time. But this almost always fixes itself and queens will start laying one egg per cell, usually, within a month.

Amy 46:01
Okay, so would you, I guess, would you say that someone, a beekeeper would have to wait about a month just to wait and see? Or what would you recommend?

Jamie 46:08
Yeah, so Amy, when in doubt, I try to find her. And I know a lot of new beekeepers maybe struggle finding the queen. So then I look to see, is it a solid laying pattern? Laying workers usually have very scattered patterns. And so if I'm seeing a solid laying pattern, one egg per cell, maybe two or three eggs per cell, but I'm seeing a solid laying pattern, I'm seeing the larvae and pupi in those cells looking like workers, then I know that it's a queen, and even if she's laying multiple eggs per cell, it's going to clear up soon. But if I'm seeing a very scattered pattern, and I'm saying exclusively drone brood produced and multiple eggs per cell, then I do an inspection and don't find the queen, I'm beginning to feel more strongly that it's a laying worker.

Amy 46:54
That's fair. Okay, so for the third question that we have, this person is wondering how, specifically, do you clip the wings of queens and what other techniques do you use to prevent swarming? I know that I've received this question quite a bit as far as clipping the wings. And one wing, both wings, the forewing, the hindwing, you know, what wings are we trying to clip here?

Jamie 47:16
Yeah, I do clip my queens wings primarily as a method of swarm prevention. Now, to be completely realistic about this, this is really something only hobbyist beekeepers, maybe some sideliners can do. But commercial beekeepers simply don't have the time to find all their queens and clip the wings of their queens. I like to make sure my queens, if my colony does try to swarm, that they won't be able to do so. But like I said, it's just not practical once you've got hundreds and hundreds of colonies. So you've got to remember that queens have four wings on one side of their body, they have a large wing, and then a small wing. The small wing is behind the large wing. The large wing is called the forewing, the smaller wing is called the hindwing. You only need to remove half of one of the forewings before a queen is unable to fly. So I only clip half of one of the forewings on one side of the queen's body. And

so, to do this, I have to handle bees enough to where I'm comfortable grasping the queen. So what I do, what I recommend is if you are interested in clipping and marking your queens, but don't feel like you have the experience to do that, start by grabbing and manipulating drones. Grab a drone by the wings, pick it up, and with your pointer finger and your thumb, on the other hand, grab either side of the drones abdomen. So once you do this, release the drone from the hand that you grabbed him with originally. So let's just make sense of this. Let's say I pick up the drone with my right hand, I grab it's wings and gently pick it off the comb. I use my pointer finger and my thumb on my left hand to grab either side of the drone's thorax, and now, I remove my right hand. Holding a drone this way with the face of the drone pointing to the palm of my hand and the abdomen of the drone pointing away from my hand and with my thumb and pointer finger on either side of the drone's thorax, the wings are up. Right? The wings are up and away from the palm of my left hand. So with my right hand, now grab a little small pair of scissors, a lot of those scissors that you'll see, for example, sold with fingernail cutting and maintenance kits. A little small pair scissors. I will clip half of one of the forewings of the drone and I'll do this for dozens and dozens of drones until I'm comfortable handling drones, and then I repeat the process with the queen. I grab her wings and gently try to lift her off of the comb with my right hand. I use my left thumb and my left pointer finger to grab the queen on either side of the thorax. And then I use my right hand to grasp a small pair of scissors and cut off half of one of the forewings of the queen. So this is just one of the ways that I manage swarming. The questioner said, how do you clip queens, and then how do you control swarming? So there's a lot to unpack here. But what I will say, with regard to swarm control, I'm going to kind of abbreviate it because we've got a good document on swarm control, we'll make sure to link it in the show notes. But in addition to clipping queens, from a hobbyist perspective, I go into my colonies once a week during production season, during swarm season, I remove all the queen cells, I add space as needed. So I will super colonies when needed. And those three things seem to be enough for me. Clipping queens, adding space as necessary and removing queen cells once a week. I know commercial beekeepers manage swarms very actively through the process of splitting colonies. And basically, a split is a controlled swarm. You're going in there and essentially, splitting the colony. You're swarming the colony for the bees. And so swarm management, it goes beyond those simple recommendations and make sure you check out the document that we link in the show notes for more information related to that.

Amy 51:17
Yeah, absolutely. And I do want to take this time to, I guess, kind of promote another one of the programs that we have. And they're really just short bee learning courses. It's kind of like elearning, which is why we think we're so punny here. But a lot of the answers for the question and answer for the Two Bees in a Podcast, we actually go pretty far in-depth with our online courses. So if you're interested in learning more about these topics, just about swarming and about honey bee biology, we highly recommend visiting our website and taking a look at either our master beekeeper program, our bee learning short courses or any of the available resources that we have online. Part of our job is to share the science and to try to communicate as best as we can. So if there is something that you're looking for that we don't have, please feel free to let us know. But that said, thank you so much for listening to this Q&A of Two Bees in a Podcast. Hi, everyone, thanks for listening today. We'd like to give an extra special thank you to our podcast coordinator, Chelsea Baca, and to our audio engineer James Weaver. Without their hard work, Two Bees in a Podcast would not be possible.