Episode 252: Q&A on Laying Workers, Pseudo-queen-Queens & Pesticide Exposure

Jamie

Welcome to Two Bees in a Podcast brought to you by the Honey Bee Research Extension Laboratory at the University of Florida's Institute of Food and Agricultural Sciences. It is our goal to advance the understanding of honey bees and beekeeping, grow the beekeeping community and improve the health of honey bees everywhere.

In this podcast, you'll hear research updates, beekeeping management practices discussed and advice on beekeeping from our resident experts, beekeepers, scientists and other program guests. Join us for today's program. And thank you for listening to Two Bees in a Podcast.

Amy

All right, welcome to Two Bees in a Podcast. This is the first time – Jamie, we're doing something a little bit different.

Jamie

I'm excited about it.

Amy

Are you ready to hear about what it is?

Jamie

I am excited. You're keeping me in suspense, although I sort of know.

Amy

Yeah. I think you do know. Many of our listeners were talking about how they love the Q&A segment, right? They like to hear our interaction; they like to hear the discussion between the two of us. So, I think we're going to do an every other episode where one episode we will be interviewing a speaker and then one episode will be a full Q&A segment. And so instead of just three questions, we'll go a little bit more in depth with five questions. And so, they get an entire episode of Amy/Jamie every other week.

Jamie

I don't know why they would want that, but we aim to please. So, we're going to do our best to see if this is something that the listeners enjoy. So, it's exciting to be able to do this.

Amy

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Let's see how they feel about it. If you all decide you don't like it anymore, we'll try something new. All right, let's go into the five Q&A's that we have today. The first question that we have is about identifying different ages of workers and whether you can do that visually.

You know, I'll say a little bit of background and summarize the question. But this person found a swarm, and they're not sure if the swarm is just there temporarily, if it's new or if it's an established colony. And so, they're wondering, you know, if these workers are going in and out of an entrance somewhere, can you tell whether this is new or whether they've settled for good?

Jamie

This is a bit of a hard question, I guess, because it's nuanced. So technically you can look at a worker and give it a rough age. And what I mean by rough is if you think about workers, you know, they go through a lot of different tasks as they age.

The first set of tasks they do are inside the hive, they feed brood, they feed the queen, those kinds of things. Then they do those middle age tasks, and then they do those old bee tasks, which include, you know, foraging, defending the nest, all of those things. And you can kind of age bees into those three categories, young, middle and old.

But it's very subjective. And so let me just kind of start from the beginning. When a bee emerges from her cell, she's very hairy. She's almost wet in appearance. I mean, her hair looks like it's slicked to her body. Within a few hours, it puffs up, it dries and she's very hairy.

And as a bee ages, she or he, the drones lose that hair, just through natural interactions in the nest, you know, just standard things. And so, as they age, they can get a little less hairy. When they're much older, usually foraging age, you start to see their wings getting tattered.

And I don't mean deformed, like what you would see with a bee that's got deformed wing virus. I mean tattered. Usually, the edges of those wings can be frayed. So, a very old bee that's been foraging for some time might have frayed wings, you know, less hair, things like that.

But we know viruses can cause, you know, these frayed wings, we know viruses can cause bees to lose hair. So, it's a little tricky and a little bit nuanced. So, I would say it's somewhat difficult to look at the bees, say, at the nest entrance, and be able to guess whether that colony is a new colony that just moved in that's composed of very young bees or an older colony that may have been there a while that's composed of a natural assortment of bees.

First of all, the bees that are showing up at the nest entrance are going to be that late, middle age to early older bees, where they're in that guard bee or they're doing those orientation flights. But you can, if you're going through the brood nest of a colony, it's fairly easy when you pull out a frame to see those newly emerged workers because they've got all of that hair.

They look wet in appearance. They might be stumbling a little bit as they learn to walk those types of things. But I just think it's a bit too subjective after they get past that young bee age to really put a good age on those middle age or older age bees. It's funny, my wife's background is in wildlife biology and there are ways that you can age a lot of different mammals.

For example, deer, you can look at certain teeth in their mouths and the wear pattern on those teeth to get a really reasonable guesstimate of their age. Well, there's really not an equivalent in the honey bee world. It's really easy to spot those newly emerged bees, but after that it becomes very subjective very quickly.

Amy

Yeah. So, I'm going to follow up again with a question because now that I'm looking deeper into the question, one, it says that the removal is from an apartment building. And then the other piece of it is that this person can't find the nest and they've used a thermal camera. And so, they're wondering, like, is a thermal camera, if it's showing that there's heat, but they can't find the nest. Could that be because the walls are insulated? I mean would the thermal camera be able to tell the difference between an established colony or insulated walls?

Jamie

Well, for our listeners out there, in the bee removal business, one of the keys is that you often encounter bees, right? People know that there are bees there because there are bees flying in and out of some sort of entrance, right? A hole. A hole in the wall of the house, a hole in the eave of the house, things like that.

Well, for the removal specialist, that's all well and good, but that nest could be feet away from the entrance because the bees may be using that hole and walking a few feet to the actual cavity that's formed where the colony is living.

And so, it's very common for folks in the bee removal business to use thermal cameras to see hot spots, say on the wall or the eave. And then they deduce, well, this is probably where the colony is. You know, the entrance is over there, but the colony's nesting here. Well, it sounds like, in this instance, they're trying to get some thermal data to guesstimate where that colony is.

And if they're not finding that thermal data, either they've not hit the colony yet or the building is sufficiently, you know, insulated to where they can't pick up that heat signature of the colony. So, my guess is it's probably the latter of the two. And how this interacts with the age of the bees at the nest entrance or whether the colony's been there a long time or it's a young colony, those kinds of things.

I think it's just too tricky and nuanced to link those things directly. So, if you're struggling with these thermal imaging cameras to find the colony, there are really nifty strategies that you can

use. They make, for example, these endoscopes that you can purchase that are relatively cheap that you can hook up to your cell phone.

And they're basically a video camera on the tip of a long rigid tube. And you can thread that through the Nest entrance and until you get to the colony, and that can give you a guesstimate of how deep that colony is into the structure away from the nest entrance. This is an interesting question though, because there's a lot of different things at play and assumptions that they're making in an effort to find this colony.

Amy

Definitely. So, Jamie, the second question that we have today is about workers and detecting inbred eggs. So, we know that workers will detect eggs and they'll remove larvae if they detect something going on with it. But how do workers do this?

Jamie

What a great question because I have often wondered the same thing. Let me just elaborate on the behavior just a little bit. So, the idea, let's just say for the sake of argument that a queen lives in a colony that is located exclusively on an island and it's the only colony there.

And so, your colony goes queenless. They produce virgin queens. The first virgin to emerge kills her sister. She goes out to mate, and the only drones available to her in the environment are those from the same colony that she was born from herself. So those would all be her brothers.

So, she would be laying 100% inbred eggs, right? So, she's mated exclusively with her brothers. Well, worker bees can detect that and abort the inbred eggs. Now expand it to a more typical situation where you might have three to five colonies, or 10 colonies in your backyard, or 30 colonies if you're part of a commercial apiary.

Then there's feral honey bee colonies in the environment. Then there's other beekeepers in the area, etc. The chances are not super great, but they're there that your virgin queens are going to be mating with drones they're related to. So, when she starts laying eggs, maybe some of those eggs are fertilized with semen from drones that she mated with that are related to her.

So, you've got workers in that nest that are capable of detecting amongst all of those eggs being laid, they can detect those that are inbred. Now, this is pretty remarkable, right? We all talk about it in passing. We say that it happens.

We say that it's a cause of spotty brood patterns, and then we just kind of leave the story there. Well, how is a worker able to determine that that egg that's in the back of that cell was fertilized by a drone that the queen's related to?

Well, we know that when you get these inbred eggs, we know that there can be mortality associated with them. So maybe workers are just detecting eggs that aren't going to make it. But what I found when I looked this up for more information is that this is actually a discussion that hasn't been settled yet.

Most of the hypotheses are related to chemical signatures that workers recognize that they go, OK, well, we can chemically detect that this egg was fertilized by a drone related to the queen.

But even if that's true, there's still a lot of questions surrounding that. Like, why would an inbred egg have a unique chemical signature related to an egg that's laid by the same queen? It's just fertilized by a different drone. We don't know. And it even gets more complex because when we talk about Cape honey bees in South Africa, when their workers start laying eggs, you can actually get multiple laying workers in a colony.

Let's just make this an easy discussion and say there are five laying workers in a colony. Well, the offspring from laying worker A can detect eggs laid by laying worker B and abort those eggs in favor of the eggs laid by their own mother.

So, this behavior is called policing behavior where workers from one mother are removing the eggs by other workers in the nest. And clearly, workers have this heightened sense to be able to detect eggs that they are related to versus eggs they're not related to.

So right now, the best guess is that there's chemical signature. When I was prepping to answer this question, I was able to find a few papers that kind of make that claim. But it still seems very much in the hypothetical sense at the moment. I also struggle to understand how this is even possible.

It sounds like an opportunity for active research, if people want to do a PhD or master's. Probably a PhD or even a post doc in this topic because it sounds complex. But Amy, I guess the short answer through all of that is it appears to be a chemical signature on the eggs that worker bees can say this is good or this is not.

But even that to me just leads to a multitude of questions that, still, I don't believe we have satisfactory answers for us. So, it just seems like one of those things that's just waiting to be uncovered.

Amy

I mean, you even talking about that, of capensis being able to, you know, pull eggs that are from a different mother, a different queen. I mean, is it every single egg that they're pulling out? Are they going and picking and choosing which eggs? Is it just because they're not related to them? You know what I mean? There are so many questions like that. My brain just starts to hurt thinking about that.

Jamie

I mean, well, let's just boil it down to an example of capensis where you've got two laying workers in the colony. And the reason this is studied in capensis is because if you've listened to this podcast for a while, you'll know that laying workers in capensis colonies, unlike laying workers in all the other honey bee colonies, can produce diploid eggs that ultimately become female, right?

So, you can have two laying workers in a colony. Both are laying eggs, so they're producing female offspring. So, other workers. So, workers produced by worker A can detect the eggs of worker B.

Well, that also means that they can detect eggs of their own mother and discriminate between the two of those. So how do those workers even know that they are related to an egg? We often say, well, they can detect eggs that aren't from their own mother.

Well, how do they know what they're related to, right? So, we know that workers have really heightened sense to detect, you know, eggs that they're related to and eggs that they're not. And then when you think about it from the perspective that the questioner was asking, well, how can they just detect an inbred egg. That's not even an egg they're related to or not.

That's an egg that's just been fertilized by a semen from a drone the queen's related to. That's a completely different, it would seem, sense perception. So right now, chemical signatures are the best hypothesis. But even that, to me, hardly satisfies my desire to know the answer in this space as well.

Amy

Pretty wild. All right. So, for the third question that we have, this beekeeper was worried about pesticide exposure. The bees that they had basically collected were sprayed by pesticides, but the assumption at that time was that the pesticides would be water soluble.

So, what the beekeeper was trying to do was wash the nectar out of the foundation. And so, they were hoping that the bees could reuse the wax. But then, you know, after thinking about it, they thought, well, maybe the nectar was fine and maybe the wax was more likely to be contaminated.

And so, at this point, you know, what should the beekeeper do? Should they return the wax to a colony or can they reuse it? What are your thoughts on this?

Jamie

When I get questions like this, I often ask myself, what would I do if I encountered the situation that the beekeeper is describing in the question. So, the questioner here is saying, I believe I had a pesticide kill, and as a result, I wanted to reuse the wax.

Bees put a lot of energy into making wax, so I wanted to reuse it. So, my thought is maybe if I wash out the honey and the pollen, I can reuse those combs in the future. But then the beekeeper said, oh, snap, maybe, just maybe the pesticide has moved into the wax and now I've got a completely different problem.

And then I can't reuse it. So, what should I do? Well, the clearest answer to that question is we have to know the pesticide that did the killing in order to answer this question because pesticides can be hydrophilic.

And if you think about the constituent parts of that word, hydro, water, philic, loving, hydrophilic, right? Or they can be lipophilic, lipid, fat, philic, loving, so fat loving or wax loving. If a pesticide is hydrophilic, then presumably you can wash out the nectar and pollen and reuse the beeswax in the future.

If it's lipophilic, it's going to move from the nectar and pollen into the wax and be there in the future. So, if you don't know what the active ingredient was, then it's very difficult to know if your response to that is relevant or not.

So, I would say most of, or a lot of, at least, maybe most is a little bit too general, but a lot of the pesticides to which bees are exposed are lipophilic, meaning that they're going to move into the wax and stay there. But Amy, before I even get into that and we dissect that, I think it's better to just step back one layer.

Why do you think you had a pesticide kill in the first place? When I go through my list of things that killed colonies, I go through a triage before I even end up on pesticides. You know, Varroa. What were the Varroa treatments I used? What were the varroa populations?

What about nutrition? What about queens? Assuming you go through that triage, and you have confidence to believe that it was pesticides, you now kind of got another fork in the road. Is this an acute kill or is it a chronic kill?

The acute kill is the easier of the two to recognize. Acute means that they got exposed to a high enough dose to give a pretty immediate response. So, you see lots of dead bees on the bottom of the hive or outside the nest on the ground, those types of things.

A chronic kill, on the other hand, means that they're exposed to very low doses that give smaller impacts over time. And those to me, even to me, are very difficult to untangle from other things that can kill bees or cause pesticide stress.

So, for example, it's hard for me to spot a chronic kill versus Varroa or a chronic kill versus nutrition or chronic kill versus Nosema. So, presumably, if this beekeeper really believes that it was a pesticide kill, the only way they can feel reasonably comfortable is if that's an acute kill and you've got lots of dead bees.

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So, assuming it was that, there's a couple things to consider. First, if you're seeing lots of dead bees, then, hopefully, they're not storing that stuff in the combs in the first place because as quickly as they're encountering it, it's killing them.

So, if you wash out the nectar and pollen, then the chances are pretty low that it's made it into the wax at appreciable levels that are going to impact bees later anyway, right? Does that make sense?

But if it's chronic, you know, you're going to have to work hard to convince me that you've untangled a chronic exposure from bees. So, I'm going to go all the way back, Amy, to the first question, which is what would I do if I expected a pesticide kill? If it were me and I expected a pesticide kill, I would just throw away the combs and not reuse them because I would be too concerned that the stuff is in there waiting to do its thing again.

So, I would really have to believe that it was pesticides. And if I did, I would probably not reuse the combs at all, regardless of if I washed out the nectar or the pollen. So, I hope this long discussion helped you understand why I would make that decision.

Amy

Yeah, definitely. And you know, as I'm reading the question, it says that the bees were rescued and they were sprayed. So, I guess there are, you know, a couple of assumptions that kind of come to mind, like maybe it was a colony that a neighbor had or friend had and they tried to spray, it didn't work, and then this person had to come rescue it, you know what I mean?

So, it almost seems like this individual knew that they were sprayed. So, I guess in that aspect, if you knew what was sprayed, one, you would want to detect or know what the active ingredients were. And two, I mean, it sounds like an acute, you know, situation if that were the case, right?

Jamie

Yeah, if the bee survived it though, and they're not like actively declining, then I would say, well, it looks like the worst is over, maybe things will be better. But you know, there's no safer answer than moving the bees to new comb, right?

I mean, if the bee survived it and you're worried about residues and the combs and things like that, then the safest, most conservative answer just to put bees on new combs, and then you don't have to don't worry about it moving over. I mean, if they survived it and they're beginning to recover and they're thriving, then maybe the stuff's not in there anymore and you're OK. But you know the most conservative answer is always to put them on new stuff.

Amy

That's fair. Would you put them in another box? Like, would you incorporate them into an already established colony?

Jamie

Yeah, I thought hard about that actually before answering this question. Personally, if it were me, I probably wouldn't move them into a new box unless the box was sprayed. I'm less worried about residues on boxes and more worried about residues on combs and in pollen, honey, and beeswax and things like that.

If, on the other hand, enough bees died and I was worried about brood and things like that and there's just a smaller population of bees, that may not be worth trying to save that colony. In which case you could just combine them with another one just like you suggest. You wouldn't move the hive constituents over to that other colony. You would just shake the bees in it to make sure that you don't take the pesticide with them.

Amy

Definitely. All right, OK, so for the 4th question, it's so weird for me to say 4th, because I'm like, OK, 1, 2, 3 done. But here we go. We got 4 and 5. For the 4th question that we have, is there such thing, Jamie, as a false queen where a queen emerges, doesn't go on a mating flight and so the colony basically just lets another queen take over? Does that original queen become a worker or what happens to her? Like what's the situation here? Does this exist?

Jamie

Well, there's really no such thing as a false queen. There is such thing as a pseudo-queen. And well, what is a pseudo-queen?

OK, workers exist and queens exist. And we all know that both of them come from the same egg. And the larva that emerges from that egg, if they are fed exclusively royal jelly, and a lot of it, they become a queen. If they're fed royal jelly the first few days of their life and then the diet changes to worker jelly, then they become a worker. So, it's really diet driven, right?

One diet produces a queen, the other diet produces a worker. All right, we all know that. Now, bees can start feeding those female larvae too late or potentially incorrect mixtures of diet to where that female maybe was on track to be a worker.

But now she's getting enough diet and she's starting to get the type of diet that she would be fed if she were going to become a queen. So, she moves away from worker-dom, so to speak, and becomes kind of queen-like. So that phase between worker and queen we would call pseudo-queens.

And those pseudo-queens show varying levels of queenliness or workerness. And maybe, let me give an example that would provide the best way to think about this. Imagine a colony's queen is having a problem, and she laid her last egg five days ago before the workers recognize that she's failing and they kill her.

Well, if she laid her last egg five days ago, that means once she's dead, all of those eggs will have gone through three days of egg development and two days of larval development. So that means her last laid egg would now be a 2-day old female larva.

So, let's say the bees get rid of the queen and it's another day or so before they start making queen cells. Well, if it's another day or so, that means the youngest available larvae in that nest are now three days old, right? 6 total days. Three days in the egg, 3 days of larvae.

Well, larvae that are 24 hours old or older, and here we're talking about, you know, even older, but larvae that are 24 or 48 hours old or older are starting to get in that age that they were really heading down the worker route and not the queen route.

But the bees have no option. So, they start going to those females that are available and start feeding them lots of royal jelly. Well, you get a situation where they're not optimal queens. They were heading down a little bit, even if just a little bit, down that worker path before they were redirected to become a queen, but it's a little bit too late.

So, you get the smaller queens whose ovaries aren't great and well developed. So, you can get pseudo-queens where they're not optimal queens. And that's usually a size thing. They're not quite as big, they don't have developed ovaries, etc. But if that's the only option that the bees have, that's what they have.

Well, these girls can go out and mate, they can lay eggs, but maybe they're not optimum. So, the worker bees will actually replace them shortly after they start producing female eggs so that they can then try again and do a better job. And so, you can kind of get that continuum between workers and queens based on when they were pushed towards becoming a queen.

But the idea of a false queen where one is produced and she fails to go on to mate, so the bees make a new queen so the one that was first produced goes back to being a worker, that doesn't happen. Now, you can get queens that fail to mate for lots of reasons.

Maybe they're incapable of flying, maybe the weather was bad the days that they wanted to mate, in which case these queens just become drone layers. And for the most part, those colonies are doomed because even when they do lay eggs, the bees can't make females from those.

So yeah, those would be doomed. But the idea of a false queen is not really the case.

Amy

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You know, it's funny because many of our questions today were related to workers and eggs and laying workers. And then I was just realizing, of course, on our very last question, that these all came from videos of what you did related to queens and laying workers.

So that makes a lot of sense. I'm like, what are the odds that all these people are asking these questions related to queens and eggs? Well, they're really high because you had put a video out and these questions are from those videos.

Jamie

Amy, it's funny you say that. I know people, when they produce YouTube videos like we did when I was at UF, a lot of the YouTube folks who do that, they are actively engaged in the Q&A discussions on the bottom of those YouTube feeds. And so, people will post questions and then the person who published the video post answers.

Well, I'm really terrible at that. The reason I'm terrible at that is because, you know, YouTube videos aren't the thing that I do all day, right? And so this is giving us a platform for me to be able to answer those questions without necessarily having to sit down and go through all the videos that we produced during my time at UF.

On the flip side of that is those folks who are watching our videos and asking questions also have to be podcast listeners in order to get their questions answered. So, hopefully they are. Maybe you guys at UF now can start answering and saying, hey guys, if you want to know the answer, listen to episode whatever in the podcast and that might redirect folks to the podcast as well.

Amy

That's right. We'll just give Jeffrey one more, Jeffrey, our podcast coordinator, one more thing to do.

Jamie

He needs something else to do, right? He twiddles his thumbs all day.

Amy

That's right. Oh, he's going to be so upset with us that we're saying this right now while he's listening to the podcast. OK, so for the very last question, question number five of today. So, this was a question related to one of your laying worker videos, and this person was saying, you know, what a fascinating phenomenon.

And they're wondering if this evolved as kind of like a last-ditch attempt for the hive genetics to continue, which I think we've talked about a little bit, right? And so, basically, these workers develop ovaries, they're able to lay eggs. They will produce unfertilized eggs, unless you're

capensis, but typically the bees that we have will lay unfertilized eggs that have drone production. And so, is this something that is a last-ditch attempt to continue genetics or is this a specific determinant, like, a unique sex determinant genetics within Apis mellifera?

Jamie

It is a pretty fascinating topic, right? This idea that if colonies go hopelessly queenless, some of the workers can start laying eggs. Now, this actually raises a lot of questions. Amy, you know, I just answered a question and made the statement about, well, a fertilized egg becomes either a queen or a worker, depending on the diet they're fed.

That means, essentially, that workers, and I'm going to anthropomorphize here, but workers are females that have essentially forfeited the right to lay and raise their own young in favor of taking care of the young of their queen, which is kind of weird biologically, right?

Because, you know, biology teaches us that all things that are alive, all they want to do is just have babies of their own to pass out their own genes. Well, workers in honey bees and for that matter, in Hymenoptera, a lot of workers have forfeited that right in order to take care and raise their own sisters rather than raise their own offspring.

There are genetic reasons for that. Maybe that's another Q&A for another day. But in the case of honey bee colonies, when they go hopelessly queenless, workers don't mate, so they can't lay fertilized eggs, so all they can do is produce drones. And as a beekeeper, we know that essentially, laying worker colonies are doomed.

Again, except for that caveat Cape honey bees that we could talk about for days. So, when our own colonies go queenless and workers start laying eggs and they can only produce drones and drones can't forage, they can't build comb, they can't take care of the babies, all of that stuff, the colony is essentially doomed.

So what benefit is it to workers laying eggs? Are they just naive and saying, hey, I'm going to become a queen, I'm going to lay eggs, and the colony is going to be fine? Well, probably not. The best answer that I've always heard and always read is exactly the answer that the questioner provided us with.

It's probably the colony's last-ditch attempt to get its genes out there because the drones produced by workers are capable of going to drone congregation areas and mating with queens and fertilizing those eggs.

And so, it's almost like the colony saying, well, you know, we're on our way out, but let's throw our genes out there to ensure that we're immortalized in offspring that are produced in other colonies. And so that is a benefit of laying workers from the colony's perspective is while the

colonies dying, true, essentially the drones are able to go out and mate with queens and there's that last-ditch attempt to make sure that those genes persist in the environment.

Amy

Definitely. All right, everyone, that was a five-question Q&A. If you liked it, let us know. If you have any other questions, send us an e-mail. You know what to do. We really appreciate all your questions. We'll pull questions also from YouTube videos. So, our podcast listeners, if you haven't watched our YouTube videos, check out Beekeeping Academy on YouTube and hopefully our Youtubers are listening to this episode as well. So, we appreciate it very much.

Hey everyone, thanks for listening today. We would like to give an extra special thank you to our podcast coordinator, Jeffrey Carmichael. Without his hard work, Two Bees in a Podcast would not be possible.

Jamie

Visit the UF/IFAS Honey Bee Research and Extension Laboratory's website, UFhoneybee.com, for additional information and resources for today's episode. Email any questions that you want An Equal Opportunity Institution. answered on air to honey bee@ifas.ufl.edu. You can also submit questions to us on X, Instagram, or Facebook @UFhoneybeelab. Don't forget to follow us while you're visiting our social media sites. Thank you for listening to Two Bees in a Podcast.