Episode 253: Small Hive Beetle Control with Dr. Aaron Gross

Dr. Jamie Ellis

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

Hi, everybody. Welcome to this episode of Two Bees in a Podcast. Today we are joined by Dr. Aaron Gross, who is an Associate Professor in Toxicology and Physiology with the Department of Entomology at Virginia Tech. And today we're going to be talking to Dr. Gross about research on managing small hive beetles.

Dr. Gross, we have a lot of questions here in Florida about small hive beetles. Small hive beetles are spreading throughout the world, and so we're really excited to have you join us today.

Dr. Aaron Gross

It's great to be here.

Amy

Yeah. So, with all of our new guests, we always ask them to tell us a little bit about yourself and how you got into the honey bee world. Whether you worked with honey bees or whether you just work with small hive beetles, we'd love to hear a little bit of your background.

Dr. Aaron Gross

Yeah, so my area of expertise is insecticides, insecticide mode of action and repellents. I started working on repellents when I was in grad school with Dr. Joel Coats at Iowa State University and then continue to work with repellents, but more on insecticide and mode of action when I was at the University of Florida with Jeff Bloomquist.

And then when I started my lab at Virginia Tech, we kind of wanted to focus a little bit more on honey bees, and part of that was looking at the pest. So, we did some work with Varroa mites, and really, a lot more work with the small hive beetle.

Dr. Jamie Ellis

All right, Aaron, so did you get interested in bees? Where along the way? Was that in Jeff's lab at UF or was that before that?

Dr. Aaron Gross

I think it started in Jeff's lab at UF and looking at some of the chemistry that was safer for honey bees as part of that registration.

Dr. Jamie Ellis

Yeah, obviously I was at the University of Florida for 20 years almost. He's a great scientist, Jeff. And so, it's really neat that you worked with him and are working as your own lab leader at Virginia Tech. And you know, you're studying killing things that bother bees, which is great news for everybody listening to this podcast around the world.

Obviously, we would love for you to knock off Varroa, knock off small beetles for us so we can all enjoy beekeeping again. But in this podcast episode, we're really focusing with you specifically on small hive beetles. I've got a love-hate relationship with these things. I did my PhD with them and their biology is amazing.

But I also wish they would all die in honey bee colonies, right? So beekeepers could keep healthier colonies. So, talk about what small hive beetles are as we kind of get down into this and why they are a problem. Because many of our listeners around the world may not even know what these things are. So, could you introduce us to these things before we talk about your research to kill them?

Dr. Aaron Gross

Small hive beetles are a really interesting pest because they've essentially found a way to figure out how to exploit the honey bee colony incredibly well. With their introduction, which was actually originally in Florida, they spend some of their time in the colony, but they also spend some of their time outside of the colony.

So, in the colony is really when they're destructive, that's the larval stage where you'll find a lot of those destructive small hive beetles. They're going to be feeding on almost anything that's available to them, and they also will release aggregation pheromones to draw in more adult beetles to that hive.

The adult beetles lay the eggs and then the larvae emerge and larvae feed on everything. They also release a fungus that can result in slime, and then the small hive beetles will actually leave the colony, go to the soil around the colony and burrow down and that's where they'll pupate and then re-emerge as adults to start that cycle over again.

An Equal Opportunity Institution.

Amy

Dr. Gross, I've been working at the honey bee lab for 8-9 years and I've had no idea that, first of all, it was introduced in Florida. I did not know that. Jamie, how did I not know that? I don't know.

And then the other thing that you had mentioned was a fungus that is the cause of that smelly, disgusting slime-out that you had mentioned.

Dr. Aaron Gross

Yeah, Kodamaea ohmeri is a yeast and it was isolated. Really, we found it in almost all of the beetle life cycle, and it's associated with that beetle fermentation, and it contributes to a variety of volatiles that are produced by the invasion of that beetle in the hive causing that slime but also attracts more and more of those beetles to that hive.

And that's really where we started to get interested in looking at some of this behavior that's associated with small hive beetles and if we were able to manipulate that behavior or change of biology, if you will, of the beetle itself.

Amy

Yeah, let's talk about that a little bit. Can you go more into detail about what you just said?

Dr. Aaron Gross

Yeah. So, one of the interesting things of the production of some of these smells from beetle invasion is actually the production of isopentyl acetate, which is odd enough because that's a component of the alarm pheromone, and it's believed to be at a lower concentration that will draw more beetles into the hive.

And so, we were thinking that if we could find a way to look at the antennae of the small hive beetle to do some behavioral bio assays, could we draw beetles in or make them attracted to a source? And then on the opposite end, could we find chemicals that will actually repel those beetles.

So, kind of like a push/pull strategy with the idea of really using less chemicals in the hive and then using, I guess, chemicals outside of the hive.

Dr. Jamie Ellis

So, Aaron, I am interested in diving into this further because I'm interested in hearing about some of your successes. Maybe, like, do you have a list of compounds that attract and a list of compounds that repel? And you don't have to give a specific name if all of this is still in the process of being studied.

And my follow-up question of that, which is, Aaron, a pre-emptive follow up, is given you're talking about pheromones and other smells, what simultaneous impacts could this have on bees? So, for example, if it's an alarm pheromone component that attracts beetles, but pumping that into the beehive, what might that do to the homeostasis of the nest? So again, to summarize, what are some successes that you're having, but also what are some things that you're thinking about how these might also impact bees?

Dr. Aaron Gross

Yeah. So, a large focus of our studies were could we find or could we start with compounds that are not affecting the bee, or at least, from a preliminary screen, appear not to affect the bee.

And so, we started with these heterocyclic amines, and this was studies that was actually done at Virginia Tech before I got here where they looked at a variety of these heterocyclic amines. And so, some of those compounds were like a pyrrolidine that really did not appear, at least in a laboratory setting, to have a strong effect on the bee.

But what we found with that particular compound is that it would affect the behavior of the beetle. Now we kind of moved away from utilizing pheromones and we just focused on the attractive nature of pollen patties and could we pull outside of the hive beetles towards a pollen patty.

And then the idea would be could we use pyrrolidine to push them away. But really the problem that we saw right from the start is that we wanted to have a positive control. And the positive control that we focused on was DEET. Indeed, of course, it’s a mosquito repellent, but it is not a beetle repellent.

So, it did not push away or activate the antennae of these small hive beetles, even though it's quite effective against mosquitoes.

Amy

That's so interesting. You know, Aaron, while I'm listening to you talk, I'm thinking about, you know, some of the research that I've seen as far as lures and trying to figure out, small hive beetle, what are they attracted to? What is the deterrent? And I'm just wondering if we could take a step back real quick to talk about maybe the methods of both lab and field work. What does a project like this look like?

Dr. Aaron Gross

Yeah. So, we started with looking at the antennae of the small hive beetle, and essentially, we would cut it off and we did a procedure called electroantennography where we would measure,

essentially, that antennae becoming activated by a smell, or could essentially a beetle smell a compound that's being blown on that antennae.

And that's where we started to utilize some of the pheromones like isopentyl acetate, but also with the pollen patties, we were able to show that those beetles are able to smell that pollen patty. So, the first step was saying, you know, these attractive smells that we know, does the beetle antennae respond to them?

And we found that they do. Now the question is could that antennae smell the repellent compounds? And with DEET, like I mentioned, that was not effective. Essentially, the antennae were not capable of smelling DEET, but it was capable of smelling pyrrolidine.

Now, that's, of course, in a lab setting, so it doesn't necessarily translate to the field or really even to behavior. So, the next step was to look at these beetles within an olfactometer, which is like a behavioral test where we took a variety of Petri dishes, and we connected them together and we gave the beetles a choice.

Would they prefer an attractive source like a pollen patty? And would that attractive source be less beneficial or less attractive in the presence of a repellent? And so, we've linked this antennal response to a behavioral response.

Now again, a lot of this is just working within the lab and translating it to the field is an entirely different beast. And that's what we're still working on. So, it's really not necessarily utilizing these chemicals today in the field but at least showing the potential to use them in the future.

Amy

That's so crazy. I'm just thinking about how difficult, you know, it is to set something up, also just in the field, right? So, part of the work that you were working with as far as them being able to smell certain pheromones, is there a distance that you think or was that anything that you were able to look at as far as, yeah, they can smell the pollen patties, but at what distance?

Dr. Aaron Gross

Yeah. So, that's some of the work that we were focused on with Dr. Cameron Jack at University of Florida was could we put this under a semi field study to see how effective it was. And of course, there's challenges when you find something that works in the lab to actually translate it out to the field.

And so, those are still studies that we're trying to figure out. Could this be an effective measure or an effective treatment out in the field?

Dr. Jamie Ellis

Eric, I love how you are doing this research to get it from the lab to the field. And I know we want to talk a lot about field stuff and why small hive beetles are difficult to control, but I want to circle all the way back to one of the things you said earlier so that our listeners can get an appreciation for this. So, you said you were passing odors over small hive beetles' antenna and you were doing this with an electroantennogram.

What is that measuring? How can you tell what a small hive beetle can smell or not smell? Maybe get into the weeds a little bit with this particular method.

Dr. Aaron Gross

Yeah, sure. An electroantennogram is an experimental tool that we utilize in entomology, and really what it does is that it measures the collective electrical response of the insect's antenna. So, what that really means is that there are neurons that are within that antennae, sensory neurons that are giving that ability of the beetle to smell.

And so, if we take that antenna and, essentially, we cut it off from the beetle and we take two electrodes and we hook it up to both ends of them antennae, one that's facing out and then one that actually projects into the beetles brain, we can measure how those neurons are responding to different smells based on activation of those neurons.

Dr. Jamie Ellis

Well, how long is an antenna good once it's been removed from the beetle?

Dr. Aaron Gross

Yeah. So, we were able to keep those antennae alive and able to respond for a good 30 to 45 minutes after we had cut them off.

Dr. Jamie Ellis

Incredible. And I love this idea, right? So, you've got these antennae, you can do kind of high throughput screening assays of compounds, both repellent and attractives. Right now, you're only able to tell, I guess, that they can detect it. And then you can take those repellents and attractives to the lab. Then you do some work that gets it to the field.

But I want to talk a little bit more about why small hive beetles are so difficult to control in the first place. Could you elaborate on that?

Dr. Aaron Gross

Yeah, one of the main features about the small hive beetles is that the larvae feed extensively on those hive resources. So, they're actually within the hive. And then when the adult emerges, an

adult female could potentially lay anywhere from one, maybe 2000 eggs, which means that really a few adult beetles could potentially produce a substantial amount of larvae within that hive.

And again, that larvae is really the main destructive life stage of the beetle as a pest. And then, the other thing with beetle control, we don't really have targeted compounds that work against small hive beetles.

A lot of times we just recycle what's utilized from another important pest, Varroa mites. And what we found through other studies was that those chemistries, those insecticides don't work as well against the beetle. Maybe they work well against the Varroa mite, but they just don't translate over.

Amy

So, you had just mentioned something that I think, I don't know why I've never thought to ask this or I don't know the answer to it, but is small hive beetle, the only thing they eat is within a colony? Or do they also expand their diet?

Dr. Aaron Gross

Within the colony or outside?

Amy

Both.

Dr. Aaron Gross

OK. So yeah, they'll feed on almost really anything that's available in that colony itself. But they will also be attracted to a variety of different smells or rotting fruit or even fruit itself, and therefore, probably will feed on that too.

Amy

That's fair. OK, So I do have to ask the question that we receive all the time. And Jamie has gone into this as an extension specialist. A lot of people will ask if I pour concrete underneath my colonies, how large of a space should I pour concrete or put black plastic down to avoid small hive beetles from being able to reproduce? Do you have an answer to that or a theory of what that would be?

Dr. Aaron Gross

No, I don't have a direct answer, but I would say probably, you know, the beetle is going to find a way to survive and so, it does burrow down into the soil to pupate and to complete its life cycle.

And I think, you know, immediately putting black plastic down or cement down might decrease populations.

But again, it only takes one or two beetles to come into a hive, and maybe they would move further away, or they would find a place to pupate within the colony itself.

Amy

Cool. So, you talked about some of the lab work that you're doing, and I know that you're working with Dr. Cameron Jack. I know that guy. We see each other pretty often. But I was wondering, you know, you're talking a little bit about the field work that he's doing. I know he's doing a little bit of field work with the small hive beetle and luring and deterring them. But what do you think needs to be developed further to help with controlling small hive beetles around a colony?

Dr. Aaron Gross

Yeah. So, utilizing the smell or the repellents, we really need to find a good assay to measure its ability to push or pull within the field. And then, you have to start to look at these attractive sources and the repellent sources and how often do they need to be applied or slow-release chemistry and changes that chemistry.

But also, what's really important, we alluded to this earlier on, is that we have to have a good understanding of how these chemistries affect the bee itself. So, the push/pull strategy will not work if it pushes bees from returning to their hive.

And so really, it's that optimization of one, can we get this or can we translate it from the lab to the field? And then, what types of effects have we not seen yet against that honey bee? And all of that's really important to actually implement this into the field.

Dr. Jamie Ellis

Yeah, I agree, Aaron, I think it's probably not good if we develop something that pushes the bees from the hive. I'm really glad that you've got that mindset. I know that folks listening, we're going, now wait a minute, what about all these things? And I know that you've got those covered. So, listen, this is your opportunity to expand and talk a little bit more about things that you're doing not related to beetles.

You do have a footprint here in the honey bee world. You're working on small hive beetle control. You mentioned a little earlier, potentially even some Varroa control. So, what are some other honey bee related projects or topics that really get you excited or that you might be working on currently?

Dr. Aaron Gross

Yeah. So, some of the things we have looked at, Varroa mite, we've looked at resistance of Varroa mite. So, a large focus of my lab is not only finding new chemistries that could be used to control pests but also figure out why they stopped working and how they no longer have an effect.

So that's a major focus of the lab. And then we continue to look at different ways that chemicals or different insecticide chemistries are affecting honey bees or getting into that hive and some of the deleterious effects they have based on the change in that physiology.

Amy

All right, well, Dr. Gross, I'm really excited to share some of your research and resources with our listeners out there. You know, we talk constantly about Varroa, nutrition, queens, but we love talking about secondary pests. I know that everyone has dealt with small hive beetles at some point or another, our listeners. So, we really, really, really appreciate you joining us today and look forward to your future research.

Dr. Aaron Gross

Yeah, I know. It's been great.

Amy

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.

Dr. Jamie Ellis

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.