EPISODE 218 TRANSCRIPT

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

Hello, everybody, and welcome to this segment of Two Bees in a Podcast. Today, we are joined by Dylan Ryals, who is a Doctoral Candidate in the Entomology Department at Purdue University. We are going to interview Dylan about implementing genetic sequencing and analysis to select breeding candidates in an apiary. And so, before we get into that, of course, welcome Dylan to this podcast.

Dylan Ryals

Yeah, thank you. I'm super excited for the conversation. Been really looking forward to this interview.

Amy

Absolutely. We found you because one of our beekeepers here in Florida had heard a virtual seminar from you and was like, you need to get Dylan on this episode. And so here we are. We're happy to have you. And of course, before we get talking about genetic sequencing, can you tell us a little bit about yourself and how you got into the beekeeping world?

Dylan Ryals

Yeah, absolutely. I have been a lifelong beekeeper. I was a beekeeper long before I was a scientist. When I was really little, maybe 11 years old, one summer, a swarm flew onto my parents' property and landed in a tree. Of course, this totally caught our attention, and my dad was kind enough and had the forethought to help me catch the swarm and put it together.

And we had our first bee colony. As a kid, this is something that just totally captured my curiosity. And I really loved going out and watching the bees do their thing and opening up the colony and kind of pretending to work.

Of course, it was our first summer, we had no idea what we were doing. And like many upstart beekeepers, our colony died the first winter. I think as a young kid, this was really heartbreaking for me. And it sort of hits differently than pets in the sense that it's, you know, it's a whole society. There are thousands of individuals, and it's so different than our idea of mammalian way of life or mammalian society. And to watch that just grow sick and collapse really left a lasting impact. This started what would become a lifelong pursuit of trying to figure out how to stop the bees from dying, really how to keep colonies better.

And I started going to local beekeeping clubs. And unfortunately, our local club was pretty mismanaged and didn't have a lot of firm guidance or teaching, and I started working with a local, retired beekeeper. But when I met him, he was 99 years old, and of course, had his whole beekeeping career was before the 1980s when we didn't have Varroa in the United States, so his way of beekeeping was almost obsolete, and my beekeeping education really started when I was about 15. I started working at a local commercial apiary out in Oregon where I grew up, and that was definitely jumping in the deep end with both feet.

They ran 10,000 colonies for honey production and pollination in California, and it was a really incredible summer job. I did so many things I would have never expected, and it was a great introduction not just to beekeeping, but to this industry, commercial side, and this world that's practically hidden from most people and how all of our grapefruits and vegetables receive commercial pollination.

Basically, around that time I had got a book, *Honeybee Democracy* by Thomas Seeley. Seeley, I think, for me, as for a lot of people in beekeeping, really inspired me and opened my eyes to this whole scientific way of understanding the colony.

His really simple and elegant experiments really inspired me, and for the first time, I actually considered going to university and actually looking at research as a route to answer that question, how to keep more healthy colonies and improve honey bee health and survival.

So, I applied for university and as luck would have it, I got a really nice scholarship to university that didn't have any honey bee research. However, this forced me to branch out, which I think was really good for me. In the end, I got interested in genetics and worked in a genetics lab, and by the time I graduated, I realized that I could kind of meld these two interests together and start looking more specifically at honey bee breeding and genetics.

After that, I spent some time working on a queen rearing apiary, learning how to produce queens and how to sort of take control over the colony reproductive cycle. And speaking with different queen producers at that time, I started to realize that there was a bit of a gap in our queen producing industry in the United States and that we have a lot of really, really incredible beekeepers producing very high-quality queens and in high numbers.

But there's a gap in that technical aspect. The amazing amount that we've learned about genetics and the incredible technology that we have at our disposal isn't really being translated to the honey bee industry. And some of those queen producers were mentioning that they were interested in finding somebody who could give them that technical aspect to look at their honey bee production programs and really manage the breeding aspect. I thought that sounded like a really incredible job that didn't exist yet. And that's the sort of thing that requires a PhD. So, I started looking at different graduate programs across the country, and Purdue University really stuck out to me as a perfect fit for the thing I wanted to do.

The work of Krispn Given, who's our apiary manager, is just really top notch in terms of queen breeding and the actual hands on activity, and running a breeding program out of the university is somewhat rare across the country.

And that coupled with the really cutting-edge genetic work that Dr. Brock Harper was doing. And I was lucky enough that they had space for a graduate student and started there, working on this idea of learning more about genetics and breeding and honey bees and trying to find a way to translate that into the beekeeping industry. And so that's the long and short of my path here.

Jamie

Well, Dylan, that's an interesting path. And the topic that we're discussing with you today to me is very interesting as well. There's a lot buried in the title, right? We brought you on to discuss this project concerning implementing genetic sequencing and analysis to select breeding candidates in an apiary.

So, I think I know what all of that means and I'm excited to hear you talk about it. So, could you give us the background of this project and talk to us kind of what all of that means for our listeners?

Dylan Ryals

Yeah. As I mentioned a bit in my preamble, this project and one of the primary reasons why I decided to go to grad school was to bring a modern understanding of genetics and modern genetic technologies into our beekeeping industry. And the technique that we're using and this project that we're working on is called genomic selection. We have partnered with a larger commercial apiary in Indiana. This is Clover Blossom Honey Company, and they are a really cool commercial apiary out in the Midwest.

It's currently run by a third-generation beekeeper. So, they have a really rich history and ever since the beginning of their company, they have been very focused on grafting and producing all of their own queens. And not just for the economics and the reduction in cost, but mostly for their understanding that they're improving genetics in this way and that they are maintaining and selecting for genetics that are going to work better in their environment and for their specific goals.

Most of their profit comes from honey production, but they really understand that the queens are the backbone of this honey production and they spend a lot of time and focus on those queens. And I think they spend a lot of time thinking about research and they understand that it's an important way forward, which I think is somewhat unique for commercial beekeepers.

Understandably, beekeeping is their profession, it's their livelihood. And anything that they might do that's a little risky is risking that whole operation. I mean, beekeeping at that commercial scale is incredibly difficult as it is.

If you have a researcher in there changing up variables, asking you to do things a little differently, you're really risking everything that you've built. And in a third-generation company, you know, that's quite substantial. So, I think it's really impressive that they do so much to work with researchers.

And at Purdue, they have a long association doing projects with our lab. This project in particular, we are taking a cross section of their operation. We have a sample size every year of about 400 newly produced queens, and we track basically three kinds of information about those colonies and put that information together.

The idea is to select the best possible breeding candidates that they can, then take those back to their breeding apiary and use those for grafting in the next season. This is, of course, something that they've been doing for a very long time, what we might call the traditional method where the beekeeper is of course intimately familiar with all of his colonies, you know, as many as they can be.

They have about 3000 colonies for three employees. So, it's a lot of brain power devoted to all these colonies, but of course with their skills and expertise, they're able to pick the colonies that they find the best. Ones that really stand out, whether that's in terms of health, productivity, etc.

What we wanted to do is take the more modern approach of data collection analysis and genetic analysis to try to add, basically, an extra layer on top of their expertise, and, using data analysis, try to improve their estimation of the quality of their colonies.

Amy

So, Dylan, you kind of discussed this a little bit, but specifically, you know, for the product that you're working with the commercial beekeeper, what were the objectives of the project?

Dylan Ryals

Right. So, as I mentioned, we are implementing this technique called genomic selection and this is nothing new. It was mainly developed for dairy cattle and all sorts of cattle around the 1960s and that gives a big hint as to the technique, because this is before we could really easily sequence DNA. So, genomic selection doesn't really require genetic data, although that helps.

What genomic selection is really looking at is the relationship between relatedness and performance in individuals. So, you can do this with something as simple as a pedigree or something as complex as whole genome sequencing.

And so, it's a very flexible method, particularly if you compare it to something like marker assisted selection, which requires a great deal of information about genetic sequences and markers and so on and so forth. Of course, the issue with genomic selection is it was developed for the cattle industry, which is very different, both in terms of the size and the structure of the industry and in terms of the genetics of the organism from honey bees. Honey bees have a lot of genetic challenges that really throw lots of wrenches in this method.

For example, the unit that we care about of a colony is actually tens of thousands of unique genomes, whereas a cow just has a single genome. So, we really don't just care about the queen in a colony, we really want to think about the queen and her workers, which are related to her, of course, as her offspring, but also the set of drones that the queen mated with.

That also introduces the second main problem, which is mostly uncertain paternity. If you're keeping a large commercial apiary, thousands or tens of thousands of colonies, you cannot possibly control all of that mating through instrumental insemination.

So, most of your colonies that are being raised for productivity are going to have uncertain paternity through open mating in the environment. And all of these are challenges when we want to think about analyzing our apiary and figuring out the genetic quality of individuals, if that fraternity is just a big question mark.

Luckily, a lot of these problems have been addressed and there are some really awesome groups in Europe and New Zealand, Australia, Canada that have been working on these problems. And literally in the last five years, there have been some really phenomenal publications adapting genomic selection into this unique biology of honey bees.

Unfortunately, it has met some roadblocks in actually being implemented. Like I mentioned earlier, commercial beekeepers, this is their livelihood, and beekeeping is very difficult. Throwing in extra steps and extra variables could risk their whole operation. And so, I think there's been a lot of friction between researchers looking at this very promising method and the actual industry in terms of implementing it into their industry. So, that's why I'm so excited about our partnership with Clover Blossom Honey.

They're really going out on a limb and testing this method in their operation so that we can see if it really works and how much progress we can expect through this implementation. Some of the advantages of genomic selection are that we can use lots of different types of data.

As I mentioned, we don't need to be sequencing every colony in operation as long as we understand the pedigree, so the lineage of different queens. And additionally, what I think is sort of the most important benefit is that we can address many traits at once in a single analysis.

So, we're not just looking at honey production, even though that's the main profit for this particular commercial apiary, but we're actually looking at about six different traits in their colonies. We can include all of that in a single analysis. And this, I think, is really powerful compared to genetic work that might focus on just a single trait. On one hand, you're actually collecting more data for a single colony, say, even if you're very interested in honey production, you can only measure honey production once.

But if you also have other measurements from this colony, say the colony size, the amount of brood, the brood pattern, these other measurements might be correlated to honey production. Larger colonies produce more honey, and in that way, you're actually collecting and using more data than just that single measurement.

What I think is more important is that we're actually tracking the progress of many traits in our apiary. And this really avoids some of the common pitfalls with breeding. I think people think about a lot in our industry and others.

If you are so laser focused, say, on increasing productivity, you might be losing progress in other traits. And this is something that has happened historically in dairy cattle to, really, almost a catastrophic extent. When they started introducing this very intensive and nationally coordinated breeding in the 1960s, they were able to increase milk production by something like 80% by 2004.

But inadvertently, they had decreased fertility for cows. By 2004, cows took 30 days longer to have a successful conception than they did in the 1960s. And what was going on was that there was actually a genetic link between more or good milk production and low fertility. And because the breeders were not tracking fertility and they were pushing milk production so heavily, they saw the effects of that unfavorable genetic link. Luckily, this is something that they've been able to correct for in the last few decades.

And by tracking both traits and indeed many, many traits at the same time, they're able to make progress in the traits that they want while also not sliding behind in in other traits. So, this is something that I would really like to see us implement in the honey bee industry so that we're able to make improvements on these sorts of beneficial traits like honey production, colony sizes, temperament, without losing progress on other traits. We could think of queen longevity or mite resistance, these sorts of things.

Jamie

So, Dylan, I think that's a good background. It's a good outline of your objectives and what you're trying to do. So, could you tell us a little bit about your method? Like, how are you doing this and what type of data are you collecting?

Dylan Ryals

Yeah. So, like I mentioned, we collect basically three types of data. And of course, the first and most important are those trait measurements. And every trait that we're including in our breeding program, we go out and we assess that for every colony. To keep things manageable for just the size of our lab, we work with about 400 colonies per year, but we actually get to include all of that data from each year in our analyses.

So now, three years into the project, we have something like 1200 records, which is really allowing us to perform these analyses well. The second type of data are what we might call environmental or fixed effects.

So, these are things that are affecting the colonies that have nothing to do with genetics. Primarily, we could think about the year or the location that that colony was in. If we think of something like honey production, certain years are far better than others. And that has nothing to do with the genetic quality of the queen or her workers in the colony.

That's just the location and the season they happen to be performing in. But, I think, importantly, we can extend this to other ideas in a large commercial apiary. They do not treat every colony exactly the same.

They have different methods, and these methods might even change over time as they have to adapt to conditions. For example, in our projects, one Spring had an incredible amount of rain, and they had to really change a lot about their operation.

They put their colonies in different locations due to flooding, and they had a different structure of making splits. They were only able to begin with nucleus colonies rather than splits from old colonies because the rain had set their operation back so far. And all of these, say, management decisions that are different, they're going to have impacts on the performance of the colonies. But again, this has nothing to do with the genetic quality as long as we're able to track all of these environmental and management differences, we can start to account for them in our model. And the final bit of information, it would be genetic relatedness.

And as I mentioned, this can be something as simple as a pedigree. In our case, all of the breeding queens that they have for a given year, they keep in an apiary, and they make grafts from them, and they send those out to different locations to requeen splits and that's how they make their increase.

The really simple data collection is just to track on every colony the maternity of that cell that was placed in the colony. And already, this gives us a great idea on the relatedness between different queens in the operation. We have this sister, half-sister, and then further relations.

We can greatly improve on these phenotypes by including genetic sequencing. And that is something that we've been doing at a very shockingly low cost. As sequencing technologies have gotten better, the cost has come far, far, far down. We're using a method called genotype by sequencing where we take DNA sample and we break it up into a very small percentage. So, we don't need to sequence the entire genome, but just a few markers. And this is a powerful method because what we're really interested in is the relatedness between different individuals. We don't need to know whether or not they carry every individual gene because we're taking a more statistical approach.

I know if these two individuals in the operation are related by, say, 10%, that means they share 10% of the genes. When it comes to a trait of interest, they probably share 10% of those genes that influence that trait.

So, we know they're going to be a little bit more similar than two individuals that are only related by 1%, and they're going to be a little more different than two individuals that are related by 50%. We can see this sort of structure starts to give us a lot more information about the apiary.

Not only do we know the actual performance of all of our colonies, we can adjust that performance by taking into account different years and different locations to come to what we call an adjusted phenotype, which is what we think is a little closer to, say, the genetic merit of an individual by accounting for all of those non-genetic factors. And then we can look at the relatedness between all of our individuals and start to piece out, how much of this phenotype is due to genetics? Because we have, in a sense, many different observations.

I think one simple example of how this works and what used to be the standard in the cattle industry would be progeny testing if you want to know, well, I suppose the classic question is how much milk does a bull produce?

This is not something we can directly measure, but we can mate that bull to many different cows and then take a look at all of those female calves that are progeny from that bull. And we can take an average of all of their milk production. And this is pretty intuitive. That's how we figure out the genetic quality of the bull for a phenotype that we can't directly measure. But what's going on here is we know that all of these individuals that are closely related to the bull, they share a lot of genes with the bull. And because we've mated them randomly, or we've mated him randomly to other cows, that maternal contribution is averaged out and what we're left with is just that genetic contribution of the bull. Now, progeny testing is a little bit contrived and expensive, particularly as beekeepers.

We don't have time or the resources to produce tons of offspring from every single queen that we're interested in ranking or estimating her genetic merit, rather than a set of progeny that are all, say, related by 50%, instead, we can actually look at all of our records and now we don't just have the single set of individuals, but we have every individual within our operation that might be related by 50% if they're a direct offspring or 25% if they're a half-sister and so on and so forth for all of your distant relations all the way down to individuals that are completely unrelated.

And by using a little more sophisticated methods, we're able to take all of that data and estimate the genetic quality for these individuals. This specific method is – normally, we refer to it as the initialism BLUP or the acronym BLUP. This is best linear unbiased prediction. This is a linear model at its heart, which is something that is incredibly standard and familiar to scientists and probably most people. And the initials best means that, for the data that we collected, we're estimating the parameters that explain the most data. Linear implies that the method we're using to solve this system is linear. Unbiased means that we're not over or underestimating the quality of any particular colony or individual.

We're trying to keep things even handed. Predictions are actually what we get out the other end, which are our predictions for the genetic quality of individuals. Again, using all of the traits that we directly observed, all of those environmental factors that we can account for, and then the relatedness between all those individuals.

In a way, this is sort of getting multiple observations on quality by looking at closely related individuals and seeing how well they perform. In a sort of back of the envelope sense, if you find a collection of individuals that are all highly related and all score well on your particular traits, then you can be fairly certain that there's something genetic going on here. It's not just dumb luck.

Amy

So, Dylan, I'm going to loop back to you working with the commercial beekeepers on this project. What have your findings been so far? I know you said that you've been doing it for three years in a row, so you've got 1200 colonies that you're working with. Do you have any findings that are, you know, common between the three years or what are you just seeing in general?

Dylan Ryals

Yeah. So, so far, this project has been pretty exciting in that we are already seeing progress in their population. We ended up with a really nice structure for this project where each year we have offspring from individuals that the beekeepers themselves chose in the same way that they've been doing for many decades.

So, we could consider this traditional selection. We have random offspring that were either queens that we chose completely randomly from their operation to breed from, or swarm each spring. And we can consider these natural selection.

These are offspring simply of colonies that survived the winter. And finally, we have selections that we're making using this method. And so we have this genomic selection. Looking at these three different categories of individuals throughout years, we actually saw that we made the most progress with offspring that were selected using genomic selection. And in terms of the traits that we are looking at, after three years, we saw 13 fewer mites on average for mite washes. We saw an improvement in brood pattern. We saw an improvement in overwinter survival, we saw an improvement in deformed wing virus symptoms, and we saw an improvement in brood disease symptoms.

And this is just after two years implementing the program. The first year we collected data and set up and selected individuals, and now we've been performing that again for two additional years and can already see improvement over that first population we started with.

So, what I think is really cool to see in this project is that the beekeepers are definitely making improvements using their traditional methods by selecting colonies that they find their favorite, but we're actually making a little additional improvement by using these methods.

And what I think this really comes down to is when we are looking at multiple traits at once, a colony that performs the best in that analysis isn't necessarily one that's going to stick out to you as a beekeeper, right?

It's not a colony that's producing an incredible amount of honey or has an absolutely perfect brood pattern. It's a colony that balances all of these traits. It's going to be somewhere in the middle of your operation. So, it's very difficult to detect unless you're using very sophisticated methods, a lot of data collection and analysis to find these colonies that balance all the traits you're looking for, not just a colony that performs incredibly well.

But I think one of the most interesting results from this project is that we found a very strong genetic correlation between honey production and mite symptoms, and a disfavorable correlation. That means we found genes that seem to improve honey production also seem to be increasing mite loads in these colonies.

And this is not necessarily shocking. We can imagine that big populist colonies are going to produce a lot of honey, but they're also going to have issues with mites. But because this analysis is looking at relatedness and, thus, genes shared between individuals, it seems that there's something genetic going on that links these two traits.

And it's exactly analogous to that problem in dairy cattle where milk production was linked to low fertility. Here in honey bees, honey production is linked to high mite counts. What was very interesting, due to this genetic link, if we look at the natural selection in our project, these are colonies that were either randomly selected or came via swarms just from colonies that survived the winter. They actually had lower mite counts than the rest of the colonies in the operation, which is to be expected.

However, they had much lower honey production because, by selecting for low mite counts, you are also selecting for low honey production. What I think is really promising about the method we're using genomic selection, is we're looking at both traits and we're finding colonies that go against the trend.

So, colonies that produce a large amount of honey while still managing to keep mites low. And these are very rare in the operation. And as a beekeeper working with thousands of colonies per day, it's very difficult to notice that. But, with this genetic analysis we can start to find those colonies.

So, what we found using our selection method, we were able to decrease mite symptoms while still retaining a bit of honey production. So, this, I think, was really interesting where the colonies that the beekeepers were selecting, they indeed produced a lot of honey, but they had worse mite problems. And by using this method, we were able to balance those two traits. What I think could be very dangerous if this genetic correlation is something broad in honey bees – we don't really have the data to make that claim, we're just looking at this one population in Indiana.

But if this is something that could be affecting bees, say, around the country, by just selecting for honey production or productivity in colonies, beekeepers might be inadvertently increasing problems with mites. I think this is a really incredible finding from the project and something that, you know, I think about all the time.

Jamie

So, Dylan, that's really fascinating hearing about all the benefits that you guys were able to see through this research. So, I guess that sort of answers itself, but what could this mean for the beekeeping industry?

Dylan Ryals

Right. I think what it comes down to in the industry, sort of as I mentioned in the beginning of our discussion, they're already doing a phenomenal job producing high quality queens and in very large numbers.

But what I think we're really lacking in the United States is being good stewards of our phenomenal genetic resource. I mean, we have imported, historically, honey bees from all over the world, and in the 18 and 1900s, beekeepers were really interested in taking bees from diverse beekeeping cultures and diverse areas and importing them and trying to work with those genetics. And as a result, we have a really incredible genetic diversity in the United States. It's a really phenomenal resource as long as we're willing to harness that and work with it. I think by implementing methods like genomic selection, we are specifically looking at traits and looking at relatedness between individuals and trying to understand more about the genetic basis for these traits, we can do a much better job maintaining the genetic diversity in the country and improving the genetic quality of our stock.

This is something that I don't think you really get if you're not maintaining an analysis on a deep level for many of the reasons that we mentioned. Primarily, that if you're not measuring a particular trait and you're breeding very selectively for a different trait, you stand a good chance of losing progress in that trait that's not being measured.

So, I believe that by really measuring things, we can improve on them and avoid the consequences of strong selection, which are, of course, accidentally increasing traits that we don't like or losing progress and traits that we do like, and losing genetic diversity by breeding too many offspring from too few mothers. Both of these are problems that we can address with genomic selection.

Amy

Dylan, I love that you started out as a beekeeper, you fell into the genetics world and now you're bringing both of them together while bringing in and collaborating with commercial beekeepers as well. I think it's amazing. I'm not a genetics person, so I'm glad there are people like you out there who understands the genetics way more than I do and are able to share with our audience. As we close this podcast, is there anything else that you'd like to add?

Dylan Ryals

Yeah, In regards to implementing this in the industry, one of the misconceptions that I hear from beekeepers a lot is this idea that if you could just bring the best genetics together and breed the best queen, that you would solve many, many issues. And I think the unfortunate reality of the world we live in is that every year our parasite problem with Varroa and our disease problem with various bacterial and viral diseases is getting worse. These biological organisms are evolving to take advantage of our honey bee colonies.

At the same time, we're continuing to lose natural areas that provide forage. We're continuing to develop more and more potent pesticides and our environments and our climate is changing. And in all of these ways, the world of today is not going to be the same in the world of next year or two or three years.

So, breeding isn't something that we do to find a magic bullet to create the perfect honey bee queen. It's something that needs to be done constantly to maintain pace with all of these changing and adapting difficulties.

Amy

Absolutely. I agree. Dylan, is there anything else that you wanted me to follow up on?

Dylan Ryals

There's nothing that comes to mind. I think I would just like to thank you both for inviting me and having this conversation. This is obviously a topic that I'm really excited about and believe a lot in and I, yeah, I'm really excited to talk about it and share the work that we've been doing.

Amy

I think that's fantastic, Dylan. As I mentioned, the reason we found you is because one of our beekeepers had heard a seminar that you had given. So, we're really excited to see where your research goes, some of the research that you'll be doing in the future and excited that we could interview you today. So, thank you so much for joining us.

Dylan Ryals

Yeah, yeah. Thank you for inviting me. It's been really fun.

Amy

Jamie, I was happy to have Dylan on today because our beekeepers are really excited about his work. I'm really excited about his work and seeing where he goes with everything. I am not a genetics person at all. I think that, you know, people who work with genetics are like the smartest people in the world.

In my mind, I'm like, it's just a foreign language to me. So, I thought maybe we could just summarize, you know, genetics and what are we looking at when we're looking at genetics and how does the sequencing all work and things like that.

Jamie

Yeah. I mean, his project was really interesting to me. It is very technical, right? When people hear the word genetics or gene or things like that, they tend to flip the off switch. But it's interesting. If you think about the way that selection has happened in the beekeeping world, historically, it would have been like, hey, that colony over there, it's the strongest, the biggest, produced the most honey.

I'm going to use its daughters next year to make queens. Well, then, you know, along comes this idea that we can actually breed for and select for traits that we want them to have. An obvious example is hygienic behavior. This selection process all uses the power of genetics, but it does it because genes are governing the traits that they want.

Now, we have these technologies available to actually link a gene responsible for the trait to the trait. The idea is that you can use these genetic technologies to select for these traits without ever having to track down the behavior or, you know, freeze kill bees for hygienic purposes and things like that. And what Dylan was saying, he's doing this with one beekeeper, but over hundreds of colonies and he's able to find, you know, genetic markers, as it were, for honey production. If you heard one of his last statements, it was, we were able to increase honey production and increase brood production and increase bees and decrease deformed wing virus and decrease brood diseases.

And that's all just by this kind of genetic selection throughout this apiary. And so, as he mentioned, it's very arduous. It takes a lot of work, right? Not every university is doing this. You know, beekeepers may not have the technology readily available for them to implement it in themselves.

So, they're having to partner with someone who has this genetic skill set and, and, and, and, and, and, but when used appropriately, it could be a very important tool for the selection and maintenance of stocks, for the improvement of stocks in our beekeeping industry.

I mean, and there were some other tidbits that were interesting. I like that story he told about dairy where they were breeding so hard for cows that produced a lot of milk that they ended up, you know, selecting for cows, I think, he said less fertile or longer gestation periods, whatever it was. Well, he also mentioned in the honey bees that he was working with you, they're finding traits to have more and more honey production, but those colonies also had the traits for more and more mites. And so, there's a lot still to be figured out, but what he discussed really sounds like a very significant step in the direction we want to head as an industry for improving the stock that we have available to us.

Amy

Absolutely. Well, for our listeners out there, this guest, so Dylan was invited because a beekeeper heard him speak and loved his research and reached out to us. So, if you've got a researcher that you want us to interview, want us to bring onto the podcast, please feel free to let us know. Send us an e-mail or message us on one of our social media pages.

Stump the Chump

It's everybody's favorite game show, Stump the Chump.

Amy

All right, welcome back to the question-and-answer segment. Jamie, the first question that we have today is this individual's wondering if they have a bait hive out and a swarm goes ahead and moves into that bait hive, what do you do? Is it best to wait for a day or two to let them settle in? Do you recommend looking for the queen, caging her so that she stays in there and they stay in there? Or what's your advice on this?

Jamie

Yeah, Amy, this is actually an interesting series of questions because I've had to deal with this personally myself. It sounds to me the listener who's asking this question had an occurrence where a swarm moved into a bait hive. They then moved it into a hive, and very quickly thereafter it left, or maybe it left in the bait hive after the beekeeper went in and manipulated.

So, the idea here is when you have a swarm move into something and you want to capture them, what's the best way to do that without them leaving? And the reason this is a good question is because I've seen this plenty of times in my life. You know, when you hive a swarm, it's entirely possible that they don't want to be where you've put them, right? And then it looks like things are going well. Today you collect a swarm, you put it in a hive, only tomorrow to go to the hive and now it's empty. And it doesn't matter if it's a hive that you've put them into because you've captured them or a bait hive that they move themselves into, they can still elect to leave.

And so, the listener is basically asking the question, well, what's the best way when catching a swarm to keep that swarm, right? The idea here is, well, should I quickly go and find the queen and cage her? And that way they can't swarm because they won't have their queen? What can I do to make sure that in those initial stages of a swarm being gathered, be it in a bait hive or personally putting it into a hive, what's the best way to keep that hive? So, yes, you could go and cage the queen and leave her caged for a few days until the colony settles.

But really, there's no guarantee that once you release that queen, they won't try to swarm again. I mean, everybody listening to this podcast knows that I say biology is messy. So, there's really no perfect way to do this. But anytime I put a swarm in a box and I want to push it in favor of staying rather than in favor of leaving, what I'll do is I'll actually go to other colonies and take frames of brood from those other colonies and give it to that swarm so, they've got that stimulus of, OK, we've got comb and brood.

I also begin feeding it instantly, so they have sugar resources just right at the nest entrance. Brood and feeding are really good ways to help them, I don't know, for lack of a better phrase, to feel at home.

But even that's not guaranteed, but that certainly helps. I don't mind caging the queen, but probably what I would do would actually just go find the queen and clip her. They could still try to swarm with a clipped queen, but obviously they can't do it because she can't fly and they'll go back into the hive and hopefully stay.

So, giving them pulled comb, giving them brood, feeding them, clipping the queen, or caging the queen are all good ways to tilt the scales in your favor, but no way is perfect. But these things certainly can help out with you keeping that swarm rather than them just wanting to take off instantly.

Amy

So, Jamie, the second question that we have is someone was asking about nectar and how it may give bees a sugar rush or nectar may give bees something so that they want to gather more and said that some flowers play a tricky game. They mix in a small amount of caffeine with the nectar, so the bees are more quickly satisfied. Is this true? And if there's caffeine in a plant or in nectar, does it have an effect on bees?

Jamie

Amy, I had a breakfast meeting this morning and drank a couple of cups of sweet tea, and I can confess that the sugar and the caffeine and that sweet tea kept me wanting more.

Amy

Yeah, that's fair. That's me and coffee for sure.

Jamie

So, really, really, it's scaling me down to the size of a bee and saying, is that the case? OK, let's just get the obvious part out of the way. Bees want and need sugar. So, nectar has sugar. It doesn't need much help beyond that to keep bees wanting to get more nectar. Now there are some plants, you know, coffee as an example, that may secrete caffeine in their nectar. And there may be other plants that secrete other secondary plant metabolites that cause bees to want that nectar maybe more than they would have if it were just sugar water. Maybe some of those things are scent-based attractants, things like that.

But nevertheless, there can be things in nectar beyond sugar that kind of keep bees wanting more. But the biggest motivator of nectar is sugar, without question. There may be some other secondary plant metabolites that keep bees coming back for more. But you've got to think about it from two angles.

There's the bee angle and the plant angle. Obviously, bees want as much sugar as they can because sugar is what powers everything, all the activities in a hive, they need it. They need sugar to do what colonies do, to make the wax, feed the babies, defend the nest, all of that stuff.

All right. But if bees, if a single honey bee leaves her nest and she goes to a single flower and that single flower gives that single bee all the nectar that she can consume and rightfully carry in her crop, and that bee fly back to the nest, the bee benefits because she only had to visit one flower and she got everything she wanted.

But the plant doesn't benefit because the bee only visited one flower. The plant needs that bee to go to multiple flowers, and so as a result, most plants that produce nectar and that are pollinator dependent will produce small but just enough amounts of nectar to make the bees go there, but not too much, so that bees will have to go to multiple flowers before they can fill up, right?

This is a behavior, for lack of a better phrase, that's rigged by the plant. So, it benefits plants to both give the right amount of nectar to make bees want to go to other flowers, but maybe also have other secondary plant metabolites in that nectar that naturally keep the bees wanting more.

Maybe not all plants do this, but some have been documented to do this, for example, in the case of caffeine producing plants. So, it's a little more nuanced and complicated than just saying that all of them produce this chemical that also keeps bees wanting more.

Bees go there because they want sugar, and they go to multiple flowers because they don't get enough from one flower. But there are some species of plants that might do a little bit more than just offer that sugar to keep bees going and keep bees wanting more.

Amy

This is a shout out to my grandpa. When he found out that beekeepers fed, you know, sugar water and all this stuff, he was asking how the bees didn't have diabetes. And I'm like, I don't know.

Jamie

Yeah, I mean, you think that's pretty cool because they do just eat sugar, right? That's not good for us, but good for bees.

Amy

Definitely. OK, so the third question that we have is from our podcast coordinator. I love Jeffrey. Thank you so much for asking us questions. So, Jeffrey's our podcast coordinator. He's the one who helps us, you know, with the logistics and he listens to every single thing that we have to say.

Jamie

Multiple times at that.

Amy

Well, yeah, multiple times. That's what he does all day every day is listen to our voice, and he also has questions. And so, his question is that he remembers, probably around 2015, 2016, he remembers reading an article about a new attempted development of robotic pollinators or robotic bees. Did you hear about this, Jamie, in 2015, about 10 years ago or so?

Jamie

So, I did hear about it, but I love the fact that Jeffrey says, "When I was in middle school, circa 2015 to 2016." I love it. Way to go, Jeffrey. Love it. Love it, love it. All right, Well, I wasn't in middle school around 2015 or 2016.

Amy

Me either.

Jamie

But I did hear about this. It was hot news for a few weeks. It's this idea that, I forget the company or companies, they were basically trying to make robot bees or robot pollinators because, you know, 10 years ago, we were 10 years into the news that bees are suffering significantly. And the honey bee colonies had this thing called colony collapse disorder, and the world was freaking out and all that stuff. So, there were folks who were motivated to perhaps look for other ways to achieve pollination if this bee thing kept happening. So, they've got this idea to have these robot pollinators and were making, basically, micro bees. And I'm aware of it.

I don't know where it's gone because it was kind of one of those temporary flash in the pan news stories. I haven't since looked it up. I'm sure there are folks who are continuing to work on this. But the idea is to provide pollination services should the bee population ever suffer. So, I've got a lot of thoughts on this.

So, the short answer is, I'm not really followed up with this robot bees or robot pollinators since the circa 2015, 2016. But I am aware that other scientists have said, what are we going to do if there was to be a genuine absence of bees? For example, why go through the process of having to produce, you know, millions upon millions of robot bees that would need to be distributed around the world? And then what happens when AI grabs a hold of those bees and turns them against humans?

But instead of kind of going that route, I know of other folks who've looked at it from a plant phonology route. In other words, can we breed plants that you know, may have otherwise been dependent on bees as pollinators to now no longer need bees as pollinators?

So, in my head, the robot pollinator route seems very complex. There are probably other ways to circumvent the need for pollination, and I know folks looking at it through a plant breeding perspective. So, yes, I am aware of that.

No, I don't know where it's gone in the last 10 years, but I know that the premise behind this is to provide pollination services in the absence of or in the dwindling populations of bees. But I know that folks are looking at this from multiple perspectives, not just robot pollinators, but also plant breeding, perhaps other ways as well.

Amy

Definitely. If anyone has heard of, you know, Elina Niño at UC Davis, she actually did a study on the production of almonds, and she was looking at some of the – what are they called, self-fertile? They're not self-fertile, are they?

Jamie

Yeah, they can be self-fertile.

Amy

OK. Yeah. So, she was looking at the almonds and looking at the comparison between the self-fertile varieties with pollinators, without pollinators. And there still was a huge difference. So, it's always interesting to see how research comes into play and then taking a look at it to see the reality of what pollinators do.

Jamie

Well, Amy, I think that's a good example because I would say, in this kind of world of robot pollinators and self-fertile plants, we're just not there yet. It's just people are trying to take steps towards that should the bee crisis ever manifest at the level people think that it has been.

Jamie

So, what are we going to do if there were problems in this field? That's kind of how people are looking at it.

Amy

Definitely. Alright, listeners, don't forget to send us a message if you've got follow up questions on anything. These questions are so much fun. It's like a never-ending list of questions, Jamie, that we get from people.

Jamie

I know, fantastic, love the creativity and the things that people think about that I've never thought about.

Amy

Yeah, definitely.

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 answered on air to honeybee@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.