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SPEAKERS

Serra Sowers, Amy, Jamie, Guest, Stump The Chump

Jamie 00:10
Welcome to Two Bees in a Podcast brought to you by the honey bee research extension Laboratory at the University of Florida's Institute of Food and Agricultural Sciences. It is our goal to advance the understanding of honeybees and beekeeping, grow the beekeeping community and improve the health of honeybees everywhere. In this podcast, you'll hear research updates, beekeeping management practices discussed and advice on beekeeping from our resident experts, beekeepers, scientists and other program guests. Join us for today's program. And thank you for listening to Two Bees in a Podcast. Hello, everyone, and welcome to another episode of Two Bees in a Podcast. Amy and I are very privileged today to be joined by Dr. Mohamed Alburaki, who is a research entomologist at the USDA ARS Bee Research Laboratory in Beltsville, Maryland, in the USA. He and his colleagues did a really interesting study that they've published that, I think, even though it's a lot of US data, that it has really international implications. That study has been titled, "Honey bee populations of the USA display restrictions in their mitochondrial DNA haplotype diversity." Beekeepers, I know that study title was a mouthful, but Mohamed is going to break it down in so much detail so that you guys can appreciate what he and his colleagues did. Mohamed, thank you so much for joining us on this episode of Two Bees in a Podcast.

Guest 01:40
Thank you very much, Jamie, for having me. And it's really a great pleasure to be here with you and your audience.

Jamie 01:47
The topic that you and your colleagues published is very interesting to me. It's something that's kind of growing in me over the last 10 years of an interest in my own lab. So I really want to jump straight into the science. But I'm afraid before we get there, I have to kind of ask the first question that we always ask our first-time guests, which is could you tell us a little bit about yourself and how you got into the research in the first place?

Guest 02:10
Yeah, sure. So, I am, in fact, Mohamed Alburaki, and I am a second-generation beekeeper in my family. So my dad used to keep bees in the Middle East. I grew up with bees, basically, from a very young age. My dad also is a scientist, so he did research in France on honey bee behavior too. So this is where I started growing up with bees and beekeeping with my family and as a professional beekeeper. Then, so a little bit about my education. So my background, I hold a bachelor's degree in agriculture and studied in the Department of Entomology from the University of Damascus. And I grew up in France. I was born in Syria, I grew up in France. I did my PhD in France at the University of Pierre and Marie Curie. I worked in the lab in Paris. So my PhD research was really on the genetic diversity of honey bees. And then I moved to Canada where I worked at Laval University in Quebec. I did my first postdoc, and I studied there, a little bit different concept, but it was to study how agriculture pesticides are affecting the health. And then I moved to the US in 2014, and I did my first postdoc in the US at the University of Tennessee. I continued at that time working on the effect of pesticides on bees. That was a very productive postdoc there for three years. Then, I did a short postdoc at University of USM, Southern Miss, in the state of Mississippi. I worked more on the same principle. It was more how the stressors, the abiotic and biotic stressors are affecting the gene regulation of bees. And so recently, or not, really recently, in 2019, I moved to Maryland. I got a position here. I'm currently a research entomologist at the USDA Bee Research Lab in Beltsville.

Amy 04:35
Mohamed, I'm amazed, first of all, by your experience. It seems like you've had just a lot of experience in many different locations. I think, we've had other beekeepers that are second-generation beekeepers. Jamie, you can correct me if I'm wrong. I don't think we've had a single guest that's second-generation honey bee researcher.

Jamie 04:55
I know, that is interesting. That's one of the things that I was listening to when you were talking about that. You mentioned your father had worked with honey bees, both professionally as a beekeeper and also a scientist. And that's pretty cool.

Guest 05:08
Yeah, in fact, that is amazing because I still, up till today, I debate scientific ideas, beekeeping practice with my dad. He was here visiting from Canada. And he was telling me, "No, this doesn't work like this. You have to change your idea about that. And this and that." So it's a great opportunity, in fact, you're right. And then the other thing is being scientists also, and being a beekeeper first and then a scientist will give you the opportunity to start implementing, in your research, what would benefit the beekeepers and solve their problems?

Amy 05:40
Absolutely. I think you and your dad should do a podcast together, just every time you guys are debating something, just record it.

Guest 05:50
Oh, yeah, that's a good idea.

Amy 05:52
Alright, so now we are getting to the publication. And in the publication, you were looking at honey bee populations in the USA, and their mitochondrial DNA. Okay, I'm gonna say it. Mitochondrial DNA haplotype diversity. I really need to go back and take biology. But can you go ahead and tell our audience what is mitochondrial DNA, and why do we even look at it?

Guest 06:17
Okay, great question. In fact, to simplify things, you can replace in that hard-to-understand title, somehow, maternal diversity instead of haplotype and mitochondrial DNA. We are looking at the diversity received from the mother side, which is the queen in that aspect. Now, the title has changed because I had some debate with some of the reviewers, and they wanted to be more precise, and I knew that this would be more difficult for general public to read and understand. But, now I can tell you that it's just the maternal diversity. And the mitochondrial DNA itself is a circular chromosome that is located in the cellular organelles, which we call the mitochondria and all those are located in the cytoplasm. But the specificity of the mitochondrial DNA is that it has a uniparental inheritance. So basically, we get it as it is, to make it simple, from our mothers with little to no recombination. The structure is conserved. So basically, it's like a marker, a tool that you pass on through many generations. Now, using that tool, you can track down way, way back, your ancestors and from wherever. The closest example that we understand in a simple manner is that, recently, I've seen some advertisements, 23AndMe and the Ancestry DNA kits. In fact, I took that test, it's like $100, you do it. And those companies, in fact, they use the mitochondrial DNA to tell you you came from Italy, you came from Eastern Europe, South Europe, from Africa, you've got ancestors from here and there in the old world. People are very keen to use it in the US to know from where we came, in fact, as a nation of immigrants here. So that is the concept of the mitochondrial DNA. Now, to simplify, we mainly measure markers on honey bees. We can study the paternal heredity, what we are getting in terms of genetics from the fathers, which are the drones in our case, or we study the mtDNA, and we know our lineages from where those queens came originally. Now, every marker is different from the other, but what we usually do is we first type using the mitochondrial DNA, and then we understand 50% of our genetics, from where it's coming. And then we see what we have inherited from our parents, our fathers, and this is what we call the paternal heredity. So, this paper, Amy, is basically tackling a portion of the diversity in the population of the US. Let's say 50% of the diversity is tracked by this marker that we've used in this study.

Amy 06:48
This marker is very common with honey bees, looking at the lineages, right?

Guest 09:55

Now, that's a very interesting question, too. The thing is that, yeah, this is a universal marker not only for honey bees, it is used for human beings, it's used for any type of phylogeographic analysis and study. And why? Because the reason is that it's so conserved when it is passed through, there is very little modification. And basically, it will give you an idea way back to where you belong, and from where you came by this marker, as the mother will pass it through their progeny, intact. Not intact completely, but, in a very similar manner. I'm trying to really simplify here. So there is no recombination, very low rate of recombination in this market. And it's very common, in fact. Now, the other thing that I would like to add here is that when our beekeepers say, "Oh, I've got an Italian queen, I've got a Carniolan queen, maybe they are mixed, maybe they are of African origin," and stuff like that, they look at the color. That is good because they've got experience, but in fact, the color is just a phenotype. It's one attribute that will represent the genetic background of a living organism or bees, in our case. Here, the marker, the mtDNA will not lie. It will tell you, based on the analysis that we did in this study and that other people did, it will tell you that this is 100% Italian mother, Italian queen, or this is 100%, black bee, mellifera mellifera, and so on and so forth. So this particular marker that we use, the CO1, CO2 region of this marker, has been used to basically determine what subspecies we are dealing with. And this is very important to know.

Jamie 11:48
So Mohamed, there's really so much to unpack here, because when you're talking about maternal lineages, when you're talking about paternal lineages, and you're looking at specifically mitochondrial DNA, which of course is maternally inherited, like you said, it comes down from the mothers, there's very little change over time. It's relatively stable. And you keep using these words, lineages, honey bee lineages. You're using it to look at honey bee diversity and honey bee lineages. So could you tell us a little bit about what a honey bee lineage is, what the major honey bee lineages are? Because that's going to segue into my next question, which is how specifically did you use this marker to look at these things?

Guest 12:28
Okay, awesome. So basically, we know, currently, that we have different subspecies of bees. Within each subspecies, we have different haplotypes. Okay, now, the upper level of classification of subspecies is evolutionary lineages. So bees have been classified to evolutionary lineages based on their evolution throughout millions of years after the last glaciation, bees came back to some geographical area, and then they started to adapt. And then they're precolonized, this is in the Old World, not in the US and the new land. So, based on that movement, they have recolonized different geographical areas. The resemblance in their genetic material, and in this case, is the mtDNA, allowed to classify them into a group. You can imagine, like lineages, our group, we have a group of West Europe, we have a group of the African continent, we have a group of the Middle East, we have a group of Southeast Europe. This is the definition of lineages and every lineage will comprise basically of different subspecies. Every subspecies has different haplotypes. Now, how many? We're looking at that. A lot of people did a lot of studies, but the main thing to understand is that the more haplotypes you have within a subspecies, it means that you have more diversity, eventually. I mean, why there are differing then,? Now, your other question is how we detect that? Well, that is the beauty of the marker,

the mtDNA CO1 and CO2 region, which is a noncoding region, located between the cytochrome oxidase one and two. And this was discovered by my former PhD supervisor, Dr. Lionel Garnery and others, as well as Dr. Solignac, his supervisor. They discovered that this region is a non-coding region, or if you want, some people they like to call it the junk region. It doesn't code for anything, in fact. But when they started studying this region, they've discovered that sometimes this region is longer, it's like exceeding 100 base pairs, sometimes shorter. This length and difference in that region, those people and scientists, they've linked it to the diversity of the bees. So they've seen that in some location, it's longer, shorter, there is a difference in the structure of this region, and they link that to the geographical locations of the samples. And then they were able to map that molecular marker with the previously great research done by Rittner et al., Rittner is a famous bees scientist from Germany, they were able to map this molecular marker and compare it with what he has already described as lineage, but as lineages on bees throughout his life, but based on more symmetrical characteristics, because he was working on the 45 different, more symmetrical characteristics on bees. Then, he was able to determine throughout his travels, that, okay, those bees are African, those bees are from West Europe, those bees are this subspecies, those are mellifera mellifera, those are ligustica. And he differentiated that based on their phenotypes. And now, because this group of people were able to learn to link this molecular marker with the previous work done on more symmetrical characteristics, we can now use this marker to type and it's much faster and more reliable because the DNA will not lie. Basically, it's not like a phenotype that is usually affected by the environmental condition, or adaptation, or other environmental stressors.

Amy 13:16
So I'm interested in how you collect the honey bees, your samples, and what that whole process kind of looks like?

Guest 17:09
Okay, that's a great question, Amy. In fact, for the mtDNA, it is much simpler than the paternal marker for a simple reason. A honey bee colony with one single queen will have the same type, the same mtDNA type. They will all have the same haplotype signature if you want, because they all belong to the same mother and the queen has passed through this mtDNA as it is, and then when we study this region, we see that they are all the same haplotype. They should be. If we find a bee with a different haplotype from the same colony, it means that this bee has most probably drifted or came from elsewhere or is just stealing from the hive, but that's very, very rare. So basically, every colony will exhibit the same haplotype, whether it's a C1 or C2J or African haplotype, or West Mediterranean haplotype, M2, M1. So for us, we've sampled, and I should acknowledge on the collaboration of the University of Maryland, and particularly, Dr. Dennis vanEngelsdorp for really supplying us with the majority of the sample from the National Honey Bee survey, this helped a lot. So we've sampled. Basically, what we need for this type of analysis is a single bee from a colony because we are not typing the colony, we're typing the queens. Any bee that you analyze, basically you're analyzing the mother, the queen, but you don't want to kill the queen. So you just take her daughter, and that is the beauty of this marker. Now, the paternal heritage is completely different. But we may talk about it later on, if you want, guys, but not in this context.

Amy 19:00
Yeah, absolutely. So, you took the samples, you're looking at their lineages and I'm wondering, what lineages did you find in the United States and do they differ between states or even maybe within states?

Guest 19:16
Okay. So, what we do is we take those bees, we do DNA extraction, we extract their total DNA, and then we do some cooking and we get this marker, we amplify this region of interest, and then we leave this region with some enzymes. Then, we look at the profile, and then, here you need experience to know what is this profile. I mean, otherwise, you will be looking at a shell or a fragment analysis that's difficult to comprehend. But then, basically, you will characterize those haplotypes based on their pattern of restriction. And then you see, okay, I got 20, 30 samples from the state of Florida. Okay, guys, we're gonna talk about Florida since you're hosting the podcast there. So I've got 20 samples from Florida. Those are from 20 beekeepers, mainly. Every beekeeper has a different operation from the other. So basically, it will give us an idea. Now, our sample in the United States is huge. Our sampling is well scattered, but we don't have a high number of samples per state. For example, what we were able to do from the same year is to really collect 22 to 23 - 24 sample per state. But the beauty of it is that we can later on, eventually, every state can amplify this number and do more targeted research within their state. But for now, for us, we wanted to do a nationwide survey to really just explore what we have currently. And since our samples are very well scattered, they give a very good representation on the diversity we have. Now, in the state of Florida, let's say we have 24 samples, we analyze them, and then they all came from the same lineage. How did we detect that? By using this marker. So we analyze the sample with this marker, and then we see that they are all the haplotypes. The haplogroup belongs to the same maternal lineage. And then we will say, "Okay, guys, Florida has 100% of its sample from the C lineage, or the M lineage or the African lineage," and so on and so forth. And then we can go in-depth a little bit more. We can be precise about what type of haplotypes they have in Florida, using the same test. This is why this test is extremely powerful. We can give an estimation of what we call the haplotype diversity. Now, haplotype, you can imagine the haplotype is like a subspecies if you want. So we already have subspecies. But, a single subspecies, like let's say, ligustica, it can have -- not ligustica -- cornica has different haplotypes. And we can consider them for now, subspecies, if you want to really facilitate the word of haplotypes. But this haplotype diversity basically will reflect the genetic diversity we have within each subspecies as well as within each evolutionary niche.

Jamie 22:34
So you guys have done a lot of work with all these bees that were from the national survey that represents a good survey of bees from around the country. It's really fascinating that you're able to do this by state. So I'm kind of dying to know, what are some of the primary findings that came out of your research?

Guest 22:51

Yes, thank you, Jamie. So I'll go over the main findings, and really, simplify them in a couple sentences. So the major thing that we need to understand and that as a beekeeper myself, I would love to know, is what is the percentage represented of each niche within our population in the US nationwide? Now, nationwide first, and then in my particular state? And that's a question that I think every beekeeper would love to hear an answer. So basically, nationwide, what we found is that 94 -- and I'm rounding the numbers, for more detail, you guys can go to the paper -- 94% of the whole sample, our sample was 1062 sample, belonged, in fact, to the North Mediterranean lineage. I will give some more detail about what is the North Mediterranean lineage. For some people, it's just an alphabetic clutter. And then, 3% are from the West Mediterranean lineage and three other percent were from the African niche. Now, the C lineage is mainly represented by many species that we know of outside, like ligustica, the Italian bees, Carniolan bees, carnica, macedonica, cecropia, cypria. The origin of this lineage is central and southeastern Europe. Now, the second lineage is the M lineage which is the West Mediterranean lineage. This lineage is a nice lineage because it's represented by only two subspecies, which makes our job much easier, and those two subsepecies are mellifera mellifera, the black honey bee, located now mainly in France, but in West Europe as well as iberiensis, a little bit south like North Spain, Portugal, those areas. And then you have the African lineage. This lineage is a beautiful lineage with the highest diversity that we know of. Now, it has some bad reputation because of the Africanized bees. But we really tried to clarify that concept in this paper. The Africanized context, the Africanized term is completely different from African haplotype or African niche. They are completely separate notions. Now, the African lineage has 13 differwent subspecies, including intermissa, syriaca, lamarckii, sahariensis, and yemenitica, and so forth and scutellata. So we have 13 subspecies, defined subspecies on the African lineage, and its location is the whole African continent.

Jamie 26:19
It's really great that you guys were able to look at this across the US actually. I'm really quite fascinated because you still have 3% from that Western Mediterranean lineage and 3% from the African lineage, which could include snippets from any number of subspecies there. So you did this at the US level, you mentioned also doing it at the state level. So can readers of this manuscript see at the state level what you found?

Guest 26:43
Yes, in fact, I took into consideration this specific aspect, because I know that every beekeeper from different states would love to see what's going on in their own state. What I did is I put a very simple table, although it's a long table, but I emphasized that we need to keep it in the manuscript. I detailed per state, the lineage found, and per state, also the number of haplotypes found, and the haplotype diversity, as well as the name of each haplotype found per state. I added, also, the novel haplotypes, because we identified 14 novel haplotypes and where they are in each state, if they have novel haplotypes or not. So all this information, in fact, they are detailed in a very simple manner, I hope. I mean, they seem very, very simple and clear. Every beekeeper can go back, "Okay, I'm from North Dakota, I'll see, where is North Dakota, I see, what do we have, what those people are saying we have." Of course, within the scope of our sampling size, we need to know that because this is already a lot of samples analyzed, but we can't analyze thousands and thousands of samples from the same

state. This is the job of the local authorities and local labs to emphasize more on their state and identify maybe more diversity or not, or this is up to the state level to determine.

Amy 28:15
I want to go back to my comment earlier about you being a beekeeper growing up as a second-generation beekeeper and a researcher, because I think it really shows when we're talking to you that you're doing great research, you're considering everything from the research perspective, but also you want to be practical. You want it to help the beekeepers as well. So I applaud you on that because I think it's very apparent when we're talking to you on this podcast.

Guest 28:43
Well, awesome. That means a lot to me, Amy. Thank you.

Amy 28:46
Yeah. So, I get to ask you the million-dollar question. And that is what does this all mean for beekeepers?

Guest 28:54
Okay, so this is the most important question, in my opinion. We did all the studies just because we want to better the life of beekeepers, basically, and also, at the national level. We want to take care of our honey bee populations to make sure that they are healthy and that they can sustain ourselves and our next generations to come. This question is very interesting because we need to be sensitive to a very critical point here. The US doesn't have its own native honey bee species or subspecies. We basically imported everything from the Old World, so we don't have a native honey bee here. And then we've imported everything but maybe we have not imported enough, let's say, or maybe we have just imported a small chunk of the diversity found in the Old World. You need to keep in mind that those bees, they've evolved in the Old World for millions of years. We're not talking about like 100 years or 10 years or decades. So they've developed very sophisticated adaptation to their local environment, to the local predators, to disease and so on, as it is expected for any living organism. Now, we've brought them here. But now we need to understand are they healthier? Do we have a healthy diversity? Now, the general consensus is that the more diversity you have, the better for the health of any given population, including human beings, by the way. But let's stick to bees here. More diverse honey bee populations will mean that you have more genetic traits that will be able to face the challenges, environmental stressors, abiotic, biotic stressors, disease, health, productivity, A declined diversity within a population is very bad because it will create a bottleneck, a genetic bottleneck or an inbreeding process that will limit the traits of resistance to disease and adaptation to climate, etc. So what we did, the whole study here is to check with beekeepers, at the national level and state level, do we have a healthy diversity in our honey bee population? Or do we need to work harder and find and improve this diversity because everything that we face in nature, in the environment, in the flora or forage that you have in the field is basically reflected, you can take advantage of it based on your genetic capacity. So the adaptation is based on your genetic background. If you have a diverse genetic background, you can deal with much more challenges than if you are in an inbreeding process and you have very limited

genetic attributes. If you face a new predator, then you can't defend yourself. If you face a new disease, you don't have what it takes genetically, to be able to overcome this challenge. And that's a very critical, very critical point to understand.

Jamie 32:27
So you and your colleagues have done a lot of work. This is really fascinating. It's very exciting. I'm just curious, what are some of your follow-up plans? You mentioned a lot about this paternal versus maternal. Are you guys going to follow up looking at paternal lineages? What do you guys have planned next?

Guest 32:43
Yes, in fact, that is what we are working on, currently. Now, we did phase number one, and fortunately, we have those samples. We've already extracted the DNA that are saved at minus 20. Now, the next phase that I would like to do is, since now we've evaluated the maternal diversity, and we know every single sample from where it has been sampled, when, from which state, and we know its haplotype and its lineage, now we are going to check using a different marker, which, is this time, a genomic marker, mainly using the microsatellite loci, a marker to define the paternal heredity, how much diversity we are having from the father's side. In our cases, the drones. Now, we will use a different marker, and this time, it's not going to be on the mitochondrial DNA. As I said earlier, it's going to be on the genomic DNA, the huge DNA, because the mitochondrial DNA basically is like just 16 KB, it's a small circular DNA. Now, here we are dealing with a different technique that we'll be using. This technique is also, I think we're familiar with it because it's used even in hospitals or even in investigation here and there to prove the paternal, the fathers in crime scenes and so on and so forth. So, this is the marker that we are going to use, and then we're going to say, "Okay, we're going to link diversity from the maternal side, and then after our phase two, we will see what the same sample have from their paternal side and then we will make a comparison." But make no mistake, now, this is a very simple idea here that I would like to clarify. The queens are the origin of the drones. I mean, the drones are not going to pop up from the sky or drop from the sky on us. Originally, they carry the genetics of their mother, except if you're bringing drones from outside the study population. So, basically, they might vary a little bit, but my own expectation, and I may be wrong, but I would estimate that what we found in the paternal side won't differ too much from what we have on the maternal images. It will bring a little bit, maybe, more diversity, but this is to be seen. Because a simple reason in a closed population, the drones are originated from the queens, and what we will find from the drones, it will differ definitively, but it will not differ too much. So, we'll see, maybe we'll get surprised. This is really the phase number two that we're going to do using those same samples. And hopefully, we can bring the results to the scientific community and the beekeepers to really have a full picture of the overall diversity of the US honey bee population.

Jamie 36:02
Mohamed, you've really done a great job explaining something that's very technical throughout. I know all of our listeners everywhere around the world are going to really appreciate this. They're going to wonder the second thing, which is, well, gosh, what is the genetic diversity in the country or the region

where I live? So you might be inspiring research projects to pop up all over the place on this topic. Amy and I wish you the best of luck moving forward into phase two, and thank you so much for joining us on Two Bees in a Podcast.

Guest 36:28
Thank you very much for having me.

Amy 36:47
You know what, Jamie, talk to me 10-15 years ago, I don't think I would have ever imagined I would be sitting here talking about mitochondrial DNA or haplotype diversity in honey bee populations.

Jamie 37:02
Well, you're lucky to be here, then.

Amy 37:05
I'm so fortunate to be here.

Jamie 37:06
It's a fascinating topic to me. And obviously, in our own lab, it's something that I've got a growing interest in. And so I find it fascinating, quite frankly.

Amy 37:15
Well, just looking at the abstract, when I was reading the publication, I was just like, "Oh my gosh, there's so much on here that I just don't understand. I don't understand the background. What is going on?" And then after talking to him, I was like, "Wow, this is really cool." I know that you're very passionate about it, and so I can definitely see how it's very intriguing to understand the different lineages and the different species and subspecies of honey bees.

Jamie 37:40
Yeah, so he did a really good job explaining it. We knew coming in that this was going to be a little bit of a difficult topic. But the shortest potential explanation is that animals carry DNA in their nucleus, and they carry DNA in their mitochondria. And the mitochondrial DNA, which is what we've been talking about, exclusively comes from the mom. The nuclear DNA is, in the case of humans, at least, half mom and half dad. And the same is true for worker honey bees. It's a little bit different when we talk about drones, but that's another story for another day. And so you can use this mitochondrial DNA to understand the genetic diversity, and you mentioned species and subspecies of honey bees. Just a few years ago, I was telling people there were nine honey bee species. Well, now I'm telling people there's 10. And now I'm looking at more data thinking that there may be more. Just within mellifera, the species that we keep and study ourselves, there's 30, maybe 35 subspecies, and he's arguing that within subspecies, you get a lot of diversity and that diversity is represented among things called haplotypes. And so we've done some work on honey bees in South Africa, where we were looking at diversity within Apis mellifera capensis, the Cape honey bee, and we found it was remarkably diverse. Same thing for

scutellata, Apis mellifera scutellata. And that's what he's doing. He's looking across the diversity here in the US. To make it a little bit more digestible, most beekeepers are very aware of the fact that there are these different lineages. He mentioned the ACMO lineages, the A Bee and the African, the M, the most notable subspecies in the M lineages, Apis mellifera mellifera, the German black bee, or the black bee, or the dark honey bee, and then the C lineage that has things like ligustica, the Italian honey bee. There are also some other cryptic lineages that may exist. And we might see those in the US in some of these analysis. So it's a really interesting first step looking at the genetic diversity. I love the fact that he mentioned he's going to follow up looking at the paternal lineages, which you can only do in honey bees, and for that matter, animals in general, by looking at the nuclear DNA.

Amy 37:40
Yeah, I mean, just looking at the lineages, being able to separate them out by that North Mediterranean, the West Mediterranean, the African lineages, sometimes, I'm just like, it's just all a melting pot. But it's not. I mean, it is, but at the same time, they're just very specific lines going way back.

Jamie 40:05
Amy, you make a really important point. Because the mitochondrial DNA is so conserved from one generation to the next, I would suspect, and I could be wrong here, but I would suspect you would see more, for lack of a better term, true lineage representation. Whereas, when you look at the nuclear DNA that's contributed from the mom and the drone, and there's crossover, and within a colony, there's multiple drones represented in a single hive, you can get what I think will be more of a melting pot of lineages. So whereas your mitochondrial lineage might be, let's just say for the sake of argument, the C lineage and the nuclear lineage can be something entirely different based on the drone contributions, it gets complicated, fast. But why is all this important in the first place? Well, that's what Mohamed kept mentioning, this idea of diversity. Knowing diversity precedes knowing whether or not conservation is important. He mentioned that it's possible that we have somewhat reduced diversity here in the United States if there's no native honey bees. But he also talked about the ridiculous diversity that you see in Africa, for example, from the African lineages. So thinking about conservation, thinking about improving the stocks that we have in the US, and for that matter, folks around the world are taking up this cause as well, all of that kind of starts with, what do we have? How diverse is what we have? And that's an important first step.

Amy 41:34
All right, I have to finish this episode just by saying that Mohamed is doing the 23 and Bee.

Jamie 41:42
I was thinking the same thing. I thought about that. I've said that, actually, before to other people. There's actually places you can send your bees to get them, and I've always thought that they should call it 23 and Bee, but maybe they will.

Amy 41:44

No you weren't. I said it first.

Jamie 41:56
You at least said it first on the podcast. I'll give you that.

Amy 41:58
That's fair.

Stump The Chump 42:03
It's everybody's favorite game show, Stump The Chump.

Amy 42:07
All right. Welcome back, beekeepers, to the Q&A segment. Jamie, the first question we have today, so the question is, should beekeepers be treating proactively? And with this question, I am going to assume that they're talking about Varroa. So do you think that beekeepers should be treating for Varroa proactively?

Jamie 42:33
So, I do not think that they should, Amy. I think the data bear this out, and it's going to come with a couple of caveats, but I'll state from the front end, you should only control problems you have, not problems you don't have. And so the Theory of Integrated Pest Management rests on the assumption that you are going to do as many non-chemical things as possible to keep Varroa numbers below an economic threshold. And then, if they reach the threshold, you can use chemical treatment intervention. So what does that look like, practically? Well, maybe you use screen bottom boards and resistant stock or drone brood removal, or whatever. You're doing non-chemical things to reduce the Varroa populations. Simultaneously you are sampling for Varroa throughout the production season. And as long as your Varroa numbers are below the economic threshold, you don't need to treat with a chemical. So that economic threshold is roughly two to three mites per 100 bees. We usually say three mites per 100 adult bees as discovered through an alcohol wash. But, it all depends on the time of year and the Honey Bee Health Coalition table of Varroa treatment shows that. It shows you what the economic threshold is based on the condition of the colony, but it's usually around three mites per 100 bees. So as long as your chemical-free treatments, your bottom screens, your resistant queens, your drone brood removal, whatever it is you're using, as long as they're non-chemical treatments, keep the Varroa loads below three mites per 100 bees, you don't need to treat with a chemical. So you'd be wasting money applying a chemical. And furthermore, the more you treat with chemicals, the more likely Varroa are going to become resistant to those chemicals. So integrated pest management is structured in such a way that you do as many non-chemical treatment options as possible, and only treat when you hit the threshold. Now, that sounds good for me to say. It sounds good for everybody out there listening to hear, but it can be tricky in practice, especially for commercial beekeepers. Right? Think about it this way. Let's say you've got 10,000 colonies and an apiary has 40 colonies. You go in and find one colony. So, now you've got to sample 10,000 colonies and you need to do it maybe once a month. There are strategies out there where you can sample fewer colonies per apiary, but let's just

say for the sake of argument that you still have to sample 1/3 of your colonies once a month. That's 3333 colonies once a month, you've got to do Varroa washes on. Well, then on top of that, what happens if only one colony in your apiary is over three mites per 100 bees? Do you treat it? Do you treat the apiary? What if two of the 40? Or 20 of the 40? A lot of commercial beekeepers, I don't want to make a blanket statement, will just simply say, regular sampling is just not worth it. It's too time-consuming. There's too many colonies, there's too many what-ifs. And on top of that, let's say I hit three mites per 100 bees and I'm in the middle of a honey flow. Am I going to treat and not be able to use that honey? Or am I going to get the bees through the honey flow and then treat? So they say, considering how complex the commercial beekeeping landscape may be, maybe it's not beneficial for us to sample and treat only when we exceed the economic threshold. Maybe we should treat when we have known designated treatment windows that are outside production, and that we know are necessary for keeping Varroa from hitting the threshold a month or two months from now. So I argue that it's never best to treat proactively. You should always treat in response to Varroa crossing that threshold of three mites per hundred bees. But a lot of people who are big scale beekeepers find that difficult to implement because of the cumbersome sampling, because of the timing of the year, the production season, the treatments that are available. And so a lot of those guys and girls will just treat on schedule. And they're like, "It's okay if we have to treat an extra time or two on schedule because that beats the cost of sampling or the cost of this or the other." And until there are economic models showing overwhelmingly that the IPM approach is best, I think you're going to continue seeing that strategy in the commercial industry, where we treat in our known treatment windows rather than build on top of this IPM, we're going to sample, we're going to treat when we exceed. So, the simple question was, should beekeepers be treating proactively, you said, for Varroa? I would say they shouldn't be. But I understand the real world and the real answer is very complicated depending on management setting. Yeah, absolutely. I mean, you've brought up the commercial industry, for sure. But I think even as a hobbyist, before I started working at the lab, I was pretty intimidated by the whole process of monitoring using the alcohol wash. I wasn't sure if I was doing it right. So I think, sometimes, even for hobbyist backyard beekeepers, that can be kind of intimidating. So it's just easier to purchase something, slap it on the hive, and be done with it. The reality versus theory with both, I think, yeah, we can agree, should they be? Probably not. But do they? Probably. I mean, it's tough, Amy. You've hit the nail on the head. The best recommendations are to use non-chemical treatment options until you hit the threshold, and then you can treat with the chemical. We even have preliminary data from my postdoc days at the University of Georgia that shows that, economically, is more beneficial than just treating on schedule. But it's just hard. It's just hard to world complex. And if you're living in Florida versus living in England versus living in South Africa versus living in Australia versus living in Germany, versus living in Florida, versus California, you can understand that. It's just complicated. It's difficult, and I get it. I'm a stuck record but the Honey Bee Health Coalition's Varroa treatment guide really talks about this. They walk you through how IPM is best done, and of course, you'll remember Dr. Cameron Jack and I published a research manuscript on Varroa integrated pest management that we can link in the show notes today to kind of give it more of an academic spin, as well. We've got a series of recommendations in there too. So there's a lot of thought going into this, but it's not as clear-cut as we'd all like it to be.

Amy 49:03
All right. Well, speaking about complicated matters, that leads me into my next question. How is climate change impacting honey bees? So if you could just answer that question in a sentence, tell me how you'll save the world? That would be great.

Jamie 49:21
Well, listen, this is a very politically charged question, right? Surveys show that in the United States, at least, maybe only half of the people believe in it, the other half don't. I think maybe around the world, you get a greater percentage of individuals believing in climate change, but in the US, it seems to be split down the middle, half and half. I'm not going to even dip my pinky toe into the political aspect of this because I know we've got a lot of listeners from all around the world listening to this. So there's a lot of varied perspectives here. But I would say the research data suggests that storms are frequent, but the world is warming. And the question is how are bees going to handle this? Well, a couple of things come to mind. Number one, there's not a huge, robust literature associated with climate change and honey bees. So it's an emerging research topic. I feel like in the next 10 years, it's going to absolutely explode onto the scene with scientists all around the world studying this, at least bee scientists. And it's just under-studied at the moment. But, one can imagine that a warming earth with all of these other things that happen as a result of that, more rain, or less rain, or increased temperatures, etc., all of those things can affect plant phonology, plant success, plant distribution, plant bloom, plant availability of nectar or pollen, because their pests and diseases, plant pests and diseases are affected by these warming temperatures. Their distributions are affected by these warmer temperatures. I'm in South Africa right now, as I answer this question, and there's been an eight-year drought where I am. Locals here, everybody we've spoken to, have talked about the reduction in the number of wild honey bee colonies they've seen, just because the plant life responded to this significant drought. It died or it decreased. And so as a result, there's less forage for bees. I can give another example of a potential impact with honey bees. In Florida, we have Africanized honey bees in the southern half of our state. In the US, they're in the southwestern US as well, Southern California, Texas, Oklahoma, New Mexico, Arizona, places like that. Well, if we're getting incremental increases in temperature and significant climate change, you can imagine a scenario where their distribution starts to expand. The reason they're not in the rest of the United States is because they don't overwinter. Well, they don't cluster well. Well, if it warms, maybe they can move up, maybe they're in Georgia in 30 years, or in wherever, established populations up north, even after that. Maybe spread to places in Europe will be facilitated. Europe has going for it that it's got, in a lot of places, cold winters. And that's not something that African honey bees can survive. Or maybe the spread of bee pests. Small hive beetles may be all over the US. But, their significant damage is really in the southern states. Well, maybe it starts to warm, you'll see significant apiary-wide damages in the northern states. We know the small hive beetle is now in Europe, it's in Italy. Well, if it warms in Europe, you might see them in Germany and Finland or Sweden. Who knows how the honey bee diseases and pests will be affected by these expanding range distributions made possible through a warming Earth. And I will throw on top of that, the honey bee that we keep, Apis mellifera, has a natural distribution from Northern Europe to the southern tip of Africa. So that means it lives in cold environments, wet environments, dry environments, hot environments, windy environments, and you name it. So the species itself probably will not struggle that much. But specific

subspecies that are acclimated to very specific environmental parameters or conditions in certain areas could suffer. For example, Apis mellifera mellifera is a very cold hardy honey bee. It's the Northern European honey bee. Maybe it can't do as well in warming climates, maybe scutellata or capensis, or some of these other warm, adjusted or adapted bees are going to do well in these warming climates. So it's difficult to predict because there's not been a ton of research on it, but it's not a very big stretch to suggest their diseases and pests will be impacted, they will be impacted, the plants on which they rely will be impacted, so you can really envision a scenario where it significantly impacts honey bees. And I think this will be an increasing story in the news, and kind of in the research and beekeeping world as well moving forward in the next decade or two. Yeah, absolutely. Well, good job. That was a good response to how the world is changing the world of honey bees. Well, yeah. Alright, so the third question. So this question has been a topic of discussion at many of the associations, I've seen it online, and people have just been bringing it up to me left and right. And so let's answer it. So the question is, people have been using soapy water like Dawn dish soap or just a general dish soap to monitor for Varroa instead of alcohol. So, the question is, one, is it okay to use soapy water to monitor for Varroa or is it as good as alcohol at all? So, I mean, I would say it's okay to use soapy water, and I would say we don't know how good it is relative to alcohol. So you and I were talking about this a little bit before we got on the air. I know Jennifer Tsuruda at the University of Tennessee and Jeff Williams from Auburn University had been looking at the efficacy of using powdered sugar versus alcohol when you're doing these Varroa washes. But I'm not aware of any studies with soapy water versus alcohol when doing these Varroa washes. If any of you listeners out there are aware of some of those studies, you can just let me know, and then Amy and I in the future can reanswer that question, or this question. But I will say, even with the lack of that information, it's easy to suppose that when you do a Varroa wash with 300 bees in a jar and you add ethanol, that's the alcohol, or soapy water, you would probably get very similar results. I can't promise you since I'm not aware of the research been done. Maybe it's being done now. But my hypothesis is that you would get very similar results. So you do this wash, you will likely get the same number of mites within a few mites if you had done it with soap water versus alcohol. I think one of the reasons people have shied away from soap water is that when you start shaking up a jar of bees with alcohol, you just get bees, alcohol, and Varroa, but when you shake up a jar of bees with soap water, you get bees, Varroa, and a whole lot of suds and bubbles. That makes it very difficult to see Varroa.

Amy 56:16
I was gonna say that too. The suds will probably prevent you from seeing Varroa, especially, sometimes, it's hard enough. My eyesight is starting to get bad. So I'm not sure if I'd be able to see through the suds.

Jamie 56:29
For that matter, Amy, why soap water at all, why not just water? I think it would be neat to see a research project done on water versus alcohol versus soap water. Again, maybe that's already been done, and I just don't know the literature as well as I should. And if it has, listeners, please let me know and we'll try to correct this. But I can envision a scenario where some sort of killing agent, soap or ethanol, would cause a Varroa release from the bee moreso something like water. So I could buy the

argument that maybe water is not quite as good to use as soap water or ethanol. But honestly, I just have to see the data. Someone needs to do this study, and generate the data, and then I'll be able to answer the question with more authority. Until then, I would argue that soap water, alcohol, assuming all else is the same, same number of bees, same volume of liquids, same amount of shaking, for the same amount of time, I would guess you would get similar numbers of Varroa out of those jars if you were doing it one way or the other.

Amy 57:25
Alright, well, there's a call for beekeepers to go ahead and send us an email if you have that study or if you found that study anywhere. Thank you so much for the questions. Be sure to email us at honeybee@IFAS.ufl.edu or send us your questions on our social media pages @UFhoneybeelab.

Serra Sowers 57:46
Thank you for listening to Two Bees in a Podcast. For more information and resources on today's episode, check out the Honey Bee Research Lab website at UFhoneybee.com. If you have questions you want answered on air, email them to us at honeybee@ifas.ufl.edu or message us on social media at UF honey bee lab on Instagram, Facebook and Twitter. This episode was hosted by Jamie Ellis and Amy Vu. This podcast is produced and edited by Amy Vu and Serra Sowers. Thanks for listening and see you next week.