Tracey Peake:

Hello and welcome to NC State's Audio Abstract. I'm your host, Tracey Peake. Honey bees are amazing insects, from their contribution to agriculture to their delicious honey. But how do they do what they do? We're speaking today with David Tarpy, Professor of Applied Ecology and all around bee expert on what bees know. Welcome, David.

David Tarpy:

Great, thanks, Tracey.

Tracey Peake:

Let's get started by just talking about bees in general. How many species of honey bee are there?

David Tarpy:

Worldwide, there are nine species of honey bees, but only one of them is here in America. And in fact, even though they're out state insect, they're not native to the Americas. They were actually imported by the first European settlers. So we have the indigenous species that's in Europe and all of Africa, but all of the other species of honey bees are in Southeast Asia.

Tracey Peake:

Does anyone have an idea of how many honey bees we have in the US?

David Tarpy:

We have good guesses and estimates, but it's a hard number to really pin down. Our best guess right now based on USDA surveys is that we have 2.9 million managed honey bee colonies in the US, which is actually a slight uptick. In the last decade or so when colony collapse disorder was making a lot of headlines, we only had about 2.4 million beehives there. So the colony collapse issue and the problems that honey bees and beekeepers have been having is not the total population of managed beehives; it's their ability to keep them alive and healthy. We're losing something like 40% of honey bee colonies every single year. Beekeepers have 40% of their colonies dying every year, but then they grow them back. Because they're managed, they're able to do that. So we have this oscillating population, this unsustainable right population of honey bees that makes it more difficult to address our pollination needs.

Tracey Peake:

I was going to ask you if there was a particular species of bee that was popular, but since there's only one species of honey bee in the US, that is a silly question. What is the species?

David Tarpy:

But there are many different stocks or breeds. There are different types of the same species. So there are many different subspecies in Europe and in Africa. The notorious one that we've all heard about are Apis mellifera scutellata, the killer honey bee, the Africanized bees. We don't have those in North Carolina. Those are kind of tropically adapted, so they tend to be more defensive oriented, hence the name. But there's lots of other different types of Apis mellifera ligustica that we have here in North Carolina and in the US. There's something like 20 or so, a couple dozen subspecies, half of which I would say that we have here in the US. But in essence, everything, because they're the same species, they're subspecies, they can interbred. So we just have kind of good old American mutts is what we have.

Tracey Peake:

I was going to ask about that. If you had a subspecies in your hives that you were managing, could you get a queen from another subspecies if you had to replace one?

David Tarpy:

You can. You can. And in fact, there is a niche industry within apiculture where there are queen producers and bee breeders that are selecting for stock where some colonies make more honey, some colonies are better at overwintering, some colonies are more disease resistant. Those different breeds, those different stocks have different traits to them, just like in other kind of animal systems.

Tracey Peake:

It's like the AKC of bees, right? Do you want the Saint Bernard or do you want the chihuahua bee? Or what kind be bee?

David Tarpy:

Correct. Maybe not quite as diverse or different as we see in canines, but it's the same kind of aspect that colonies have different traits, and so selecting for those traits or against unfavorable traits is what bee breeders do.

Tracey Peake:

On a related node, when you mentioned the Africanized bees, I remember being alive as a child and we were all terrified that the killer bees were going to take over the entire country. Did they just kind of stop? Did they get to a certain place and they're like, "We can't really go any further than this"? What happened?

David Tarpy:

That's a great question. In the '70s and '80s, there were just so many-

Tracey Peake:

Killer bees.

David Tarpy:

... killer beef films, bad B bee films that were made about this looming threat. They did arrive in southern Texas in 1990, and they did kind of fill the ecological niche in the southern tier of the US. But they've kind of petered out, because again, they're tropically adapted, so colder winters or just colder temperatures in general, they're not as amenable to that. So they haven't really kind of spread further northward like was predicted back in the '70s and '80s. So pretty much they're kind of a non-issue now, because they always were. They were just sensationalized more than they were an actual threat to people and to beekeepers. They're just not as amenable to beekeeping because they are more defensive. They can't be used in commercial apiculture where they move from one orchard to another orchard, because that kind of movement by a beekeeper, they'll just get up and leave. So that was always really the main threat. But beekeepers in the US have been able to handle it for the last several decades, and it's pretty much a moot point.

Tracey Peake:

Do they interbreed with our tame colonies that we have?

David Tarpy:

They do, because they're also a subspecies. So that's always been part of the problem of how genetically are they going to be integrated into the US population. But again, beekeepers are on the front lines. So if they see any of these kind of tropical or Africanized traits, they just swap out the queen of that colony, replace the genetics, and they're able to stay on top of it.

Tracey Peake:

Okay. Well, that's good to know. Young me is relieved that we are not under constant threat of killer bees. Do bees recognize their beekeepers? Can bees recognize faces?

David Tarpy:

The short answer to that is yes, bees can recognize the faces and differentiate faces of humans, so they can recognize their beekeepers over somebody else. There was this really interesting and splashy study that was done coming out of Cambridge, I think, in 2004 or 2005, around that time, that demonstrated that, where they were able to reward bees and have them learn human faces and discriminate among human faces. Bees are really, really good at learning. So kind of like training Pavlov's dogs where they would salivate just by the ring of the bell, bees can stick out their tongues expecting a little bit of honey reward if they get a particular stimulus. So they can see how well they learn, and if they can learn different faces. And the answer is they can.

The real question is if they do in kind of normal practice. Probably not. There's no real need for them to distinguish one big mammal from another big mammal. But the fact is that they can, and it's very interesting how well they can learn and discriminate different things in their environment.

Tracey Peake:

Has there been any anecdotal stories that you hear from beekeepers and conversation who talk about how their bees know they're coming or their bees recognize them or interact with them when they walk toward the hive?

David Tarpy:

Absolutely. This happens all the time. If you go out and visit your colony the same time, day after day, they will be waiting for you. They will anticipate your arrival. But that's really based on their ability to learn things like, oh, this flowering plant only opens up in the late afternoon. And so they're able to integrate these kind of collective decisions through their circadian rhythms to be able to anticipate rewards that are important to them, such as pollen and nectar that's in their environment, the food that they eat, or threats such as bears or humans coming and robbing their honey. So they can actually distinguish and learn those things over time.

Tracey Peake:

Why don't they get more upset when you harvest their honey if you're a beekeeper? Or do they get upset and that's why they smoke, they put the smoke on them?

David Tarpy:

Well, yeah. So two things. One is that honey bees are actually not nearly as defensive as what we have in our heads in our zeitgeist. Honey bees are actually quite passive. Yes, they don't like their homes being robbed of their resources. But again, the second thing, as you just said, beekeepers for millennia have been using smoke to pacify the bees because they have very bad eyesight. Even though they can see human faces, their eyesight is not nearly as good as their sense of smell, which is the primary means by which they communicate. An alarm pheromone is something that increases their defensiveness. If another nest mate recognizes that they're being robbed of their honey, they will send out the alarm pheromone and everybody else will get a little more defensive. Smoke masks that alarm pheromone, and so it greatly pacifies them. And so beekeepers can go in and work the hives safely without them getting overly defensive.

Tracey Peake:

That leads me perfectly into my next question, which is, what do bees see? You said their eyesight is not as good as their sense of smell. Is that how they're differentiating between objects in the world? Like, here's a flower, here's a car, here's a tree.

David Tarpy:

Yes, but they put together this very blurry mosaic of different images. They can't focus like we do with our eyes and really be able to discern specific things. But why are flowers very colorful? Because it makes them stand out from a background of green. So they can see these blurry images of the flowers, but they're very attracted to color, so that's how they're able to find flowers in the environment. But more importantly is their sense of smell, which is, again, twice as good as that of dogs. They're very, very discriminating when it comes to smell. So between those two things, they're able to really make sense of their universe.

You got to remember too, is that the first half of an adult worker's life is spent in the dark in the hive doing chores on behalf of the colony. It's only the last three weeks of her life or so that she's out foraging in the environment anyway. So their eyesight is important, but it pales in comparison to understanding their universe than their sense of smell.

Tracey Peake:

Is that why beekeepers wear white?

David Tarpy:

Correct. They tend to wear light clothing or white overalls, not just as a means of protection from stings, the occasional sting, but more because it provides less of a contrast with the background. And the bees, because they can't focus very well, they can see moving objects and they can see contrast much more easily. They can see something if it sticks out from the background, so wearing light colored clothing helps to minimize their defensive response to that. There's also a phrase, no jerks in the bee yard, which is not just only you can only keep bees if you're nice, but also you don't want fast rapid movements. You want to move very slowly and methodically, because then it doesn't alarm the bees.

Tracey Peake:

I'm learning a lot about beekeeping, and I like it. On a kind of similar note, you had mentioned that in the hive, the worker bee is only going to go out and forage for pollen for the last three weeks of their lives. How long does a bee live?

David Tarpy:

A typical worker bee that is the majority of that 50,000 within the colony lives about six weeks in the summer. The first three weeks they're doing chores inside, like nursing the young, building the comb, ripening the honey, those kind of things. And then the last three, they're out foraging for their two food sources, nectar and pollen. Nectar is sugar water in flowers that the bees collect, bring back, and that's what they make their honey from. And then pollen also from flowers is their protein source. So they bring that back to the hive, and then they feed that to the young, the developing young, as the protein source.

So all of honey bees are vegans, right? Only plant sourced foods. They go out and they can forage up to four miles away from the hive, collect the resources that they're looking for, bring them back, and they're providing that to the rest of the hive for them to have something to eat.

Tracey Peake:

I've always wondered exactly how getting the pollen from place to place translates into honey, and it's not. The pollen is just what they're eating, and the nectar is the honey?

David Tarpy:

Right. Well, they're eating both, but pollen is their protein source that they're feeding only the young. The nectar is their carbohydrate source that they themselves are eating for fuel, but then also feeding to the young. But then also, any excess they're storing in the combs, ripening it into honey so that it doesn't spoil, so that they have something to eat during the winter. Because honey bee colonies make it through the winter as a colony just huddling inside the hive, staying warm, and eating the honey that they collected all summer.

Tracey Peake:

How much does it take and how long does it take to fill an average size honeycomb? Like a beehive frame sized honeycomb?

David Tarpy:

David Tarpy:

The average honey yield of a colony in North Carolina is about 50 pounds of honey per year, and that's surplus. But it only takes a single worker's lifetime of flying from the hive and coming back many times a day for three weeks of her foraging life, she only makes the equivalent about of 1/16th of a teaspoon. So it takes a tremendous amount of effort in order to make pounds and pounds of honey. But again, collectively, when you have 50,000 bees working all summer long, it adds up, and that's how they're able to make their honey so that they can survive the winter.

Tracey Peake:

You referred to ripening the honey. What exactly happens?

David Tarpy:

The nectar is, again, it's a sugary bribe to literally lure the bees to the flowers so that the plant can be cross-pollinated. So it's a reward for them to just visit. But it's very dilute. On average, it's about 20% to 40% sugar. Honey is like 85% sugar. So by ripening it, what the bees in the hive have to do is evaporate off that excess moisture, and they also actually chemically convert the sugars from the nectar to the main sugars that are in honey. And then once it is dried enough and kind of ripened, they seal the cell over with wax. And as long as it's airtight, it will never spoil. It is so devoid of moisture, and it's so sugary sweet, and it has a low pH. All of those things are against microbial growth, so it won't spoil.

Tracey Peake:

I had read an article just the other week where they were pulling out jars of honey from Egypt or something, and they were still, because they were sealed, perfectly fine.

David Tarpy:

It was not spoiled.

Tracey Peake:

It was not spoiled. Not perfectly fine, but not spoiled.

David Tarpy:

I would probably say it would taste like garbage.

Tracey Peake:

Okay, excellent. And then to kind of come back to, we talked a little bit about colony collapse at the beginning. We heard so much about it for so many years. Where are we with that right now? What's going on?

David Tarpy:

Colony collapses really made a lot of headlines, in large part because it was mysterious. And again, beekeepers have been dealing with colony losses for a very long time. There's a lot of threats from pests and disease. There's a lot of threats from pesticides in the environment. There's a lot of threats from deforestation and the loss of habitat, so there's not as much nectar and pollen out there for them to gather. So all of those things have been very problematic. But there came this tipping point in 2006, 2007, where it made a lot of headlines of these mysterious reasons why colonies were dying, not the typical reasons why colonies were dying. We've never really kind of been able to figure that out, because it's such a complex issue of all these different moving parts that we just think collectively is just an over accumulation of stressors is in essence what that is.

We don't really see that syndrome happening nearly as much as it was 10, 15 years ago. But the threats and the stressors are still there. So again, we're still losing 40% of our colonies every single year, but that doesn't mean that the total population is in steady decline. It declines and then bounces back because the beekeepers are growing them back.

But a lot of us are worried, and my question is, "What happens with the beekeepers can't?" It's an unsustainable model of a kind of this turnover rate. And so what we really need to do is come up with solutions to alleviate these stressors so that the colonies don't die off as much, and so it's economically better for the beekeepers, and it's more stable and sustainable for a greater agriculture.

Tracey Peake:

So it's a amalgamation of stressors, and then the colony will eventually just reach a tipping point. Because for a while, they were talking about mites or disease. But it could be mites and disease have been around for a while, but that combined with less flowers to find and-

David Tarpy:

Correct.

Tracey Peake:

... predators and this, that, and the other thing.

David Tarpy:

Correct. The [inaudible 00:22:21] viruses, new families or formulas of pesticides that are out there. All of these things, it's such a complex Gordian knot that it's been really, really hard to untangle. But honey bees and really all pollinators are so important that we need to keep our eyes on them because they're kind of the canaries in the coal mine to how we're treating our environment and just making sure that we don't go too far.

Tracey Peake:

One random question about bee stings. Do honey bees die when they sting you?

David Tarpy:

Honey bees do.

Tracey Peake:

100%. Wasps are terrible and they will not die.

David Tarpy:

Wasps are not bees. Yellow jackets are wasps. Most people, when they get stung by a "bee" it's really a yellow jacket, and they give honey bees a bad name. That's why everybody thinks that they're so defensive, because yellow jackets and other wasps are. And they don't die when they sting, so they'll just kind of keep coming after you. And again, they give honey bees a bad name.

Honey bees though are unique, even among other bees, where their stingers are barbed like a fish hook. So as it kind of goes into our elastic skin, it gets left behind as they pulled away, and the stinger remains with the poison sac that actually still has muscles that are kind of pumping the venom into us. It's a very effective deterrent. If there's a great way to drive away a bear or other predator from the colony, that's a very effective thing. So the sacrifice of the one benefits the many. But not all bees do that, and certainly wasps don't.

Tracey Peake:

Okay. I just always felt bad for the honey bees.

David Tarpy:

Yep.

Tracey Peake:

All right, well, that leads me to my final question, which is a question I ask everybody on the podcast, which is, what is the coolest thing you've learned about bees, your favorite bee fact?

David Tarpy:

Oh my goodness. You can't possibly think that I can narrow that down to one.

Tracey Peake:

You can have a few.

David Tarpy:

I think one of the real sensational things that I think a lot of people have heard about when it comes to honey bees is the famous dance language where they have a means of communicating to others. If they find a patch of flowers in the environment, they can come back and tell their sisters exactly where those flowers are by doing these kind of dances on the vertical comb in the dark. It's the only other abstract form of language in the animal kingdom except for human languages, because it translates the direction of where the food is with respect to where the sun is. They're using gravity as a proxy of where the sun is, and so they're communicating in the abstract. That's just fascinating. It's just really well known, and the scientists who did a lot of work on that got the Nobel Prize for it because it really is sensational.

But that's not my favorite fact. That's not my favorite thing. The thing that continues to really fascinate me when it comes to bee biology is that in biology, we learn that everything is a combination of genetics and the environment, nature and nurture, that any trait that we have, eye color, how strong we are, all these different traits are a function not just of our genetics, but what we do in our lives in order for those things to come together. Well, in honey bees, they're kind of the one example, or the best example that I know, where making the bees is either nature or nurture.

There are three types of bees in the colonies; the workers that we've been talking about. The drones, which are the males; they don't do any work; their only purpose is for reproduction. And then the queen, a single queen within the colony, and she's the mother of all the workers and drones within it. Now, in order to make a male drone, the queen just simply doesn't fertilize the egg. So the males don't have any fathers. So the distinction between males and females is entirely genetic. It has nothing to do with their environment or what they're fed. Anything else, it's entirely genetic.

But once you have a female larva, it can become either a worker or a queen, there's no genetic distinction between those, and it's entirely what they're fed as a larvae. If they're fed kind of a bread and water diet, kind of a thinned down honey and pollen, they become a stunted sterile worker bee. But if they're fed this nutritious food that you've probably heard of, royal jelly, then it develops into a queen. So it's entirely nurture to make a queen versus a worker. It has nothing to do with genetics. But to make a drone, it's entirely genetics and has nothing to do with nurture.

Tracey Peake:

That's really amazing. I was going to ask you about the little drones. We always forget the drones.

David Tarpy:

Yeah, a lot of people use drones and workers interchangeably. That's really an insult to the workers, I think. The drones, they don't do any work. Their only job is to fly from the hive and look for love among queens from other hives. But they then get kind of kicked out of the colony going into winter and they don't survive.

Tracey Peake:

Well, there's your payback. Thank you so much for being here today. We could talk about bees probably all day, but that would be a very, very long podcast that people might not want to listen to. But I do appreciate it. This has been fascinating. Thank you for being here.

David Tarpy:

Thank you so much. I appreciate the opportunity.

Tracey Peake:

We have been speaking today with David Tarpy, Professor of Applied Ecology here at NC State. This has been Audio Abstract. I'm your host, Tracey Peake. Thank you so much for listening.