Ask a Biologist Vol 002 (Guest Gro Amdam)

What's the Buzz about Bees and the Bee Genome -

An interview with biologist Gro Amdam - one of the members of the group that recently brought us the bee genome. Hey just what is a genome and could bees hold the answer to aging? In this show we learn the answers to these questions and why researchers are buzzing around bees.

Transcript

Dr. Biology: This is "Ask a Biologist", a program about the living world. I'm Dr. Biology.

My guest today is Assistant Professor Gro Amdam, who is a faculty member in the School of Life Sciences, and also a member of the Center for Social Dynamics and Complexity.

Her research involves honeybees. She has published research articles in important journals such as "Nature", and the "Proceedings of the National Academy of Sciences", and is part of a large group of scientists responsible for mapping the genome of the honeybee. We'll be talking about that work later in the program.

Welcome to the show, Professor Amdam.

Gro Amdam: Thank you, Dr. Biology.

Dr. Biology: Doing my reading, I found that bees are really pretty amazing insects. Before we get to the importance in biology and research with bees, I thought I would talk about a few bee facts.

Honeybees can fly 15 miles per hour, which sounds pretty good, but we can actually run up to 30 miles an hour, so you could outrun a bee if you had to. But what's more impressive is that while they're flying along, their wings beat at 180 times per second, which is pretty darn fast. If you think of just blinking your eye is that fast.

On an average trip, a trip, a single bee visits at least 50 to 100 flowers. And to make that favorite sweet, golden honey that we like, one pound of it, a honeybee hive, which is about 60,000 bees, they have to fly, collectively, 50,000 miles, which is like flying around the Earth two times.

While flying the 50,000 miles, honeybees visit at least two million flowers, just to make that one pound of honey. And all of this has been going on for 10 to 20 million years.

So, let's see what the buzz is about bees. Bees often are in the news, but mainly about European honeybees, and Africanized honeybees, which we often hear them called as "killer bees".

One of my questions for you, is, are Africanized bees really dangerous?

Gro: Well, Dr. Biology, cars are dangerous too. It really depends on the context. Africanized bees are more defensive than European bees. And that implies that if you walk close to their nest and you act in a threatening way, their response will be much stronger. They will send out many more bees to attack you, than what the European bees will do.

A person can take a couple of hundred bee stings. It's very rare that European bees will send that many stinging workers after you, but the Africanized bees will. And therefore, if you're attacked, you have a considerable risk going on. So yes, in that sense they are dangerous.

Dr. Biology: Well, along that line, I also read that the Africanized honeybees are replacing European honeybees, as they migrate up through the United States. Is this true, and what concerns should we have?

Gro: Well, another interesting thing with Africanized bees is, they produce more colonies per year, so they have more children colonies than what the European honeybees do. Therefore, they can rapidly spread and take advantage of the natural nesting sites, than the European bees can. This is the reason for the replacement that you're talking about, and yes. It's going on.

A larger and larger proportion of the colonies out there are African. They produce a large number of drones, males, that can interbreed and cross their aggressiveness into the European bees. So there's also this hybridization going on, one thinks, that is also causing the number of gentle European bees that are out there to decrease.

This is a concern from the perspective of probability. Because if you're out there, and you're walking along the trail, and there's a honeybee colony that you happen to stumble upon. Because of this replacement, it's now much more likely that that colony will be Africanized, and that it will attack you and then we're back in the danger zone and what might happen to you next.

Dr. Biology: OK. So I'm going to be careful where I'm walking, and try not to be aggressive around these possibly Africanized honeybees.

Gro: That's a very good idea.

Dr. Biology: Are there some other issues with them? For example, do they still, do the Africanized honeybees provide the same functions and the same roles as European bees, such as pollination?

Gro: Yes. There's, to the best of our knowledge, no decline in the efficiency of the natural tasks that the bees perform, with this replacement. The Africanized bees still pollinate flowers, and are probably also an important nutritional source for many predators of bees.

Dr. Biology: OK. Well, that gives the Africanized bee a little bit of a break in the press, I suppose.

I've also read that honeybees have an unusually sensitive sense of smell. So just how sensitive are honeybees to smell?

Gro: Well, they're obviously better than a couple of other insects, like mosquitoes and flies. But I believe they are not as good as dogs. So there were some suggestions made by other researchers earlier this year that maybe bees could be used for similar tasks like what you use dogs for, like smelling tumors in people, which is a new thing. Also bomb detection.

But bees have fewer sensory cells dedicated to smell than dogs. And probably, their ability to discriminate between smells is not so good. So we might have to stick with the dogs for some of those purposes still.

Dr. Biology: Well, that's one of the things that I was really curious about. That really helps. It also means that my dog is safe right now, for that task.

So sense of smell, they're better. Do they use that to communicate? Or do they use some other method of communication?

Gro: Well, smell is very important inside the nest of bees, because it's dark. The larvae, for example, use pheromones, or odors, they send out to the adult bees to communicate if they're hungry and how things are.

But bees also have one other very interesting means of communication inside the dark nest. This is a dance that the foraging bees perform when they come back to the nest. It's been referred to as a dance language. And the discoverer of this language, Karl von Frisch, got the Nobel Prize in 1973 for this discovery.

What bees do, bees that are foraging, when they come back to the nest, they will perform a dance that tells other bees the direction and the quality of the food that's out there. They provide direction by transposing the angle of the sun using gravity, instead of the sun, because it's dark inside the nest.

They use the duration of a certain waggling they do with their bodies to communicate the distance, and also the quality.

Dr. Biology: Marvelous.

As I mentioned at the beginning of the program, you're part of a very large group of biologists that have recently mapped and published the genome of the honeybee in the Journals "Nature" and "Science". It seems that these are exciting times for researchers with bees. We often hear the word "genome" used, such as the human genome, the Drosophila, or as we might call it, the fruit fly genome.

Before we talk about how the bee genome can tell us some more about what we want to know in biology, can you tell us what a genome is and why it is important to know about the genome of different animals and plants?

Gro: Well, a genome is often referred to as the "blueprint". It's the "blueprint" from which you can build a form of life. The genome is a sequence of DNA that codes for various genes that are translated into proteins. Proteins are what build up our bodies and govern many of the processes that happen to us. And this is general property of every living form.

The reason why it's important to know about the genomes of different animals and plants is that, of course, many of these principles are general. There are also differences. We are different than the plant. And we are different from apes. And bees are different from us. And how do these differences emerge from a genome? And how can changes occur in evolutionary time, to change a being from something to something else?

One thing that was kind of a poster child idea for sequencing the honeybee genome was that it could tell us something about how you become social. One thought was that you could compare the honeybee genome to the genome of the fly and the fly has a simple solitary lifestyle, lives alone. And maybe when you look at the difference between the two genomes, you could say, "Well, hey, these genes are in the bee, but not in the fly. So maybe they're responsible for social behavior and maybe the stance language and a lot of other exciting things that bees do."

The surprise came when the genome was mapped out and they saw it was smaller than that of the fly, meaning it had fewer genes.

Dr. Biology: How much smaller is it?

Gro: It's missing, I believe, a couple of thousand genes.

Dr. Biology: OK.

Gro: And this actually makes sense. In the context of work I've done here at ASU with the founding director of the School of Life Sciences, Robert Page, we launched a new theory for social evolution about two years ago.

We are claiming that social life isn't something new and exciting that has relied on new social genes that only the bee would have, and not the fly. But that social evolution is built on all genes. It's an exploitation of old evolutionary inventions and it builds something, it appears to be new, but that in truth, is very old.

Dr. Biology: Is that published in "Nature"?

Gro: This work was published first in "Proceedings of the National Academy of Sciences, USA". And new work was published in "Nature' in January of this year.

Dr. Biology: Do you like writing?

Gro: Yes. I like it very much.

Dr. Biology: Is it kind of a combination of all the work you do in the lab and the research? Is it a nice way to get it out at the end?

Gro: One thing is how everything comes together, but another thing is how your ideas unfold on paper and how you would like to tell other people your story. And that's what I like.

Dr. Biology: Very good.

Well, it brings me back to one of the first times I met you. You came to my office and you brought in this really wonderful photograph. And it had these bees that are standing on top of an old-fashioned pocket watch. It's just a marvelous picture in itself, but there's a story behind that. I'd like to know a little more.

Gro: Well, the clock under the bees represents time and the context of this time with bees is their aging pattern, which appears to be fundamentally different from a lot of the other organisms that researchers use to understand aging.

Popular organisms for understanding aging are the fly, also mice, and a little worm called Caenorhabditis. All of these organisms are characterized by progressive aging, meaning that you're born, it moves along, you get older, and you age.

In bees, it's different. Bees have a division of labor between bees that are inside the nest, that we call nurses because they take care of the larvae, and foragers, that are outside collecting nectar and pollen.

And a bee can be a nurse for anything between a week and a year, and while she is a nurse, she doesn't appear to age. But as soon as the bee becomes a forager, independent on whether this happens the first week of life or up to a year, then aging starts.

We have several markers for this aging, it's a buildup of protein damaging the brain and the loss, for example, of learning performance of its loss of immune function, which also characterizes human aging.

And the fact that bees have this plasticity, so it's not progressive aging, but it's more an aging switch.

Dr. Biology: Like you can turn it on and turn it off.

Gro: Turn it on. And "off" is a key word here because what we can do with bees, that I don't think any other organism can be used for, is to reverse aging. And this implies that we can take bees that are foragers and that show signs of aging, and we can put them inside the nest and give them larvae, and then remove all of the normal nurse bees. And what will happen to these foragers is that many of them will become nurses again.

And this is linked to a rejuvenation of their physiology and, seemingly, a negative rate of aging. So, becoming younger again.

Dr. Biology: That's fabulous. This ties us back to the genome again. This becomes really important for you, because I'm assuming you're going to use that as a map as you compare these different bees and their different aging.

Gro: Yes. What we're doing is we're doing large scale kind of finger printing of the genes and proteins that are expressed differently in these different types of bees: the aged bees, the young bees, and the reverted, or newly become-young-again bees.

And for these large scale finger printing experiments we need to know genomic information, of course. And it will allow us to pinpoint more specific candidates, meaning candidate genes and candidate proteins, for understanding what is going on with these bees and how they can have this amazing plasticity of their aging.

Dr. Biology: I'm actually going to shift gears a little bit here. You've been at ASU for a little over a year now, maybe two years.

Gro: One year.

Dr. Biology: One year?

Gro: Mmm hmm.

Dr. Biology: OK. Well, when good things are happening, it goes really fast. Before you joined the faculty there at State University in the School of Life Sciences, you were a researcher in Norway. Actually, you still conduct research in Norway and, in fact, you grew up in Norway.

So what I was curious about, for some of our young scientists. Do you notice a difference between the two schools, the cultures, or the way things are done?

Gro: Yes. I'm Norwegian. I grew up in Norway. The Norwegian school and research system is based on a different philosophy, in many ways, than the US system. It is not a system where it's perceived that excelling in something is a virtue on its own. It's much more a society of equality. This you see at every level of social organization.

But in the research area, it implies that most researchers get an OK amount of money to work with. Nothing spectacular. Even if they do really, really good research, it's difficult to build a big lab and truly excel at an international level.

Not many researchers can hope to do that, because if you become too big, there will be restraints in the system saying, "Please, There are others not as fortunate as you, and you will have to share your resources with them."

Now, I'm not the sharing kind of person, and I do like the US system better, where there are opportunities to excel, and where excellence is rewarded.

Dr. Biology: That leads me off in another, slightly different area. I was reading about you a little bit, and one quote I got out of this little story, which I found interesting, is that you admit to being a control freak. So I want to make sure. Is this true?

Gro: Yes. This is true. And it probably affects my ways of doing things.

Dr. Biology: So is this a good quality in your research area, or in scientists in general? Do you advise this for the young scientist? Or is it just the way you are, and you flow with it?

Gro: I think you should go with your personality. This is one of my features, and it works for me, because I can channel it into productivity, right? So my control freakiness makes me really anal about the quality of the work I do. And it makes me supervise my lab efficiently.

And also, in a way, I hope, it helps my young people in my lab. It makes them see how they can systemize the work they do, and how they can achieve to take their ideas from the level of a desk to the level of experiments and to the level of publication.

Dr. Biology: So with this, some people might think that that's all you've ever done. You've only been a scientist. That's all you think about. But I also heard that you were a radio host in Norway. I was curious what got you started in radio, and what was the program about?

Gro: This was actually a university type of radio, maybe much like what we're doing here now. We were primarily presenting to students, once a week, an hour-long program about what was going on at the university: social issues, political issues, concerts. We were interviewing guests, artists, also directors and political figures in the context of the university and how education was conducted.

Dr. Biology: So were you getting your degree in science at the same time?

Gro: Yes.

Dr. Biology: Oh, that's great.

These are three questions I always ask everybody on the show. One of them is, when did you first know you wanted to be a scientist or a biologist?

Gro: That's an interesting question, because I realized first that I wanted to be a veterinarian. It was all I could think about. I decided when I was five years old, because I loved animals. And all of my basic training up until undergraduate level, was based on getting into vet school and becoming a veterinarian.

Luckily, I must say, after enrolling at the vet school, before classes started, I had to do a six month internship with a veterinarian. This was part of the training program. I realized, as I knew already, that I really loved working with the animals. I loved figuring out what was wrong and prescribing treatments, and bringing the solution to the owner.

But what I hadn't factored in, and what no one had really told me, was that the owner didn't necessarily have to agree with me.

Dr. Biology: [laughs]

Gro: I could have this perfect solution to the issues at hand, and the owner might say no. And within a couple of weeks only, I realized I couldn't live with this. It was absolutely not acceptable not to have people doing what I knew was right.

And so I quit. I enrolled in a conservation biology program. I was very much without direction. I enrolled because my father and mother and both grandfathers and whole family had been at this university, doing similar things.

It took a couple of years before I found my direction. And it was basically a very, very interesting lecture given by a professor that worked with social insects and mathematics. That was where I started.

Dr. Biology: OK. I know you wouldn't be a veterinarian. But if you weren't a biologist, what would you be?

Gro: Oh, this question has tormented me. Because, especially in graduate school, I think, many young scientists feel this way. It's a lot of pressure, and it's tough, and you stay up at night, and you're worried about your experiments and what might blow up the next day in the lab.

And you think, isn't there anything else? Anything? Anything that can make me as happy and engaged? And I was struggling with this. I wanted to find an answer to this question. At least I would know I had some kind of alternative. I never succeeded in finding one.

Dr. Biology: You didn't?

Gro: So if I were not a biologist, what would I be? I would be miserable and unhappy.

Dr. Biology: [laughs] Well, we'll keep you on as a biologist, without a doubt. I guess I would like to leave it with one more question, and actually one after that.

What advice would you have for young scientists?

Gro: My best advice is, don't get too caught up into what other people say. Think about what you want, and do it.

Dr. Biology: That's very good. The other question I had, and it's more particular to you, of course. Have you ever been stung by a bee? Or maybe I should ask, how many times have you been stung by a bee?

Gro: I can't give you any specific numbers. But I can guarantee you that after a couple of stings, you get really, really good at wearing protective gear. And duct tape your suit closed, so no bees can ever come in.

Dr. Biology: No bees.

Well, Gro Amdam, thank you for visiting with us.

Gro: Thank you for having me.

Dr. Biology: You've been listening to "Ask a Biologist", and my guest has been Assistant Professor Gro Amdam, from the ASU School of Life Sciences.

The "Ask a Biologist" podcast is produced on the campus of Arizona State University. If you'd like to contact us about this program or would like to ask a biology question, you can visit our website at askabiologist.asu.edu.

I'm Dr. Biology.