Ask A Biologist Vol 065 (Guest: Jennifer Fewell and co-host Jane Rector)

Ant Life Part 2

Wait - there's more! Dr. Biology and co-host Jane Rector continue their visit with Jennifer Fewell, a biologist who is exploring the world of social insects including ants. There is even some talk of how professional basketball teams could learn a thing or two from these six-legged insects. Not that we are saying there are tiny basketball games taking place inside ant colonies.

Transcript

Dr. Biology: This is "Ask a Biologist," a program about the living world, and I'm Dr. Biology. We're back with part two of our show, with guest biologist Jennifer Fewell and co-host Jane Rector, and Jane's many questions about ants and ant research.

Now, Jane remind me, where did we leave off?

Jane Rector: You were talking about when the ants got older, they would do different tasks. Do they like different tasks? Or do they just know that it's the right task to do.

Dr. Jennifer Fewell: Well, our data suggests that they actually, I guess you could say, like different tasks. Beyond the fact that they tend to do different tasks at different ages.

Also, if you take any two ants that are the same age, they're likely to actually prefer to do different tasks from each other. One might be more likely to guard, and the other one might be more likely to forage.

We've actually developed a whole model around this that we call the "dishwasher model," or the "response threshold model." Basically, what it says is that, you imagine that you start to perform a task when you notice that the task is there.

For example, you could notice that there are dishes in the sink and you need to wash them. So you wash the dishes.

Now, let's imagine that the different ants, or different people, have different thresholds that they notice the task for. So one person may not see the dishes because they haven't reached their threshold yet. But somebody else, the dishes in the sink might drive them crazy.

When that first person washes the dishes because they drive them crazy, they've actually taken the stimulus away from the second person. It's not your fault that you didn't do the dishes. It's the fault of the person who took the stimulus away.

Jane: So when your mom might may say why didn't you do the dishes, you could say, "You took my stimulus away."

Jennifer: [laughs] You could. Or you could say, "What dishes?"

So if you have a group of ants or a group of people with these different response thresholds, right, some will start performing one task, and then others will perform another task, and others will perform a third task.

Now you have different individuals getting different jobs done. You might have an ant that has a high threshold for all of the tasks, and we call that ant a couch potato. [laughter]

Dr. Biology: Yes, or a teenager.

Jennifer: [laughs] Or a teenager, yes.

Jane: I noticed that in school, when I'm doing a project, some people have a really low threshold for people who don't do their work and don't follow through. Some people have a really high threshold where they just sit back, and relax, and say, "Oh, hey. Yeah, are you doing the work? OK, good job." Just sit back and watch them.

Jennifer: That's right. You might get somebody who likes to write up the notes, or somebody who will take charge of the discussion, and then you might get somebody that says, "Oh, you guys are doing it." Yet you have to do the project anyway, right?

Jane: Good job!

Jennifer: The group has to get it done.

OK. I have a question for you. Imagine that you had an ant queen that had just mated. Then you had other ant queens that you allowed to excavate the nest, and go underground, and start to rear their brood.

If you measured the brain of the queen on the surface right before she excavated, and you compared it to the brain a couple of weeks later, which one would have the biggest brain? Or would it be the same?

Jane: I think it's going to be the same, because, do brains actually decrease or increase in size?

Jennifer: They can.

Jane: They can? Wow.

Jennifer: That's the first interesting question. Can brains change in size? In the ants, they actually can change in size.

Jane: Wow.

Jennifer: Here's a follow up question. When do you think she has to respond to the most complicated environment? Because that's what brains are for, right? They're for responding to complicated things.

Jane: Probably when she starts out the colony, because she's just starting out. She has no worker ants. She has this tiny piece of fungus that she has to grow. She has to make the brooding care for the brood. I think that's probably the time that the brain has the most stimulation.

Jennifer: Excellent. You got it right. When she mates, she actually has to fly around the external world. That's pretty complicated to navigate, right, in a 3-D world.

Then she mates and she goes down and she has to excavate a nest. She has to take care of that fungus, and she has to produce brood. She has to do all of those different things. She has to multitask.

Then, after the workers are made, she gets to sit back and she only does one thing. She doesn't need that big brain anymore and it actually shrinks in size.

The part that shrinks the most is what they call the mushroom bodies, which are the part of the brain she uses to navigate in a complicated world.

Jane: Oh, okay.

Dr. Biology: It's actually after two weeks later, you'd say?

Jane: A few weeks, yeah. You can compare the brain size right as they hit the ground to a few weeks later. Wait until the workers are produced, perhaps, and you're going to see a difference in brain size.

Jennifer: Wow.

Dr. Biology: Wow. Even more wow, can you imagine trying to measure the size of a brain of an ant?

[laughs]

Jane: That would be like, "OK, how big is this?"

Jennifer: I don't do that, but they do it down to the individual neuron.

[laughs]

Jane: Oh, gosh. Do you use a lot of technology, or do you just go off by the ants?

Jennifer: I collaborate with a lot of people that use a lot of technology. So my specialty is in Behavioral Analyses. But, I collaborate with someone who does Metabolic Physiology, so he can actually measure the metabolic rates of ants and look at how they change with colony size or with the tasks.

Jane: What is Metabolic Physiology? I didn't quite...

Jennifer: Metabolic Physiology is basically how your cells use energy. Have you heard of metabolic rate?

Jane: Yes.

Jennifer: Every organism has a metabolic rate. Every organism has to take in energy, break it up, and use it to do work.

Jane: Like your heart rate, maybe?

Jennifer: Like your heart rate, right, and also how you break down sugars and fats and proteins for energy.

Jane: Like some… This is kind of gross. Guinea pigs take in the nutrients when they eat their food. It goes through the digestive system and comes out, but then they eat their feces.

Jennifer: They eat their poop. Yeah.

Jane: They eat their feces, too.

Jennifer: Coprophagy.

Jane: They eat their feces to get all the nutrients because they didn't quite get all the nutrients out of it when it went through the digestive system.

Jennifer: Right. You know, that is actually a little bit related to leafcutter ants, right? They're eating plants. Plants are very hard to digest. You can't break down the cellulose. What they do is they let the bacteria in their gut--in the hind end of their gut, unfortunately for us thinking about it--digest the food. Then it goes through and it comes out, and now it's digested. Now they can eat it and actual absorb the nutrients. So the ants are doing the same thing with the fungus. They're putting the plants onto the fungus and letting the fungus break down the nutrients, and then they're eating the result.

Jane: Oh, okay.

Dr. Biology: So they have a fungus doing work for them.

Jennifer: Yeah.

Dr. Biology: When we have a lot of our biologists on the show, there are people that probably wonder why anyone would study social insects or study this kind of organism. We have a tendency, being humans, everything has to come back to the human themselves. We somehow have to relate it. Interestingly enough, you have some new research, and it really is quite new, that links social insects and basketball, which, to me, is pretty cool.

Jane: Yeah. That's really kind of amazing how you linked basketball, how they passed the ball back and forth, to the ants.

Jennifer: You think at first, here, that that's kind of a leap, right, between ants and basketball. But ants, like other social insects, are really interesting to humans because they have complex social interactions that are more complicated, in a way, than anything else except for humans. When we want to look at how humans do social things, we often go to the social insects.

One of the things that social insects do really well is that they function as a team, right?. Everyone in the colony has a common goal, and that's for the colony to grow and the colony to reproduce. I thought, "Does that shape the way that they interact with each other?" The answer seems to be yes. They have very specific ways of moving information back and forth between them so that they can get things done.

Then I thought, "What kinds of human systems have those kinds of interactions?" I just happened to be a basketball fan. I love the Suns and I started to watch basketball games as if the players were ants. I started watching them moving the ball back and forth, back and forth, thinking about it as information flow. All of a sudden, the team was a network. I got really interested in finding out whether or not we could use network analyses to understand the game of basketball.

I approached a math professor who works on network analyses. We recruited some students who watched hours and hours and hours, and hours and hours and hours of basketball in the finals last year. We actually mapped out the 16 teams in the first round and their network interactions.

We found some very interesting things, one of which is that you have to play like a team to win. Which doesn't sound like news, but we can actually look at it visually and say, "This team is playing like a team more than that team's playing."

Jane: So the ants, they kind of center on the queen, right?

Jennifer: Yeah.

Jane: But the workers are a team because they all take the food together. You can see what big leaves...You see a lot of ants under the leaf helping the ant to get it to the...

Jennifer: That's right. There's no worker that's more important than another worker. They divide up the labor, they communicate with each other, and they take over the role that needs to be done. The queen herself, again, is not a boss. She's not telling everybody what to do, right? She has her own role, which is to produce offspring for the colony, so she's part of the team also. The whole colony is the team and everybody's working towards getting done what needs to get done.

Jane: You see some kind of failing basketball teams that center on this one player. That one player, they always have him out there but he gets exhausted near the end and they don't know what to do, because it's like, "Oh no. We don't have our star player out here."

Jennifer: That's right. That's actually one of the strategies that basketball teams use is to go to a dominant player. It could be a good strategy if you figure that what the goal of the team is to move that ball into the basket. Why not continuously feed the ball to the person who's most likely to get it in the basket? But there's another team on the floor at the same time who's trying to prevent that guy from moving it to the basket.

So another strategy is actually to use all of your team members in a way that distributes the ball so that the defending team doesn't know where the ball's going to go. There's a measure for that. We call it entropy. We found that last year the teams that made it to the finals had the highest entropy of all the teams. The triangle offense is actually a triangle in the network where individuals move the ball back and forth around this circle of three individuals. The Lakers and the Celtics had more of these triangles than any other team, so they were the ones that were less predictable in their ball movement.

Dr. Biology: And more successful.

Jennifer: And more successful. Revamp of the Heat is a really interesting attempt to capture that triangle offense with multiple good players, but each player has to back off from their star status of the year before. LeBron James can't play like LeBron James this year. He has to back off.

Jane: Kobe Bryant.

Jennifer: Yeah, Kobe Bryant was very successful individually but when they got other team members that he started distributing the ball to, that's when that team took off.

Dr. Biology: I guess the question is, are social insect scientists going to lend some insight into basketball, [laughter] or is it that the basketball coaches already have insight for the social insect scientists?

Jennifer: I don't know, I think it's a two way street. I think that we can learn a lot from basketball, but who knows? Maybe, at least at the college level, if you want to teach your team to play like a team you might want to do some network dynamics and show them what it looks like.

Dr. Biology: You really can break down team play based on these network rules or these network observations and predict success?

Jennifer: Well, I'm not going to go so far as to say we can predict success. I'm not going to Vegas on this, [laughter] but I think there are some things to be learned about looking at your team and who is communicating with whom, who's being left out and what the dynamics are. Certainly if you're the defending team, you would like the information that the forward never passes to the center, so if the forward has the ball, you can take your man off the center.

Jane: You also said in your lab, that when the defending team found out how the other team was working, like this player never passed to the outside player because he was always open, but he never passed it because he always passed it forward. They could take their man off of him like you just said and guard the man he was most likely to pass to.

Dr. Biology: Amare you were talking about, right?

Jennifer: Yeah, this was a couple of years ago and our first analyses were of the Suns. What we noticed in our network was that Amare was not good as passing the ball back except to Steve Nash. There were other players that were always open that he never shot to. At that same time he was complaining in the news that he was getting double and triple teamed all the time. His movement was always to the basket so there's no point in guarding the other guys because he's not going to pass the ball out to them. Somebody though, on the Suns, caught that independently of us, because he changed. This was January/February, he started to pass the ball a lot more, and actually his success rate went up quite a lot after that.

Jane: When did you know you really wanted to become a scientist and go into this kind of study about the social insects?

Jennifer: Well it's hard to pinpoint the day when I decided to become a scientist, but I have to say when I was a kid your age, even much younger than you, I was always out playing in the dirt. I was always picking things up and looking at them. I was trying to do little experiments about where I could grow this or grow that. I was collecting caterpillars and putting them in boxes and things like that. I was always outside.

My mom used to complain because I was always dirty. I have four sisters and they were always clean and they always dressed up, and I was always getting into something. So I sort of, I think I had that basic curiosity about the world and lack of good grooming perhaps, I don't know [laughter] that leads you into biology especially.

I thought when I was younger I wanted to be a librarian because I loved to read so much and you thought, "What if it would be a world of books and I can read all the time?" Then I realized that the librarian actually doesn't get to read that much. [laughter]

Jane: Yeah, I realized that too. I used to want to be a librarian.

Jennifer: Yeah, so when do you get to read about science? If you're a scientist. You get to explore and you get to play. I realized when I went to college that, "Hey you could do this for your entire life." It was amazing that you can actually play at exploring about what's going on and ask questions. I think that I probably just was already geared to be a scientist by the time I got to college.

Jane: Do you have a favorite book?

Jennifer: No, I don't have a favorite book. I have lots of favorite books.

Dr. Biology: What are you reading right now?

Jennifer: Oh, I'm reading George R.R. Martin's series, a fantasy series. [laughter] I'm reading "The Name of the Wind" which is another fantasy series. I just read, actually, "Unbroken" which is not a fantasy. It's a historical work about a guy who was a mile runner who was ready to break the world record in the mile, but then World War II came. He was actually in the Air Force and captured and was a prisoner of war. They talk about how things just got worse and worse and worse for him but he managed to persevere. That's just an amazing book also. So I read a lot of different things.

Jane: I think my favorite book is "The Hunger Games" series, which is a post-apocalyptic book.

Jennifer: Yeah, I like post-apocalyptic books. You think that's weird. Why would you like something that's that horrible? I think it's because in that context, you have to think outside the box, right? You have to think to survive, that's the idea behind those books, right?

Jane: Yeah.

Jennifer: That's something that is really interesting.

Jane: It's kind of like telling you, "Hey, if you don't stop this you're going to destroy the world."

Jennifer: That too, the message about what we do, I think, is really important for people to pay attention to. They don't usually like it in the form of news, but if you put in the form of a novel then people might listen.

Dr. Biology: So as a biologist and a scientist, since you've been doing this for so long, one of the things we do to our guests is we take it all away. You don't get to be a scientist. You don't get to be a biologist. Just about everyone we know loves to be a teacher, so I always take that away. What would you be, what would you do, if you could do anything?

Jennifer: If I were able to do anything?

Dr. Biology: Right.

Jennifer: One thing that's obvious that you should probably take away is I could write science fiction and fantasy books, which would be great to actually create those worlds.

Jane: Yeah, I wanted to write a novel for a while but I just can't get the words on the paper.

Jennifer: Yeah, it's a hard thing to do. It's hard to imagine and then actually create it as something that you can transfer to somebody else, so they'll understand what you're talking about.

Jane: Even if books are really horrible, I kind of admire them for actually getting their words on the paper and actually publishing it.

Dr. Biology: So one hint for the ad is to simply get a notebook, don't even think about writing a book, and start writing little snippets like...

Jane: That's right, Rowling did. In fourth grade, we had to do a report on an author, and we had to go through her life. When she was little, she used to write little short stories about talking rabbits and mystical stuff and she would keep that all in a box.

Then she'd start writing down her ideas for books and she'd also keep that in her little shoebox. She finally decided she had a really great idea to write Harry Potter. She took all of her ideas out of that box and kind of...

Jennifer: Oh, that's a great idea.

Dr. Biology: It's a lot easier, too. I'm not writing a book, I'm just writing a short story. I'm writing... could be just a paragraph or a sentence, or sometimes, it's just, "Hey that's a really cool character that would be if I could use these qualities in some kind of character."

Jane: Yeah.

Jennifer: But writing is also a skill set you need for science. People think, "Oh, well, I'm a scientist, I don't need to write." No, most of what you do is writing. Because it's not enough to just go out and do an experiment. You actually have to tell the world what you've found. Writing's an important skill.

Jane: Yeah. My fifth grade teacher used to say, if you want to be a scientist, you have to write a lot. She would make us write for all of our experiments, because we did a lot. She would make us write down all of our notes.

She'd make us write down the procedures and what to do next. Then some people complained, "Who would want to be a scientist if you have to do all this writing?" [laughter]

Jennifer: Well, when you're a famous scientist, you should write her a letter and say thank you.

Jane: Yes.

Dr. Biology: You don't even have to be a famous one. Just say...

Jennifer: Thank you.

Jane: "Thank you."

We kind of took away all of your science and asked you, what would you do if you couldn't be a scientist? What if I wanted to be a scientist, what advice would you give?

Jennifer: Wow. There are a lot of things you could do. One of the things though, I have to say is, you have to want to be a scientist. You have to love it. You have to love discovering things, love exploring the world.

Because although it sounds like fun the way I'm describing it, it's a lot of work. It's a day after day after day of little things that kind of get in the way, and you have to conquer that.

If you're starting in terms of skill sets, well we already talked about writing. Math and English, that's the way to go.

Jane: Yes. When I talked to an oceanographer and she went on lots of cruises. That sounds like a lot of fun, like you're saying.

But really she just had to work. It probably was really fun, but it's probably a lot of work, too. Because you have to do lots of things. You have to take samples, you have to bring them back to the lab and everything, right?

Jennifer: Yes. That reminds me of one of my projects where we went to Australia. The south coast and it was beautiful there. We got to see rain forests, and we got to see kangaroos and koalas, and what did we do most of the time?

Most of the time we were in a dark room with bees in observation nests. Walking around and around and around, and writing, "She's digging, she's guarding. She's digging, she's guarding." [laughs] You have to be prepared for some drudgery.

The other thing besides having, we talked about writing and math skills, those kinds of skills, I would just suggest that you think about learning in terms of asking questions, about why and what and where. I call it concept learning.

Not just memorizing, because science is not about memorizing a bunch of facts. Science is about discovering the way things work, learning new things and understanding how things work with each other.

The kids that are best at that are the kids that can look at something that the teacher is talking about, and not see just a list of things that they need to remember for the test, but actually ask questions about, well, "Why are you telling me that? How does that work? Why are we learning this this way? Because it's really interesting to me."

Those are the ones that are going to go on to keep asking those questions as they get older, and those are the ones that are going to make new discoveries.

Dr. Biology: I can see a new challenge now. The next time you get an assignment from a teacher and they give you a list of five to ten questions due, you not only answer those questions, but you write two or three more and give them back to the teacher.

Jennifer: Yes. I think the teacher should love it.

Dr. Biology: Wouldn't that be great?

Jennifer: Yes, it would.

Dr. Biology: I love it. It's evil, and that's the fun part about it, right? Not only did I do your assignment, but guess what? I've got questions for you.

Jane: Can you answer these for me?

Jennifer: If you can go into an assignment and not just answer the questions, but look at them first and go, "Why did she or he ask me this question?" If you transfer that into college, you will do so much better, because that's really the way that you learn… by understanding, not just by memorizing.

Dr. Biology: Dr. Fewell, we want to thank you for being on "Ask a Biologist."

Jennifer: Well thank you for inviting me. It's been a lot of fun.

Dr. Biology: Jane, I really appreciate you coming down and being on "Ask a Biologist." It's been, well, in my generation I would say, a blast.

Jane: Thank you so much. It's been amazing. Dr. Fewell's just so smart, and I've loved talking to her.

Dr. Biology: By the way, Jane, what was the most unusual thing, or something you didn't expect to see today?

Jane: The fungus. I never knew that leaf-cutter ants actually fed off of a special fungus before.

Dr. Biology: Right. You mean you thought they were eating leaves, right?

Jane: Yeah, I did.

Dr. Biology: Yes, well that's what I would've thought too. They're carrying these leaves back, what would you be doing? You're going to be going ahead and eating them, and they're not. OK, well, and the next time you go out and you do any baking...?

Jane: Yeah, [laughter] I'll probably bring sour dough starter.

Dr. Biology: Well, Jennifer Fewell, we really appreciate you being on "Ask a Biologist." It's been a pleasure.

Jennifer: And thank you. I'd like to especially thank Jane for asking such great questions. I'm looking forward to when you become a famous scientist.

Jane: Thank you.

Dr. Biology: Maybe we can just say right now you are a scientist.

Jennifer: You can.

Dr. Biology: You've been listening to "Ask a Biologist." My guest has been Jennifer Fewell, a professor of biology at Arizona State University School of Life Sciences.

My guest co-host has been Jane Rector. Together, we've been learning about the amazing world of ants and some surprising links to the world of basketball.

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Remember, even though our program is not broadcast live, you can still send us your questions about biology using our companion website. The address is AskABiologist.ASU.EDU, or you can just Google the words Ask A Biologist. I'm Doctor Biology.

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