SciencePodcast_220923

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0:00:05.7 Sarah Crespi: This is the Science Podcast for September 23rd, 2022. I'm Sarah Crespi. Each week, we talk about the most interesting news and research from Science and the sister journals. First up this week, online news editor, David Grimm. He's gonna talk again about pets and our love for our pets, and we're gonna specifically talk about the special bond between humans and dogs and a way to test whether this kind of bond could have formed between people and wolves before domestication. Also on the show this week, we have Amy Zanne. She's a professor and Aresty Chair in Tropical Ecology in the Department of Biology at the University of Miami. We're gonna discuss a big project that's really a global project to measure the activity of termites and microbes that break down wood and how this breakdown process could be sped up by climate change.

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0:01:04.6 SC: Now we have David Grimm. He's the online news editor for Science. We're gonna talk about not being raised by wolves, but raising wolves. Hi, Dave.

0:01:15.9 David Grimm: Hey, Sarah.

0:01:16.8 SC: I guess one way you could put the situation here is, "Which came first?" Domestication or our bond with canines? Did we love dogs ancestors and they loved us in return, and then we just hung out more and more, and the next thing you know is I have a car seat for my dog? [laughter] 10,000 years later, we have this special bond with our dogs that really no other animal could compare with, except for cats.

0:01:45.7 DG: Except for cats, of course. Yeah, it's not just a question with dogs, it's a question with all domesticated species. It's, "What behaviors or traits came almost out of whole cloth over the course of domestication, and which behaviors and traits were already present maybe to a small extent, maybe to a large extent, in the ancestors of these species?" And so for dogs, things like... Dogs do all these incredible things, like they play fetch and they understand what we mean when we point at an object, which even chimpanzees can't do, and they're very strongly bonded to us. In fact, some researchers have said the bond between... That dogs feel towards us is very similar to the bond that infants feel towards... Infant humans feel towards their mothers. And so the question in this study is, "How much of that predates domestication? How much of that was wolves capable of, and how much arose over the course of hundreds or probably thousands of years of dog domestication?"

0:02:40.2 SC: Wolves are kind of a social animal, right? They have packs, and dogs are a social animal. We're a social animal. Is it surprising that we mix so well together?

0:02:49.2 DG: Well, wolves are a social animal, but wolves also have a very different relationship with their mothers than dogs have with us. Wolves, they don't have a strong bond with their mother after basically they're weaned, whereas dogs basically are kind of our puppies for life. So there definitely do seem to be some differences, at least biologically. Now, whether that transfers to behavior is another question.

0:03:10.7 SC: Yeah, let's get to the raising wolves part. I was really surprised of this method here, so researchers actually got some wolf puppies.

0:03:20.1 DG: Yeah, 10 wolf puppies, and they basically raised them since birth. So these animals hadn't even opened their eyes yet. I believe they were about 10 days old, perhaps a little bit younger, and the researchers did what they call intensive socialization. So this is like sleeping in a research station on a mattress, on a cot, with these animals for weeks and weeks and weeks on end. 24 hours a day, you're feeding them, you're always interacting with them. It's super intensive socialization. It sounds like a lot of fun, except for when the wolves are getting up every two or three hours in the middle of the night, and you got 10 wolves that you gotta bottle feed.

0:03:55.2 SC: Oh wow.

0:03:55.8 DG: The author said it was sort of like having 10 newborns at the same time.

0:04:00.0 SC: So they also raised Husky puppies for the same, basically, period of time. Same tough job, and then they made some comparisons between these two groups: The hand-raised wolves and the hand-raised dogs. What kind of tests did they do with these puppy groups?

0:04:15.2 DG: They did something called the Strange Situation test, and this was a test that was originally developed to test the bond between young children and their caregivers. And with the infants, you sort of put them in a room that they're not familiar with, you have their caregiver in the room sometimes, but also sometimes just a stranger in the room, and there's also toys and stuff in the room. And the idea is like, "How much are they kind of connecting with their caregiver versus the stranger?" And the researchers basically did something very similar with the dogs and the wolves. At about 23 weeks of age, they brought these animals one by one into this room. It was a pretty barren room, and sometimes their caregiver was with them, one of the people that had helped raise them was in the room with them. Sometimes that person would leave and leave them alone in the room. Sometimes, a stranger would enter the room, somebody they had never met before, and then that stranger would leave. And so it was all these different situations. Essentially, you're kind of trying to stress the animal out in a way, but also see that when it's stressed out or when it's reunited with its caregiver versus the stranger, are the behaviors any different?

0:05:19.5 SC: And so what did they see when a stranger came in? Was the wolf much more nervous about it than a puppy, a dog puppy?

0:05:27.4 DG: Wolves were a bit more nervous at baseline. So, one of the things the team measured was pacing, how much time the animal spends pacing around the room. And dogs almost never paced, even when they were alone or they were with a stranger. Wolves almost always paced. There was that baseline difference between wolves and dogs where wolves were really... Seemed more jittery at baseline, which makes sense. We're still talking about... Even if you're hand-raising them for 17 weeks, you're still talking about a wild animal here versus a dog that's been domesticated for 15,000, perhaps more years. You're gonna expect some different baseline behaviors between these animals.

0:06:00.4 SC: What were some of the differences in terms of the experimental conditions? Were the dogs more attached in terms of these measures, than the wolves?

0:06:07.5 DG: Well, what the researchers saw, which is really interesting, is they saw that dogs and the wolves for the most part, behaving pretty similarly. So the dogs and the wolves both similarly favored the caregiver when the caregiver was in the room. They spent more time greeting this person, they spent more time making physical contact with this person, with the person they knew than the person they didn't know. It's not the spending more time with the person that's a measure of attachment, it's the fact they preferred one person over the other, which is a measure of them being attached, more attached to that one person, which in this case, for both of them, was the caregiver.

0:06:39.5 SC: They were similar, there was a similar magnitude of attachment appearing, but how do we really know that this is attachment, that this is bonding, and not just like, "Oh, a familiar thing is less scary than a strange thing."

0:06:51.9 DG: These are experiments that have been adapted and adapted and adapted over decades, but you're right, Sarah, this is not proof that dogs are exactly the same as wolves, and even the researchers themselves say that we're not saying dogs are the same as wolves but what we're saying is that wolves may be capable of some of these attachment behaviors that a lot of people have said, "Oh, that's just only dogs can do that."

0:07:14.8 SC: Right, and this kind of lends credence to the idea that there was at least a little seed of bonding available to cultivate, through domestication, over this time.

0:07:24.8 DG: Exactly, you could imagine a scenario where the wolves that were the ancestors of dogs, maybe those wolves that were able to form an attachment with people, even though it was much less of an attachment than dogs have with us today, as you said, Sarah, that's the seed, "Okay, those are the wolves we're gonna keep around, those are the wolves we're gonna feed. Those wolves get to reproduce, maybe their offsprings are a little bit more attached to people, and then you have... What you have happened over the course of hundreds or even thousands of years, especially people are really favoring this behavior, because they want the animal to be bonded to them. Then, you get sort of a flicker that turns into a fire with dogs.

0:08:01.3 SC: A fire of love.

0:08:02.8 DG: The fire of love. [laughter]

0:08:05.3 SC: Okay, so here's my inevitable question. Could this kind of study be done with cats?

0:08:11.3 DG: The study has been done with cats. Not this exact study. So, the advantage this study has is that we're able to compare dogs directly with their ancestor. These wolves weren't the exact ancestor of dogs, but they're pretty much the same species or very similar species. We know the cat wild ancestor is the African wildcat, and they're still around today. But very, very hard to work with it. I don't think anybody's been brave enough to...

0:08:34.3 SC: Sleep in a bed with them.

0:08:35.8 DG: Sleep in a bed with a wildcat, and so... But the experiments that have been done with cats, and this is something I wrote about a few years ago, have also shown that cats do show attachment to people, especially people that they know, which I don't think is a surprise to any person who owns a cat. But this ability to directly compare the animal to its ancestor hasn't been done in cats. And Sarah, it's not just cats, we interact with all different kinds of animals. And one of the interesting findings of this test was, I mentioned before that the wolves spent a lot of their time... Not a lot of their time, but they did spend some time pacing. And one interesting result the team found was that when the stranger left the room and then the wolf was alone, the wolf got even more jittery. And then the caregiver came back, the wolf pacing dropped almost to zero. And the researchers say this is evidence of something they call, wolves sort of seeing us as a social buffer, maybe even as a source of comfort and support. And so the question comes, there are other animals, even other wild animals that we have intense relationships with them. And think about maybe the cheetah at the zoo, if it's raised from a very small cheetah... I don't know what a small cheetah is. Is it a kitten?

0:09:41.8 SC: Cub.

0:09:42.1 DG: Cub, thank you, Sarah. So if it's raised from a very small cub by a caregiver or maybe a couple caregivers, and this is the person that bottle-feeds them and plays with them or trains them... Not trains them, but maybe give some enrichment or whatever, they may be also potentially forming these very strong bonds with us that we're not aware of. We think, "Oh well, it's a wild animal. Yes, it tolerates me, but how does it actually view me?" And if cheetahs or elephants or whatever are behaving in the same way wolves are behaving in this experiment, it suggests that maybe that they view the bond much stronger than we even realized.

0:10:15.8 SC: Thank you so much, Dave.

0:10:16.5 DG: Thanks, Sarah.

0:10:17.1 SC: David Grimm is the online news editor for Science. You could find a link to the story we discussed at science.org/podcast. Up next, researcher Amy Zanne talks with me about microbes and termites that break down wood, and how global temperature increases might push them to eat more faster.

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0:10:45.0 SC: To understand the global carbon budget: Sinks, sources, one thing we need to know is how fast biological material is breaking down. In particular, this matters for dead trees which store a gigantic amount of carbon. How fast are they releasing carbon as they break down? To make things a bit more complicated, the carbon release from decaying trees is temperature-dependent, so it could change when climate changes. In some cases, this temperature sensitivity is because the microbes that do a lot of this work act differently at different temperatures. But we also can't forget about termites, which are famous for breaking down wood, and they also, it turns out, have some temperature-dependence. Amy Zanne and colleagues wrote about the effect of climate on microbes and termites on a global scale, this week in Science.

0:11:38.0 SC: Hi, Amy.

0:11:39.8 Amy Zanne: Hi, Sarah.

0:11:40.3 SC: So how were you able to undertake a study of this scale? We're talking, all the continents but Antarctica, 9000 blocks of wood on all these different sites. How were you able to deploy wood in this way?

0:11:53.5 AZ: So this was a massive cat herding event at monumental scales, and so it started as a small pilot project as I was trying to get funding for our work in far north Queensland where we started a pilot study, and the researchers at TERN in Australia, which is similar to NEON in the US, were interested in using this as a metric to look at carbon cycling in their system, so they deployed across Australia. I happened to be on sabbatical that year, and as I talked in different places in Europe and Asia and Australia, I heard people saying that they wanted to join the effort, but I realized that there were certain places in the globe that weren't represented, so then I went on social media, Facebook, Twitter, and recruited. And so what was amazing about this was that we were able to get people to join in at all career stages, and equally in the southern and northern hemispheres and tropics and temperates. So we were really able to include people and places that often aren't included in these big studies. We certainly have big, wide holes in where we represented, but I think it was really amazing to have this bottom-up approach to fill in sites, and that led us to be able to have all these small pieces that really added up to this huge finding that we wouldn't have been able to do without all of those individual studies, with our simplified approach joining in.

0:13:08.1 SC: Now, is everybody... Everybody that did this, were they scientists or were they just anybody?

0:13:13.3 AZ: I think that everybody in the end was a scientist, some people left science. There's somebody who's now a beer brewer in Australia, so we had different pathways afterwards, but I think everybody was scientist. My brother almost did it, so we almost had a non-scientist. [laughter]

0:13:28.4 SC: Say I'm someone who volunteered on Twitter to participate in this study, what did I have to do?

0:13:34.3 AZ: People had to source their own materials, which was finding radiata pine and also finding mesh and stapling those together and being able to dry down the wood and... And everybody had to put out locks that excluded or allowed termites.

0:13:49.1 SC: So, this is where the mesh comes in. So microbes can get through pretty much anything that's not air tight, but then the termites could only get to certain blocks if they were around?

0:13:58.6 AZ: Yes, exactly. We had this tiny, tiny mesh, 300 microns is the size of it, and that we believed was smaller than the mandible size the termites could use to crack open the mesh. And so we could exclude termite, so then we cut holes in half of them and put that in the bottom next to the soil, so the termite could colonize the wood.

0:14:16.0 SC: Why was it important to both source it locally, but also have it be the same species if possible?

0:14:23.1 AZ: There's been lots of local to regional studies looking at wood decay, but we really wanted to try to understand the sensitivity of the termites and the microbes at global scale so that we could then think about climate change effects. If you piecemeal studies together, so many things change. The species of wood changes, who the decay agents are changes, the climate changes. And so we wanted to simplify the system, so we required everybody have the same species, so we could simplify, to look at really the decay agents and their relationship to climate.

0:14:57.4 SC: Once everybody has set their blocks out for a certain amount of time, what happened after the end of the study?

0:15:04.9 AZ: Everybody would harvest the wood after a certain period of time, the entire group harvested at one year, but some places in the world harvested at six months. Most places harvested it at 24 months, and then some even up to 48 months. When they collected the wood, they scraped away any of the mud and any of the fungi or termites or things like that they found growing on the wood, they dried it down, and so we compared the initial dry mass when they stuck the wood out, to the final dry mass, and that told us how much mass loss, how much change in mass happened through time.

0:15:37.1 SC: Were you looking to find out whether or not termites were in all of these places? Were you able to say, "Yeah, these guys have termites, these guys don't have termites?"

0:15:46.2 AZ: We depended upon all of the local scientists to tell us whether there are termites in the system, and then when they gave us the data with those mass loss measures, we had them record whether there are any evidence of termites. So there's two parts, is one, can the sites have termites? And then the second, even if you offer termites the food from the wood, do they actually go and find it? And then... So that discovery was really a critical part of the study. And one of the really surprising parts of the study that we found was how frequently do termites, even if they're there in the system, how often do they find that wood?

0:16:19.5 SC: Yeah, so let's talk about that. So how common is it for a termite just to wander over to a mesh bag and look inside to see if there's any wood in there?

0:16:29.2 AZ: We know a lot more about microbial decay, and it's generally thought that spores can get everywhere. So you don't know if it's gonna be a particular fungal species that's decaying the wood, but something will get there. For termites, it's much more idiosyncratic whether they find a particular piece of wood or not. And so when we were doing our pilot study, we would have two pieces of wood that both allowed termites in right next to one another, and they'd go into one and not the other. And so what makes them like or not like one piece versus the other, is really interesting. And so what we were able to record was these discovery rates. We separated the decay process by termites into a discovery phase, and then a decay phase. And this discovery phase was super, super interesting because it was this that was really sensitive to both temperature and precipitation. It was the only thing that was sensitive, in our measures, to precipitation, as they went to discover the wood. It was variable, but some places were really, really high, especially in the dry tropical areas.

0:17:20.9 SC: So were you surprised at some of the places that termites showed up in the study?

0:17:24.8 AZ: Yes, I think they occurred largely in the tropics, we had some interesting findings in different places in the tempered areas. Like there are sites in the southeast US that had really high discovery, comparable to some of our tropical studies. But I think that the most interesting finding is that we have this dogma that the termite abundance and diversity is greatest in tropical rainforest systems, but what we found was that their impact, their discovered rates were highest in more arid tropical areas. The highest rates were in subtropical deserts as well as tropical seasonal forests and savannas.

0:18:02.9 SC: Let's talk a little bit about decay rates here. So were you able to kind of link the activity of microbes and the activity of termites with temperature in the study?

0:18:14.5 AZ: So that was really the main focus of the project was trying to understand the sensitivities of the termites and the microbes to climate, especially to temperature under a warming world, so that we could use these to predict their responses under future climates. We found that for microbes, they responded, as regionals to local studies had been finding, that the rates of decay doubles for a 10 degree increase in temperature. Termites are much, much more sensitive. They increase their rates by seven-fold with a 10 degree increase in temperature. So they had this massive response of really speeding up decay rates as temperatures warmed.

0:18:53.2 SC: Do we know anything about the mechanism for say the increased rate of decay for microbes? So, the temperature dependence of the rate there?

0:19:01.9 S4: Microbes, they don't have stomachs like us, so what they have to do is they excrete enzymes out into the environment that do the decomposition and then they slurp back up whatever they've digested. And so, it's one, dependent upon moisture to deliver those enzymes, but two, it's dependent upon temperature. If you know anything about enzyme kinetics, you'll see that the rates of enzymatic processes usually increases with temperature and it's usually a doubling, so that's what was known for microbes, and that's what... We found support for that.

0:19:32.1 SC: Let's go over to termites now. Microbes are part of the process for them, is that why you were seeing such an increase? Even then, why wouldn't it be the same as microbes?

0:19:41.9 AZ: Right, that is a great question and one that we didn't necessarily measure in the study, but we have some thoughts about. So certainly, termites, they have these amazing guts that are kind of like little pows with these guts that they pack full of microbes that help them to do the decomposition process. They have some of their own cellulases to break down cellulose, but then they recruit all sorts of protists, and bacteria, and things like that to help with the decay process. And because they stick them in their gut, they create this nice environment with lots of moisture. So all of that digestion can happen in their stomachs where the microbes are happy, so that you expect that the microbes should have this temperature dependent process, just like we found for the... Just the microbes alone. Why termites are so sensitive, we don't fully know beyond that. One thought is that their activity rates, because they're ectothermic. So it could be, they're just more active as temperatures warm. Another could be, you just get different species in warmer places and so you get more different species packing in, or more individuals total. So we don't know how much is just about the community composition, the population dynamics, the microbial responses. All of these things, I think probably, are part of it. And it's something that would be really fun to dig into further in future studies.

0:20:56.5 SC: Okay. So that means that termites will be finding a lot of deadwood that hasn't kind of been subjected to this form of decay in the past?

0:21:04.1 AZ: Right. There is a nice word, "tropicalization," which simply means that as places outside the tropics start experiencing tropical climate, what we're seeing is this expansion of termites into subtropical and even temperate areas around the globe that hadn't previously had high termite discovery. They probably do already have termites there, but what we're expecting is that the discovery rates will increase around these places.

0:21:29.0 SC: Do you have a sense of where on the planet that the termites might be going next as the climate changes?

0:21:34.8 AZ: We could predict that many of these are in subtropical areas around the globe. If you look at say the US, you see Florida... All of Florida and a bunch of the Southern US has much higher rates, but you see really extreme upticks in places... In Southern Africa, parts of South America, further parts in Australia. So, a lot of the southern hemisphere had especially high, increased prediction rates.

0:21:57.4 SC: What about buildings, things that we've built out of wood? Are they gonna be more vulnerable if termites start discovering them?

0:22:06.1 AZ: Potentially yes. That wasn't the focus of our study. So our entire study focused on natural systems, and I think that's one of the things that gets really confusing for people, is they're so used to what the termites are doing in their homes.

0:22:16.7 SC: Exactly.

0:22:17.8 AZ: And I think most of the research on termites is really focused in on these pest species, and pest species only make up about 4% of the total species in the world. So probably the pest species world similarly march into new places as the climates became correct for them. That wasn't our study, but I think you could probably expect that that might be an implication of our study.

0:22:38.9 SC: Should we think about this as a feed forward mechanism, that termites are going to be releasing more carbon as climate changes, and so we're gonna see an upward spiral?

0:22:50.8 AZ: I think that that's the potential is to see increasing rates. I think one of the things that we didn't study here, but is something I'm studying in my work in Australia, and that I'm starting to work on more in the Savannah, so how those systems here in Brazil, where I'm currently on sabbatical, is that the actual form of carbon differs, how it's released from the wood depending on who does it. So everything respires and releases CO2, which is the most important greenhouse gas. However, termites also release methane. Anytime we've had termites in our wood, we measure methane signals, and methane is a 30-fold worst greenhouse gas. And so termites potentially have the ability to tip towards more methane being released. However, it's only some fungi and solar radiation that can break down lignin, which is the most recalcitrant compound in wood.

0:23:41.3 AZ: That's only some of the fungi. Other fungi just modify it and it goes into the soil and becomes organic residues. Most termites don't have the ability to break down lignin, so it goes into their mounds and their nests, and then it could get locked up there. There's these really amazing fungus farming termites in Asia and Africa that farm these fungus that can break down lignin. So whether lignin gets released as CO2, or methane, or goes down into the soil, can be different. So I think it's not just how climate change is affecting the rates of decay, but also the forms that carbon's being released that could have positive and/or negative feedbacks with your system.

0:24:17.6 SC: All right. Thank you so much, Amy.

0:24:19.3 AZ: You are very welcome, Sarah. This has been a delight talking to you today. And so I hope everybody becomes curious about going to find termites in their systems.

0:24:25.1 SC: Amy Zanne is a professor and Aresty chair in Tropical Ecology in the department of biology at the University of Miami. You can find a link to the study we discussed at science.org/podcast. And that concludes this edition of The Science Podcast. If you have any comments or suggestions, write to us at sciencepodcast@aaas.org. You can listen to the show on the Science website at science.org/podcast, or search for Science Magazine on any podcasting app. This show was edited and produced by Sarah Crespi, with production help from Podigy, Kevin McClain and Megan Cantwell. Jeffrey Cook composed the music. On behalf of Science and its publisher, AAAS, thanks for joining us.