Termites Digest Wood Thanks to Microbes

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Animated Short
Transcript

[Sounds of bubbles]

[Ta-da sound]

Ed Yong: Do you ever have those days when you just can't stop eating?

[Crunching vegetables]

Ed Yong (mouth full): What's up with that? And more importantly, what happens to all that food?

[Old film projector]

Science Film Narrator: This is digestion. Food matter enters one end of the tube. Along the way, bigger pieces of food are broken down into smaller ones, dissolved, and nutrients and energy-bearing molecules are absorbed. The rest is expel…

[flatulence and a film reel unspooling]

Ed Yong: Alright, alright! But eating is actually much more complicated than that, and animals typically cannot do it alone. Especially when it comes to … plants. (mouth full) Plants consist of a complex range of carbohydrates. And we typically lack the enzymes necessary to break all that down. And so we need help, and we get that help from microbes.

They are masters of biochemistry! They do have the right enzymes necessary to digest something like this.

Which is why the digestive tracts of many animals are full of microbes. When we eat, they help us to digest the indigestible—to break down our food so that we can get nutrients from it.

These kinds of partnerships go back hundreds of millions of years, and they have shaped the evolution of the animal digestive system.

Xinning Zhang: I think we're learning more and more that, that we rely on gut microbes for, to help us digest our food.

Ed Yong: This is Xinning Zhang from Princeton University.

Xinning Zhang: I'm an environmental microbiologist. But within that sort of very vague umbrella term, I would say … I'm a microbe person.

Ed Yong: Hey, me too!

Xinning Zhang: I think of the microbes as the underdogs in our world. They were the first life forms on earth, and I'm sure they're going to be the last ones on earth! *[laughter]*

So I'm really interested in just understanding how they work, why they do the things they do—for example, why are they so important for termite guts?

[Wood snapping]

Ed Yong: Well, I imagine that eating wood would require some serious teamwork.

Xinning Zhang: Yes, yeah. Termites and their gut microbes are really two sides of the coin. The termites have their gut microbes to help them do the job of living on a, and feeding on a very difficult-to-digest food.

Ed Yong: But the process begins with a termite and its jaws.

Xinning Zhang: You start with the termite chomping on the wood and breaking it into small particles. They're just basically macerating the wood into, like, sawdust.

Ed Yong: The bits of wood are the bright brown chunks in this microscope video of the guts of a termite. The large clear blobs are protists. They are microbes, but their complex cells are more similar to our own than to bacteria. These protists engulf the wood particles and then get to work digesting them.

Xinning Zhang: *[Wood cracking]* The wood is broken down into little molecules to access the, the yummy sugars, which can be used, uh, ultimately to feed the termite.

Ed Yong: Right! And everyone, the microbes and the termite itself, everyone *[sound of biting apple]* gets a meal!

Xinning Zhang: (laughs) Everybody gets fed. Everybody does, does their fair, uh, share of work, let's say.

Ed Yong: And so how does that partnership evolve?

Xinning Zhang: It turns out that termites actually evolved from a cockroach, an omnivorous cockroach, like the ones you might find in your house…

Ed Yong: Oh right, like the ones I try unsuccessfully to kill.

[Man crying out, glassware breaking]

[Sounds of dinosaurs]

Xinning Zhang: I guess it was in the Jurassic, about 150 million years ago, it turns out that the social behavior of the cockroaches allowed these omnivorous cockroaches to basically take advantage of another food source—and a very abundant food source—that being wood.

Xinning Zhang: These, let's say wood-feeding cockroaches and then termites, they're able to inoculate their young with, uh, gut microbes. So, this basically you could think of them as being able to transfer the potential to eat wood to the next generation and so forth and so forth and so forth.

Ed Yong: So you're saying that they're passing along the microbes that they need to digest wood through, uh, social behavior?
Xinning Zhang: Yes, enabled by social behavior, yes exactly.

Ed Yong: And how exactly do termites do "social"?

Xinning Zhang: So how do they do that? Oh, it's a term that's called, the technical term is called proctodeal trophallaxis. And basically, it's … um …

Ed Yong: So...

Xinning Zhang: … like proc-, proct-, is there a doctor? a proctol…?

Ed Yong: A proctologist?

Xinning Zhang: That. That. Yeah. That. Procotodeal trophallaxis.

Ed Yong: Right, and trophallaxis means when animals feed with regurgitated fluids, so…

Xinning Zhang: I guess you want me to say the word butt? (she laughs)

Ed Yong: (laughing with her)

I am. I am. I am trying to get you to say butt. That is exactly what I am trying to do. So really the way in which termites pass on these microbes from one to another is through butt-licking.

[Wet feeding sounds, spinning wheel sounds]

Xinning Zhang: Exactly. (laughs) So there is a little blob of the gut fluid that comes out from the, uh, the end, the posterior of one termite, and another termite, some of them, like, some of the juvenile termites will eat that. And it's full of nutritious, tasty, you know, microbes in there and uh …

Ed Yong: Ah! Which allow them to digest wood. So really this is a superpower bestowed by intergenerational butt-licking.

Xinning Zhang: Yes, exactly. The fact is that one organism can't do everything, right? Just like one person can't do everything. At some point, you have to outsource some of the functions.

Ed Yong: Very true. Like ordering take-out.

Science Film Narrator: If you're getting excited about the microbiome and you want to learn even more, then leave us a question below or on our Facebook page. I'll have a video up shortly that answers some of your top questions. So see you then.

END OF EPISODE