A Wasp Mom's Gift: Blankets of Bacteria

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Animated Short
Transcript

[Music playing]

[Ed on camera holding a picture of Orson Welles from The Third Man*.]*

Ed Yong: Orson Welles said, "We're born alone, we live alone, we die alone." But Orson, you are mistaken.

[Close-up of the picture of Orson Welles held by Ed. Microbes on Orson and Ed.]

Ed Yong: Even when we think we're alone, we aren't. We are completely surrounded by microbes.

[Photos of young Ed with microbes. Microbes on Ed's photos.]

Ed Yong: They live on us. They live in us. They are everywhere. Every one of us is a multispecies collective. And with these microbes we exist in symbiosis, a wonderful term that refers to different organisms living together.

[AUDIO: THE BLUE DANUBE PLAYS]

[Bee buzzing around Ed.]

Ed Yong: Animals and their microbes go through life in this long waltz, and some of these partnerships take hold at the moment of birth. Animals have many ways of passing their microbes on to their offspring.

[AUDIO: THE BLUE DANUBE PLAYS]

[Two circle insets of footage of beewolves. A beewolf crawling on the ground. Bees around a flower. A beewolf hovering around a hole in the ground. A close-up inset of a bee on a flower. Text: ''Honey Bee''.]

Ed Yong: Here is a beewolf. An aptly named wasp. A fierce predator. On the hunt for honey bees. *[buzzing]* This one's a female and she's looking for food for her young.

[A beewolf attacks a honey bee in a circle inset. Beewolf digging hole in the ground with honey bee next to it.]

[buzzing]

Ed Yong: The beewolf stings the bee, but she doesn't kill it. She just paralyzes it. A dead bee would rot, but this way it stays nice and fresh.

[Music playing]

[Beewolf drags honey bee into ground and lays egg on it, part of it in a circle inset.]

Ed Yong: The beewolf drags the bee down into her burrow and lays an egg on it.

And when the egg hatches, the grub starts to eat the bee alive.

[The cocoon moves around. A beewolf emerges, crawls on the ground, and flies off (part of it in circle inset).]

Ed Yong: Once it finishes, the grub encases itself in a silken cocoon and starts transforming into an adult. So the beewolf mother has given the gift of a honey bee to her young, but it's not the only gift.

[Martin Kaltenpoth holds a tweezer that holds a beewolf. Intercut back and forth between Ed & Martin, which includes beewolves in a circle inset. Circle inset of beewolf with animated paste emerging from antennae. "Weird" graphic pops up.]

Ed Yong: Meet Martin Kaltenpoth. He studies beewolves.

Martin Kaltenpoth: Hey, Ed. How's it going?

Ed Yong: Hi, Martin. So let's get right to the paste, because when you were doing your Ph.D. your advisor noticed something weird about beewolves that they secrete this paste from their antennae like toothpaste coming out of a tube.

Martin Kaltenpoth: Yes, and that's really weird because no other insect is known to secrete such large amounts of stuff from the antennae.

[Exit Sign, Exit Diagram/Map.]

Ed Yong: And so why do the beewolves do this?

Martin Kaltenpoth: This is kind of an exit sign for the larvae to leave their cocoon and get out of the ground.

Ed Yong: But there's more to the story, right? Because when you looked at the paste under a microscope, you saw something weird.

[Graphic effect of microscope video with black light that flips and shows Martin with graphic effect of antenna sticking out of his head.]

Martin Kaltenpoth: I still remember sitting there with my Ph.D. advisor in his office. We looked at the pictures and we were like, "Wow. This is weird. This is full of cell-like structures." So there's some bacteria in there. And that was fascinating because it was completely unheard of in insect antennae.

[Martin working in the lab on a computer and looking through a microscope.]

Ed Yong: So there were bacteria living inside the beewolf antennae, which is a strange place to call home even for a microbe. What was it doing in there? No matter what it took, Martin was going to answer that question. He became obsessed by bacteria, which I can understand.

[Martin examining beewolf held by tweezers. Martin working in the lab.]

Ed Yong: He examined beewolves from around the world, and in every one he found bacteria teeming in their antennae. And even more surprisingly, those antennae only contain one type of bacteria: *Streptomyces*.

[Graphic effect of microscope view. Assembly line footage of pills on conveyor belts. Circle inset of *Streptomyces* as well as circle inset of dollying over conveyor belt of pills.]

Martin Kaltenpoth: It was amazing to see. Wow! *Streptomyces*! And then even to us as zoologists at that time it did ring a bell *[buzz]*, 'cause *Streptomyces* is so well known for antibiotic production. And we use it, as humans we use it for human medicine as well.

Ed Yong: And that was a big discovery. *Streptomyces* is a vast group of bacteria, many of which are the source of antibiotics, the drugs that we use to kill other microbes.

[Martin working in his lab. Computer screen of Martin's work. Footage of beewolf in cocoon in a circle inset.]

Ed Yong: So the question became: Were the *Streptomyces* making antibiotics that somehow benefited the beewolf?

[buzzing]

Martin spends a lot of time watching beewolves. Watching their cocoons, their grubs. Looking at their symbiotic bacteria under a microscope. And eventually Martin found something. The fibers of the cocoon were saturated with the paste. The grub is covered in a protective blanket of *Streptomyces*. And it needs all the help it can get. For nine long months it's trapped in this warm, humid chamber that's perfect for nurturing fungi and bacteria. The kind that cause disease.

[Animation: Eyes blink in the dark.]

Martin Kaltenpoth: In the cocoon, it's pretty dark. So the larva is sitting there or lying there in the dark for about nine months, and, and very lonely. So there's nobody to protect it, to help it.

Ed Yong: Ooh! Except for the antibiotic-producing bacteria.

Martin Kaltenpoth: Exactly. Yeah.

Ed Yong: But that was just a hypothesis, right, so you didn't *know* if the antibiotic paste actually protected the young beewolf.

Martin Kaltenpoth: Um, not really. So the next step was testing whether the microbes, indeed, have a benefit for the beewolves.

[Music playing]

[Martin walks down a hallway, opens door to lab, and works on beewolves.]

Ed Yong: So Martin divided beewolves into two groups. One he raised normally with access to their paste, and the second he deprived of paste. And then he waited.

Martin Kaltenpoth: Yeah. I mean, I would check them daily and see how, how the, um, larvae with and without bacteria were doing. I would never know whether they would, might still survive and emerge successfully.

[Martin works in the lab with beewolf cocoon. Archival footage of beewolf emerging from cocoon in a circle inset. Text: "No Paste'', "Paste".]

Ed Yong: So would the beewolves survive without their antibiotic paste? Well, almost all of the young beewolves that he deprived of paste died from infections. While those that have access to the paste, they usually survived. The results were crystal clear.

[Martin working in the lab. A circle inset of graphic effects along with footage of a microscope in a lab and a computer screen. Cartoon animation of bacteria making antibiotics in a circle inset.]

Ed Yong: By analyzing the chemistry of the bacteria in the cocoons, Martin's lab confirmed that they were indeed producing a cocktail of antibiotics, and the young beewolves exploit those chemicals to protect themselves from other microbes that might cause disease. But this is a two-way relationship. Those defensive bacteria might benefit too.

[Circle inset of beewolf with animated paste emerging from antennae.]

Martin Kaltenpoth: The antennae is like a nice and secure place for the bacteria because they get all the nutrition from the beewolf. So that's wonderful, a wonderful place to be. I mean, I don't know whether they're happy in there. Uh, they look happy, but that's a difficult question to ask a bacterium.

Ed Yong: But how do those bacteria get into the antennae in the first place? Well, take a look at what happens when the young beewolf emerges from its cocoon.

[Beewolf emerging from cocoon in a circle inset with Martin talking to camera in another that appears. Beewolf emerges from ground and flies off.]

Martin Kaltenpoth: Right before um, the, the beewolf female leaves its cocoon, it will rub its antennae against the cocoon's surface and take up its bacteria because it will need them later to give it to its, its young.

Ed Yong: It's a bacterial inheritance to go along with the genetic inheritance. Kinda like us. We are not so different from beewolves.

[A human mother holding a newborn baby. Segues to birth diagram graphic effect.]

Ed Yong: Humans also get our first microbes from our mothers, but we spend nine months not in a cocoon, but in a womb. A chamber that separates babies from the outside world. And at birth, … we unite with the world's microbes.

[Newborn baby with her mother. Baby's feet, and baby's hand with mother's finger. Diaper change. Toddler walking outside. Sleeping baby. Childhood photo of Ed. Adult photo of Ed dancing.]

Ed Yong: Think of how significant that moment is. In just our first few seconds, we transform from just an individual into an entire world, a colony, a thriving ecosystem. And with every new experience, that ecosystem changes in ways that scientists are still trying to figure out. We pick up more microbes from our parents' skin. Our mother's milk. The blankets we are swaddled in. We change and transform throughout our lives. And when the time is right, we pass on our microbes to our own children. None of us dances alone. We all contain multitudes.

Ed Yong: Thanks so much for watching this episode. To check out more microbe content like articles and images, visit our Facebook page linked here. And if you're curious about your own microbiome, leave us some comments. I'll be back in a couple of weeks to answer your burning questions. See you next time.

[Music playing]

END OF EPISODE