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Bacteria Podcast and Scientist Interview
Bacillus subtilis

Roberto Kolter of Harvard explains the relationship between one bacterium, *Bacillus subtilis*, and the majestic trees outside his office windows at Harvard Medical School. There's a lot going on, down among the roots.

Transcript

Ari: From the Encyclopedia of Life, this is One Species at a Time. I'm Ari Daniel Shapiro. Over the last few years, we've created more than 60 episodes for this series. But there's one group we've neglected – the bacteria.

Kolter: The most spectacular aspect of life on the planet Earth is the stuff we don't see!

Ari: Roberto Kolter is a bacteria fanatic. He's a microbiologist, after all.

Ari: Kolter lifts the blinds of one of his office windows at the Harvard Medical School. He looks outside, and he says everything he sees – depends on bacteria. The people bundled up on the street below rely on the bacteria in their guts to digest their food. There's the dirt…

Kolter: A lot of that soil is actually produced by bacterial activity.

Ari: Even the trees dotting the landscape.

Kolter: Without the microbes, none of those trees would make it.

Ari: And it's this last point – that most plants really benefit from a remarkable relationship with bacteria – that Kolter's especially interested in. To explain, let's focus on a particular bacteria – a tiny rod-shaped cell called *Bacillus subtilis*. This little guy is everywhere on the planet.

Kolter: Glaciers in Alaska, deserts in Africa, swamps in South America – just to mention a few. You take a sample, and then you ask, "Is *Bacillus subtilis* there?" And it's there.

Ari: This single cell has a rotating flagellum that it uses to propel itself through the soil. And *Bacillus subtilis* keeps on moving until it bumps into a plant root. Then, molecules from the plant stop the bacterium in its tracks.

Kolter: It recognizes that it's at the root, and that it detects as a signal to dramatically change its lifestyle. So it actually sheds being a nomadic cell that is searching. And now it ceases to separate as it divides.

Ari: In other words, *Bacillus subtilis* becomes multi-cellular – something you might not expect from a single-celled bacterium.

Kolter: It makes long chains of cells. They are long threads, but then the threads are side by side – they are bundled side by side.

Ari: These threads are held together by a mesh of interlocking proteins and sugars. The result – *Bacillus subtilis* helps create a coating around the root. Something called a biofilm. And a special kind of give-and-take emerges.

Kolter: Any chemicals that the bacteria secrete are gonna be readily accessible to the plant. So what sort of things do they secrete? They secrete some compounds that we know help in the growth of the plant. They also secrete compounds that are anti-fungal agents – actually, they go out and kill potentially dangerous fungi.

Ari: So they're there kind of like a catering service for the roots?

Kolter: A bit more like a pharmacy, if you want to call it that way, providing lots of wonderful chemicals that help the plant. Importantly, the plant releases through its roots a lot of small molecules, many of which are wonderful food for the *Bacillus subtilis*, so it's a beautiful case of a mutualistic symbiosis.

Ari: Kolter thinks that most plants depend on bacteria in exactly this way – and not just *Bacillus subtilis*, but an array of microbial species. Each plant root is enrobed in a complex microscopic community. Now, I'd always thought of bacteria as single-celled beings. But the more Kolter told me about biofilms, the less the bacteria sounded like bacteria. And the more they sounded like…us.

Kolter: Within the biofilm, some cells are making matrix, other cells are making signals, just like you have heart tissue, and you have lung tissue.

Ari: Not all bacterial cells within the biofilm are the same. They differentiate, and take on different roles. Of course, all those instructions – on how to function as a biofilm – are contained within the genes of *Bacillus subtilis*. Now, for most creatures – animals, plants, fungi – it's our genes that define which species we belong to. Elephant genes stay in elephants.

Maple tree genes stay in maple trees. But in bacteria, things are – you guessed it – more complicated. In fact, it kind of throws our whole One Species at a Time approach out the window. Because of something called horizontal gene transfer.

Kolter: That is, genes freely move from one species to another species – a type of bacterium to another type of bacterium. And it is such a large percentage of bacteria that is making up this pool of genes that is moving back and forth, that to say that it is this set of genes that makes a particular species is impossible. Because many of those genes will be found in bacteria that are dramatically different.

Ari: Before I leave, Kolter takes me over to the wall behind his desk, and he runs his fingers along a rusted iron sculpture that's almost as tall as I am. It's a branching tree of life, and he worked with a Colombian ironworker to fashion it. Kolter points to three little stems.

Kolter: That's the animals, the plants and the fungi. That's it – this tiny little corner of the tree.

Ari: Meaning that genetically, animals, plants, and fungi aren't all that different from one another. But the rest of the sculpture – the long branches, the sudden bends – that's where – in Kolter's view – the real beauty of life is. Amongst the countless diverse microbes that feed on everything from sunlight to sulfur. That live from the top of the atmosphere to the bottom of the ocean. And that defy any kind of box you try to put them in. Our series, One Species at a Time, is produced by Atlantic Public Media in Woods Hole, Massachusetts. I'm Ari Daniel Shapiro.

Meet the Scientist

Meet Dr. Roberto Kolter, Professor of Microbiology at Harvard Medical School:

Where do you work?
I work at the Department of Microbiology and Immunobiology at Harvard Medical School.

What do you study?
We pursue numerous and eclectic aspects of the microbial world, from mechanistic details of bacterial development to the chemical ecology of oceanic symbioses that influence climate.

What are three titles you would give yourself?
Microbiologist, Enophile, Runner

What do you like to do when you are not working?
Can be found cooking, and consuming the results, in good company and with good wine. Can also be found running, biking and swimming, burning the calories thus consumed.

What do you like most about science?
The opportunity to observe the growth of the inquisitive minds of scientists-in-the-making that work in the context of my research group.

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