In evolutionary arms race, a bacterium is found that outwits tomato plant's defenses

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Tracy Rosebrock, a graduate student in plant pathology and lead author of a paper appearing in Nature, stands among wild varieties of tomato plants at the Boyce Thompson Intstitute on campus. Photo: Robert Barker

An arms race is under way in the plant world. It is an evolutionary battle in which plants are trying to beef up their defenses against the innovative strategies of pathogens. The latest example of this war is a bacterium (Pseudomonas syringae) that infects tomatoes by injecting a special protein into the plant's cells and undermines the plant's defense system.

"Plant breeders often find that five or six years after their release, resistant plant varieties become susceptible because pathogens can evolve very quickly to overcome plant defenses," said Gregory Martin, Cornell professor of plant pathology, a scientist at the Boyce Thompson

Institute for Plant Research (BTI) on the Cornell campus and the senior author of the research paper, published in the July 19 issue of the journal *Nature*. "However, every now and then, breeders develop a plant variety that stays resistant for 20 years or more."

Understanding why some varieties have more durable disease resistance is important to the development of more sustainable agricultural practices, he said.

The study by Cornell and BTI scientists describes how a single bacterial protein, AvrPtoB, which is injected by P. syringae into plant cells through a kind of molecular syringe, can overcome the plant's resistance. Normally, the plant's defense system looks out for such pathogens and, if detected, mounts an immune response to stave off disease. As part of this surveillance system, tomatoes carry a protein in their cells called Fen that helps detect P. syringae and trigger an immune response.

But some strains of P. syringae have evolved the AvrPtoB protein that mimics a tomato enzyme known as an E3 ubiquitin ligase, which tags proteins to be destroyed. Once injected, AvrPtoB binds the Fen protein, and the plant's own system eliminates it, allowing the bacteria to avoid detection and cause disease.

"This paper explains how a pathogen can evolve to escape detection," said lead author Tracy Rosebrock, a graduate student in Cornell's Department of Plant Pathology and BTI. "The bacterium has one specific protein that it uses to turn off the plant's immunity."

The researchers found that the Fen gene is present in both cultivated tomatoes and many wild tomato species, leading them to believe that the gene is likely ancient in origin and that many members of the tomato family have used it to resist P. syringae infections over the years. Since the Fen protein still detects AvrPtoB-like proteins from some strains of

P. syringae, prompting an effective immune response, the researchers believe new P. syringae strains have only recently evolved a version of AvrPtoB that includes an E3 ubiquitin ligase enzyme that interferes with the plant's surveillance.

"This paper provides molecular data that supports the evolutionary 'arms race' theory" that as pathogens develop new ways to spread and attack organisms, the organisms in turn create novel defenses, each in a continuous battle to outdo the other, said Rosebrock.

Source: Cornell University

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