Plant pathologists discover unusual evolutionary transition in common bacteria

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A leafy gall caused by the Rhodococcus bacteria grows at the base of a butterfly bush. Credit: Melodie Putnam, OSU.

It's the "Strange Case of Dr. Jekyll and Mr. Hyde" in a nursery setting.

There are mostly benign species in the soil-borne, plant-associated genus of bacteria known as *Rhodococcus*, but a few species can be pathogenic. A team of researchers at Oregon State University used genome sequencing to identify species of *Rhodococcus* that transition between beneficial and pathogenic - stimulating growth in some plants in the former case while deforming tissues in the latter.

The findings were published today in the journal *eLife*.

The key to *Rhodococcus* transitioning between being a "good" and "bad" bacteria is made possible by DNA molecules known as plasmids, said Jeff Chang, a microbial genomicist in OSU's College of Agricultural Sciences and leader of the study. A plasmid is a DNA molecule maintained separately from the chromosome of bacteria.

"The ease to which the transition occurs is rather unusual, and it presents a difficult challenge for nurseries," he said. "Beneficial strains of *Rhodococcus* cause growth of the plant that could be misinterpreted as disease symptoms. We traced how the beneficial and pathogenic members of *Rhodococcus* are moving from plant to plant and nursery to nursery. Now we can inform the nursery industry to implement practices to limit its spread."

Rhodococcus infects primarily herbaceous perennials, including Shasta daisy, speedwell and chrysanthemum. There are fewer woody hosts that are commonly infected, but they include butterfly bush and false spirea.

The evolutionary transition by the movement of plasmids has the potential to make new lineages of pathogenic *Rhodococcus* in nurseries and other environments, Chang said.

The study results could have an impact on Oregon's $900 million greenhouse and nursery industry. The deformed plants aren't aesthetically pleasing and diseased plants can't be shipped out-of-state, so the only alternative is to destroy the infected plants.

To assist nurseries, OSU developed molecular tools to work with commercially available kits that allow the user to quickly and effectively discriminate between the beneficial and pathogenic strains of *Rhodococcus*. OSU has filed for a patent for the molecular tools, developed by Skylar Fuller, who earned a master's degree in molecular and cellular biology at OSU this past spring.

The observation that plasmids are moving between strains of *Rhodococcus* was made by Alexandra Weisberg, a postdoctoral fellow in Chang's lab. Weisberg used genomic tools to study plasmid patterns.

"These plasmids can be transferred from one bacterium to another, which makes tracking the disease difficult," Weisberg said. "Tracing the plasmids separately from the chromosome was the key to understanding how these transitions relate to each other."

For more than a decade Melodie Putnam, chief diagnostician at OSU's Plant Clinic, has been working with Oregon nurseries to correctly identify bacteria that are causing unusual growth defects in infected plants.

"The symptoms of *Rhodococcus* are often not easy to recognize," Putnam said. "Until this study, we didn't know how *Rhodococcus* behaved in nurseries. We didn't know if there was a resident population that just

kept re-infecting or if the nurseries were getting it from other nurseries. Now we have a clearer picture of different scenarios."

In 2014, Putnam was contacted by a researcher at another university who found odd symptoms in pistachio trees. They were short and bushy, had knobby stems and wouldn't properly graft. The researcher assumed pathogenic *Rhodococcus* was the culprit, but Putnam only found the non-pathogenic strains of bacteria in the 100 or more symptomatic plant samples submitted to the Plant Clinic.

Putnam and her research group worked together with Chang and his group led by Elizabeth Savory, then a postdoctoral researcher in Chang's lab, and Fuller. The two groups studied some of the pistachio-associated bacteria and tested them on several species of plants. The studies led to similar conclusions: the strains cultured from pistachio appeared to be non-pathogenic.

"That was our first indication that these strains they were culturing from the pistachio were what we find on plants in general that have a beneficial effect," said Savory, now the plant health manager for the Oregon Department of Agriculture. "It is possible that beneficial strains of *Rhodococcus* cause growth changes to the plant that could be mistakenly interpreted as disease symptoms."

More information: Elizabeth A Savory et al, Evolutionary transitions between beneficial and phytopathogenic Rhodococcus challenge disease management, *eLife* (2017). DOI: 10.7554/eLife.30925

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