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Rice disease-resistance discovery closes the loop for scientific integrity

UNIVERSITY OF CALIFORNIA - DAVIS

When disease-resistant rice is invaded by disease-causing bacteria, a small protein produced by the bacteria betrays the invader. Upon recognizing that protein, the rice plants sense that a microbial attack is underway and are able to mount an immune response to fend off bacterial infection, reports a research team led by the University of California, Davis.

Identification of the tiny protein, called RaxX, holds promise for developing more disease-resistant crop varieties and therapeutic treatments for blocking microbial infections in both plants and animals, said the researchers, who found particular satisfaction in this discovery, two years after retracting the announcement of a similar find.

Results of the new study will be reported July 24 in *Science Advances*, an open-access journal published by the American Association for the Advancement of Science. The paper will then be available online from the journal at http://bit.ly/1OmytAd.

Discovery unlocks clues to disease protection:

In this new study, researchers discovered that the RaxX protein was present in at least eight species of the disease-causing *Xanthamonas* bacteria that are known to attack rice -- the staple food for half of the world's population -- as well as maize, cassava, sugar cane, tomatoes, peppers, wheat, alfalfa, onions, banana and citrus.

"Our research team is delighted to announce the discovery of the RaxX protein, a new class of microbial signaling molecules ," said Pamela Ronald, a professor in UC Davis' Department of Plant Pathology and Genome Center, who directed the study.

Ronald noted that her laboratory is currently investigating the role of RaxX during bacterial infection of rice in the absence of the immune receptor.

The researchers have noticed that RaxX closely resembles a class of plant signaling factors that promote growth and modulate the immune response. They suspect that the bacteria could be mimicking these natural plant-signaling factors to inhibit the plant immune response and thereby enhance the competitiveness of the bacteria.

In the long term, the researchers hope to use this information to develop new strategies to prevent infection in various crops.

New findings have special significance:

Publication of the new study is particularly poignant for Ronald and lead co-authors Rory Pruitt and Benjamin Schwessinger, because it brings the research team full circle in correcting unintentional errors that led the Ronald lab in 2009 to misidentify the protein now known to be RaxX.

Pruitt and Schwessinger both worked on the new study as postdoctoral scholars in the Ronald lab, and Schwessinger is now an independent research fellow at the Australian National University in Canberra, Australia.

Ronald's laboratory has been studying rice genetics and disease resistance for more than two decades and in 1995 announced that a gene called Xa21 confers resistance to the bacterial blight pathogen. Bacterial blight, one of the worst bacterial plant diseases in the world, has been found in virtually every crop species including rice.

The discovery of Xa21 was widely acclaimed by the scientific community and sparked further research into other key parts of

the disease-resistance puzzle. Researchers were confident that if Xa21 produced a "receptor" in the plant cell that was capable of recognizing and thwarting a bacterial invasion, there must be a complementary protein in the bacteria that triggered that immune response in the plant.

In 2009 the Ronald lab announced discovery of a bacterial protein called Ax21, which their research indicated was the protein that triggers the immune response by the Xa21 plant receptor. A second related study, based on identification of Ax21, was published in 2011.

Then in 2013, as researchers in the Ronald lab began repeating the earlier experiments in preparation for a new study, they discovered that a bacterial strain had been mislabeled in the previous work and that one of the tests used in the earlier study turned out to be quite variable. These errors had led to the misidentification of Ax21 as the bacterial protein that sparks an immune response by the Xa21 receptor in the plant cells.

After finding the errors, Ronald retracted two papers from her laboratory about this research, published in 2009 and 2011 in the journals *PLOS ONE* and *Science*, respectively. She chronicled the story of that process in an October 2013 Scientific American blog posting titled, "Lab Life: The Anatomy of a Retraction," which can be found at http://bit.ly/1KdEDli.

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Collaborators and funders:

Collaborating with Ronald, Schwessinger and Pruitt on the new study were researchers from UC Davis; Lawrence Berkeley National Laboratory; University of Tübingen, Germany; University of Texas at Austin; UC Irvine; and the Council of Scientific and Industrial Research, India.

Funding for the study was provided by the U.S. National Institutes of Health, the U.S. Department of Energy, the European Molecular Biology Association, the Human Frontiers Science Program, the Council of Scientific and Industrial Research in India, the Welch Foundation, and Monsanto's Beachell-Borlaug International Scholars Program.

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