Latin American Scientists Explore Mechanisms to Fight Plant Disease

Two Pew fellows discuss challenges and opportunities in their work

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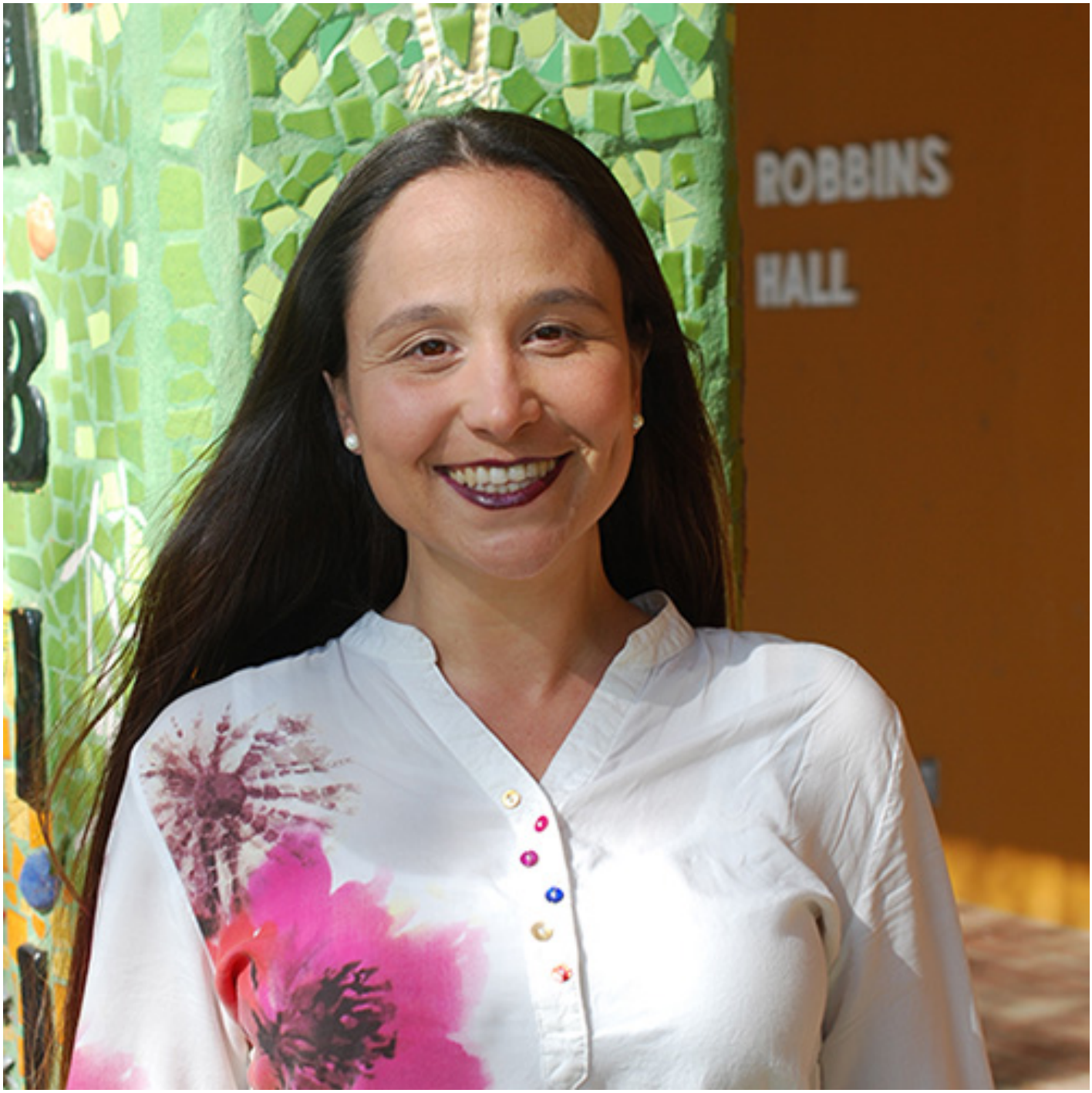


Courtesy of María Florencia Ercoli

María Florencia Ercoli, Ph.D.

María Florencia Ercoli is a member of the 2019 class of the Pew Latin American Fellows Program in the Biomedical Sciences. Ercoli, who is from Argentina, works in the laboratory of Professor Pamela C. Ronald at the University of California, Davis. Her research focuses on the molecular strategies that certain bacteria use to invade plants.

Fausto Andrés Ortiz-Morea, Ph.D.

Fausto Andrés Ortiz-Morea is a member of the 2019 class of the Pew Latin American Fellows Program in the Biomedical Sciences. Ortiz-Morea, who is from Colombia, will work in the laboratory of Dr. Libo Shan at Texas A&M University to explore how plants integrate and execute immune responses against invading pathogens.

Courtesy of Fausto Andrés Ortiz-Morea

As the world's population continues to grow, global food security—that is, ensuring sufficient supplies of nutritious and affordable food—has become an increasingly important concern for scientists. Disease-causing pathogens can wreak havoc on plants, threatening the health and sustainability of essential crops.

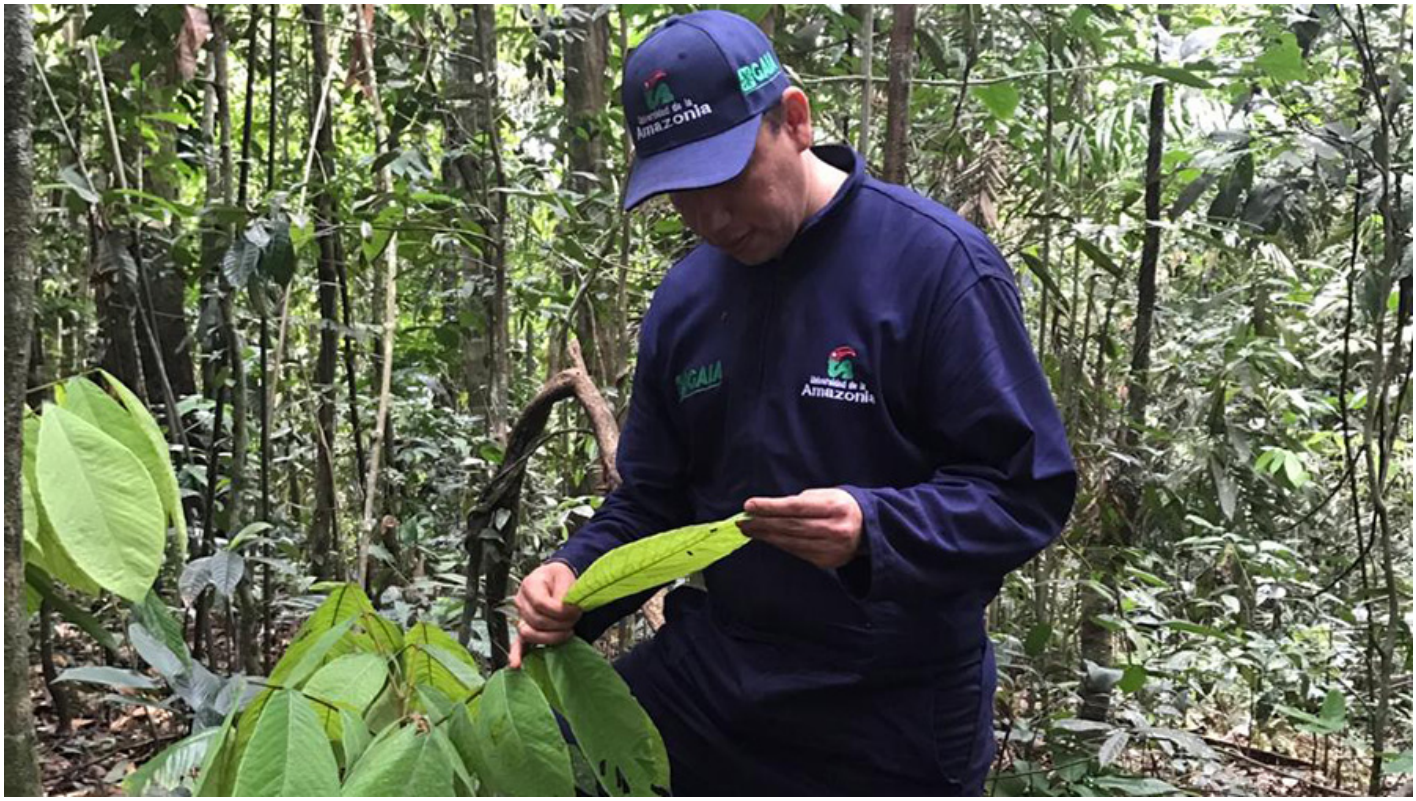
María Florencia Ercoli of Argentina and Fausto Andrés Ortiz-Morea of Colombia are exploring, respectively, how pathogens attack plants and how plants fend off such attacks. Both are members of the 2019 class of the Pew Latin American Fellows Program in the Biomedical Sciences.

The program, which began in 1990, provides support for young scientists to receive postdoctoral training in the United States and additional resources when they return to their countries to begin their independent research. These two experts recently discussed their research plans and challenges in the field. Their responses have been edited for length and clarity.

Q: What about plant biology interests you?

Ercoli:While finishing my undergraduate education, I had the opportunity to study in a lab where they were asking intriguing questions about plant biology. I realized there that I love plants as models of study, and how research with plants has contributed to countless scientific advances. I quickly came to appreciate how questions are asked and answered in the field, and, most importantly, the impact these answers have on society.

Ortiz-Morea: I have always been intrigued that, despite their stationary lifestyle, plants adapt to and colonize different environments around the world. If plants experience biological stress—they need food and water, or pathogens attack—they must cope while staying in the same place. This aroused my curiosity about the mechanisms plants use to monitor their surrounding environment and adjust their growth and development accordingly, plus how they differentiate between “good” and “bad” microorganisms.



Fausto Andrés Ortiz-Morea, a 2019 Pew Latin American fellow from Colombia, will explore how plants execute immune responses against invading pathogens.

Courtesy of Fausto Andrés Ortiz-Morea

Q: What do you hope to discover during your postdoctoral fellowship in the United States?

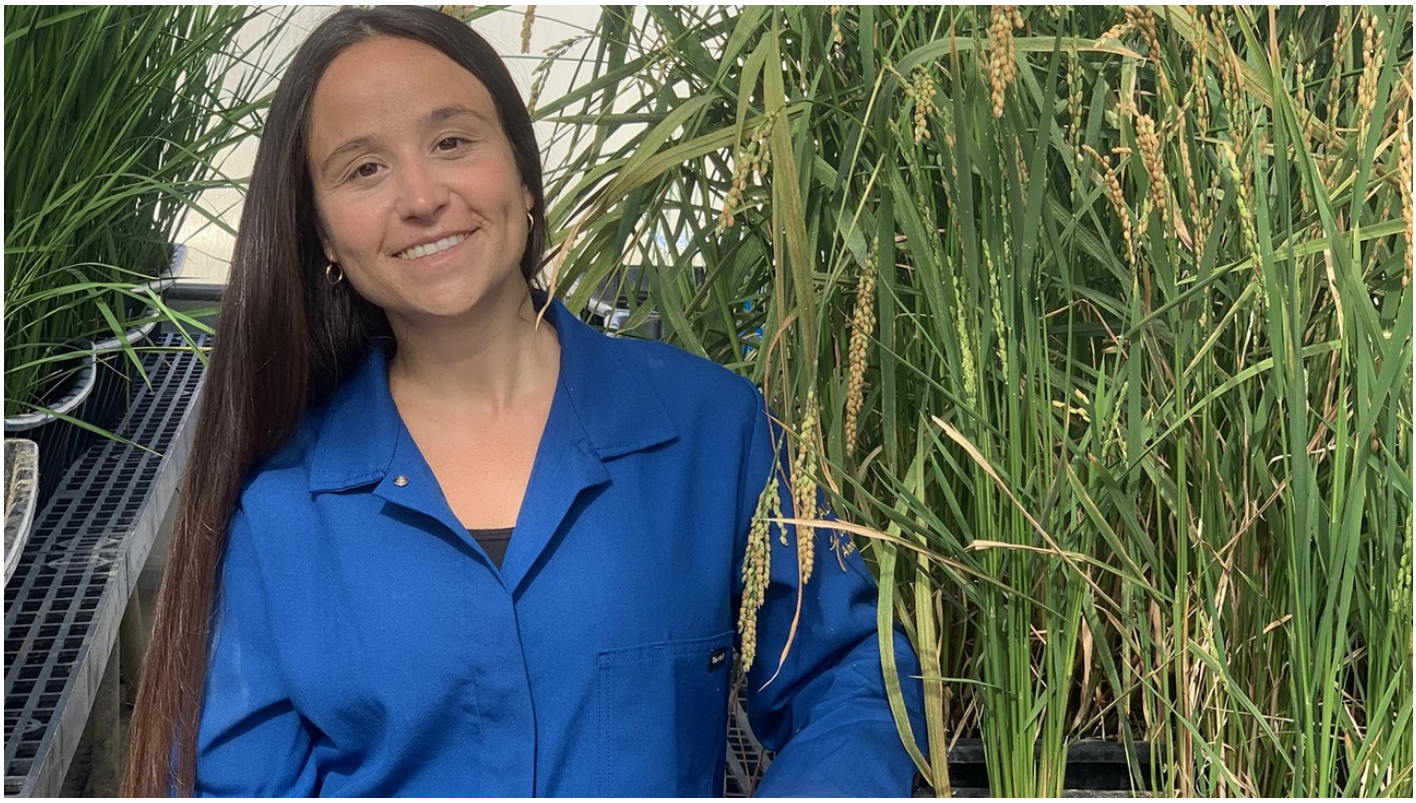
Ercoli: I hope to advance science's understanding of how pathogenic bacteria utilize "molecular mimicry" to their benefit. Molecular mimicry is a strategy where pathogens produce and use molecules that resemble vital host molecules to manipulate the host environment and facilitate infection. By understanding the interactions between invading bacteria and the host, we can help develop new ways to fight diseases in plants.

Ortiz-Morea: I will focus on plant immunity, or how plants detect dangerous signals and integrate external information with internal information to trigger biological immune responses to survive infections. This research will uncover knowledge of how plants activate and modulate their defense systems. What we find then can be used to facilitate the strategic development of disease-resistant crops.

Q: What are the major challenges in the plant biology and immunology field?

Ercoli: We face a situation today where we have a stagnant level of natural resources, yet our crop production must increase by 70 percent by the year 2050 to feed the world population. Each year, farmers must increase yields while reducing the need for external inputs—such as water, nitrogen, phosphate, and other soil resources—and improving nutrition. Most importantly, we must enhance plants' ability to resist pests and diseases, which together create substantial economic losses worldwide and threaten global food security.

Ortiz-Morea: Our main challenge is to increase plant productivity to meet the demands of the growing global population, estimated today at 7.5 to 7.7 billion people. We need to produce enough food, but also healthy food within sustainable parameters—using less pesticides, water, energy, and land. At the same time, we need to prevent plant diseases, which cause 20 to 40 percent of crop production loss worldwide annually. To overcome this challenge, we must understand how plants interact with their biological and physical environments and use this knowledge to enhance agricultural productivity and maintain environmental sustainability.



María Florencia Ercoli, a 2019 Pew Latin American fellow from Argentina, will investigate the molecular strategies that infectious bacteria use to invade plant hosts.

Courtesy of Maria Florencia Ercoli

Q: Can you detail what your research will examine?

Ercoli: Through my research in the Ronald Laboratory, I'll be examining the molecular strategies that bacteria use to invade plants. Recently, the lab discovered that the Gram-

negative bacterium—a type of bacteria that have a protective layer to resist immune responses—called *Xanthomonas oryzae pv. oryzae* (*Xoo*) deploys a molecule, RaxX, that mimics a plant hormone produced by rice, a critical crop consumed by more than half of the global population. Plants, in turn, have a gene called XA21, which is the immune receptor that detects RaxX. It then promotes an immune response and confers resistance to infection.

While *Xoo* strains lacking RaxX can evade the XA21 immune system, they are impaired in their ability to infect rice plants in the absence of XA21. That suggests that RaxX plays an important role in spreading disease. Interestingly, some field strains of *Xoo* produce slightly modified forms of RaxX, thus evading detection by the XA21 receptor and establishing infection, showing again the importance of RaxX for *Xoo* transmission.

By identifying how the hormone mimic renders rice plants more susceptible to infection, we can understand how to engineer these plants to resist disease. Understanding how bacteria overcome plant resistance is crucial to understand how plants can be engineered to fight bacteria effectively. In short, we hope to better understand the mechanisms behind a plant-pathogen system to prevent infection and, by extension, crop loss.

Ortiz-Morea: At Texas A&M University's Institute for Plant Genomics and Biotechnology, I will be looking at the two-tiered immune response that plants use to fight infection. When pathogens invade, sensors on the surface of plant cells recognize specific molecules, or patterns, derived from the invading organisms and trigger the first line of defense in a process called pattern-triggered immunity (PTI). Often, pathogens have evolved a suite of diverse molecules called effectors that can block the PTI response. If this happens, plants activate the second line of defense using sensors inside the cells that detect the effectors and trigger a stronger, more aggressive response called effector-triggered immunity (ETI). These responses are memorized to efficiently neutralize future attacks by the same pathogen.

Although much is known about how plants fight infections, many questions remain. For example, how do molecules within the plant cells amplify the immune response? What are the specific bacterial molecules that are recognized by the plant cell? How do plants integrate diverse external and internal stimuli to mount an immune response? What mechanisms drive the decision on which plant immune signaling molecules are to be used against different stimuli? I hope to answer these questions and help develop strategies to generate disease-resistant crops, enhance sustainable farming practices, and improve crop productivity.

Q: What are you hoping to gain from being part of the Pew scientific community?

Ercoli: I hope to share my expertise and strengthen my connections with other scientists that work on exciting, diverse projects so we may learn from one another. I believe being connected will make us, and our research, stronger.

Ortiz-Morea: It is exciting to be part of the Pew scientific community because it is widely recognized for its contribution to science. I look forward to connecting with this multidisciplinary network of outstanding scientists and establishing scientific collaborations through research with shared goals.

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