Researchers identify a pair of receptors essential to male-female plant communications

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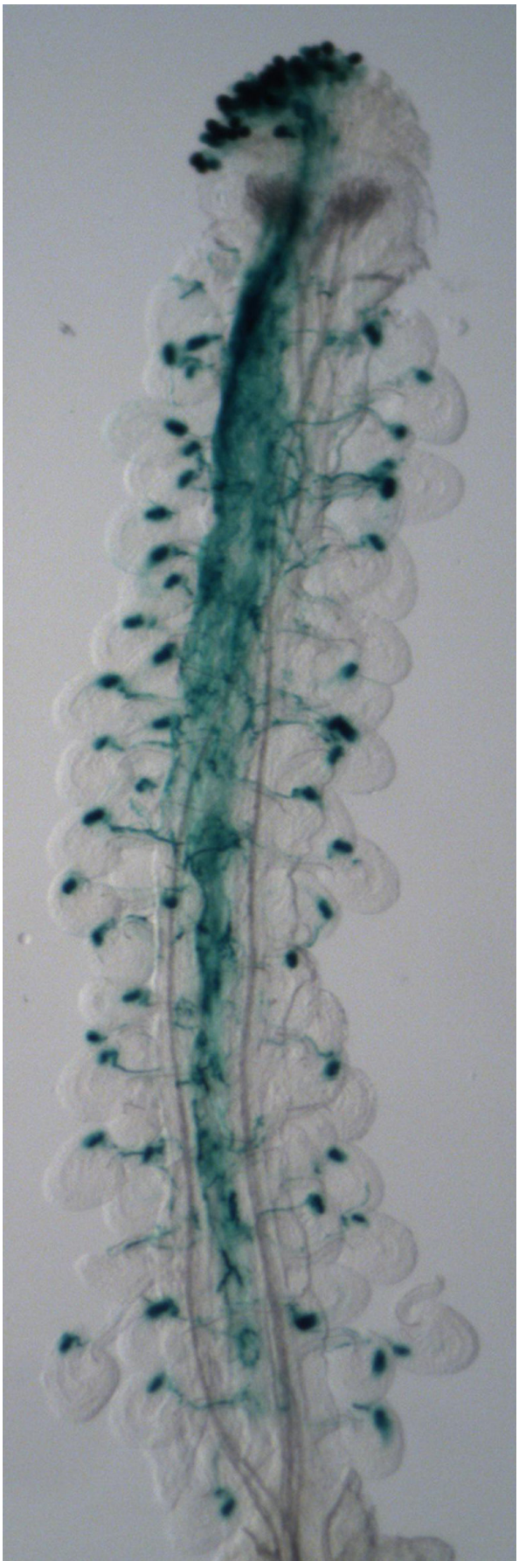

UMass Amherst plant molecular biologist Alice Cheung says the male plant's pollen tube transports sperm to female target cells. She and colleagues identify two new receptors essential to this communication and other molecules whose interactions regulate the process. Credit: UMass Amherst

Two groups of plant molecular biologists, at the University of Massachusetts Amherst and Peking University, China, have long studied how pollen tubes and pistils, the male and female parts of flowers, communicate to achieve fertilization in plants. Today they report in a *Science* early release paper that they have identified a pair of receptors essential to these communications as well as molecules that modulate the receptors' activity.

The work, in the model plant *Arabidopsis*, advances basic understanding of plant reproduction, say Alice Cheung and Hen-Ming Wu at UMass Amherst, with Li-Jia Qu and Hongya Gu in China. The researchers named the two new receptors Buddha Paper Seal 1 and 2 (BUPS1/2). Their paper also identifies several small peptides known as Rapid Alkalinization Factors (RALF) 4, 19 and 34 as their ligands - molecules that modulate the receptors' functions.

Further, the authors describe how BUPS1/2 and a second pair of related receptors called ANXUR 1 and 2 (ANX1/2), and RALF 4 and 19, all expressed in the pollen tube and required for male fertility, interact together to get their jobs done.

Cheung says, "Our paper describes an important elaboration of the male and female interaction network in plant reproduction. Molecules involved in the process have to work intimately together to orchestrate

and support the male-female interactive events. In this process the pollen tube grows inside the pistil, often over distances hundreds or thousands of times greater than the tube's diameter, to deliver sperm to the target egg cell. The pollen tube must remain intact throughout this journey, but then must burst open at exactly the right time and place when it arrives at the target to release sperm for fertilization. Bursting too soon or failing to burst when it should are both devastating to reproduction."

The two research teams found that the receptors and RALF4 and 19 are required to maintain pollen tube integrity during the growth process. They also show that RALF34, expressed from the female, facilitates the bursting process, along with some known and other not yet identified factors. They demonstrate how these molecules interact with each other, illustrating an "intriguing communication mechanism" between male and female to produce seeds, Cheung says.

She adds, "In showing how receptors and their ligands work together to ensure reproductive success, our work illuminates one of the most mysterious processes in biology."

The plant reproduction research community has a tradition of naming important genes from ancient mythology, the biologist says. For example, a gene her group also works on, FERONIA, is named after the Roman goddess of fertility. The researchers named the new factors Buddha paper seal 1 and 2 after a Chinese tale about a naughty monkey held under a rock for 400 years by a charmed paper seal. When a kindly monk passing by broke the seal, the monkey burst out, which is what the scientists were reminded of when they saw how the pollen tube explodes to release sperm and enable fertilization.

This work continues the Cheung-Wu group's many years of plant reproduction research, especially on FERONIA, a receptor related to BUPSs and ANXURs that plays a major role in controlling plant female

fertility in development and in coping with environmental stresses.

"It's actually very interesting," says Cheung. "The pollen tube transports sperm to female target cells. FERONIA is waiting there for the pollen tube to arrive. BUPSs, ANXURs, RALF 4 and 10 in the pollen tube make sure the tube does not burst too early, but wait until it gets to the target female cell. There the tube bursts abruptly, an action controlled by FERONIA and in part mediated by a different set of RALFs, releasing sperm at the right time and place."

The team used a combination of reverse genetics, biochemical and biophysical approaches for this work, in collaboration not only with the Chinese group, but also involved investigators from Brazil, Germany, the United States and Mexico. Cheung says the U.S. National Science Foundation's Research Coordination Network in Integrative Pollen Biology, of which she is the principle investigator, provided the catalyst and forum that stimulated these international interactions.

She adds, "I want to emphasize this work as a collaboration. We and the Peking University group, close colleagues with common interests, worked in parallel on some of the topics in this paper without knowing about each other's efforts. In a discussion one day we found out that we had common results, but each group had also generated unique observations and developed distinct insights, so we decided to merge our efforts and publish jointly."

She adds, "In my mind, this sort of collaboration is probably the best kind of scientific interaction. As scientists, we value our own independence and creativity. Even with common results, our thinking could diverge, leading each team to further investigate in different directions, getting to end points that complement each other. This collaboration is not a matter of different expertise, but a matter of common interest and curiosity that took us in different directions that

eventually came back together in a complete story."

More information: "Arabidopsis pollen tube integrity and sperm release are regulated by RALF-mediated signaling" *Science* (2017). science.sciencemag.org/lookup/ … 1126/science.aao3642

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