Plant sex signal found
Posted byMegan Scudellari
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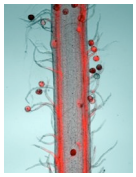
Today, more than a century after a German-Polish botanist first described the process of fertilization in flowering plants, scientists have identified an elusive molecular signal critical to that process.

The finding, published this week in PLoS Biology, sheds light on the evolution of plant fertilization mechanisms and could lead to strategies to overcome species-specific barriers for crossbreeding crops.

"This is an exciting paper," said University of California, Davis plant biologist Venkatesan Sundaresan in an email. "They show exactly how [the signal] works by some very elegant experiments," added Sundaresan, who was not involved in the research.



Pollen tube, stained in red
Image courtesy of PLoS Biology

When a pollen grain, which contains the male sperm, lands on another plant, it grows a pollen tube into the female reproductive tissues. Eventually, the pollen tube halts and bursts to release two sperm cells, one to fertilize the egg and another to fuse with a female cell and generate the endosperm, a tissue providing nutrition to the embryo. But little has been known about the cell-to-cell signaling between the male and female cells that causes the pollen tube to stop growing and rupture.

Nine years ago, while looking for molecules that attract the pollen tube toward the female egg cells in maize, Thomas Dresselhaus and colleagues at the University of Regensburg in Germany stumbled across four defensin-like proteins expressed exclusively in the embryo sac. It was a strange discovery, since defensin proteins are typically involved in the immune systems of plants, insects, and other animals.

At first, Dresselhaus believed the proteins were localized in the female tissues as a way to protect the valuable reproductive machinery from pathogens. But through additional gene expression studies and the creation of knock-down plants, Dresselhaus and his team found that one of the four defensin-like proteins, ZmES4, is discharged by the embryo sac during the fertilization process and actually causes the pollen tube to burst and release sperm. "[The protein's] role was not in defense, but in bursting the pollen tube tip. It was quite exciting," said Dresselhaus.

It's likely that this reproductive technique was adapted from a pathogen-fighting mechanism at some point during evolution, Dresselhaus suggested. He plans to test the theory by trying to engineer "reproductive" defensin-like proteins into "defensive" defensin-like proteins and vice versa.

"It's neat to think that fertilization might be triggered by the female embryo sac recognizing the pollen tube of its own species as an invader -- albeit a desirable one -- and mounting an attack that causes it to rupture," said Sundaresan. "Fascinating!"

The team also identified the protein's target in the pollen tube -- potassium channels. When treated with ZmES4, potassium channels open, leading to an influx of potassium ions and water into the tube, upsetting the osmotic balance and causing an explosive rupture that releases the two sperm cells.

Additionally, they found that ZmES4 only induces pollen burst species-preferentially. When a synthetic ZmES4 protein was added to maize pollen tubes, they burst within seconds. Added to maize's closest relative, Tripsacum dactyloides,the rupture was delayed, as long as 30 minutes. When added to the pollen tubes of tobacco and lily, non-related plants, no bursts were recorded. In this manner, the protein acts as a barrier to prevent fertilization between non-related species.

With this knowledge, crop breeders might someday be able to develop tools to increase current cross-fertilization rates or even create new crossbreeds. Dresselhaus is interested in expanding his own research into more applied work, such as trying to cross barley with maize by expressing the ZmES proteins in barley to see if they would burst a maize pollen tube near the barley embryo sac. "There could be other problems after that, such as the genomes being too diverse," said Dresselhaus, "but I think, as a breeding tool, this [mechanism] could be really interesting."

S. Amien et al. "Defensin-Like ZmES4 Mediates Pollen Tube Burst in Maize via Opening of the Potassium Channel KZM1."PLoS Biol 8(6): e1000388.

http://www.the-scientist.com/blog/display/57483/