Researchers uncover reason that male moths can keep finding females

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(Phys.org) -- A female moth sitting on a goal post could attract a male moth on the other end of a football field. And even if she switched her scent over time, the male could still find her because of a mutation to a single gene in his antenna.

A team of researchers led by Montana State University entomologist Kevin Wanner identified that gene after seeing how it adapted to even the slightest change in the chemicals female moths emit to attract males. The scientists explained their findings in the Aug. 13 online edition of the *Proceedings of the National Academy of Sciences (PNAS)*.

Understanding the genetics behind moth communication could lead to natural ways to control pests, said Wanner, who has dual assignments in the Department of Plant Sciences and Plant Pathology and MSU Extension. Scientists could someday design new scents that would make it impossible for male moths to find females of the same species. The European corn borer alone is one of the most damaging insect pests of corn throughout the United States and Canada. The losses it causes and the cost to control it is estimated at more than $1 billion each year.

In the meantime, the discovery that involved hundreds of moths, an MSU-University of Montana collaboration, and a vital piece of equipment adds to the basic understanding of insect genetics, Wanner said. One area of interest focuses on the genetic barriers that keep moths from mating outside their own species.

Scientists have studied communication between male and female moths and butterflies for more than a century. They found the first sex pheromones in moths 50 years ago. But they still know little about the molecular mechanics that make communication so specific to a species, Wanner said. In some cases, different moth species are so much alike that scientists can only tell them apart by their different pheromones.

Pheromones are the blends of chemical odors that females emit to attract males of the same species for mating. If the ratio or chemicals themselves change during the evolution of a new species, the male needs to adapt or he won't be able to find the female. How male moths adapt to pheromone changes in females has been a long-standing question.

Female moths release just nanograms - a billionth of a gram -- of pheromone from a gland at the tip of their abdomen, Wanner said. He added that this amount is far too small for humans to smell, but male moths within 300 feet of the females can detect it with the sensory cells on their antennae.

The journey that led to the PNAS paper began in 2008 when Wanner came to MSU. It continued in 2009 when Jean Allen became a master's degree student in Wanner's laboratory. Allen - who earned her undergraduate degree from New Mexico State University - received her master's degree in December 2010 and is now a research associate in Wanner's lab.

She started her thesis work by obtaining live corn borer moths raised in colonies at Cornell University in New York, from collaborator and coauthor Charles Linn Jr., Allen said. She extracted RNA, genetic material from the male moths' antennae, to find the receptor genes that detect the female pheromone. She identified the probable receptor of interest.

Wanner then turned to Greg Leary and Michael Kavanaugh in the Center for Structural and Functional Neuroscience at the University of Montana. Since Wanner didn't have an instrument to analyze male moth receptors to see how they responded to a parade of different pheromones, the two tested the receptors with their equipment. They also made a series of mutations that were later confirmed by Allen. After Wanner was able to buy an Opus Xpress instrument, Leary helped trained Allen how to use it.

After analyzing several receptors and 47 possibilities for amino acid mutations, the collaborators finally found the one that clearly provided an adaptation to the changing pheromone structure.

It was a eureka moment, according to Allen and Wanner.

"It was a lot of work," Wanner added. "We had no rational way to know which one it was."

He noted that the Opus Xpress instrument was critical for their discovery. Commonly used in pharmacology and medical research to study how different drugs interact with their target receptor, the instrument in this case allowed the researchers to study, in the lab, how the pheromone receptors in the male moth responded to different pheromone chemicals.

"Without this instrument, we would not have been able to identify the critical receptor and identify the specific mutation in that receptor that allowed it to adapt to a new pheromone structure," Wanner said.

Leary is lead author on the PNAS paper. Co-authors in addition to Allen, Wanner, Kavanaugh and Linn are Peggy Bunger, a research associate in Wanner's lab, Jena Luginbill at UM,and Irene Macallister from the U.S. Army Engineer Research and Development Center in Champaign, Ill.

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