How moths find their flame: Genetics of mate attraction discovered

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Credit: CC0 Public Domain

The mysteries of sexual attraction just became a little less mysterious—at least for moths. A team of six American and European research groups including Tufts University has discovered which gene expressed in the brain of the male European corn borer moth controls his preference for the sex pheromone produced by females. This complements a previous study on the gene expressed in the female pheromone gland that dictates the type of blend she emits to attract males. The study was reported today in *Nature Communications*.

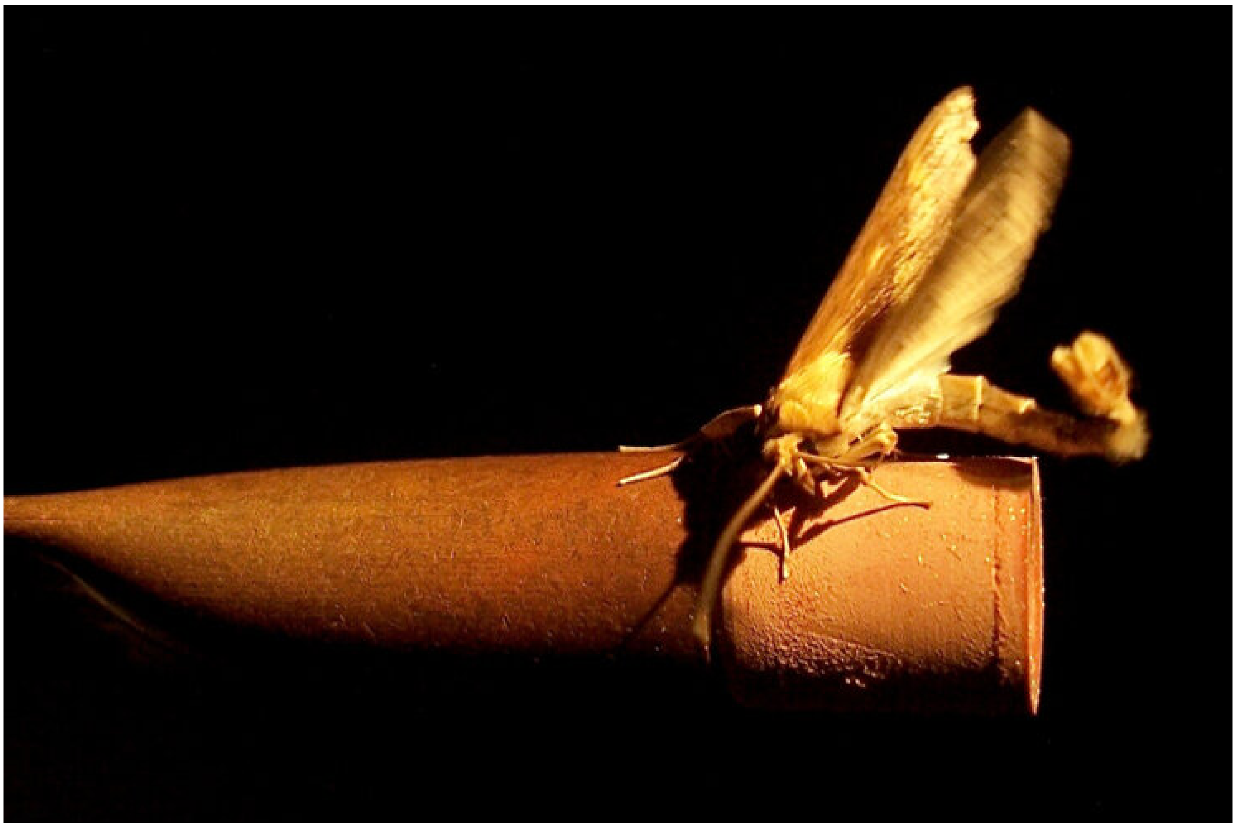
The implications go beyond making a better dating app for bugs. Now scientists can begin to ask why mating signals and mating preferences change in the first place, which is a long-standing paradox since any change could reduce the ability of an organism to successfully mate. Knowledge of these two genes will provide a better understanding of how the pheromones of the 160,000 moth species have evolved.

Of course, one important role for mating preferences is to make sure you are not matching up with a completely different species. The signal sent by females must be preferred by males of the same species to ensure that like mates with like—a mechanism called assortative mating. The European corn borer is interesting because there are two types, called E and Z, with assortative mating within each type. Even though the two types can be mated to each other in captivity, E mostly mates with E, and Z with Z in the field. For this reason, the European corn borer has been used as a model for how one species can split into two, ever since the two pheromone types were first discovered 50 years ago.

"That means we now know—at the molecular level—how chemical matchmaking aids in the formation of new species. Similar genetic changes to pheromone preference could help explain how tens of thousands of other moth species remain separate," said Erik Dopman, professor of biology in the School of Arts and Sciences at Tufts and corresponding author of the study.

Different aspects of the research were conducted by the three co-first authors Fotini Koutroumpa of University of Amsterdam, Melanie

Unbehend of the Max Planck Institute for Chemical Ecology, and Genevieve Kozak, a former post-doctoral scholar at Tufts University and now assistant professor at University of Massachusetts, Dartmouth. "Our study's success can be attributed to a team with a common vision and strong sense of humor that helped make the science worthwhile and fun," said Dopman.



A male European corn borer moth (Ostrinia nubilalis) sexually courts a rubber septum doused with the sex pheromone of a female European corn borer moth. Credit: Callie Musto, Charles Linn

One of the surprise discoveries made by the team was that while females may vary their signals in the blend of pheromones they produce, preference in the male is driven by a protein that changes their brain's neuronal circuitry underlying detection rather than affecting the receptors responsible for picking up the pheromones.

Preference for a particular cocktail of pheromones is determined by any of hundreds of variants found within the bab gene of the male. The relevant variants of bab are not in parts of the gene that code for a protein, but in parts that likely determine how much of the protein is produced, which in turn affects the neuronal circuits running from the antennae to the brain. The researchers were able to determine anatomical differences in the male, including the reach of olfactory sensory neurons into different parts of the moth brain, and link them to their attraction to E or Z females.

"This is the first moth species out of 160,000 in which female signalling and male preference genes have both been identified," said Astrid Groot of the University of Amsterdam, who also helped identify the gene controlling the pheromone difference in E and Z females. "That provides us with complete information on the evolution of mate choice and a way to measure how closely these choices are linked to evolving traits and populations."

The ability to predict mating could also help control reproduction in pest insects. The European corn borer is a significant pest for many agricultural crops in addition to corn. In the U.S., it costs nearly $2 billion each year to monitor and control. It is also the primary pest target for genetically modified "Bt corn" which expresses insecticidal proteins derived from the bacterium, Bacillus thuringiensis. While Bt corn remains an effective control of the corn borer moth in the U.S., corn borers in Nova Scotia are now evolving resistance to another variety of Bt corn.

"Our results can help to predict whether Bt resistance could spread from

Nova Scotia to the Corn Belt of the U.S., or whether assortative mating could prevent or delay it", said co-author David Heckel at the Max Planck Institute for Chemical Ecology, who also studies how insects evolve resistance to Bt. "Bt corn has enabled a huge reduction in the use of chemical insecticides, and it should be a high priority to preserve its ecological benefits as long as possible."

More information: Melanie Unbehend et al, bric à brac controls sex pheromone choice by male European corn borer moths, *Nature Communications* (2021). DOI: 10.1038/s41467-021-23026-x

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