Decreasing the reproductive fitness of mosquitos

October 26 2021, by Angela Nicoletti

Nouzova and Noriega. Credit: Florida International University

The secret of the world's deadliest animal's reproductive success could lead to fewer baby mosquitoes. That could mean improved pest control.

FIU Biomolecular Sciences Institute researchers collaborated with an international team to study juvenile hormone, a molecule that regulates development, reproduction and behavior in insects. They produced genetically modified Aedes aegypti mosquitoes—carriers of deadly diseases including yellow fever, dengue and zika—that cannot make juvenile hormone. The mutants could still mate and have babies. Just not as many as their juvenile hormone-producing counterparts. The researchers say greater understanding of hormone action could unleash a new generation of mosquito control tools.

"It's essential to understand why juvenile hormone is so important, so we can use this information to control insects and pests in a better way," said FIU biological sciences Professor Fernando G. Noriega, the study's corresponding author.

All insects—from bees and butterflies to mosquitoes—produce the hormone in question. It plays a critical role in their development, controls different functions and dictates certain behaviors. It helps mosquito larvae to complete metamorphosis into an adult when they're ready. It functions similar to the hormones people rely on for puberty and to reach sexual maturity.

Mosquitoes and their distant relatives—crabs and lobsters—both have methyl farnesoate (MF). In crustaceans, MF regulates reproduction. Insects have the ability to turn MF into juvenile hormone, giving them an evolutionary reproductive advantage in producing more and more

offspring.

The team of biologists and chemists— including FIU's Noriega, Marcela Nouzova, Francisco Fernandez Lima and Matthew DeGennaro—worked together to take the mosquitos back in time, where it was as if they never evolved to produce juvenile hormone at all.

Nouzova is the lead author of the study and the mastermind behind this project. She designed the experiments and led the genome editing process, creating the mutant mosquitoes for the experiments.

"In order to explore the evolutionary significance of the two hormones, we used CRISPR/Cas9-mediated mutagenesis to generate Aedes aegypti mosquitoes lacking the enzymes needed to catalyze the synthesis of either juvenile hormone or both methyl farnesoate and juvenile hormone," Nouzova said.

While the mutants that only had MF successfully reached adulthood, they were lacking in reproductive competence. They couldn't keep up with the stronger, non-mutant males. The mutant females also were affected. Normally, a female can lay up to 100 eggs after mating. In their short lifespan, they can lay three different sets, amounting to hundreds of eggs. The mutants, though, laid 50 percent fewer eggs.

The other mutants lost the ability to make MF completely. They died as a larva and never reached adulthood. This means juvenile hormone is a master regulator of mosquito reproduction, DeGennaro said.

This information about mosquito reproduction biology can help control populations of insects we want less of, like mosquitoes. It can also help us improve reproduction success and boost the populations of insects we need more of.

The findings were published in *Proceedings of the National Academy of Sciences*.

More information: Marcela Nouzova et al, Epoxidation of juvenile hormone was a key innovation improving insect reproductive fitness, *Proceedings of the National Academy of Sciences* (2021). DOI: 10.1073/pnas.2109381118

Provided by Florida International University