

ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC

News: Evolution, Animals, Biomedicine

Sexual conflict in mosquitoes may have worsened spread of malaria

Mating issues drove evolution of better disease carriers

By Susan Milius 2:00pm, February 26, 2015



AFTERMATH Intimate mating concerns among *Anopheles* mosquitoes may have inadvertently pushed the evolution of greater ability to spread human malaria.

The relentless spread of malaria may be largely a side effect of a long, slow battle of the sexes among mosquitoes.

Certain reproductive quirks of male and female *Anopheles* mosquitoes look as if they evolved in some back-and-forth scenario, researchers report in the Feb. 27 *Science*. In four of 16 species analyzed, males dose their sperm packages with unusually large amounts of a steroid hormone. Among other effects, it virtually ensures a male that he alone will father all the offspring of the hormone's recipient. In turn, females of these species make their own compound that modifies the steroid's activity in their bodies. Out of all this sexual chemistry come traits that help make these four species among the most dangerous malaria spreaders for people.

"Historically we've been so narrow-minded in studying mosquitos," says Laura Harrington of

Cornell University, who works with species that spread dengue and yellow fever. The new study, however, puts basic biology in a broad evolutionary sweep. “The more we learn, the more new and novel targets will be revealed for controlling mosquitoes,” she says.

About 40 species of the *Anopheles* mosquitoes carry malaria, explains Adam South of the Harvard T.H. Chan School of Public Health, a coauthor of the study. Despite decades of medical research, the annual death toll still hits about 600,000.

Mating mosquitoes “are really, really, really hard to study,” South says. They mate in swarms of 20 to several hundred, or even several thousand, and some species just won’t swarm in labs. In the field, males gather in the dark, and encounters with females, all in midair, can last just 17 seconds.

For decades of studying insect ejaculates, “people focused on proteins, proteins, proteins,” South says. But in 2008 researchers were startled to discover that *A. gambiae* mosquitoes dope their sperm packages with the steroid hormone called 20E. South says that hormone has turned out to be “a very big deal.”

The steroid triggers egg-laying behavior, and recipient females produce about 20 to 25 percent more eggs than they would without it. Those females hardly ever mate again. An injection of 20E changes the activity of hundreds of the female’s genes, South says.

In 2013, the female side came into focus. *A. gambiae* females produce a protein nicknamed MISO that turns out to be essential for some of the big effects that 20E has on them, reported many of the same authors of the current paper, including lab leader Flaminia Catteruccia of Harvard. When researchers sabotaged MISO, the hormone-induced egg boost disappeared.

Making mosquitoes better malaria vectors was hardly likely to have mattered in the evolution of the mutual chemistry. But after some 20E, female *A. gambiae* mosquitoes develop especially large populations of parasites and tend to live longer, both traits that make them better at infecting people.

Checking on patterns of intimate biology across some of the many other *Anopheles* species, the researchers concluded that 20E and MISO systems probably evolved in tandem. For instance, the males of four species — *gambiae*, *arabensis*, *stephensi* and *funestus* — all brewed a substantial amount of 20E in glands that secrete their seminal fluid. And all deliver their hormone in a tidy package called a mating plug. Females in these four species made very similar forms of MISO.

Hints of similar patterns are showing up in the *Aedes* mosquitoes that Harrington works with. These mosquitoes don’t transfer the 20E hormone, but something else in seminal fluids could be affecting transmission of various diseases.

Whether his-and-hers compounds represent the outcomes of actual sexual conflict isn’t clear just from the genetic data, South says. Maybe the his/hers chemistry started as a conflict. And maybe, when males chemically enforced fidelity, the hormone became more like a nuptial gift of fecundity. In any case, the sexual politics of insects power a human scourge.

Citations

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Further Reading

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