

## GENES &amp; CELLS

# Malaria molecule lures mosquitoes

Chemical cues prompt insects to gorge on infectious meal

BY LAUREL HAMERS

Malaria parasites seduce mosquitoes on the sly.

*Plasmodium falciparum* parasites produce a molecule that makes parasite-infected blood more attractive to malaria-transmitting mosquitoes, scientists report online February 9 in *Science*. The insects slurp up this enticing meal, helping the parasite spread to new hosts.

"It's a really intriguing glimpse into how *Plasmodium* might have evolved to enhance its probability of transmission," says Conor McMeniman, a mosquito

researcher at Johns Hopkins University.

Scientists had suspected mosquitoes are preferentially drawn to malaria-infected people, but it was unclear what piqued the insects' interest. Biologist Noushin Emami of Stockholm University and colleagues got an unexpected lead when studying the effect of a molecule called HMBPP on the immune systems of *Anopheles gambiae* mosquitoes, which spread malaria. *P. falciparum* releases the molecule into its hosts' blood.

While watching mosquitoes sip blood from artificial feeders, the researchers noticed that mosquitoes ate more blood when HMBPP was present, says biologist Ingrid Faye, also at Stockholm University.

When HMBPP, or (E)-4-hydroxy-3-methyl-but-2-enyl pyrophosphate, was mixed

with serum, which lacks red blood cells, the mosquitoes weren't that interested. But red blood cells with added HMBPP released more carbon dioxide than regular red blood cells, and produced greater amounts of airborne chemicals called aldehydes and monoterpenes. That aroma attracted more mosquitoes, which also ate larger than usual meals.

Mosquitoes use the CO<sub>2</sub> that humans exhale as a cue to find food. So it makes

sense that increased CO<sub>2</sub> would draw more mosquitoes. Aldehydes and monoterpenes might make humans smell a bit like the plants mosquitoes get nectar from, McMeniman says. But since HMBPP was tested in artificial feeders, it's unclear how strongly the molecule lures mosquitoes to infected humans, he says. ■



A molecule in blood infected with malaria attracts *Anopheles gambiae* mosquitoes.

## HUMANS &amp; SOCIETY

# Abuse hinders children's social learning

Inconsistent rewards early in life lead to disruptive behavior

BY BRUCE BOWER

Physical abuse at home doesn't just leave kids black and blue. It also bruises their ability to learn how to act at school and elsewhere, contributing to abused kids' well-documented behavior problems.

Derailment of a basic form of social learning has, for the first time, been linked to these children's misbehavior years down the line, psychologist Jamie Hanson of the University of Pittsburgh and colleagues report February 3 in the *Journal of Child Psychology and Psychiatry*. Experiments indicate that physically abused kids lag behind their nonabused peers when it comes to learning to make choices that consistently lead to a reward.

"Physically abused kids fail to adjust flexibly to new behavioral rules in contexts outside their families," says coauthor Seth Pollak, a psychologist at the University of Wisconsin–Madison. Youth who have endured assaults by their parents view the world as a place where hugs and other gratifying responses to good behavior

occur inconsistently, if at all. So these youngsters stick to what they learned early in life—rewards are rare and unpredictable, but punishment is always imminent. Kids armed with this expectation of futility end up fighting peers and antagonizing teachers, Pollak says.

If correct, the finding could lead to new interventions, such as training kids in impulse control and how to distinguish safe from dangerous settings, Pollak says. Current treatments focus on helping abused children feel safe and less anxious.

Over 117,000 U.S. children were victims of documented physical abuse in 2015, the latest year with available data.

"Inflexible reward learning is one of many possible pathways from child maltreatment to later behavior problems," says Stanford University psychologist Kathryn Humphreys, who was not part of the study. Other possible influences include a heightened sensitivity to social stress and a belief that others always have bad intentions, Humphreys suggests.

Hanson's team studied 41 abused and 40 nonabused kids, ages 12 to 17, who came from various racial backgrounds and lived with their parents in poor or lower middle-class areas. All had similar intelligence and school achievement.

In one test, kids saw an image of a bell or a bottle and had to choose between the two to earn points. With enough points, kids could select any of several desirable prizes, including a chemistry set. With fewer points, kids could choose plainer prizes, such as colored pencils.

Over 100 trials, one image chosen at random by the researchers at the start of the experiment resulted in points 80 percent of the time. The other image yielded points 20 percent of the time. In a second round of 100 trials using pictures of a bolt and a button, one randomly chosen image resulted in points 70 percent of the time versus 30 percent for the other image.

Both groups chose higher-point images more often as trials progressed. But abused kids lagged behind in learning: They chose the more-rewarding image on an average of 131 of 200 trials; nonabused kids did so on 154 of 200 trials. Abused kids were held back by what they had learned at home, Pollak suspects. ■