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The war on bugs

Melissa Pandika, OZY 10:34 a.m. EDT October 13, 2014



An adult female mosquito piercing skin with proboscis. (Photo: © 3d4Medical.com/Corbis)

You'd think they'd just kill the little buggers.

Faced with more than 600,000 deaths a year from malaria, scientists and their philanthropic backers have set their sights on the lowly mosquito. If we could annihilate mosquitoes, malaria would go, too, and with it dengue and other plagues.

But simple extermination by DEET is not going to work — the ecological consequences could be disastrous.

Enter mosquito disorientation, misdirection, sabotage and even torture: Researchers from the World Health Organization to the Gates Foundation are trying to confound the insects before they pass on the deadly malaria parasite. The new crop of inventions goes well beyond the reliable bed nets of yore. Think light curtains that disturb mosquitoes' nervous systems. A human-scented cologne that will make them suck cows' blood instead of yours. There's even a fence that zaps them with a laser beam midflight. And, of course, there are glow-in-the-dark parasites.

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Total cost of the global bug war? Unknown. But billions of dollars have been spent trying to eradicate malaria over the years, a good chunk coming from the Gates Foundation itself. Of course, mosquito control is just part of a three-pronged strategy against the spread of malaria, which remains one of the world's thorniest and most tragic health challenges. [It sickened some 207 million people in 2012](#) and killed roughly 627,000 — most of them kids in African countries. Confounding the bloodsuckers won't solve everything. That's why scientists are also developing drugs for malaria treatment and prevention. Several companies are at work on a vaccine, which could be the ultimate malaria killer.

"If you put all three together, working in a concerted fashion, then I think you could really have a shot at eliminating malaria," says Miguel Prudêncio, a principal investigator at the **Instituto de Medicina Molecular in Portugal**. It's still early, of course, with most of the innovations still being tested. A vaccine that offers complete immunity will take much longer.

State-of-the-art today: Insecticide-treated nets (ITNs) that hang over beds. They're effective — according to the CDC, they've [reduced children's deaths \(from all causes\) by about 20 percent](#). But the insecticide needs to be re-applied every six to 12 months, and even the longest lasting ITNs keep their insecticide for only a few years.

The "photonic fence" zaps the hapless bugs with a laser, shooting them out of the sky.

Here's something that could last longer: a light curtain. Developed by Szabolcs Marka, a Columbia University physics professor, the curtain emits light at wavelengths that disturb mosquitoes' nervous systems. The curtain can be hung from doors and windows, and multiple curtains could be positioned to herd mosquitoes into traps — ricocheting like pinballs toward their doom. To make the curtain cost-efficient in developing countries, the physicist-inventor is taking it even more high-tech. He'll outfit the curtains with sensors, about \$2 a pop, so that the lights flash on only when mosquitoes are present. He and his colleagues plan to test the light curtain in Tanzania next year.

Marka is also developing a solar-powered rod that emits ultrasound waves that kill mosquito larvae before they hatch. It's an alternative to chemicals, of course. "Local people know where mosquitoes breed, so they can just take it into their own hands," simply touching it against the surface of the water, Marka says. Right now, his lab is scaling down the prototype to make it more portable.

Meanwhile, ISCA Technologies is creating a "cologne" for cattle that temporarily makes cows smell like humans, enticing mosquitoes to bite them instead of us. (Don't worry: Unlike humans, cows can't get malaria from Plasmodium-carrying mosquitoes.) And Intellectual Ventures has developed a "photonic fence," an infrared LED array that can detect female mosquitoes, the only ones that bite humans, by the beat of their wings. The fence zaps the hapless bugs with a laser, shooting them out of the sky.

Scientists are also developing more powerful antimalarial drugs, though it's tricky, because the parasite that causes malaria, Plasmodium, changes considerably over its life cycle. Most drugs kill Plasmodium when it's already in the human bloodstream, and few prevent transmission or kill the parasite inside the mosquito – which would be more efficient. Testing the drugs is a long, painstaking process. It involves feeding mosquitoes blood containing Plasmodium and a drug, dissecting them, and then counting the number of dead and living parasites.

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To speed it up, Koen Dechering, CEO of TropiQ Health Sciences in the Netherlands, inserted a firefly gene into Plasmodium, making it glow inside the mosquito. A photon detector measures the amount of light in the mosquito's midgut, revealing right away whether the drug it ingested killed the parasite. Today, TropiQ provides a drug screening service using the glowing parasite for companies and universities.

Of course, an effective vaccine could really do malaria in. The most advanced candidate, RTS,S/AS01, is in stage 3 clinical trials in seven African countries, with final results expected late this year. RTS,S contains a protein fragment from Plasmodium falciparum that triggers the production of antibodies that attack the protein if it reappears. But **Prudêncio** points out that RTS,S confers only partial immunity: It doesn't completely block infection, but it lowers the risk that it'll cause severe disease – in 30 percent of cases. Plus, its protection wanes after three or four years.

So far, the only way to provide complete immunity is a vaccine that contains the entire Plasmodium. But that process raises safety concerns, since it involves mass-producing deadly parasites. So **Prudêncio** is looking to a malaria parasite that infects rodents and shares many of the same proteins and other vital features as the human parasite – but doesn't cause disease in humans – cloaked with proteins unique to the human parasite.

Although **Prudêncio** believes an effective vaccine could eradicate malaria, "many years will pass" before one emerges. Until then, "we need to keep the investment in terms of bed nets, insecticides ... better drugs." To put it another way: Glow-in-the-dark bugs and light curtains won't eradicate malaria right away – but innovation across multiple fronts could zap it for good.

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