Science vs. Mosquitoes

We squash mosquitoes with our enormous hands. We poison-bomb them from spray trucks and airplanes. We irradiate them, drain their habitats, breed them experimentally in laboratories to confound their DNA. We’ve known for more than a century that a mosquito’s bite can pass on brutal disease: Zika is the virus receiving the most attention now, but malaria alone kills more than 400,000 people a year, and scores of thousands die from mosquito-borne yellow fever and dengue. To this day, insects smaller than a child’s thumbnail remain the most dangerous nonhuman animals on the planet.

And we are still trying to figure out how to vanquish them. There’s a line one hears frequently from entomologists and other mosquito experts, especially amid the Zika alarms: “We have no silver bullet.” What they really mean is no stake through the heart; silver bullets are for werewolves. Mosquitoes—some of them, anyway—are vampires. Of the 3,500 species that researchers have identified so far, only a few hundred feed on human blood, including the Zika-carrying *Aedes aegypti* and *Aedes albopictus*. Some, notably *Ae. aegypti*, turn out to be assailants of astonishing formidability.

Start with their physical equipment, especially in the mosquitoes that are the most anthropophagous, which is an elegant way of saying they prefer human blood. A mosquito homes in on you by sensing the proximity of blood from your sweat, your breath, your warmth. Her feeding apparatus, that elaborate proboscis, is a multipart marvel with a skin-piercing fascicle of tiny stylets that can suck your blood while injecting mosquito saliva laced with an anticoagulant. A mosquito can slip that fascicle into your skin so gently that you have no idea what’s happening until the blood meal is already under way. She can sip your blood until she’s more than twice her weight and has to lumber off someplace to rest, jettisoning the liquid and retaining the nutrients, before she can fly properly again.

Yes, your vampire is always a female. In
The Feeding Tube

The mosquito's proboscis consists of tightly bound stylets called the fascicle, surrounded by a sheath known as the hypopharynx— which doesn't penetrate the skin.

Multipronged Strike
The fascicle pierces the skin. Each of the stylets has a different role in extracting blood.

Stealth Attack
Mosquito saliva acts as an anesthetic to numb the victim's skin, making the pain of penetration less noticeable, and as an anticoagulant to keep the blood flowing.

A Vicious Cycle
Viruses and parasites pass through the mosquito and into a new host in three general stages, usually over several days.

1 An infectious agent enters the mosquito in consumed blood, making its way to the gut.
2 It then moves through the mosquito's body, accumulating in the salivary glands.
3 Once in the saliva, the agent infects a host when the mosquito sucks blood.
Mosquito Maladies
Pathogens have adapted to thrive in different species of mosquitoes with characteristics that make them good hosts.

- **Zika Virus**
  - **Disease**: This rapidly spreading virus can cause defects in the unborn babies of infected pregnant women.
  - **Spread**: Nearly 50,000 cases were reported in 2015.
  - **Symptoms**: Fever, joint pain.

- **Chikungunya**
  - **Name**: Named after a Kimakonde word meaning "to be contorted.
  - **Spread**: Discovered in Tanzania, causes severe joint pain.

- **Yellow Fever**
  - **Symptoms**: Nearly 60,000 deaths a year are attributed to this skin-yellowing disease, which can be prevented with a vaccine.

- **Dengue Fever**
  - **Spread**: Spreading since the 1970s, the potentially fatal virus now threatens 50 percent of the world's population.

- **Malaria**
  - **Disease**: The parasitic disease killed more than 400,000 people in 2015. Most of the fatalities were in sub-Saharan Africa.

- **Lymphatic Filariasis**
  - **Disease**: This tropical disease alters the lymphatic system and causes disfiguration and enlargement of body parts.

- **West Nile Fever**
  - **Date**: In 1999, the appearsance of this virus in the U.S. highlighted the threat of vector-borne diseases outside native ranges.

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Aedes aegypti
- Found in cities, this insect feeds almost exclusively on human blood.

Aedes albopictus
- The aggressive, adaptable species can easily colonize the habitats of other mosquitoes.

Haemagogus
- These forest vectors of yellow fever can be identified by their metallic sheen.

Anopheles
- The only genus that transmits malaria, it is known for its long front feelers.

Culex quinquefasciatus
- These night feeders, common around the world, prefer to lay eggs in dirty water.

*Many species within the genus can transmit the disease.*

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In the mosquito world, males live off plants. The female is the biter, the worker, the source of human peril; she lives off plants too, but all those blood nutrients are for her eggs, the nourishing and laying of which are the great project of her short, purposeful, and somewhat solitary life. A single mating may be all an *Ae. aegypti* needs; she stores sperm inside her body, fertilizing separate batches of eggs as needed, up to several hundred at a time. Five or six occasions of egg laying are common for an *Ae. aegypti* that escapes extermination by swat or insecticide and reaches her expected month-long life span. The multiplication possibilities are staggering.

Ask biologists what natural advantage different mosquito species might have gained by spreading disease—why *Aedes* became the primary carrier of the Zika virus, for example, and *Anopheles* the carrier of malaria parasites—and they’re likely to tell you that you’re thinking about the question backward. It’s the pathogens, those disease-causing organisms driven to multiply in mammalian bodies, that over millennia “learned,” evolutionarily speaking, what excellent transport and delivery services some mosquitoes happen to provide. It’s not an easy ride for the pathogens: They have to survive being sucked into a mosquito’s gut, exposed to digestive enzymes, and then pushed through membranes into a mosquito salivary gland before being injected into the next warm-blooded host. The injectors, on the other hand, are simply perpetuating their family line. “It’s such a rare confluence of evolution that has allowed this to happen,” says Karl Malamud-Roam, a mosquito research scientist who helps direct a pest management program based at Rutgers University, “It’s hard to be a successful germ or mosquito.”

A modicum of respect seems in order, then, for this remarkable confluence and the very resourcefulness of the flying vampires. Consider the reproductive strategies of *Aedes aegypti*, which because of Zika has been the subject of international symposia and plans of attack. An *Ae. aegypti* will lay her eggs in the random bowl, create just by do, or an upwelling cistern with an egg batch at its bottom. Natural or man-made, a whole brood of mosquitoes hatches. These are the species that the western world (I’m talking malaria-carrying night) aren’t afraid of. *Aedes*-carriers.

And when *Ae. aegypti* escapes the de-spiriting current back to the city, it’s time that you get your own personal pest control system. It may mean a Kentucky exterminator March visit to help keep your place "Crisis in"
random bodies of water that humans tend to create just by living day to day. A pet dish will do, or an upturned jar top, a discarded tire, a cistern with a cracked lid. She will spread each egg batch around, making it much harder for natural or man-made interventions to wipe out a whole brood at once. She can find egg-laying spots that aren’t wet yet but will be, when the weather changes; she’s that ingenious. She bites all day long; bed nets (which have helped reduce worldwide malaria deaths because the malaria-carrying *Anopheles* tends to bite at night) aren’t as effective against Zika and other *Aedes*-carried diseases.

And when you reach down to slap a biting *Ae. aegypti*, she’s likely to dart lightly away, escaping the descending palm of death, and then come back to bite you again. “So she makes sure you get a multiple dose,” says University of Kentucky entomologist Grayson Brown, who in March went to Brazil, where Zika has hit hard, to help lead an *Aedes aegypti* summit.

“Crisis in the Americas” was the summit’s billing, and Brown says the discussion included more crises than the potentially explosive spread of Zika. Yellow fever remains a terrible worry, as do dengue, chikungunya, and Mayaro, a mosquito-spread monkey virus infecting people in northwestern Brazil. Defensive strategies under consideration range from simple to scientifically ambitious: campaigns to clean out breeding spots, experimental trap designs, larva-killing acoustic signals, plans to prevent mosquitoes from reproducing successfully by infecting them with bacteria or altering their genetic makeup. One presentation described an “autocide” technique that takes lethal advantage of the way *Ae. aegypti* spread each brood to multiple sites: lace the first with larva poison that the mosquito takes in when she lands. Then at her next site, she poisons her own offspring.

No silver bullets, though. “There is not going to be a silver bullet,” Brown says. “It’s going to be hard work. But it has to be done, on a year-to-year basis—for forever.”