Insects Play Host to Bacteria

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WATER BUGS AND MYCOBACTERIA

Buruli ulcer, an often disfiguring, potentially disabling disease sometimes called the "mysterious disease," is the third most common mycobacterial infection in humans, after tuberculosis and leprosy. Most outbreaks, caused by the environmental bacterium *Mycobacterium ulcerans*, occur in rural areas near human-disturbed aquatic habitats. Despite a 1998 World Health Organization initiative that kick-started global research on this emerging disease, the mode of transmission to humans remains unclear. A study in the July 2010 issue of *PLoS Neglected Tropical Diseases*, led by environmental microbiologist Laurent Marsollier, of the University of Angers, France, reflects the intensified research aimed at answering this question.

One hypothesis, supported by laboratory-based studies, is that biting water bugs act as both hosts and vectors of *M. ulcerans*. To explore the viability of this hypothesis in the field, Marsollier and colleagues sampled water bugs from both a disease-endemic area along the bank of the Nyong River in Cameroon and a nonendemic area 100 kilometers downstream. Over a 10-month period they collected six large samples from the endemic area and two from the nonendemic area.

Marsollier's team found that five families of water bugs from the endemic area tested positive for *M. ulcerans* DNA as detected by polymerase chain reaction (PCR). None from the nonendemic area tested positive. Three of the five PCR-positive families are able to bite humans (and fly). The researchers also detected *M. ulcerans* DNA in saliva samples from one human-biting species of water bug, and showed that 3 of 21 mice injected with that saliva developed lesions typical of *M. ulcerans*.

The results of this study "provide further evidence that water bugs are hosts and vectors of *M. ulcerans*," the authors write. "However," they add, "no definitive conclusion can yet be drawn concerning the precise importance of this route of transmission."

According to Richard Merritt, an entomologist at Michigan State University who studies the ecology of Buruli ulcer, "this paper shows that [water bugs] could very well be a reservoir, a carrier, for the pathogen, but it doesn't give us any more insight into transmission of the disease." For one thing, he says, there's no evidence tying insect bites to disease cases, and "these insects, over evolutionary time, have never bitten humans. The only way that they would feed on a human is purely accidental."

But Marsollier disagrees, noting "some water bug bites are painless, while some are confused with a wound caused by cutting aquatic plants. Water bugs are able to move so quickly in water [that] we do not see them." Thus, people who contract the disease, for which symptoms take weeks to months to develop, may not remember being bitten.

Buruli ulcer may turn out to be transmitted by more than one route. But, says Marsollier, "water bugs are… composed of different families that are largely found in all [disease-]endemic areas in the world." He and his colleagues, as well as Merritt and other investigators, are continuing studies aimed at understanding the ecology of *M. ulcerans*, collaring the disease-transmitting culprit(s), and unraveling the mystery of Buruli ulcer disease.

LADYBIRDS AND MALE-KILLERS

Many insect species, including lady birds (lady beetles, or ladybugs), are infected by harmful bacteria that are passed from mother to offspring through the eggs. Because these symbiotic bacteria are transmitted by females, some have evolved a male-killing strategy that selectively kills the embryo in eggs destined to become males, thereby favoring survival of their female hosts and leading to a distorted sex ratio. Extreme sex-ratio imbalances can make it tough for females to find a mate. Thus, evolutionary theory predicts a favoring of genes in the host that can counter the male-killing effect of the parasite and restore a 1:1 sex ratio.

In the July 2010 issue of *PLoS Pathogens*, Tamsin Majerus, of the University of Nottingham, United Kingdom, and the late Michael Majerus, of the University of Cambridge, present evidence of just such a phenomenon in the ladybird *Cheilomenes sexmaculata*. Male killing is common in aphid-eating ladybirds, most likely because newly hatched offspring in a clutch of eggs often survive by eating unhatched eggs. If eggs destined to be males don't hatch, the emerging females, which harbor the bacteria, can feed on those eggs and gain an advantage, explains John Werren, an evolutionary geneticist at the University of Rochester.

Majerus and Majerus identified the male-killer in *C. sexmaculata* as a γ-proteobacterium, which is in the same class as *Escherichia coli*. Through a series of genetic crosses, they showed that some ladybirds had a version of a gene that rescues male offspring from the deadly effects of the proteobacterium and is inherited in a Mendelian fashion. "There have been very few studies…that really document this kind of [evolutionary] cat-and-mouse game that goes on between the host and the bacteria," Werren says. "This paper is particularly nice in well documenting a dominant rescue gene in these lady beetles. It's interesting, too, because the rescue gene doesn't eliminate the bacterium, it simply overrules its male-killing effect." And, Werren says, the authors also raise a good point: "There could be a lot of hidden male-killers out there in nature, and the reason they are hidden is that there is a rescue gene."

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