Of lice and man: Researchers sequence human body louse genome

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The human body louse, *Pediculus humanus humanus L.*, has been a witness to, and participant in, millions of years of human history. Credit: CDC Photo, Courtesy of Frank Collins, Ph.D.

Like an unwelcome houseguest or itinerant squatter, the human body louse shows up when times are bad and always makes them worse. Now a multi-institutional team reports that it has sequenced the body louse genome, an achievement that will yield new insights into louse - and human - biology and evolution.

The study, which also sequenced the genome of a microbe that lives inside the body louse, appears in Proceedings of the National Academy of Sciences.

Thanks to its tenacity, the tiny, blood-sucking parasite *Pediculus humanus humanus L.* has witnessed, and played a role in, millions of years of human history. The body louse spread epidemic typhus and what is now termed trench fever to Napoleon's retreating army in Russia in 1812, and body lice plagued Lewis and Clark on their adventures in the New World.

The human body louse seems to appear out of nowhere during economic downturns, wars and other crises that cause people to live in unsanitary conditions. It is closely related to the head louse, *Pediculus humanus capitis*, which also feeds on human blood. But the body louse lives in clothing and, unlike the head louse, can spread bacterial diseases.

The body louse genome is the smallest known genome of any insect, said University of Illinois entomology professor Barry Pittendrigh (pronounced PITT-in-dree), who led the drive to fund the project and coordinated the international team of scientists who analyzed the sequence. The size of the body louse genome probably reflects its rather protected habitat and predictable diet, he said.

"The ecology of lice is very, very simple. It either lives in your hair or on your clothing, and it has one type of meal, and that's blood," he said. "So most of the genes that are responsible for sensing or responding to the environment are very much reduced."

The genome analysis found very few genes for light-sensing protein receptors, for example. University of Illinois entomology professor Hugh Robertson was responsible for sorting out the genes contributing to chemical sensing, and discovered that the louse has significantly fewer taste and odorant receptors than other insects.

The body louse also has "the smallest number of detoxification enzymes observed in any insect," the researchers wrote. John Clark, of the University of Massachusetts at Amherst, and Si Hyeock Lee, of Seoul National University, led this part of the analysis. The body louse's pared-down list of detoxifying enzymes makes it an attractive organism for the study of resistance to insecticides or other types of chemical defense, Pittendrigh said. University of Illinois entomology professor and department head May Berenbaum and former graduate student Reed Johnson contributed to this effort.

The body louse is completely dependent on humans for its survival; it will die if separated from its host for very long. It is just as reliant on a microbe that lives inside it: the bacterium *Candidatus* Riesia pediculicola.

In the Riesia genome, the team found genes for the production of an essential nutrient, pantothenate (Vitamin B5), which the louse requires and cannot make on its own.

The Riesia genome also is quite small in comparison to its closest "free-living" relatives. So too are the genomes of the bacterial pathogens that the body louse transmits to its human hosts: *Rickettsia prowazekii* (which causes epidemic typhus), *Borrelia recurrentis* (the agent of relapsing fever) and *Bartonella quintana* (which causes trench fever). This, the researchers report, will make the body louse a useful tool for understanding the co-evolution of disease-carrying parasites and their bacterial co-conspirators.

The body louse genome will aid a host of other lines of research, Pittendrigh said.

"Lice have been used to understand human evolution and migration. They've been used to estimate when we started wearing clothing," he said. "The genome should also help us develop better methods of controlling both head and body lice."

"Beyond its importance in the context of human health, the body louse genome is of considerable importance to understanding insect evolution," Berenbaum said. "It is only the second genome sequenced to date of an insect with gradual development - that is, that does not undergo profound anatomical and ecological change as it matures from egg to adult. Although most of the insect species on the planet undergo complete metamorphosis - developing from egg to caterpillar to pupa to adult - in fact gradual metamorphosis is the older developmental program. The body louse genome can provide a baseline for understanding how complete metamorphosis, a key to insect domination of the planet, came to evolve."

More information: "Genome Sequences of the Human Body Louse and its Primary Endosymbiont Provides Insights into the Permanent Parasitic Lifestyle," PNAS.

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