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Parasitic wasps' genomes provides new insights into pest control, genetics (w/ Video)

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This is a Nasonia female. Credit: University of Rochester

Parasitic wasps kill pest insects, but their existence is largely unknown to the public. Now, scientists led by John H. Werren, professor of biology at the University of Rochester, and Stephen Richards at the Genome Sequencing Center at the Baylor College of Medicine have sequenced the genomes of three parasitoid wasp species, revealing many features that could be useful to pest control and medicine, and to enhance our understanding of genetics and evolution. The study appears in today's issue of *Science*.

"Parasitic wasps attack and kill pest insects, but many of them are smaller than the head of a pin, so people don't even notice them or know of their important role in keeping pest numbers down," says Werren. "There are over 600,000 species of these amazing critters, and we owe them a lot. If it weren't for parasitoids and other natural enemies, we would be knee-deep in pest insects."

Parasitoid wasps are like "smart bombs" that seek out and kill only specific kinds of insects, says Werren. "Therefore, if we can harness their full potential, they would be vastly preferable to chemical pesticides, which broadly kill or poison many organisms in the environment, including us."

The three wasp genomes Werren and Richards sequenced are in the wasp genus *Nasonia*, which is considered the "lab rat" of parasitoid insects. Among the future applications of the *Nasonia* genomes that could be of use in pest control is identification of genes that determine which insects a parasitoid will attack, identification of dietary needs of parasitoids to assist in economical, large-scale rearing of parasitoids, and identification of parasitoid venoms that could be used in pest control. Because parasitoid venoms manipulate cell physiology in diverse ways, they also may provide an unexpected source for new drug development.

In addition to being useful for controlling pests and offering promising venoms, the wasps could act as a new genetic system with a number of unique advantages. Fruit flies have been the standard model for genetic studies for decades, largely because they are small, can be grown easily in a laboratory, and reproduce quickly. *Nasonia* share these traits, but male *Nasonia* have only one set of chromosomes, instead of two sets like fruit flies and people. "A single set of chromosomes, which is more commonly found in lower single-celled organisms such as yeast, is a handy genetic tool, particularly for studying how genes interact with each other," says Werren. Unlike fruit flies, these wasps also modify their DNA in ways similar to humans and other vertebrates—a process called "methylation," which plays an important role in regulating how genes are turned on and off during development.

"In human genetics we are trying to understand the genetic basis for quantitative differences between people such as height, drug interactions and susceptibility to disease," says Richards. "These genome sequences combined with haploid-diploid genetics of *Nasonia* allow us to cheaply and easily answer these important questions in an insect system, and then follow up any insights in humans."

The wasps have an additional advantage in that closely related species of *Nasonia* can be cross-bred, facilitating the identification of genes involved in species' differences. "Because we have sequenced the genomes of three closely related species, we are able to study what changes have occurred during the divergence of these species from one another," says Werren. "One of the interesting findings is that DNA of mitochondria, a small organelle that 'powers' the cell in organisms as diverse as yeast and people, evolves very fast in *Nasonia*. Because of this, the genes of the cell's nucleus that encode proteins for the mitochondria must also evolve quickly to 'keep up.' " It is these co-adapting gene sets that appear to cause problems in hybrids when the species mate with each other. Research groups are now busy trying to figure out what specific kinds of interactions go wrong in the hybrid offspring. Since mitochondria are involved in a number of human diseases, as well as fertility and aging, the rapidly evolving mitochondria of *Nasonia* and coadapting nuclear genes could be useful research tools to investigate these processes.

A second startling discovery is that *Nasonia* has been picking up and using genes from bacteria and Pox viruses (e.g. relatives of the human smallpox virus). "We don't yet know what these genes are doing in *Nasonia*," says Werren, "but the acquisition of genes from bacteria and viruses could be an important mechanism for evolutionary innovation in animals, and this is a striking potential example."

A companion paper to the *Science* study, published today in *PLoS Genetics*, reports the first identification of the DNA responsible for a quantitative trait gene in *Nasonia*, and heralds *Nasonia* joining the ranks of model genetic systems. The study reveals that changes in "non-coding

DNA," the portion that does not make proteins but can regulate expression of genes, causes a large developmental difference between closely related species of *Nasonia*. This finding relates to an important ongoing controversy in evolution - whether differences between species are due mostly to protein changes or regulatory changes.

"Emerging from these genome studies are a lot of opportunities for exploiting *Nasonia* in topics ranging from pest control to medicine, genetics, and evolution," says Werren. "However, the community of scientists working on *Nasonia* is still relatively small. That is why we are hoping that more scientists will see the utility of these insects, and join in efforts to exploit their potential."

Provided by University of Rochester

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