

## Scientists sequence genomes of two ant species for the first time

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A worker of the jumping ant *Harpegnathos saltator*, with sickle-shaped mandibles and large eyes used for hunting prey. Credit: Jürgen Liebig

Scientists have finally sequenced the entire genome of an ant, actually two very different species of ant, and the insights gleaned from their genetic blueprints are already yielding tantalizing clues to the extraordinary social behavior of ants.

A result of a ground-breaking collaborative research project led by Danny Reinberg, PhD, professor of biochemistry at NYU Langone Medical Center and a Howard Hughes Medical Institute Investigator, the analysis of the genomes is published in the August 27, 2010 issue of *Science*.

One of the <u>ant species</u> is known as Jerdon's jumping ant, and the other, the Florida carpenter ant, is a destructive pest in the Southeastern United States. Their complex social behavior, and their ability to be maintained



in a laboratory, make them ideal species to study epigenetics, how genes are turned on or off in response to changing conditions rather than through alterations to actual sequences of DNA. Epigenetics determine which genes are expressed in cells, thereby say distinguishing a nerve cell from a skin cell, and how modifications to <u>gene expression</u> can be passed on to future cell generations.

"<u>Ants</u> are extremely social creatures and their ability to survive depends on their community in a very similar way to humans," said Dr. Reinberg, who is also a member of the NYU Cancer Institute. "Whether they are workers, soldiers or queens, ants seem to be a perfect fit to study whether epigenetics influences behavior and aging."

Dr. Reinberg has devoted most of his career to understanding the molecular machinery that determines how genes are turned on and off. He is especially interested in how epigenetics may influence longevity—in some <u>ant colonies</u> the queens live up to ten times longer than worker ants. Although he was always fascinated by ants, it took years for the technology to catch up with the inspiration to study the interaction of epigenetics with longevity and behavior in these animals.

The ant genome project began in 2008 when Dr. Reinberg and his team won a grant from the Howard Hughes Medical Institute to study the epigenetic differences between ant species and to tie them to processes in other animals, including humans. His principal collaborators are Jürgen Liebig of Arizona State University and Shelley Berger of the University of Pennsylvania School of Medicine. The genome sequencing was performed in collaboration with the Beijing Genomic Institute in Shenzhen, China.





A major worker of the carpenter ant *Camponotus floridanus* with its typically enlarged head. Credit: Jürgen Liebig

"In studying the genomes of these two ants, we were fascinated by the different behaviors and different roles that the worker ants develop," said Dr. Reinberg. "Since every ant in the colony starts with the same genetic information, the different neuronal connections that specify the behavior appropriate for each social rank, must be controlled by epigenetic mechanisms. The findings could potentially help us learn more about the effect of epigenetics on brain function in humans."

Comparing the two ant species, the scientists found that approximately 20 percent of their genes are unique, while some 33 percent are shared with humans. Researchers also established that the carpenter ant genome has about 240 million bases and the jumping ant has approximately 330 million bases, about one-tenth of the human genome. Bases are the building blocks of DNA. They also found that the carpenter ant has 17,064 genes and the jumping ant has 18,564, compared to about 23,000 in humans.

The jumping ant, or Harpegnathos saltator, lives in small colonies and



when the queen dies, fighting erupts among workers, until a few prevail and become replacement queens. These new queens, or gamergates, actually live longer than their worker siblings. In fact, Dr. Reinberg and his colleagues found an over-expression of proteins linked to longevity, including the enzyme telomerase, in these replacement queens.

Interestingly, replacement queens also contained an abundance of small RNAs, short stretches of genetic material that fine tune gene expression in many organisms, including humans.

The carpenter ants, or *Camponotus floridanus*, have a far more sophisticated cast system and social organization. Only the queen lays fertilized eggs and when she dies, so does the colony. Non-reproductive ants belong to two separate castes, major and minor workers. Major workers protect the colony, while minor workers forage for food. Even though these two types of worker ants begin life remarkably similar, epigenetics sculpt their brains and behaviors in different ways leading to their specialized tasks. Comparing major and minor workers, Dr. Reinberg and his team discovered large differences in the expression of genes that function in the brain, a small but important step toward understanding how genes influence behavior in ants.

"After the honey bee, ants are the second family of social insects to have their genome sequenced," said Roberto Bonasio, PhD, in the Department of Biochemistry at NYU Langone Medical Center and one of the coauthors of the study. "The next challenge is to start manipulating the genome of ants so that we can learn the function of specific genes related to aging and behavior."

Provided by New York University School of Medicine

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