

Honey bee invaders exploit their genetic resources

By Diana Yates
News Bureau Staff Writer

Like any species that aspires to rule the world, the honey bee, *Apis mellifera*, invades new territories in repeated assaults. A new study demonstrates that when these honey bees arrive in a place that has already been invaded, the newcomers benefit from the genetic endowment of their predecessors.

The findings appear last week in Proceedings of the National Academy of Sciences.

The researchers, UI entomology professor Charles Whitfield and postdoctoral researcher Amro Zayed, analyzed specific markers of change in the genes of honey bees in Africa, Europe, Asia and the Americas. They also focused on geographic regions – such as Brazil in South America – where multiple honey bee invasions had occurred.

The researchers were looking for tiny variations in the sequences of nucleotides that make up all genes. Certain versions of these single nucleotide polymorphisms (SNPs, or “snips”) are more common to African honey bees, while others occur more frequently in honey bees in western Europe, eastern Europe, or Asia.

By comparing these SNPs in bees from different geographic territories, and by looking at the frequency at which particular alleles, or variants, occur in functional and nonfunctional parts of the honey bee genome, the researchers were able to determine that the invading bees were not just randomly acquiring genetic material from their predecessors by interbreeding with them, but that certain genes from the previously introduced bees were giving the newcomers an advantage.

An earlier study led by Whitfield and published in Science in 2006 showed that *A. mellifera* originated in Africa and not Asia, as some had previously hypothesized.

That study revealed that the honey bee had expanded its territory into Eurasia at least twice, resulting in populations in eastern and western Europe that were quite different from one another.

The earlier analysis also confirmed and extended results of previous studies showing that African honey bees had mixed with but largely displaced their predecessors in the New World, which were primarily of western European stock. When the European old-timers mixed with the African newcomers, their offspring looked, and in most respects behaved, like the African honey bees.

These more aggressive, “Africanized” bees (so-called “killer bees”) received a lot of media attention in the U.S. as they moved north from South America. According to the U.S. Department of Agriculture, the first Africanized honey bees appeared in Texas in 1990. In less than a decade they also had spread to southern California, Arizona, Nevada and New Mexico.

Whitfield and Zayed wanted to understand the evolutionary mechanism that allowed the African honey bees to move into these new territories and dominate the bees that had arrived in the New World centuries earlier from eastern and western Europe.

Their analysis of about 440 SNPs selected randomly from throughout the Africanized honey bee genome showed that most of the alleles were common to African honey bees. But of the alleles common to European bees, those found in functional parts of the genome (in genes) were showing up more frequently than those in nonfunctional regions (between genes).

“We asked the question: Is hybridization an essentially random process?” Zayed said. When the African honey bees mated with the western European honey bees that had been in South America for centuries, one might expect that the hybrid offspring would randomly pick up both the functional and nonfunctional parts of the genome, he said.

“But actually what we found was there was a preference for picking up functional parts of the western European genome over the nonfunctional parts.”

It appeared that the Africanized bees that kept some of the functional western European genes were gaining an advantage, Whitfield said.

“Those African bees are doing better because there were western European honey bees there for them to mix with,” he said. “Now we can say we have a signature for evolution in the genome.”

While the researchers do not yet know how these European honey bee genes are enhancing the survival and fitness of the Africanized bees in the Americas, Whitfield said, it may be that specific traits from western Europe are beneficial, or it may be that being a hybrid is, in and of itself, a good thing for these bees.

In a separate finding, the researchers also discovered a genomewide signature of evolution associated with the ancient expansion of honey bees from Africa into temperate regions of western and northern Europe. In this expansion, functional parts of the genome have changed more than nonfunctional parts. Whitfield thinks that these changes may involve social adaptations to survive the hard winters.

“The way the honey bees survive in temperate regions is sort of the way humans do,” Whitfield said. “They have a shelter. They



photo by L. Brian Stauffer

Genomic evolution Entomology professor Charles Whitfield, right, and postdoctoral researcher Amro Zayed analyzed specific markers of change in the genes of honey bees in Africa, Europe, Asia and the Americas. They also focused on geographic regions – such as Brazil in South America – where multiple honey bee invasions had occurred.

store resources.”

Not needing to survive in such cold weather, African bees store less food and reproduce more.

“So how does an animal that’s basically tropical make it? How does it expand its territory and

thrive in very harsh winter conditions in this temperate region?” Whitfield asked. “Humans did it, and *Apis mellifera* did it in some interestingly parallel ways.”

Whitfield is an affiliate of the Institute for Genomic Biology. ♦

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ship on environmental issues and has provided seed funding to five working groups that are developing curricula and conducting research into global warming, renewable energy, and other issues. Through the Energy Biosciences Institute, a collaboration with the University of California-Berkeley, the Lawrence Berkeley National Laboratory and BP, the UI established the world’s first research institution dedicated to the emerging field of energy bioscience and the development of next-generation biofuels.

Herman also recently endorsed the Urbana campus Energy Use Policy, establishing seasonal building temperature guidelines, emphasizing personal responsibility in energy

conservation, and requiring larger renovation projects and new construction projects to qualify for silver-level certification under the U.S. Green Building Council’s Leadership in Energy and Environmental Design program. The Business Instructional Facility, opening this fall, is being constructed to LEED gold standards with a green roof, photovoltaic panels and special lighting controls. Accordingly, the preliminary design for the National Center for Supercomputing Applications’ Blue Waters petascale computing facility, expected to go online in 2011, includes a 98 percent efficient power distribution system and a cooling tower for water-cooled hardware. The campus also is retro-fitting the heating, ventilating and

air conditioning systems in many other buildings to maximize efficiency.

Students are involved in many green projects on campus, including a program in which waste vegetable oil from university dining halls is being collected and converted into biodiesel for fueling university vehicles. Curricular initiatives include student teams performing energy audits of campus buildings and developing a sustainable design for the South Farms. Interdisciplinary student teams also participate in the U.S. Department of Energy’s biennial Solar Decathlon, in which they design, build and operate energy-efficient, fully solar-powered homes. ♦

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