SCOTT BAUER (K7107-12)

MORE BUZZ ABOUT A BAD BEE

Africanized Honey Bees in the News Again

After 5 years of being fairly settled, Africanized honey bees (AHBs) have been on the move for the past 2 years, spreading into four new states—Florida, Oklahoma, Arkansas, and Louisiana—since fall 2005.

Before that, AHBs had spread into five southwestern states—Texas, Arizona, New Mexico, California, and Nevada, in that order—between October 1990 and 2005.

"No one can say for sure why AHBs suddenly started spreading again, but there are several factors that are likely to have played a part," explains ARS entomologist Gloria DeGrandi-Hoffman, research leader at the Carl Hayden Bee Research Center (CHBRC) at Tucson, Arizona. DeGrandi-Hoffman is also the leader for ARS's Africanized honey bee research program.

"First, it took some time for Africanized honey bees to fill up all the nest sites in the areas they were already in, so there probably wasn't a lot of population pressure to expand outwards," DeGrandi-Hoffman says. "Then, when you add in the number of empty nest sites because of the toll *Varroa* mites have taken on the feral honey bee population, it meant there was even more space for Africanized honey bees to fill up before they needed to spread north and east."

Another reason why AHBs have been found in new places is that more people are looking for them today then ever before. New monitoring trap lines were established in the past few years as new states began to expect AHBs, and individuals are more sensitized to notice honey bees that could be Africanized. "More looking often means more finding," DeGrandi-Hoffman says.

Another factor that may be contributing to this new surge in AHB spread is what's known as "human-assisted transport"—AHBs hitching rides on trucks, ships,

PEGGY GREB (D706-1)

Entomologist Gloria DeGrandi-Hoffman observes bees from an African honey bee colony.

Honey Bee Comparison

	African	Hybrids	European
Emerge earlier	❍	❍	
Drones more likely to be mated with	❍		
Sperm used preferentially	❍	❍	
Colonies prone to usurpation			❍
Faster colony growth rate	❍		
Lower survival fitness		❍	
More resistant to *Varroa* mites	❍	❍	

and railroad cars from Central and South America to the United States. Human-assisted transport is the most likely reason for the finds of AHBs in South Florida, which are not connected to the main spread up through Texas and to the east.

A Little Background

No honey bees are native to the New World, so they can't be considered true wild insects. Before AHBs appeared, all feral honey bees were descendants of honey bees brought by European colonists in the 1600s and 1700s; hence, the term "European honey bee" (EHB). European honey bees are better adapted to temperate climates; African honey bees are more suitable to the Tropics. A hybrid of the two is referred to as "Africanized." Today's AHBs most likely came from a combination of releases and escapes of bees imported in the 1950s to improve honey production.

What Makes a Bad Bee Stay Bad

While AHBs and EHBs look the same to the eye, there are several important differences between them. Among the most overt behavioral differences is the AHB's well-known defensive behavior. AHBs will ardently defend their nest, stinging in greater numbers and on less provocation than EHBs. But both types of honey bees exhibit the entire gamut of defensive behavior, from very mild to very defensive. It is simply that AHBs tend to cluster at the more defensive end of the continuum. "And on any given day, the same hive can show more or less defensive behavior, depending on factors such as food supply and weather," DeGrandi-Hoffman says.

Another behavioral difference is that AHBs are more likely to desert a nest site when food sources become less available or when disturbed. This trait makes them harder to use in managed beekeeping.

DeGrandi-Hoffman is studying whether behaviors like these are genetically controlled or due to the social environment of the nest. She takes EHB workers just as they emerge from the pupae, marks them, and places them in AHB hives and vice versa. She's currently tracking the age at which the bees first forage and exhibit their defensive response.

"Once we observe marked bees performing the selected behaviors, we quick-freeze the bees and send them off to our collaborator Gene Robinson, at the University of Illinois, for analysis of gene expression," DeGrandi-Hoffman says.

One advance making this research possible is the completion of the Honey Bee Genome Project. This project has sequenced the entire genetic map of the honey bee and is identifying which genes control expression of which traits. The CHBRC provided samples of AHBs to the project so that genetic differences could be fully mapped as the genomic library was developed.

DeGrandi-Hoffman says that the genetic differences between African and European honey bees might be very minor because they are two races within one species. "But there are some differences," she says. "We want to see if those differences govern the honey bee traits that people care most about."

What's in a Name?

The name "Africanized honey bee" came about because it was long believed that African bees would hybridize with European honey bees already in the wild, especially in temperate areas, where African honey bees were expected to lose their tropical climate adaptation advantages.

"Early in the invasion process, we expected normal and widespread interbreeding between the two subspecies of honey bees, ultimately producing a hybrid bee," explains DeGrandi-Hoffman.

But this hybridization has turned out to be less than expected. Recent population genetics studies have shown that feral honey bee populations tend to be predominantly African after several years of hybridization.

Two types of DNA govern gene flow in honey bee populations, and both can be traced. One is mitochondrial DNA, which is inherited solely from the mother (queen). The other is the DNA in the nucleus that comes 50-50 from the queen and the drone and is referred to as "nuclear DNA."

"As interbreeding continues, you would expect to find a variety of combinations and proportions of African and European genes in nuclear DNA," DeGrandi-Hoffman says. "But you don't. We've found that, in just a few years, EHB marker genes in nuclear DNA have become very difficult to detect in feral honey bee populations. European mitochondrial DNA also diminishes in frequency."

Several factors appear to give African honey bee DNA its ascendancy over hybrids and European honey bees.

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While entomologist Gloria DeGrandi-Hoffman observes, technician Mona Chambers releases marked European worker bees (see close-up above of a bee marked with a blue dot on its back) to study the role of hive environment on gene expression in an African honey bee colony.

First, European/African hybrids have lower metabolic rates than do pure African or European bees, and the wing shape in hybrids is slightly less symmetrical than in either pure race. These two points indicate that hybrids might have a lower level of fitness that could play into hybrid colonies' lack of survival in the wild.

Differences in mating-flight times also increase the chance of EHB queens mating more with African drones than with EHB drones. And oddly enough, DeGrandi-Hoffman recently found that even when queens are inseminated with sperm from an equal number of African and European drones, they preferentially use the African sperm, producing, on average, about 70 percent AHB offspring.

DeGrandi-Hoffman also found that when colonies are replacing their queens, African patriline queens (queens that had an African sire) emerge sooner than EHB rivals, giving them a big advantage in the fight to become the nest's new queen.

In addition, African colonies grow at a faster rate, devoting two to four times as much comb area to brood rearing as EHBs. So AHBs with these African traits simply outgrow the competition.

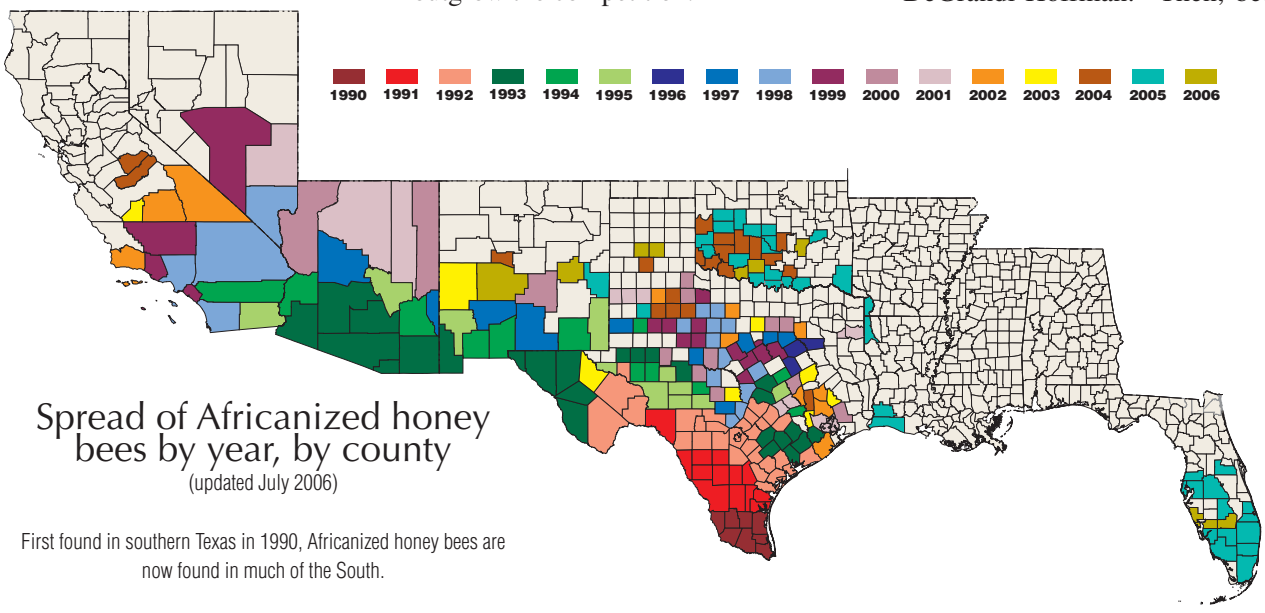
A unique AHB behavior, which also helps the population shift from European to African, is that they can invade and take over an EHB hive when the EHB queen is weakened by age or illness or is absent. In a single generation, the EHB matriline is eliminated, and an EHB hive has become Africanized. DeGrandi-Hoffman found that in southern Arizona, annual usurpation rates can reach 20 to 30 percent, especially in the fall swarming season, when AHBs are most likely to leave their nests to seek better foraging conditions.

"AHBs just seem to have a suite of traits and behaviors that enhance their ability to survive and thrive," DeGrandi-Hoffman says.

Best Advice for Beekeepers

Given all the advantages that AHBs have shown, it is no surprise that beekeeping in areas that are already Africanized is a big challenge.

"Our best advice for beekeepers is to buy European queens that have mated with European drones annually from reliable queen breeders and clearly mark the queens before putting them in the hives," says DeGrandi-Hoffman. "Then, beekeepers



Spread of Africanized honey bees by year, by county
(updated July 2006)

First found in southern Texas in 1990, Africanized honey bees are now found in much of the South.

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An Africanized honey bee (left) and a European honey bee on honeycomb. Despite color differences between these two bees, mostly they can't be identified by eye.

must be vigilant about making sure the marked queens don't get replaced."

This advice applies as much to hobby beekeepers who make a little honey as to the large commercial beekeepers who transport thousands of hives every spring to pollinate some of the 130 crops in the United States that rely on honey bees.

The other thing beekeepers can do is monitor the behavior of their bees. If a hive becomes hard to manage, it is time to introduce a new European queen.

There is one bit of good news for beekeepers. The anecdotal belief that AHBs are more resistant to *Varroa* mites appears to hold some truth.

"We don't know if that is simply because AHB workers and drones develop fast enough to prevent *Varroa* mites from completing their development in cells or if there are other things going on," DeGrandi-Hoffman says.

A research project on this issue is under way at the CHBRC. Collaborators include ARS entomologist Diana Sammataro as well as Diana Cox-Foster and Nancy Ostiguy from the Pennsylvania State University Entomology Department.

"We know that when *Varroa* mites feed on EHBs, it shuts down the bee's immune system. Right now we've started to look at AHBs to see if their immune systems shut down to the same extent," says DeGrandi-Hoffman.

They hope to have at least some preliminary answers within a year.—By **J. Kim Kaplan,** ARS.

This research is part of Crop Protection and Quarantine, an ARS National Program (#304) described on the World Wide Web at www.nps.ars.usda.gov.

Gloria DeGrandi-Hoffman is at the USDA-ARS Carl Hayden Bee Research Center, 2000 E. Allen Rd., Tucson, AZ 85719; phone (520) 670-6380, ext. 104, fax (520) 670-6493, e-mail gd-hoffman@tucson.ars.ag.gov. ✷

To Be Africanized or Not To Be Africanized?

ARS's Carl Hayden Bee Research Center in Tucson, Arizona, is home to the unit responsible for official USDA identification of honey bees as Africanized. This work is done in support of federal and state agencies.

Biological technician Mona Chambers heads the identification group, which looks at an average of about 25 samples every month, more during the spring swarming season.

"We get samples from all over the county, especially from ports and railroad stations that have cargo from South and Central America," says Chambers. "For example, we recently had positive AHB samples from swarms found on a ship in Elizabeth, New Jersey, and from a beekeeper in Mackinaw, Illinois."

The ship had come through the Panama Canal, where it easily could have picked up an AHB swarm. Port samples mostly come from USDA's Animal and Plant Health Inspection Service.

Bees that are identified as Africanized by their wing length measurements then move on to full morphometrics, which measures 37 different physical characteristics to confirm the identification.

Morphometrics remains ARS's official method of identification. "We're trying to update the system so it uses automated pattern-recognition software, like the facial-recognition software law enforcement agencies use," says Chambers. "This would speed the test up from the 40 minutes per sample it takes right now."

Some states have begun using DNA analysis for identification rather than morphometrics. "But DNA analysis will only tell part of the story about a bee sample," says research leader Gloria DeGrandi-Hoffman. "For example, mitochondrial DNA will determine whether bees have an African or European mother. If the bees have a European mother that mated with African drones, the colony is likely to be more defensive, but the DNA analysis will characterize the sample as European."

ARS does not have the resources to provide all of the testing for the United States, but it does help train people for states that are expecting AHBs. Recently, several Mid-Atlantic states have begun discussing starting a regional identification lab.—By **J. Kim Kaplan,** ARS.

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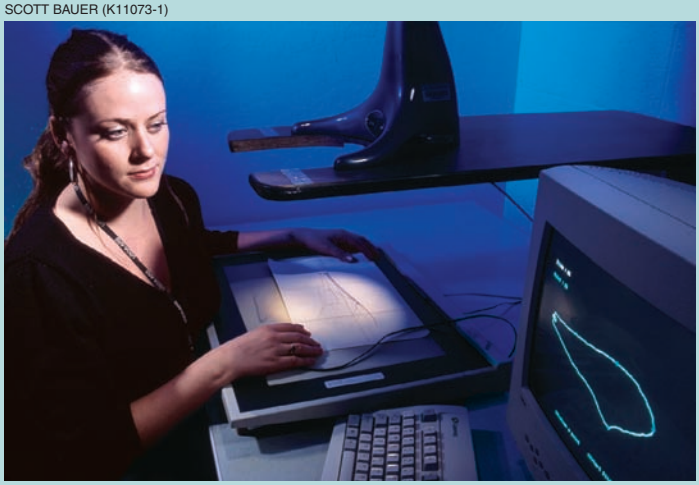

Technician Mona Chambers measures dimensions of an Africanized honey bee wing, one of the traits that differentiate these bees from European honey bees.