

# What's Buzzing with Africanized Honey Bees?

In 1990, a honey bee swarm unlike any before found in the United States was identified just outside the small south Texas town of Hidalgo. With that identification, Africanized honey bees were no longer a problem we would have *some day*. Africanized honey bees had arrived.

Beekeepers, farmers who depend on honey bee pollination for their crops, land managers, emergency responders like fire and police, and the public all wanted to know what they would be facing as Africanized honey bees began to spread.

Now, 14 years later, scientists with the Agricultural Research Service and elsewhere have uncovered many answers, but they have also come upon some new and unexpected questions.

Africanized honey bees—melodramatically labeled “killer bees” by Hollywood hype—are the result of honey bees brought from Africa to Brazil in the 1950s in hopes of breeding a bee better adapted to the South American tropical climate. These honey bees reached the Brazilian wild in 1957 and then spread south and north until they officially reached the United States on October 19, 1990.

Actually, all honey bees are imports to the New World. Those that flourished here before the arrival of Africanized honey bees (AHBs) are considered European honey bees (EHBs), because they were introduced by European colonists in the 1600s and 1700s. EHBs that escaped from domestication are considered feral rather than wild.

Africanized honey bees are so called because it was assumed that the African honey bees spreading out from Brazil would interbreed with existing feral

EHBs and create a hybridized, or Africanized, honey bee.

This has always been a major question for researchers—what, if any, type of interbreeding would happen between AHBs and EHBs and how would this affect honey bee traits that are important to people, such as swarming and absconding, manageability for beekeepers, honey production, and temper.

SCOTT BAUER (K11074-1)



**Entomologist David Gilley is part of the team investigating the usurpation of European honey bee colonies by swarms of Africanized honey bees. Because queenless colonies are particularly susceptible to usurpation, the team maintains a group of queenless colonies to lure usurpation swarms into their apiary to be studied. Gilley is shown here requeening one of these “bait colonies.”**

Many experts expected that the farther from a tropical climate AHBs spread, the more they would interbreed with EHBs. But it appears that interbreeding is a transient condition in the United States, according to ARS entomologist Gloria DeGrandi-Hoffman. She is research leader at the Carl Hayden Bee Research Center in Tucson, Arizona, and ARS national coordinator for AHB research.

“Early on, we thought the mixing would reach a steady state of hybridization, because we knew the two groups of bees can easily interbreed and produce young,” DeGrandi-Hoffman says. “But while substantial hybridization does occur when AHBs first move into areas with strong resident EHB populations, over time European traits tend to be lost.”

## A Mighty Adversary

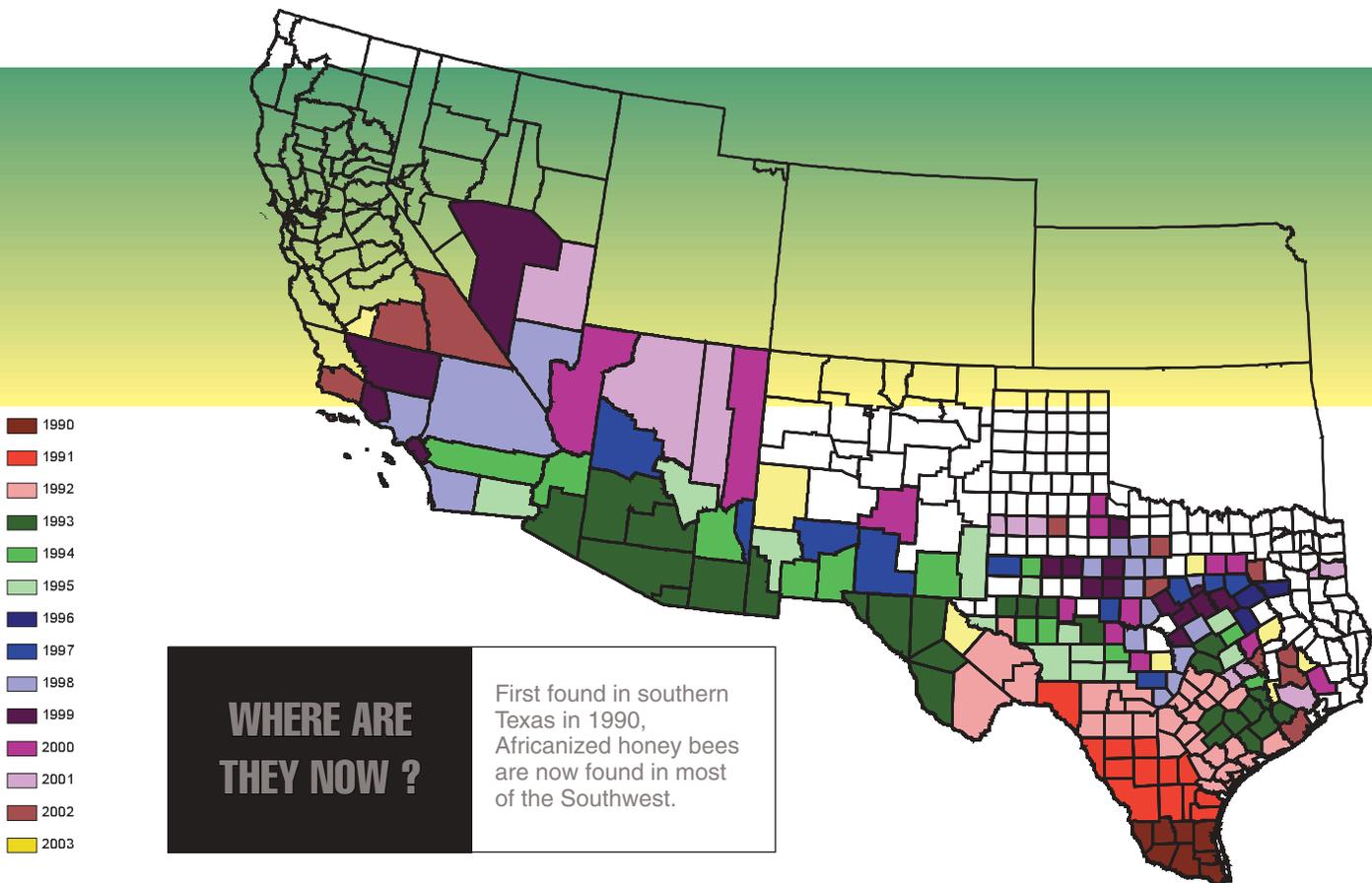
DeGrandi-Hoffman and Stan Schneider, a professor of biology at the University of North Carolina at Charlotte, have been collaborating the past 3 years to figure out why AHBs replace EHBs rather than commingling.

“We’ve found six biological and behavioral factors we think are responsible for making AHBs such successful invaders,” Schneider explains.

First, AHB colonies have faster growth rates, which means more swarms splitting off from a nest and eventually dominating the environment.

Second is that hybrid worker bees have higher amounts of “fluctuating asymmetry”—small, random differences between the left and right wings—than African honey bees have, even when raised in the same hive.

“Imperfections like fluctuating asymmetry that increase with hybridization



may end up reducing worker viability and colony survival,” says DeGrandi-Hoffman. “But this is a controversial factor right now, and it will take long-term studies of African, hybrid, and European colonies in the same habitat to truly understand its influence.”

But the third factor is undeniably true: EHB queen bees mate disproportionately with African drones, resulting in rapid displacement of EHB genes in a colony. This happens because AHBs produce more drones per colony than EHBs, especially when queens are most likely to be mating, DeGrandi-Hoffman explains.

“We also found that even when you inseminate a queen with a 50-50 mix of African drone semen and EHB semen, the queens preferentially use the African semen first to produce the next generation of workers and drones, sometimes at a ratio as high as 90 to 10,” she says. “We don’t know why this happens, but it’s probably one of the strongest factors in AHBs replacing EHBs.”

When an Africanized colony replaces its queen, she can have either African or European paternity. Virgin queens fathered by African drones emerge as much as a day earlier than European-patriline queens. This enables them to

destroy rival queens that are still developing. African virgin queens are more successful fighters, too, which gives them a significant advantage if they encounter other virgin queens in the colony. DeGrandi-Hoffman and Schneider also found that workers perform more bouts of vibration-generating body movements on African queens before they emerge and during fighting, which may give the queens some sort of survival advantage.

AHB swarms also practice “nest usurpation,” meaning they invade EHB colonies and replace resident queens with the swarm’s African queen. Nest usurpation causes loss of European matriline as well as patriline. “In Arizona, we’ve seen usurpation rates as high as 20 to 30 percent,” says DeGrandi-Hoffman.

Finally, some African traits are genetically dominant, such as queen behavior, defensiveness, and some aspects of foraging behavior. This doesn’t mean that EHB genes disappear, but rather that hybrid bees express more pure African traits. The persistence of some EHB genes is why the invading bees are still considered Africanized rather than African, regardless of trait expression, she points out.

A coincidence may have contributed greatly to an overwhelming takeover by AHBs in areas they’ve invaded. Just as AHBs began their spread throughout the Southwest, the U.S.

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



feral honey bee population was heavily damaged by another alien invader—the deadly *Varroa* mite, an Asian honey bee parasite first found here in 1987.

“*Varroa* mites emptied the ecological niche of feral honey bees just as AHBs arrived,” says DeGrandi-Hoffman. “If they hadn’t been moving into a decimated environment, AHBs might not have replaced EHBs so quickly.”

### Keeping Tabs on the Invaders

An extensive record of the AHB invasion was created by now-retired ARS entomologist William L. Rubink, who was in the ARS Bee Research Unit in Weslaco, Texas. From 1990 to 2001, Rubink continuously sampled honey bee colonies in the Welder Wildlife Refuge, about 30 miles north of Corpus Christi, Texas.

Once Rubink retired, researchers from Texas A&M University agreed to preserve and analyze his samples. “We have about 25 square feet of frozen bees that represent the only real unbroken sampling of a wild area before and during its

takeover by AHBs. Bill had a great deal of foresight to take these samples,” explains geneticist J. Spencer Johnston, who is with the university.

The data showed that within 3 years of the arrival of AHBs in the refuge there was a turnover from predominantly EHB to predominantly AHB. From 1997 through 2001, the mixture stabilized, with an average of 69 percent of the colonies made up of African queens mated with EHB and AHB drones and 31 percent composed of EHB queens mated with AHB and EHB drones. This produced a genetic mixture rather than a replacement of EHBs by AHBs. Additional sampling and more analysis of existing samples will be needed to see whether this mixing continues or whether the Africanized proportion increases, as has been predicted.

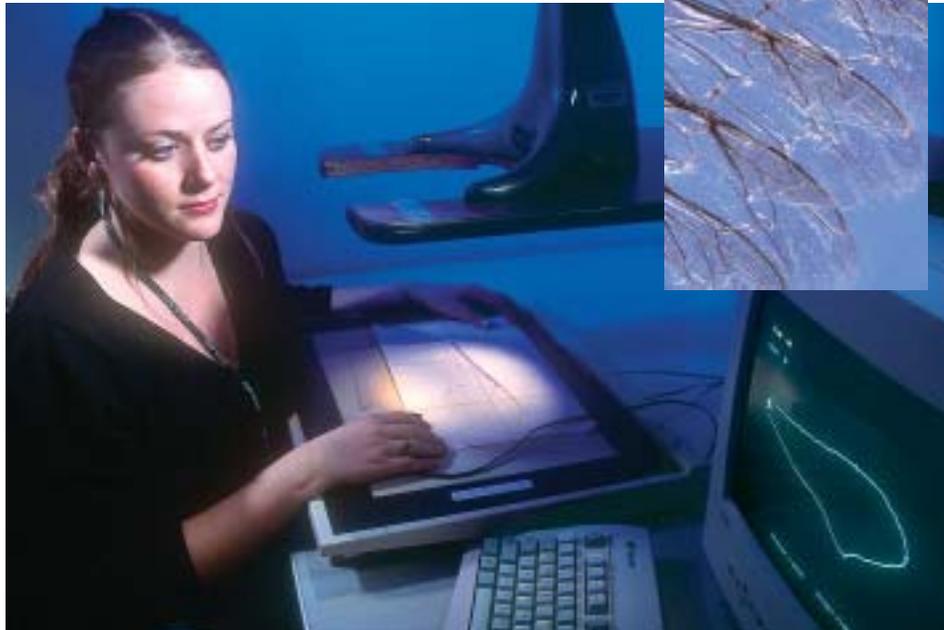
### Human Parallels?

In many ways, the spread of AHBs in the Southwest has been one of the most successful in-

SCOTT BAUER (K11073-2)



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Technician Mona Chambers measures the dimensions of an Africanized honey bee wing, one of the traits that differentiate these bees from European bees. Inset: Closeup of the wings Chambers is viewing.

ever documented. It’s even interested some as a model of how modern humans may have interacted with the European population of Neanderthals.

“Alan Templeton, a professor of biology and genetics at Washington University in St. Louis, has been looking at AHB spread as a demonstration of his model of *Homo sapiens*’ evolution and spread, which holds that there have been three major migrations out of Africa, with large amounts of genetic interchange among groups,” Johnston says. Honey bee generations are short enough that you can actually follow the invasion and the gene flow, unlike humans, explains Johnston.

### Where Did They Go?

Just how far and how fast AHBs have spread in the United States may be one of the most surprising factors in the whole issue.

Some experts predicted the bees would spread throughout the country; others thought they’d reach only as far north as the latitude of Houston. Most expected there would be a southern zone where AHBs would predominate, a northern zone where EHBs would maintain a climatic advantage, and a large transitional zone between the two. And everyone expected AHBs to spread across the southernmost tier of states. But, as of January 2004, AHBs have been found only in southern California, Arizona, New Mexico, Nevada, and Texas, as well as Puerto Rico and the U.S. Virgin Islands.

Why AHBs haven’t progressed eastward into Louisiana—though they were expected there years ago—is a mystery. So ARS entomologist José D. Villa began looking at factors that might correlate with where AHBs have spread. It isn’t just minimum winter temperature that limits AHB spread, as many believed, says Villa, who is in the ARS Honey Bee Breeding, Genetics, and Physiology Research Unit in Baton Rouge, Louisiana.

“What immediately jumped out at me was the correlation with rainfall,” he says. “Rainfall over 55 inches, distributed evenly throughout the year, is almost a complete barrier to AHB spread.”

Total annual rainfall alone isn’t a barrier; AHBs have been found in areas of the Tropics with higher rainfall. But in areas with high rainfall distributed throughout the year, Villa’s pattern of AHB spread fits perfectly.

Villa is quick to point out that this is simply a mathematical correlation and not proof of cause and effect. But, he says, “you do find that 55-inches-of-rainfall point right at the edge of where AHBs stopped moving east about 10 years ago.” He’s planning experiments that may uncover the behavioral or physiological mechanism that explains why.

How much farther AHBs may spread is still unknown. But if you apply the 55-inches-of-rainfall limit, there are still niches that the bees may fill, mainly in southern California. Southern Florida would be hospitable to the bees given its temperature and rainfall, but regulatory vigilance could keep them out, since the area isn’t contiguous with the other areas of AHB spread. Alabama, northern Florida, Louisiana, and Mississippi are unlikely to be troubled by AHBs if the 55-inches-of-rainfall barrier holds.

### Keeping on Beekeeping

One of the greatest challenges for Southwest beekeepers has been maintaining their EHB hives when they are surrounded by AHBs.

Once AHBs spread to an area, beekeepers can no longer allow nature to take its course in honey bee reproduction. ARS has always recommended that beekeepers regularly requeen their hives with queens of known lineage to keep AHB traits out of their apiaries. But, given the African bees’ strong ability to genetically usurp hives, the recommendation is now to requeen with queens that have already mated with EHB drones. It’s the best way ARS currently

has for beekeepers to manage their hives in AHB areas.

But requeening is a lot of work for commercial beekeepers who maintain thousands of hives. DeGrandi-Hoffman and Schnieder are currently trying to discover what triggers AHBs to usurp a hive. They suspect it could be a pheromone.

“If we can find out what tells an AHB swarm that this EHB nest can be taken over or that a colony or queen is strong and cannot be easily usurped, then we should be able to develop a chemical ‘no-vacancy’ sign to help beekeepers keep AHBs out,” DeGrandi-Hoffman says.

While AHBs do make honey and pollinate plants, two traits make them undesirable for beekeepers: Colonies regularly abscond from hives, and they are often too defensive to be easily tended.

Because of AHBs’ genetic dominance there has been little dilution of their strong defensive reaction to threats to their nests, explains DeGrandi-Hoffman.

This defensiveness is probably the bees’ best-known trait. All honey bee behavior runs the gamut from very defensive to very docile and can change depending on temperature, humidity, cloud cover, and food supply. But when provoked, AHBs do tend to sting in greater numbers than EHBs.

“But they’re not anywhere near the type of threat that Hollywood has made them out to be,” DeGrandi-Hoffman points out.

### Living with AHBs

While beekeepers obviously do not want to work with “hot bees,” people in the Southwest have simply learned to live with AHBs. While many will never come in contact with the bees, others have had to learn new precautions.

Retired ARS entomologist Eric Erickson, who was with the ARS bee center in Tucson, pioneered many safety methods in areas where people and AHBs collide. He developed the first instructions for fire departments—often

JACK DYKINGA (K7937-10)



Northwest Fire District’s Captain John Estes of Tucson, Arizona, uses a wide spray of water and chemical wetting agent as a means of subduing Africanized honey bees. Looking on is ARS entomologist Eric Erickson (retired), who taught this control method to fire departments throughout Arizona.

the emergency responders in stinging incidents. Most firetrucks already carried a surfactant, a soapy liquid that helps put fires out. Such soaps also kill honey bees when sprayed directly on them. Erickson also worked out ways to quickly convert a firefighter's basic turnout gear into a protective bee suit. Fire departments all over the Southwest are now trained in Erickson's methods.

Erickson also developed instructions for homeowners to help them deal with AHBs, such as how to prevent honey bees from taking up residence inside house walls and how to kill unwanted bee colonies. (It is safer, though, to call an experienced exterminator if at all possible.)

Swarm traps invented by entomologist Justin O. Schmidt, also at the Tucson honey bee center, have been a boon.

"We developed a simple, inexpensive trap with a pheromone lure to attract swarms looking for new nest sites. That's how we're able to track honey bee colonies as they spread out," Schmidt says.

The traps are also used as prophylactic barriers around golf courses, airports, schools, and botanic gardens, or anywhere else AHBs might take up residence and conflict with people. The traps lure swarms away from high-traffic areas and make them easy to remove.

### Not All Bad

People usually think only of AHBs' downside, but they also represent a potential positive. ARS entomologist Frank A. Eischen at the Honey Bee Research Unit in Weslaco, Texas, has been studying AHBs for their resistance to *Varroa* mites.

Eischen maintains an apiary in a remote part of southern Texas. "Maintains" may not be the right term, because he simply leaves hive boxes out and lets the bees fend for themselves year after year. All the honey bees in the apiary have long since been Africanized.

His AHBs, which are never treated, have a slightly better survival rate against

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Entomologist Justin Schmidt examines an ARS honey bee trap used to lure Africanized bee swarms and prevent their establishment in walls of buildings. Captured swarms are easily removed or destroyed with soapy water.

*Varroa* mites. But that rate varies dramatically.

"I've looked at about 40 colonies. Some have very few mites, and others are loaded," Eischen says. "But if these had been EHB colonies without treatment, they all would have died long ago."

He is trying to isolate which mechanism provides the protection from *Varroa* mites. He has already ruled out hygienic behavior—the time it takes worker bees to clean out mites. But if he determines what AHBs do differently, it might be possible to breed that desirable trait into EHBs.—By **J. Kim Kaplan, ARS.**

*This research is part of Crop Production, an ARS National Program (#305) described on the World Wide Web at [www.nps.ars.usda.gov](http://www.nps.ars.usda.gov).*

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Judith Hooper assists David Gilley with a gas chromatography/mass spectroscopy procedure for analyzing volatile pheromones from Africanized honey bees. Pheromones appear to be an important component of successful nest usurpation.