

The Africanized Honey Bee

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ABSTRACT

The Africanized honey bee (AHB), "the bee with an attitude problem," is described as more defensive, more likely to defend its nest in large numbers, and therefore cause multiple stings compared with the European honey bee (EHB) with which we are familiar. We can expect a greater number of toxic reactions related to multiple stings in addition to the more familiar allergic (IgE-mediated) reactions. The title "Killer Bees" is largely media derived. The first identified colony arriving by natural northward migration arrived in the Lower Rio Grande Valley in October 1990. Additional colonies have been trapped, identified, and destroyed by now. Because of extensive media coverage, the facts become very important because patients and possibly media may be contacting you as specialists in stinging insect allergy. Those living in the Southern United States are most likely to be involved. State and federal government agencies as well as certain industries have recognized this situation as important with a potentially very serious impact on agricultural interest. Some of these impacts will be discussed as well as local involvement in the Lower Rio Grande Valley of the Texas AHB Management Plan and medical plans. (Allergy Proc 13, 1:7-10, 1992)

The Africanized honey bee (AHB) was introduced in Brazil in 1956 in an attempt to find a honey bee more adapted to a tropical climate. In 1957, 26 swarms escaped, spreading north and south. Any human attempt to minimize the spread has not been effective to date. Migration northward has occurred through the southern hemisphere, and the current path through Mexico is on the east and west coasts. They tend to avoid higher altitudes; however, most recently colonies have been identified in Mexico City (Collins AM, personal communication). The final northward extent of the spread of the Africanized honey bees is unknown, although there does seem to be remarkable limitation

in South America south of 30° latitude, which would somewhat correspond to 50° F mean temperature in the coldest months or a minimum high of 60° F in the coldest months. The spread probably would include areas in Texas (i.e., San Antonio, Houston, Austin) and portions of the southern half of most of the southern states, all of Florida and Southern and coastal California.¹⁻³

Colonies of Africanized honey bees can move 250 miles per year,¹ but it requires approximately 2 years after initial introduction to an area for these bees to become well established. Therefore, we would expect significant numbers of Africanized honey bees in the San Antonio area within 3 years. A prediction of 7 to 8 years is estimated to complete the northward migration and longer relative to Florida migration. Several colonies have been identified and destroyed since 1979 in the United States that were identified via transport (i.e., ships, railroad cars, and trucking) from South and Central America and Mexico. Therefore, there could well be undetected AHBs among us.

TAXONOMY AND SPECIFIC VENOM CHARACTERISTICS

Honey bees are in the order Hymenoptera and family Apidae. The Western honey bee (*Apis mellifera*) includes approximately 23 subspecies. *A mellifera mellifera* and *A mellifera ligustica* are our main European subspecies, and *A mellifera scutellata* is an African subspecies. There is much interbreeding of the subspecies in the Americas and, therefore, the term Africanized honey bee. AHBs are slightly smaller, but this is not detectable with the unaided eye. For identification, multiple body measurements (10 bees per colony) are done at only very few labs in the United States and analyzed by a computer program to calculate probability of a colony of bees as Africanized. Likewise, the AHB's venom contents are slightly less than the European honey bees (EHB). The AHB's venom weight averages 93.5 mcg/bee in comparison with the EHB's

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146.6 mcg/bee and, therefore, approximately 36% less venom in the AHB.⁴ There are 10 to 50 μ L of venom injected per sting. Biochemical and immunochemical comparison of AHB and EHB venoms are very similar,^{4,5} and there were no protein bands unique to AHB or considered as possible neoantigens.⁵

The median lethal dose (LD₅₀s) of EHB and AHB venoms by intravenous injection in Swiss mice were similar. In venom-neutralization experiments, AHB venom was mixed with antibodies from a beekeeper exposed only to EHBs and used to challenge mice. Survival times of mice given venom plus antibodies were significantly prolonged, indicating neutralization of lethal effects.⁴ Therefore, we have *in vitro* and *in vivo* evidence of similarity of EHB and AHB venom.

HONEY BEE BEHAVIOR

The major concerns of the AHB are a difference in degree of behavior demonstrated by (1) strong defensive behavior, (2) excessive swarming and absconding, (3) high number of colonies per area, (4) lack of selective nesting sites, (5) questionable honey yields and effective agricultural pollination. Stinging experiments by the US Department of Agriculture researchers used a spray of synthetic alarm pheromone (produced by bees to warn other bees of problems) on the entrance to hives (this is similar to ringing a fire alarm to these bees). The hive is further agitated by shooting a large marble at the hive and then waving a dark colored suede target in front of the hive. The target received stings. Findings of this experiment proved AHBs had an increased speed of response and increased number of bees responding and increased number of stings, approximately 8 to 10 times greater than the EHB.⁶

MORTALITY

There have been 42 deaths in Mexico documented from 1987 to present attributed to probable AHBs (Collins AM, personal communication). It is not known how accurate and complete this number is. In Texas, from 1950 to 1984, there was less than one documented death per year due to honey bee stings. Relative to other countries' statistics, it is estimated that there will be four to five deaths per year in Texas. In the United States, the current documented number of 40 fatalities per year (of all the families of Hymenoptera) is expected to increase to 100 fatalities per year once AHBs become established.⁷ However, the difference of most of these death-related stings will be toxic AHB reactions as opposed to allergic reactions, with the increase concentrated in the southern U.S.

ALLERGIC VERSUS TOXIC REACTIONS

Most of allergists' concerns in the past have been related to allergic (IgE-mediated) effects of stings,

which affect somewhere between less than 1% to 4% of the population. However, with toxic reactions of multiple stings, anyone may be vulnerable. Honey bee stings often are associated with a perceived threat to the hive, its food, or its young. It is not unusual that over 1000 AHB stings have occurred. The LD₅₀ for number of stings per kg body weight is 19. This assumes all venom is injected. Greater than 500 stings are usually lethal in children, 1100 stings is the LD₅₀ for an average-size adult. Nevertheless, 100 to 300 stings have been known to be fatal, and a stinging event of this number should be considered serious. Those at most risk include beekeepers, those over 50 years old and children. Survival of a 30-year-old man following 2243 stings has been reported from Central Africa.

The main allergens in bee venom have been documented to include phospholipase A, hyaluronidase, acid phosphatase, mellitin, and allergen C.⁸ The pharmacological effects of the above venoms plus others are responsible for the severe toxic effects that may be fatal. Mellitin constitutes 50% to 60% of bee venom and is the major toxic component. In addition, there are significant toxic effects associated with phospholipase A (which composes 12% of the venom), smaller amounts of apamin, hyaluronidase, acid phosphatase, mast cell destroying (degrading) peptide, and minor amounts of histamine, dopamine, minimine, and phospholipase B. Pharmacologic effects of the above include hemolysis, increased capillary permeability, hypotension, smooth muscle contraction, increased histamine release, disruption of cellular functions, neurotoxic action, central nervous system excitation, vomiting, diarrhea, thrombocytopenia, rhabdomyolysis, and acute renal failure.^{9, 10-15} The usual cause of death is hypotension and or respiratory failure.

AVOIDANCE AND TREATMENT

On the medical level, we know avoidance measures are going to be more important (especially with persons allergic to bee venom) once AHBs are known to be in the area; these include avoiding dark-colored clothing when planning outdoor activities and minimizing picnics, for example. Bees will be attracted only to sugar-containing items or water (in dry areas). General garbage insects could include wasps. Garbage should be tightly enclosed in containers. Do not attempt to eradicate or disturb hives, for example, with household insecticides. Get assistance from trained personnel with appropriate protective gear (call county agent). If you are being "attacked," run for shelter because bees are slow fliers and normally can be outrun. If stung, the stinger (and often venom sack) is left in the skin (as with the EHB). Do not pull the stinger(s) as this may "inject" more venom. Scrape or flick the stinger(s) out.

Unfortunately, when a person receives multiple stings

and a toxic reaction occurs, supportive treatment is all that is documented in the literature. Treatment may include intravenous fluid replacement, epinephrine, vasopressors, oxygen, aminophylline, antihistamines, corticosteroids, and in some cases ventilators and renal dialysis.

Allergy testing and treatment with currently available honeybee venom should be considered appropriate at this time for systemic reactions to AHB venom that are IgE mediated. An antitoxin would be highly desirable as a possible neutralization treatment (as in snakebite antivenin). An ideal potential treatment would be hyperimmune IgG of beekeepers' pooled sera (especially concentrated anti-mellitin Ab). Beekeeper serum Ab to EHB venom neutralized the lethal effects of AHB venom in Swiss mice experiments.⁴ Mellitin neutralization antibodies in beekeeper IgG preparation displaced the hemolysis curve, indicating effective blocking of this hemolytic protein.⁴ Therefore, the possibility of beekeepers hyperimmune IgG as a treatment for toxic reactions should be explored. It has been shown that commercial immunoglobulins were not effective in mice experiments.⁴

PROGRAMS RELATED TO THE AFRICAN HONEY BEE

There are several programs aimed at identification and minimizing the effects of the AHB. Most of the government programs deal with agricultural concerns because EHB have been highly effective at pollination of crops and production of honey. The overall value of pollination by honey bees is estimated at \$20 billion in the United States and \$0.8 billion in Texas each year. It is estimated that one third of our food supply is produced cheaper or more abundantly thanks to the honey bee. The Texas Africanized Honey Bee Management Plan combines federal, state, county, and private industry concerns in an overall management plan.

Part of this plan includes lines of bee traps for detection of AHB. One line is along the Rio Grande River Valley from the Gulf coast to Laredo. Another line of traps is slightly north of the first line, and yet another line of bee traps is approximately 75 miles north of the Rio Grande Valley area through Kingsville (east to west). Trapline locations are being expanded as the bee moves further into Texas.

A second program is quarantine. Once AHBs are identified in an area, a 2-mile quarantine (done only on the first five swarms in Texas) restricts movement of managed bee colonies in or out until all managed colonies are rechecked to ensure no other AHBs. This quarantine is lifted once this thorough check is completed or the surrounding areas have also identified several other swarms, indicating more widespread establishment of AHBs. Also, a 100-mile quarantine re-

stricts movement of any managed bee colonies out of the 100-mile area to slow possible AHB spread. This quarantine lasts 6 months, but once AHBs are in an area, it is doubtful this quarantine will be lifted; with time, a larger quarantine area will exist.

A third program is an attempt to hybridize the AHB by introducing many EHB drones (the male bee). The reproductive female, a queen, mates with 10 to 20 drones. Maintenance of gentle productive varieties of bees by beekeepers in managed colonies will aid in this attempt. However, AHB-mitochondrial DNA indicates no significant change after AHBs mix with the EHBs in their northward migration.¹⁶ In experiments, there was no change in the number of stings in AHBs from Brazil and Venezuela indicating little if any hybridization.⁶ Most of the federal programs are through the US Department of Agriculture, which has four bee research centers including Weslaco, Texas; Tucson, Arizona; Baton Rouge, Louisiana; and Beltsville, Maryland. Further studies of ways to handle these bees and many other aspects are being addressed at these research centers.

A fourth program is especially appealing to populated areas. An increase in the calmer EHBs colonies in and around towns and cities will deplete the food source for AHBs, who will, therefore, be less concentrated in higher populated areas. This results in less AHB-human contact.

Another program is education. The Texas AHB Advisory Committee is attempting to alert local municipalities to the fact that response to calls from the public about swarms, honey bee nests, or stinging incidents will ultimately have to come at a local level, whether public or private. On a local level (in the lower Rio Grande Valley area), there is a community education program for police, fire, emergency medical services, parks, and other city departments coordinated through the Texas Agriculture, Extension service (part of the Texas A&M system). These departments at the local level will receive calls from the community. There also is a "First Strike" Committee (including persons involved with the Texas AHB program) concerned with the first significant stinging incident in an attempt to provide appropriate information to media.

Finally, more information from bee research centers will add to current or additional programs.

THE FUTURE?

Unresolved issues include migration; how far north, east, and west will be AHBs migrate? It is difficult to use South America as a model because of different geography and climate patterns. Will we be somewhat successful in decreasing or preventing the spread of the AHBs or successful at hybridization to decrease AHBs aggressiveness and problems to the agricultural industry

and public? Will legislation at different levels adequately fund needed programs? Will our bee-allergic patients on venom immunotherapy be more susceptible, no more susceptible, or less susceptible to toxic reactions by AHB stings? Of course, this may be related to each patient's level of IgE and their level of blocking IgG levels. What about persons untreated (immunotherapy) who have systemic reactions to honeybees or other families of hymenoptera? Will there be a more severe (than expected) reaction to multiple stings (for example, 50 to 100 stings) in patients with a history of skin reactions over whom we previously had little concern for severe systemic reactions such as large local reactions or urticaria in childhood?

An indirect advantage may be that some venom allergic patients who have a history of past systemic reactions (regardless of the insect involved) may be more likely to seek medical attention. It is also an opportunity to educate the community and other health professions, especially in the primary care and emergency room departments, with the outcome that there may be an increased tendency to refer appropriate patients for their needed treatment.

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