Invasive Flights of the Africanized Honeybees

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Apis mellifera scutellata or the Africanized honeybee (AHB) shares much in common with its other invasive relative, the European honeybee (Arias & Sheppard, 1996; Schneider et al., 2004). Since the inception of AHBs , they have spread across much of the globe, and have experienced continued expanse, survival, and success . AHBs may be one of the most successful invaders and there remains no long-term way to systematically control and move AHBs (Kim & Oguro, 1999). AHBs are one of the most dominant invasive species and continue to be successful because of their ability to invade, occupy, and remain in an area despite the natural and human forces that attempt to stop them.

Many people fear these small creatures due to their aggressive behavior, but they haven't always haunted individuals on the western hemisphere; in fact, AHBs were found in very few places outside of Africa at the beginning of their existence until their introduction to Brazil in 1956 (Schneider et al., 2004). The transportation of honeybees for honey production, along with the resilience, and competitive superiority of the AHB has allowed it to spread from its African origins to the majority of the world.

The genome of the AHB plays a large role in not only their invasive range determination, but also allows for their continued spread. The AHB is a subspecies of the European honeybee (Arias & Sheppard, 1996). There are two primary African lineages that occurred originally on the African continent (Arias & Sheppard, 1996). Many of the honeybees have been selected for due to human activities and the impacts we make to the surrounding environment (Arias & Sheppard, 1996). The striking resemblance between AHB and *Apis mellifera mellifera,* the common European honeybee (Arias & Sheppard, 1996; Bowen et al., 2006) makes it difficult for many people to distinguish between the two types. However, the AHB have very distinct genes and lack a genetic mixture between the two original African lineages making it possible for each species to evolve independently to habitats (Arias & Sheppard, 1996). This genetic distinction has allowed for their historic expansion and continues to propel their expansion in more modern invasions (Zayed & Whitfield, 2008). The specific genome of the AHB adds to the element of resilience as it allows for their persistence in conditions other honeybees fail in. For example, AHBs are not only a more aggressive subspecies of bee, but are also more tropically tolerant than other bee species giving them a distinct advantage in the areas they tend to invade (Arias & Sheppard, 1996; Schneider et al., 2004). However, when it comes to the actual invasion of AHB, humans play a far larger role than we are willing to admit.

Much of the AHBs expansion may be attributed to human vectoring. Since AHBs and European honeybees bare such a striking resemblance, many AHBs have been accidentally introduced into other countries (Arias & Sheppard, 1996). Brazil is one of many countries that has been dominated by AHBs due to an accidental introduction (Spivak, 1992). European honeybees were supposed to be transported to Brazil in order to promote the beekeeping and honey making industries (Schneider et al., 2004); however, the similarities in appearance made it easy for AHBs to be incidentally introduced (Arias & Sheppard, 1996). The only real way to tell the difference between the European and the AHB is to determine their aggressiveness or by genetic testing (Schneider et al., 2004); this was not done before transporting large numbers of honeybees (Schneider et al., 2004), which led to the current problem. Using Brazil as an initial introduction point, the AHB spread across most of South America and migrated up through Central America into the southern parts of the United States (Schneider et al., 2004; Bowen et al., 2006; Spivak, 1992). There have also been many cases in which AHBs take over and mate with the dominant European bee in the area, producing a hybrid (Arias & Sheppard, 1996). The spread of the AHB was an attempt to improve the honeybee industry but had unexpected results. Humans may have been involved in the initial introduction of AHBs but these bees have spread without help from humans.

The advantage that the AHB has over the European honeybee is their superior competitive abilities, which allow them to propagate and spread from human introduction points. AHBs are more active than are European honeybees over the span of a year (Spivak, 1992). AHBs also remain active over the winter months and continue to collect pollen and propagate while European bees tend to go into hibernation or a low activity period (Spivak, 1992). AHBs have, on average, heavier colony weights than those of European bees, meaning they have a much higher chance of survival, more workers, and create more offspring (Spivak,1992). AHBs may move themselves for distances of up to 17 km easily through swarming. (Bowen et al., 2006) They can continue to swarm and expand their invasive range further into the season than any other honeybee (Bowen et al., 2006). Swarming occurs when several bees move together in a set pack. This pack provides the bees protection and greatly increases their range. The problem continues because there is no exact time at which the AHB halts their advance into an environment. Essentially, AHBs are able persistently survive because they pollinate and reproduce more than the honeybees in the areas that they invade (Spivak, 1992). In one case, isolated AHB and European honeybees were monitored during the winter months a period in which many individuals die; some hives were given rock candy as a source of sugar and food for the colony's survival, and some received no special food source. AHBs that received food did no better statistically than the AHB hives that received no food while the European honeybees that did not receive food died out (Spivak, 1992). Again the resilience showed by AHBs allows them to become and remain established in their invasive range. Once human introduction has occurred in a location, there is no telling how far the AHB will be able to spread from that point, which makes it a dangerously strong invasive species.

AHBs have several factors attributing to their success as an invasive species. Their genetic structures allow them to survive in different environments as two different subspecies (Arias & Sheppard, 1996). Jump dispersal occurs on a regular basis due to intentional human introduction of the European honeybee with a few AHB hidden away (Bowen et al., 2006). Also, the resilience the species displays allows it to outcompete and survive tough conditions, keeping it established once it has invaded a particular region (Spivak, 1992). When separate, these factors may be controlled; however, when they are all combined into a single organism, they become impossible to control.

If the advance of the AHB cannot be halted, it then becomes vitally important to understand what they will do once they have invaded. Africanized honeybees have the ability to spread far across the globe as demonstrated

above. (Schneider et al., 2004; Bowen et al., 2006; Spivak, 1992). In fact, since their introduction to Brazil, AHBs have dominated South and Central America as they continue their expansion into the southern United States (Schneider et al., 2004). AHBs have been more successful in their ability to collect pollen and in general have higher survival rates than European honeybees (Roubik & Wolda, 2001). AHBs are deemed to have a significant impact on regions in their invasive range because they cause an almost inevitable change to the environment through a variety of actions.

As soon as AHBs arrive, the competition for survival begins; they exploit all the resources a given area has to offer (Roubik & Wolda, 2001; Spivak, 1992). As the AHB competes with native honeybees, their ability to outcompete other bees plays a large role in their success (Roubik & Wolda, 2001; Spivak, 1992). As the native bees continue to run out of resources, they begin to either die or migrate to other areas (Roubik & Wolda, 2001). Either outcome has complications, as the native species would leave behind all of the native plants that they once pollinated. AHBs are also generally superior in their ability to cross natural gaps, allowing them to reach areas that native bees may never have entered. (Bowen et al., 2006). These gaps could be anything from literal barriers such as water, to areas that just lack plants to pollinate. In some cases, European honeybee colonies may become Africanized through mating with AHBs (Guzman-Novoa & Page, 2000). These hybrid bees display the aggressive behavior of AHB while maintaining European pollination patterns (Guzman-Novoa & Page, 2000). Once the native bees have been moved or eradicated, the environment begins to change.

AHBs can do one of two things to the plant pollination of their newly claimed territory. If there are no European honeybees with which hybrid mating may occur, then they pollinate on their own according to AHB pollination patterns (Basualdo et al., 2000). Though in some cases AHBs show a greater affinity to agricultural crops, AHBs are rarely able to change that affinity in new territories (Basualdo et al., 2000; Couvillon et al., 2010). Therefore, AHBs are unable to pollinate newfound plants and as a result, continue to pollinate ones follow their pollination pattern (Couvillon et al., 2010). AHBs are significantly less intelligent than the European honeybee, which hinders their ability to pollinate new plants (Couvillon et al., 2010). This means that once the AHBs become settled they do not learn to associate new scents with rewards (Couvillon et al., 2010). So when combined with their already high affinity for specific plants it becomes incredibly difficult for AHBs to pollinate anything that they haven't already been accustomed to (Basualdo et al., 2000; Couvillon et al., 2010). This would of course change aspects of the environment and would be easily visible to humans, as plants that were not pollinated by AHB would perish. However, this is not the only scenario that may occur within the AHB invasive range.

If European honeybees are already present in the invaded region then instead of eradication, a hybrid bee may form. This occurs when AHBs mate with European honeybees and produce a hybrid (Guzman-Novoa & Page, 2000); in these cases the hybrid bees maintain the broad pollination patterns of European honeybees (Guzman-Novoa & Page, 2000). The hybrids don't need to relearn the pollination patterns because the hybrids receive genes from both Africanized and European species (Guzman-Novoa & Page, 2000; Couvillon et al., 2010). Though this may deal with the pollination problems that may arise from the invasion of AHBs, the most prominent issue with AHBs is their aggressive behavior.

Aggression easily remains the largest impact that AHB have on any region in their invasive range. This is the most easily perceptible attribute of AHBs by human beings as AHBs are an extremely defensive group (Basualdo et al., 2000; Franca et al., 1994; Sherman, 1995). Once a nest has become active it is almost impossible to get rid of (Sherman, 1995). All honeybee stings contain a small amount of toxin, but individual honeybees die upon stinging, so only a small amount may enter the system (Sherman, 1995). However, AHBs sting far more aggressively than European honeybees when perceiving a threat near the colony (Franca et al., 1994; Sherman, 1995). A variety of factors may invoke AHB attacks but it is believed that AHBs release more of a chemical named isoamyl acetate which recruits far more bees to attack the "marked" target (Franca et al., 1994; Sherman, 1995). The resulting stings have led to death in multiple cases, which has gained much media attention. (Franca et al., 1994; Sherman, 1995).

As AHBs spread throughout much of the West, it is important to understand what they will do once they have invaded. By driving out local bees, they take control of an area (Roubik & Wolda, 2001). Once they are the dominant species in a region, AHBs do not have the same pollen affinities and pollinate different plants (Basualdo et al., 2000). These invasive bees are not efficient at learning so it takes a long period of time for AHBs to show any pollination pattern change (Couvillon et al., 2010). Furthermore, they are an aggressive defender of their territory (Franca et al., 1994; Sherman, 1995); this aggressive behavior has caused multiple human deaths and is a serious issue when dealing with this invasive species (Franca et al., 1994). This is one invasive species that really can result in a life or death situation for individuals living in the invasive range of the AHB.

Since AHBs are such a dangerous invader, the problem slowly becomes how humans can deal with the new organism. Are there ways to halt its spread? Can we kill the creature or force it back into its native range? All these questions can be answered by how humans approach the situation.

AHBs continue to act aggressively when perceiving a threat (Kim & Oguro, 1999; Franca et al., 1994; Sherman, 1995); unfortunately, many times human beings are the ones perceived as that threat (Kim & Oguro, 1999). AHBs are not nearly as cautious as European honey bees when selecting nesting grounds (Kim & Oguro, 1999); and unlike other beehives, when an individual accidently stumbles upon an AHB nest, it may result in death (Kim & Oguro, 1999). The unusual nesting grounds of the AHB have lead to unexpected attacks on humans, and as a result, educating the public on AHB and attempts to reduce their aggressive behavior have become some of the primary goals in AHB research and education.

As AHB related incidences continue to rise, it is vital that the public become aware of the tiny invaders (Kim & Oguro, 1999; Pankiw, 2009). AHBs continue to build hives and nests in areas like holes in buildings, underground, in old tires, and under mobile homes (Kim & Oguro, 1999). These unlikely areas for hives result in many people being caught off guard and accidentally stumbling upon a hive and they are almost immediately attacked (Kim & Oguro, 1999). Although the aggressive behavior displayed by AHB isn't seen far from the nest, it is very easy to be perceived as a threat by the colony when in relatively close proximity to the hive (Kim & Oguro, 1999). A colony can be set off by something as minor as lawnmower vibrations or an unfamiliar smell, both of which can instantly mark a person as a target (Kim & Oguro, 1999). Unfortunately, once a colony has entered its aggressive defensive mode, the best one can do is exit the area as quickly as possible (Kim & Oguro, 1999). Currently there is no anti-venom for the bee stings, so when it comes to taking care of a victim, at best the care provided is supportive and does not medically treat

the issue (Kim & Oguro, 1999). Though this does not help much in terms of changing the behavior of the AHB it does give people a chance to escape an attack. Hopefully people will be more likely to check or avoid areas that are likely to contain AHB hives and thus be safe from the threat. Though public awareness is largely focused on awareness, there are other methods for controlling AHB.

One such method is focused on disrupting the aggressive AHB behavior. When a victim is stung, a pheromone is released by the stinging bee attracting other bees to strike the target (Kim & Oguro, 1999; Pankiw, 2009). Some forms of insecticide, such as DEET, will mask the pheromone for a very short time but fail to reduce the number of stings inflicted to the victim (Pankiw, 2009). However, a chemical within AHB Queens is used in a natural setting when prospective queens are fighting for the throne (Pankiw, 2009). This chemical was isolated and its characteristics discovered (Pankiw, 2009). One key component of the chemical is its ability to repel worker bees (Pankiw, 2009); scientists were able to create a similar compound that mimics the structure and ability of the natural chemical (Pankiw, 2009). Obviously this would help victims as it disrupts the ability of the bees to converge on the target (Kim & Oguro, 1999; Pankiw, 2009). The chemical spray was experimentally shown to reduce the number of stings to a victim (Pankiw, 2009). Again however, this is not a permanent solution as eventually the spray dissipates and the AHBs will once again become aggressive in their defense of the hive (Pankiw, 2009). Conversely, it could prove very useful for any commercial beekeepers that have to deal with AHBs on a daily basis (Pankiw, 2009). Although a more permanent solution needs to be discovered, no such solution has been uncovered (Kim & Oguro, 1999).

Although a permanent solution to the aggression of AHBs has yet to be found, the current short-term solutions may help to keep AHB in check. Public awareness is always a very important first step when dealing with invasive species. In the case of the AHB, if the public is made aware of exactly what they are dealing with, they have a better chance of prevention (Kim & Oguro, 1999). When the short-term approaches are paired together there is an even greater chance of lowering the risk for human beings; however, these approaches remain short term. The chemicals used to reduce aggression may serve as a springboard into future projects that may permanently dissipate the aggression of AHB (Pankiw, 2009).

As a whole, AHBs are a dangerous force to reckon with, with much emphasis on attempts to control or exterminate. While AHBs have spread across the globe it is likely that their genome has been selected for over time (Zayed & Whitfield, 2008). AHBs also have distinct advantages over the local bees and the European honeybee (Schneider et al., 2004; Bowen et al., 2006; Spivak, 1992). With the help of these advantages AHBs have spread not only over an extensive range, but quickly as well; as these bees enter this new territory they begin to cause specific changes to the environment (Roubik & Wolda, 2001; Guzman-Novoa & Page, 2000; Basualdo et al., 2000). They enter an area and change the pollination of the plants, which can have overwhelming consequences to the area that has been invaded (Roubik & Wolda, 2001; Guzman-Novoa & Page, 2000; Basualdo et al., 2000). But, more importantly, they pose a significant risk to any human being living within their range (Franca et al., 1994; Sherman, 1995). Their reputation as “killer” bees is well earned as their defensive behavior has cost many people their lives (Franca et al., 1994; Sherman, 1995). Finally, there is virtually no way to stop them; although there are a few short-term solutions available, there have yet to be any definitive long-term treatments that can control the AHB (Kim & Oguro, 1999; Pankiw, 2009). With all these factors contributing to the success of AHBs as an invasive species, it has moved from South America through Central America into the southern half of the United States within a 60-year period (Schneider et al., 2004). There is no question that AHB are certainly a model invasive species and should be considered one of the most successful ones.

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