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Genetic Diversity May Be the Key to New Honey Bee Colony Success

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Genetic diversity is critically important for the productivity and long-term survival of newly established honey bee colonies. The key to colony performance may lie in the mating habits of honey bee queens.

Figure 1. Worker honey bees on the leading edge of a comb constructed after swarming.

Photo Credit - Heather Mattila

Most social insects mate with one or, at most, two males. This mating strategy maintains a high level of relatedness among offspring, which social biologists believe is one of the driving forces for the evolution of sociality and cooperation amongst kin. For this reason, it remains curious that honey bees, prominent social insects, practice extreme polyandry, a practice whereby the queen mates with a high number of males.

Genetic Diversity

Honey bee queens mate with 6 to 20 males on average, inflating the number of patrilines (workers with a shared mother, but different fathers) in the colony, thereby eroding colony relatedness. Scientists hypothesized honey bee colonies could benefit from polyandry if multiple patrilines helped improve the efficiency and/or productivity of the colony's work force. There is building evidence that, within each colony, certain patrilines specialize in tasks, such as defending the colony, removing dead workers, or communicating. Such specialization by different patrilines could potentially enhance the speed with which colonies complete

tasks that contribute to nest construction and maintenance. Ultimately, natural selection would favor any traits, including patriline diversity due to polyandry, which would improve colony productivity and reproduction.

Research

Mattila and Seeley examined this hypothesis in context of swarming, which occurs when the queen and several thousand of her worker daughters leave the parental nest in order to establish a new nest. Workers in newly founded colonies have a variety of pressing tasks to accomplish simultaneously, including construction of new comb, stockpiling new food stores, and rearing new workers. This challenge is so daunting that only about 20 percent of newly founded colonies in the Ithaca, NY area develop fast enough to survive their first winter.

A long-term study was completed to compare the development of genetically diverse colonies (those with many patrilines) and genetically uniform colonies (those with workers that share only one father) after a swarming event. The results show genetically diverse colonies were more successful. Within two weeks of establishing colonies in new nest site, diverse colonies produced 30 percent more comb, stored 39 percent more food, and maintained foraging levels that were 27–78 percent higher than genetically uniform colonies. These differences are noteworthy considering the colonies in the study had similar potential work forces.

One of the most revealing aspects of this study was the ability of genetically diverse colonies to capitalize on infrequent episodes during the summer and fall when nectar resources were abundantly available. During these periods, the genetically diverse colonies gained weight (mostly in stored honey reserves) at rates that exceeded those of the genetically uniform colonies. This difference implies that a key advantage of genetic diversity may be related to how honey bees utilize sophisticated mechanisms for discovering and recruiting nest mates to food, which might possibly include communicating the location of food reserves through waggle dancing.

By the end of the summer, genetically diverse colonies had populations that were five times larger than those of genetically uniform colonies, they reared eight times more reproductive males, and they were significantly heavier, mostly because of large amounts of stored food. These surplus food reserves sustained the genetically diverse colonies throughout the winter months, whereas all of the genetically uniform colonies starved to death by December.

Early disparities between colonies translated into long-term effects on colony survival and productivity. Approximately 25 percent of the genetically diverse colonies made it through winter and survived at least the first year post-founding.

This research suggests that the use of poorly mated queens in commercial operations (mating quality includes number of mates, sperm stored, genetic diversity of mates) may have a large impact on the productivity of the colonies that they head.

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