Project Title: Role of Volatile Chemicals in Usurpation of European Honey Bee Colonies by African Honey Bee Swarms.

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Objectives

1) Determine if high usurpation rates of queenless colonies are due to greater number of usurpation attempts, greater success of each usurpation attempt, or both.
2) Determine whether a colony's volatile profile affects the probability of usurpation attempts or the probability of usurpation success.
3) Determine whether the volatile profile of the host queen affects her chances of survival
4) Determine how elimination of the host queen is accomplished
5) Determine whether usurpation swarm workers have a unique non-volatile signature that facilitates their entry into the host hive.

Results

1) While data are still being collected to address this objective, it appears that attempts to usurp queenless colonies are more frequent and often more successful compared to queenright colonies.

2) We have developed methods for sampling nest odor and demonstrated that queen loss affects the composition of volatile compounds emanating from the hive. Differences in nest odor between a queenright and queenless colony might be detected by usurpation swarms and be a basis for their selection of queenless colonies.

3) We have determined that amounts of E-ß-ocimene produced by queens influences the probability that they will be accepted into colonies at least during the first week after introduction. Queens producing lower amounts E-ß-ocimene had lower rates of acceptance compared with those producing higher amounts. Colonies with caged queens had higher invasion rates than those with free-running queens. Caged queens also emit lower amounts of E-ß-ocimene. These findings suggest that amounts of E-ß-ocimene might at least partially influence colony invasion and host queen retention. Studies are

still underway though, to determine whether amounts of E-ß-ocimene influence the likelihood of a colony being invaded, and the retention of the host colony queen.

4) Swarms eliminate the European queen in the host colony by surrounding and killing her (Figure 1). Death of the European queen is caused by the swarm workers rather than the swarm queen. This may occur either before or after entry of the swarm queen into the hive.

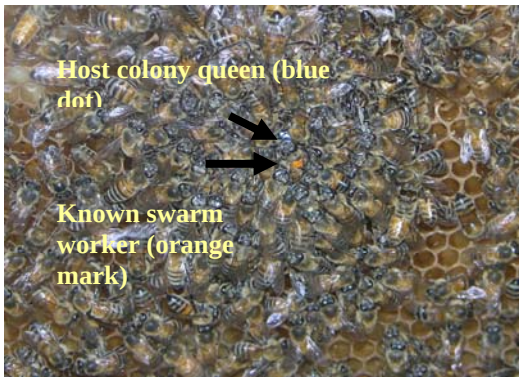

Figure 1. Worker from a usurpation swarm (marked with an orange dot) that is part of the group of workers surrounding the host colony queen (marked with a blue dot) following their entry into the colony.

5) We have determined that usurpation swarms do not have particularly special volatile chemical signatures that differ from those of African bees in swarms that are not attempting to usurp a colony. The findings suggest that usurping bees are gaining acceptance within the host colony by "blending in" rather than "dominating" or entering by force. Usurpation swarms may be capable of acquiring the host colony's nestmate-recognition cues, thereby bypassing the hosts' defenses.

Discussion

We have uncovered evidence that the choices that usurpation swarms make in terms of which colonies to invade might be largely predicated on the state of the queen. Those colonies without queens are the most likely to be successfully invaded. The state of the queen in a colony and whether a queen is present might be revealed to usurpation swarms by the volatiles emanating from the hive particularly E-ß-ocimene. Once a colony is invaded, the host queen is killed by workers from the usurpation swarm. Usurpation attempts would rarely succeed if they were simply attacks on a colony because the population of most usurpation swarms is only a fraction of that of the host colony. Usurpations may be successful because workers in the swarms are capable of acquiring the host colony's nestmate-recognition cues, thereby bypassing the hosts' defenses. This hypothesis remains to be tested.

Usurpation is one mechanism by which the honey bee population in the U.S. is becoming Africanized. The frequency of nest usurpation and its impact appear to vary by geographical region and season. Nest usurpation by African bees is potentially problematic to the Almond Industry because it will affect the number of European colonies available for pollination. Many colonies moved into California for almond

pollination are moved onto large ranches in Southern California in the late fall and winter prior to almond bloom. Many of the ranches are located in areas with resident populations of African honey bees. The high concentration of EHB colonies (some of which might have lost their queens during transport) make the temporary apiaries prime targets for usurpation swarms.

Future studies will be directed at identifying specific factors that increase the chances of successful usurpation of EHB colonies. Once those factors are determined, management strategies can be developed to mitigate the success rate of usurpation swarms.