EIGHT

Bees on the Move

Question 1: Do bees ever move out of their hive?

Answer: Bees permanently move out of their hive only under two circumstances: one is called *absconding* and the other is called *swarming* (see questions and answers below.) If environmental conditions become too stressful for the bees in the colony, they can decide to stop their normal activities and abscond. This means closing up the honey shop and moving to another location, as opposed to swarming, in which the colony divides but the old nest continues to function.

Bees may abscond because the food resources in the habitat may be inadequate, for example, or the colony may become unmanageably hot due to extreme weather conditions. They do not simply leave, however, because the workers will not abandon their baby sisters—the larval and pupal brood that cannot yet fly—nor will they leave a large amount of food in the storage areas of the honeycomb. Absconding is a process during which the bees stop rearing new brood, cease foraging, and begin scouting for a new, more suitable nesting location. It isn't well studied, and it is a variable process, more common among Africanized bees than European bees.

Beekeepers can discourage bees from leaving the nest by creating optimal conditions as the colony grows by providing more space with additional hive components into which the colony can expand (see chapter 11, question 5: How does a beekeeper manage a hive?). For reasons that are not well understood, Africanized or "killer" bees are much more likely to move by absconding than European bees (see chapter 9, question 5: Do killer bees really exist?).

Question 2: What is swarming?

Answer: Swarming is a natural process by which a new colony is formed. When a hive becomes overcrowded, the worker bees instinctively know that it is time to swarm and to raise a new queen. Several large cells are created around fertilized eggs laid by the queen. When the larvae emerge from these eggs, the cells are flooded with royal jelly to foster the development of a queen rather than an ordinary female worker (see chapter 4, question 7: What is royal jelly and how does it produce a queen?). When the queen larvae are ready to enter the pupal stage, during which they will develop into adult queen bees, their cells are sealed with wax by the workers. At some point after the first queen

Fig. 23. Bees in a swarm cluster are very docile; a gentle touch does not disturb the swarm, provided the bees have ample food stored in their collective stomachs. *(Photo by Corey J. Flynn.)*

Fig. 24. A springtime swarm alights on a tree outside Marts Hall on the campus of Bucknell University. The bees are clustered around their queen. Beekeepers can collect swarms if they are located in accessible locations. *(Photo by Corey J. Flynn.)*

cell has been sealed, the old queen leaves the hive in order to avoid being killed by the new queen when she emerges. The departing queen is guided by a group of as many as ten or twenty thousand worker bees in a primary swarm. If more than one new queen emerges in the old colony and the first to emerge does not kill the others, there may be subsequent smaller "after" swarms, each led by a new queen.

Contrary to the popular belief that a swarm refers to a marauding pack of angry bees, when honey bees swarm their bellies are full of honey and they are in a gentle mood. They are prepared to stay out in the open for a day or more, and some of the bees begin producing large quantities of wax scales from glands in the abdomen in preparation for building combs in the new hive. The entire group lands temporarily in an exposed spot on the limb of a tree or on the side of a building, and they wait while some of the bees serve as scouts. The scouts find a suitable spot for the new colony and then return to direct the swarm to this new location. When the swarm arrives at the new site, they begin to build new brood combs within hours with the wax they have been secreting (see chapter 6, question 9: How do bees make beeswax?).

Question 3: How can you tell when bees are about to swarm?

Answer: A casual observer watching the outside of a honey bee nest would probably not notice anything different during the preparations for swarming, but a beekeeper examining the inside of the hive would have a different impression. The first thing you would notice when you open the top of the colony is that the bees are "boiling," overflowing out of the top of the hive. Next, while examining the honeycomb, you would see the

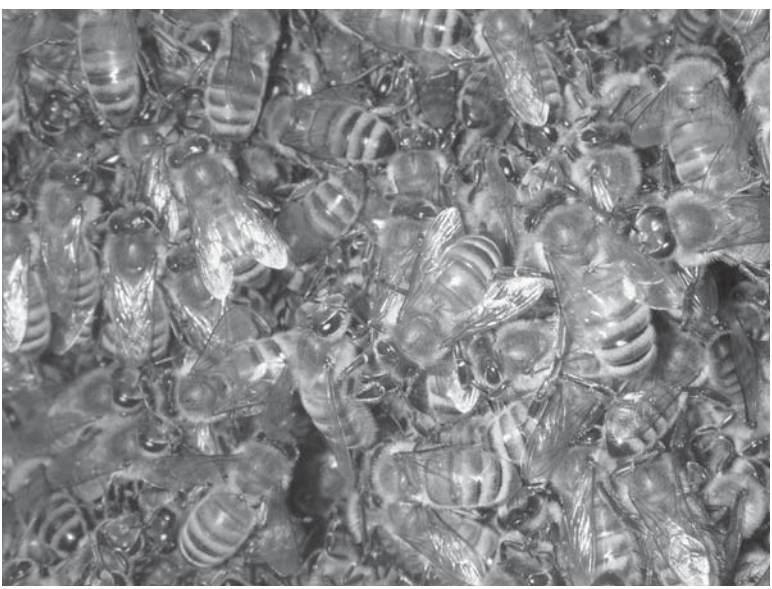

Fig. 25. Close-up photo of bees in a swarm; the bees are layered on top of one another in a large cluster. Bees communicate through odor and movement while in the hive and while in a swarm. *(Photo by Corey J. Flynn.)*

beginnings of the special cells where queens are reared, called "queen cups," that form the base of queen cells. They are larger than normal cells and are provisioned with royal jelly in anticipation of the hungry larval queen (see chapter 4, question 7: What is royal jelly and how does it produce a queen?). The original queen will only leave the hive (with a subset of the workers) after a replacement queen begins to grow.

When a colony swarms, an unusually loud buzzing noise can be heard, louder than the normal activity of the forager bees coming and going, and then lots of bees will begin to run outside and jump into flight. It only takes a few minutes for thousands of the insects to organize into a cloud and fly away. Watching a swarm depart from a beehive is truly a spectacular sight (see also chapter 3, question 8: What is piping behavior?).

Question 4: How does the swarm locate its new home?

Answer: While the swarm waits in a mass, hanging in an exposed location, certain worker bees that serve as scouts fly out of the swarm and search the surrounding area for suitable places to relocate the colony. The scout bees return to where the swarm is waiting, and they "report" on the places they have found, using the waggle dance (see chapter 3, question 7: What is the waggle dance?), and somehow a spot is selected. They prefer certain characteristics for a new cavity, including ample volume, and a dry space high off the ground. A consensus on the choice of a new location is reached by the scouts using a still-to-be-understood process (see chapter 3, question 6: How do bees communicate?).

Traditionally, the explanation of how the swarm finds the new location is via the dance and via olfactory cues given by scout bees. Scout bees post themselves at the entrance to the new location, and they elevate their abdomen and point it outward to expose pheromone-producing glands called Nasanov glands. The scout bees fan their wings to send out an odor trail, and it was thought that the bees in the swarm would follow the pheromone to the new site. But in 2006, Madeleine Beekman and colleagues at Cornell University reported on an experiment where they sealed the odor-releasing glands of the bees they were observing in order to see if preventing them from releasing their pheromones would disrupt the swarm's relocation. They found that sealing the glands did not interfere with the ability of the scouts to successfully direct the swarm, and they discovered that the bees were guided to the new location by "streaker" scout bees that fly very fast (up to 3.3 feet per second) above the moving swarm. Bees have three simple light-detecting organs, called ocelli, that are located on top of their head, and these organs may play a role in enabling bees to follow the streakers flying overhead. Bees' excellent ability to see fast-moving objects may also play a role in this process (see chapter 2, question 9: What do bees see?).

Question 5: What is supercedure?

Answer: Supercedure occurs when the hive replaces an aging queen. When an older queen begins to lay fewer eggs, the bees set out to replace her by rearing a queen from any fertilized eggs they can find in the brood cells. Based on the location of the queen cells, a beekeeper can determine the difference between this emergency queen-rearing during the process of supercedure and the queen-rearing in preparation for swarming. In preparation for swarming, bees rear queens on the bottom of the brood combs, but during supercedure queen cells are randomly dispersed. Some beekeepers will immediately replace the queen when they see this evidence of supercedure, because they believe that the resulting queen will be substandard due to the emergency nature of the process.

Question 6: Do bees migrate?

Answer: Most bees don't migrate, but species of honey bees that are native to Southeast Asia migrate long distances to avoid the stressful environmental conditions associated with the monsoon season. The giant honey bee, *Apis dorsata* (a sister species

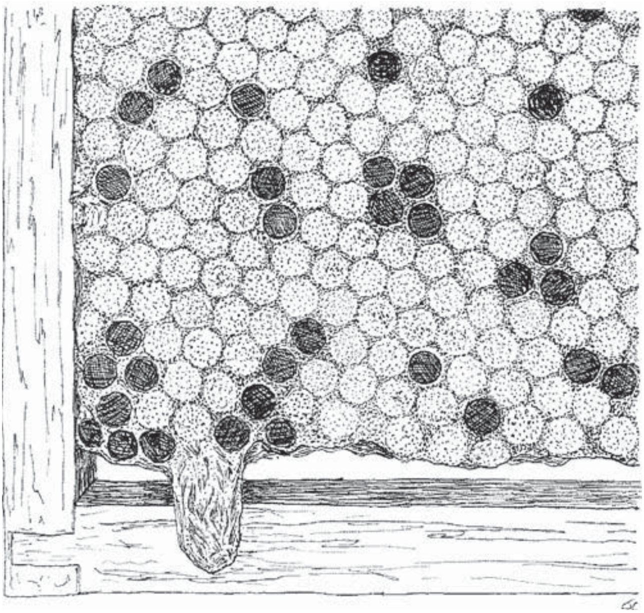

Fig. 26. Made of wax, like other types of comb, queen cells are elongated growth chambers that house the growing queens (*lower left*). Queen cells on the bottom of comb indicate swarming and in the middle of comb indicate emergency queen rearing. *(Drawing by John F. Cullum.)*

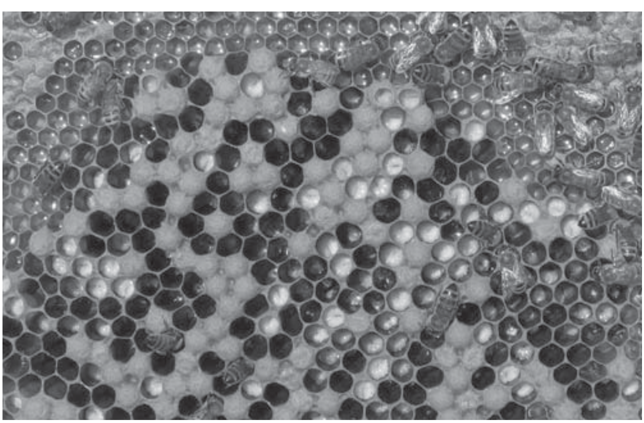

Fig. 27. The spotty brood pattern (some open cells, some capped cells containing pupae, some larvae) on this comb indicates that the queen is laying eggs inconsistently—a sign of queen aging. An alert beekeeper may decide to replace the queen to keep the colony productive. *(Photo by Debra Cook-Balducci.)*

to the western or European honey bee *Apis mellifera*), is native to Thailand and India; these bees regularly abandon their nests and move into areas that have better food resources during the time of year when their normal food sources disappear, and they come back when the dry weather returns. *A. dorsata* colonies resemble the vertical combs of *A. mellifera,* but they differ in that they do not nest inside a cavity. Instead, they build exposed beeswax combs that are at risk for being damaged or destroyed by the rains.

Many bees involuntarily migrate when roving beekeepers in the United States load up a tractor-trailer filled with honey bee colonies and transport them across the country to be temporarily located near flowering crops that require insect pollination in order to develop fruit (see chapter 6, question 5: How do farmers make sure there are enough bees to pollinate their crops?). Douglas Whynott has written a fascinating account of these bee "cowboys" in his book entitled *Following the Bloom: Across America with the Migratory Beekeepers.* Moving hundreds of colonies across the country—from Florida (for oranges), to South Carolina (for melons), to New York (for apples), to Maine (for blueberries), to California (for almonds)—these migrating pollinators have become an industry that supports commercial agriculture.

Question 7: How far do bees fly?

Answer: Scout bees regularly look for food around their hives, and they typically travel within a four- to five-mile radius. Most foragers concentrate on food sources that are within about two miles from their nest, depending on the availability of local flowers, but when hives are located far from food sources, bees can fly longer distances. In a classic series of experiments to study how far bees can fly, honey bees are trained to feed from artificial flowers laced with a sugar solution (see figure 26). When the feeders are gradually moved away from the hive with feeding bees on them, observations by Karl von Frisch and his many students indicate that bees can travel up to twelve miles from the nest to obtain food.

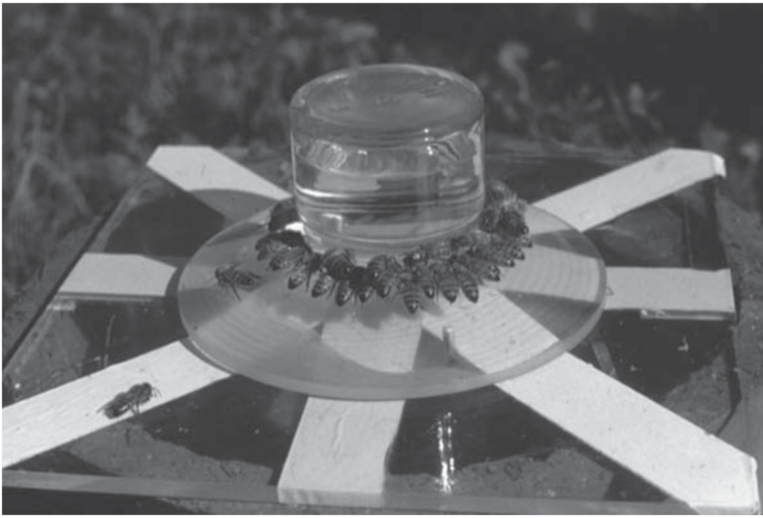

Fig. 28. Honey bees can be trained to visit an artificial flower filled with scented sugar syrup. This technique can be used to study the waggle dance or orientation behavior in an observation hive. *(Photo by Elizabeth Capaldi Evans.)*

Question 8: How high do bees fly?

Answer: The real answer to this question is not so much limited by the bees' flight ability, but rather by their reason for flying high. Bees can and do fly to the height of the tallest trees in order to reach flowers; in rainforests, there are trees that are two hundred feet tall, which would not be a problem for hungry bees. Bees can also be seen visiting flowers on window boxes on tall apartment buildings without any sign of physiological stress. The real limit to bee flight is temperature, which declines at high altitudes, and they cannot fly when temperatures are below about 45 degrees Fahrenheit (7 degrees Celsius).

Question 9: How do bees locate nectar-rich flowers?

Answer: Bees primarily use their keen visual abilities to find profitable flowers that advertise their nectar or pollen rewards with bright or showy flowers. Flowers that attract bees typically

The Great Pollinator Research Project in New York City

New York City has a surprisingly large number of bee species living in the parks, gardens, and neighborhoods of its five boroughs. Sixty species have been counted in Central Park, for example, and a community garden in East Harlem boasted 28 species at last count. Bees and beehives are also found on rooftops, terraces, and in backyards on some of the greener city streets. There are even specialists affiliated with the police department who are dispatched to retrieve honey bee swarms when people phone in to report them clinging to traffic signals or street lights. Kevin Matteson of Fordham University, along with John Ascher of the American Museum of Natural History and Gail Langellotto of Oregon State University, studied nineteen of the over seven hundred community gardens in the city for a period that included four growing seasons. They identified 225 species of bees in New York City, 88 species in Manhattan alone.

In 2007, prompted by recent declines in the populations of European honey bees and native bumblebees, the American Museum of Natural History's Center for Biodiversity and Conservation and the New York City Department of Parks and Recreation's Greenbelt Native Plant Center decided to work together to gather more information about New York City's bee populations with a long-term goal of increasing bee habitat and diversity in the city. In collaboration with the Great Sunflower Project, they launched New York City Bee Watchers—a citizen science project to recruit volunteers from the five boroughs to help gather data. According to Elizabeth Johnson, one of the leaders of the project, the goals of the project are to "identify which areas of New York City have good pollinator service (as determined by how quickly bees show up to pollinate flowers at various locations throughout the city), to increase understanding of bee distribution, to raise public awareness of native bees, and to improve park management practices to benefit native bees." The project is

(continued)

The Great Pollinator Research Project in New York City, *continued*

yielding valuable data that will contribute to bee conservation management strategies.

There are about 150 volunteers who collect data twice a month about bee activity on certain flowers in New York City as part of this project. Each volunteer planted his or her seven plants somewhere in a park or garden in one of New York City's five boroughs. To simplify identification for novice bee watchers, the study asks participants to divide their bees into one of four categories: bumblebees, honey bees, carpenter bees, and green metallic bees.

Janet David is a long-time Manhattan resident who joined the project as a volunteer bee watcher as an extension of her volunteer activities at the American Museum of Natural History. Before participating in this study, Janet admits she had no idea of the variety and quantity of bees that can be found in New York City. Her study area consists of six flowering plants native to the city that she planted in May in the southern end of Central Park in Manhattan: common milkweed, woodland sunflower, wild bergamot, rough-leaved goldenrod, slender-leaved mountain mint, and smooth aster.

To do her observation, Janet takes along a data sheet, a watch, a set of photos of the bees for identification, and her camera. The camera is helpful when the bee identification is difficult because, as Janet noted, "Bees are fast!" Observations are done on two weekends a month when the weather is sunny and calm, preferably from 10 to 12 a.m., but they can be done until 3 p.m. Following the protocol, Janet observes her area for thirty minutes or until five bees have landed on her study flowers—she says sometimes five bees land in less than five minutes.

When doing an observation, Janet records the exact location of her study plants so that the data can be charted with a GPS navigation system. She notes the date and time she starts the observation, the time each bee lands on a study flower,

The Great Pollinator Research Project in New York City

the name of the flower she is watching, the types of bees that land on her flowers, the air temperature, and an estimate of the number of flowers nearby. When possible, she submits photos of the plants and the bees.

As a result of participating in this research, Janet feels she is certainly more observant about different kinds of bees—and less afraid of them. One of the first things the volunteers learned is that bees rarely sting unless their nests are disturbed. Janet is aware that she looks at and tastes honey in a different way; she even recently noticed that Haagen Dazs Ice Cream has a new honey-flavored ice cream. So, as Janet put it, "That's the buzz about bees in New York City."

To volunteer or learn more, go to www.nycbeewatchers.org.

have yellow, blue, or purple flowers, often with radiating colors that emerge from a central point (see color plate C). Bees can see flower colors as they fly over the landscape, and floral odors are secondary cues that can help bees zero in on their targets. Because floral scents are not detectable over long distances, odors are probably only used to back up the visual information.

Question 10: How do foraging bees find their way home?

Answer: A scout bee will leave the nest without a definite destination. She will embark on a search for food resources, and as she moves she is actually noticing cues in the environment that will guide her flight home. Bees can gather directional information from celestial cues, such as the position of the sun and the sun-linked patterns of polarization that are present in the sky (see chapter 3, question 13: How do bees sense and use polarized light?). Interestingly, young adult bees must learn the sky-light compass when they first begin to fly outside the nest. This was shown in experiments by Jeff Dickinson and Fred Dyer, which demonstrated that bees are not born with the ability to use this information. The second type of information, place or location, must also be learned. Bees recognize visual landmarks in the environment, such as tree lines, buildings, landscape features like hills or ridges, and use those images to build a map of their world.

In short, bees have the ability to "dead reckon" after a scouting trip. They may take an outward path that meanders around the landscape, but when they want to head home, they can simply integrate their map and compass information and fly directly home. Without experience, or without these two sources of information, a bee cannot directly find her way home, but she may be able to do so after flying in a random search pattern.

Question 11: What happens to flying bees in bad weather?

Answer: Bees have special hairs that act like sensors on their bodies to adjust their flight path in relation to wind speed and direction, enabling them to maintain a straight course of flight. In extremely hard wind, bees will take shelter in vegetation until the winds have slowed down.

Bees can only fly in very light rain. During heavy rain, the large droplets of water can actually knock bees down. Another problem that accompanies rain is low air temperature. When bees are wet, their ability to generate metabolic heat in order to stay warm enough to fly becomes very taxed. Bumblebees, which have larger bodies than honey bees, can fly at lower temperatures and also are better able to tolerate some rain. In short, honey bees don't like rain, and they usually stay at home when it rains rather than look for food.

Question 12: What is playflight behavior?

Answer: If you were to visit a honey bee hive on a warm, sunny afternoon, you might see a large cloud of bees hovering just in front of the beehive in a way that differs from the normal, busy traffic of the foragers. Austrian scientist Karl von Frisch and others studying bee behavior first called this behavior *vorspiel* (playing about). When further examined, this behavior, now called playflight behavior or orientation flight behavior, occurs when the young adult bees take their first flights outside of the nest. This activity has a serious purpose and has nothing to do with play.

As honey bees age, their behavior changes in a regular and predictable fashion, and the oldest bees in the colony have the risky job of venturing into the outside world (see chapter 1, question 9: What is the role of the workers?). But first they need to learn about their environment, so they can efficiently scout and forage without getting lost. Bees must integrate a lot of information in their middle age involving the location of their hive entrance, the sky-light compass, and how to find and handle flowers efficiently. Playflight behavior occurs when they begin this process by taking orientation or reconnaissance flights outside of the nest, and they return from these flights without food, water, or any other resource except information. The cloud of bees seen during a playflight occurs because lots of young bees take these flights at one time. Without playflight behavior, bees cannot learn to navigate. What triggers the behavior is unknown, but we do know that it typically happens between 1 p.m. and 3 p.m. on warm, sunny days. Interestingly, beehives kept indoors for long periods of time in experimental flight rooms with an artificial light-dark cycle still exhibit these bursts of activity, even though the bees presumably cannot detect the environmental cues for the specific time of day.