Honeybee

Photo by:
Larry Crowhurst/Oxford Scientific Films

Honeybee, common name for any of several species of highly social bees known for their honey-hoarding behavior and their use as a domesticated species. The European honeybee is important in modern agriculture and in nature, providing pollination for many valuable crops and wild plants. It is native to Asia and the Middle East and was introduced to North America by early European colonists. By the mid-1800s honeybees had become widespread. Today, they are naturalized on every continent except Antarctica. Honeybees can be easily reared, are adaptable to many climates and to laboratory conditions, and have a complex social life. They are among the most studied and best-known insects.

Diversity
In addition to the familiar European honeybee, there are six other recognized species of honeybees, including the Indian honeybee, Koschevnikov's honey bee, the dwarf honey bee, the antenniform dwarf honey bee, the giant honey bee, and the mountain giant honey bee. The European, the Indian, and to some extent the dwarf honeybees are the species that have been domesticated, although the European honeybee is by far the most widespread domesticated bee and the only species kept in North America. There are many races of the European honeybee. The ones most popular in modern beekeeping are the Italian, Carniolan, and Caucasian. Most honeybees used in hives today are mixtures of these and sometimes other races. Africanized honeybees, also known as killer bees, are a hybrid of African and European races naturalized in the western hemisphere.

Social Organization
The honeybee is a social insect that can survive only as a member of a community, or colony. The colony inhabits an enclosed cavity, its nest. Domesticated colonies are kept in artificial containers, usually wooden boxes, known as hives.

Castes
The honeybee community consists of three structurally different forms-the queen (reproductive female), the drone (male), and the worker (nonreproductive female). These castes are

associated with different functions in the colony; each caste possesses its own special instincts geared to the needs of the colony.

Microsoft Illustration
The Queen

The queen is the only sexually productive female in the colony and thus is the mother of all drones, workers, and future queens. Her capacity for laying eggs is outstanding; her daily output often exceeds 1500 eggs, the weight of which is equivalent to that of her own body.

Anatomically, the queen is strikingly different from the drones and workers. Her body is long, with a much larger abdomen than a worker bee. Her mandibles, or jaws, contain sharp cutting teeth, whereas her offspring have toothless jaws. The queen has a curved, smooth stinger that she can use repeatedly without endangering her own life. In contrast, the worker honeybees are armed with straight, barbed stingers, so that when a worker stings, the barbed, needle-sharp organ remains firmly anchored in the flesh of its victim. In trying to withdraw the stinger, the bee tears its internal organs and dies shortly thereafter. The queen bee lacks the working tools possessed by worker bees, such as pollen baskets, beeswax-secreting glands, and a well-developed honey sac. Her larval food consists almost entirely of a secretion called royal jelly that is produced by worker bees. The average lifespan of the queen is one to three years.

The Worker Bee
Worker bees are the most numerous members of the colony. A healthy colony may contain 80,000 worker bees or more at its peak growth in early summer. Workers build and maintain the nest and care for the brood. They build the nest from wax secreted from glands in their abdomen. The hexagonal cells, or compartments, constructed by the workers are arranged in a latticework known as the comb. The cells of the comb provide the internal structure of the nest and are used for storage of the developing young bees and all the provisions used by the colony. Comb used for storage of honey is called honeycomb. Workers leave the hive to gather nectar, pollen, water, and propolis, a gummy substance used to seal and caulk the exterior of the nest. They convert the nectar to honey, clean the comb, and feed the larvae, drones, and the queen. They also ventilate the nest and when necessary, defend the colony with their stings. Workers do not mate and therefore cannot produce fertile eggs. They occasionally lay infertile eggs, which give rise to drones.

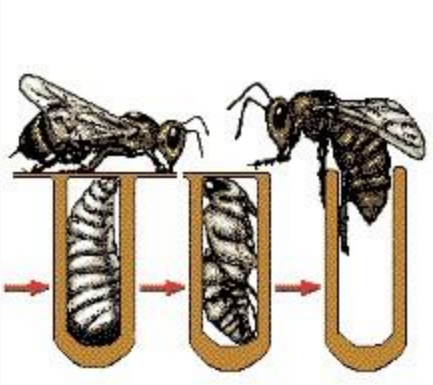
As with all bees, pollen is the principal source of protein, fat, minerals, and vitamins, the food elements essential for the growth and development of larvae of all three castes. Adult bees can subsist on honey or sugar, a pure carbohydrate diet. Besides gathering and storing food for all the members of the colony, the workers are responsible for maintaining the brood at 33.9? C (93? F), the optimum temperature required for hatching the eggs and rearing the young. When the nest or hive becomes too hot the workers collectively ventilate it by fanning their wings. During cool weather, they cluster tightly about the nursery and generate heat. The eggs, which are laid one per cell, hatch in three days. The larvae are fed royal jelly for at least two days and then pollen and nectar or honey. Each of the hundreds of larvae in a nest or hive must be fed many times a day.

For the first three weeks of their adult lives, the workers confine their labors to building the honeycomb, cleaning and polishing the cells, feeding the young and the queen, controlling the temperature, evaporating the water from the nectar until it thickens as honey, and many other miscellaneous tasks. At the end of this period, they function as field bees and defenders of the colony. The workers that develop early in the season live extremely busy lives, which, from egg to death, last about six weeks. Worker bees reared late in the fall usually live until spring, since they have little to do in the winter except eat and keep warm. Unlike other species of bees, honeybees do not hibernate; the colony survives the winter as a group of active adult bees.

The Drone Bee

Drones are male honeybees. They are stingless, defenseless, and unable to feed themselves-they are fed by worker bees. Drones have no pollen baskets or wax glands and cannot secrete royal jelly. Their one function is to mate with new queens. After mating, which always takes place on the wing in the open air, a drone dies immediately. Early investigators of the mating habits of the honeybee concluded that a queen mates only once in her life. Recent scientific studies, however, have established that she usually mates with six or more drones in the course of a few days. The motile sperm of the drones find their way into a small, saclike organ, called the spermatheca, in the queen's abdomen. The sperm remain viable in this sac throughout the life of the queen.

Drones are prevalent in colonies of bees in the spring and summer months. As fall approaches, they are driven out of the nests or hives by the workers and left to perish.



Microsoft Illustration

Reproduction and Development

The queen controls the sex of her offspring. When an egg passes from her ovary to her oviduct, the queen determines whether the egg is fertilized with sperm from the spermatheca. A fertilized egg develops into a female honeybee, either worker or queen, and an unfertilized egg becomes a male honey bee, or drone.

The queen lays the eggs that will develop into more queens in specially constructed downward-pointing, peanut-shaped cells, in which the egg adheres to the ceiling. These cells are filled with royal jelly to keep the larvae from falling and to feed them.

Worker bees are raised in the multi-purpose, horizontally arranged cells of the comb. Future workers receive royal jelly only during the first two days, compared to future queens, who are fed royal jelly throughout their larval life. This difference accounts for the great variation in anatomy and function between adult workers and queens. On average, the development of the queen from egg to adult requires 16 days; that of the worker, 21 days; and that of the drone, 24 days.

Photo by:
Stephen Dalton/Photo Researchers, Inc.

Activities

Field honeybees collect flower nectar. On entering the hive with a full honey sac, which is an enlargement of the esophagus, the field bee regurgitates the contents into the mouth of a young worker, called the house, or nurse, bee. The house bee deposits the nectar in a cell and

carries out the tasks necessary to convert the nectar to honey. When the honey is fully ripened, the cell is sealed with an airtight wax capping. Both old and young workers are required to store the winter supplies of honey.

Pollen is carried into the nest or hive on the hind legs of the field bees and placed directly in the cells. The pollen of a given load is derived mostly from plants of one species, which accounts for the honeybee's outstanding role as pollinator. If it flew from one flower species to another, it would not be effective in the transfer of pollen, but by confining its visits on a given trip to the blossoms of a single species, it provides the cross-pollination required in many varieties of plants.

Photo by:
Dorling Kindersley

Communication

An amazing symbolic communication system exists among honeybees. In studies of bees begun in the early 1900s, the Austrian zoologist Karl von Frisch determined many of the details of their means of communication. In a classic paper published in 1923, von Frisch described how after a field bee discovers a new source of food, such as a field in bloom, she fills her honey sac with nectar, returns to the nest or hive, and performs a vigorous but highly standardized dance. If the new source of food is within about 90 m (about 295 ft) of the nest or hive, the bee performs a circular dance, first moving about 2 cm (about .75 in) or more, and then circling in the opposite direction. Numerous bees in the nest or hive closely follow the dancer, imitating her movements. During this ceremony, the other workers scent the fragrance of the flowers from which the dancer collected the nectar. Having learned that food is not far from the nest or hive, and what it smells like, the other bees leave the nest or hive and fly in widening circles until they find the source.

If the new source of nectar or pollen is farther away, the discoverer performs a more elaborate dance characterized by intermittent movement across the diameter of the circle and constant, vigorous wagging of her abdomen. Every movement of this dance seems to have significance. The number of times the bee circles during a given interval informs the other bees how far to fly for the food. Movement across the diameter in a straight run indicates the direction of the food source. If the straight run is upward, the source is directly toward the sun. Should the straight run be downward, it signifies that the bees may reach the food by flying with their backs to the sun. In the event the straight run veers off at an angle to the vertical, the bees

must follow a course to the right or left of the sun at the same angle that the straight run deviates from the vertical. Bees under observation in a glass hive demonstrate their instructions so clearly that it is possible for trained observers to understand the directions given by the dancers. Certain aspects of the dance language, such as how attendant bees perceive the motion of dancers in the total darkness of the nest or hive, are still unknown. The dance language is an important survival strategy that has helped the honeybee in its success as a species.

Problems of Survival

Honeybees are subject to various diseases and parasites. American and European foulbrood are two widespread contagious bacterial diseases that attack bee larvae. A protozoan parasite, Nosema, and a virus cause dysentery and paralysis in adult bees. Two species of blood-sucking parasitic mites are particularly troublesome for beekeepers and are currently affecting wild honeybees worldwide. The honeybee tracheal mite lives in the breathing tubes of adult bees; the varroa mite lives on the outside of larvae and adults. These mites have killed tens of thousands of honeybee colonies in North America during the past ten years. Scientific breeding programs are attempting to develop tolerant strains of domestic honeybees to replace the mite-susceptible ones currently used. Tracheal mite infestations can be reduced by fumigation of the hive with menthol fumes. Varroa mites are controlled with a miticide or, in some European countries, with fumes of formic acid. Certain hive management techniques also can reduce infestations.

Many other animals' prey upon individual honeybees, which may sometimes weaken colonies. Examples are cane toads and bee eaters (birds), which pick off foragers near the colony entrance; robber flies, which take individual foragers as they visit flowers; and hornets and bee wolves (wasps), which may enter the nest or hive and steal larvae. Bears have an insatiable appetite for honey and bee larvae and may destroy many nests or hives in a single raid.

Honeybee colonies used in commercial pollination and those kept in urban areas are exposed to pesticides, fungicides, fertilizers, and other agricultural chemicals and are frequently poisoned by accident. This is a major concern of modern beekeepers.

Importance

Honeybees have become the primary source of pollination for approximately one-fourth of all crops produced in the United States and some other countries. The value of the crops that rely on such pollination has been estimated as high as $10 billion annually in the United States. Examples of fruit crops that rely on honeybees are almonds, apples, apricots, avocados, blackberries, blueberries, cantaloupes, cherries, cranberries, cucumbers, pears, raspberries, strawberries and watermelons. The seeds of many vegetables are also produced with honeybee pollination; examples include alfalfa, asparagus, broccoli, brussels sprouts, cabbage, carrots, clover, cotton, cucumbers, onions, radishes, squash, sweet clover, and turnips.

Many species of wild pollinators have disappeared from the land as their habitats have been destroyed or altered by humans. The honeybee has taken over as pollinator of many of the wild plants that remain; its ecological value in this regard is tremendous.

Honeybees are the sole source of honey and beeswax, a fine wax with unusual qualities. Honeybees also produce propolis, a gummy substance made from tree sap that has antibacterial properties, and royal jelly and pollen for human consumption. Honeybee venom is extracted for the production of antivenom therapy and is being investigated as a treatment for several serious diseases of the muscles, connective tissue, and immune system, including multiple sclerosis and arthritis.

Scientific classification: Honeybees comprise the genus Apis in the family Apidae, order Hymenoptera. The European honey bee is classified as Apis mellifera, the Indian honey bee is A. cerana, Koschevnikov's honey bee is A. koschevnikovi, the dwarf honey bee is A. florea, the andreniform dwarf honey bee is A. andreniformis, the giant honey bee is A. dorsata, and the mountain giant honey bee is A. laboriosa. The Italian race of the European honey bee is A. m. ligustica, the Carniolan race is A. m. carnica, and the Caucasian race is A. m. causcasia.

Contributed by: Kenneth A. Chambers