

## The Honey Bee (*Apis mellifera*)

Ants, bees and wasps are social insects. This means that they tend to live in colonies where all the individuals are of the same family, often the offspring of one mother. In the more highly organized societies there is a division of labour in which individuals carry out particular duties.

**Structure.** The bodies of bees are divided into head, thorax and abdomen, with three pairs of legs and two pairs of wings on the thorax. The fore and hind wings on each side are linked by hooks and grooves so that they move together in flight.

The mouth parts consist of a "tongue" or labium, which can be enclosed near the head by the labial palps and maxillae. Nectar, from the nectaries of flowers, can be drawn up the grooved surface of the labium, partly by capillary attraction and partly by the pumping action of muscles in the head. When not in use, these elongated mouth parts are folded back under the head, leaving the shorter, stouter mandibles free in front to chew pollen, manipulate wax, attack intruders etc.

The ovipositor through which the queen lays her eggs in the wax cell, is modified in the workers to form a sting.

**Organization of the colony.** There are four species of *Apis*, the honey-bee, one of which is *Apis mellifera*, the Western honey-bee, which is the commonest hive-bee in this country. There are three kinds of bee in a colony: in the summer, a few hundred drones or males, one egg-laying female, or queen, and from 20 to 80 thousand sterile females or workers. The mature queen is usually easily recognized by her large abdomen.

**The Queen.** A queen bee may live from two to five years and, except for a short period at the end of her life when one of her daughters takes over the colony, she is the only egg-laying female. All the members of the colony, whether drones or workers, are her offspring. She spends all her time laying eggs, perhaps up to 1500 a day, each one being placed in a wax cell made by the workers. The queen can feed herself but in the hive the nearest workers turn towards her, lick her body and feed her by regurgitating a special secretion of their salivary glands, called "royal jelly", on to their probosces from which the queen can absorb it.

The queen usually mates only once in her life (though second and third matings are known to happen) and stores the sperms received from the drone in a sperm sac in her abdomen. This store of sperms lasts her for the two or more years of egg-laying, a small quantity being released with each fertilized egg laid.

When the store of sperms is used up she may continue to lay eggs but they are all unfertilized and will become drones. By this time one of her daughters has been reared as a queen and is ready to take over the egg-laying.

**Life history.** Each egg is laid in one of the hexagonal wax cells and hatches into a tiny, white, legless larva. The larva feeds on substances deposited in the cell by the workers; it grows, pupates in the cell, hatches as an adult bee and finally emerges from the cell into the hive. The eggs hatch after three to four days and by nine days are fully grown and ready to pupate. The workers put a capping over the cells at this time. Ten or eleven days later the capping is bitten away and the adult emerges. The times given

above vary with changes of temperature and according to whether the bee is becoming a drone, worker or queen.

**Drones.** The drones, who live for about four to five weeks and do not work inside the hive, are fed by the workers or help themselves from the store of pollen and nectar in the combs. Their function is to fertilize a new queen. In the autumn, or when conditions are poor, they are turned out of the hive where they are unable to find food for themselves, they soon die.

**Workers.** The workers are female bees whose reproductive organs do not function. Among many other tasks they collect food from outside the hive and store it, make the wax cells and feed the developing larvae.

**Origin of the three types of bee.** The wax combs are built hanging vertically with a gap of about half an inch separating each one. The cells in each comb thus lie horizontally. The workers prepare three kinds of cell: worker cells about 5 mm across, drone cells about 6 mm across, and queen cells quite different from the others. The queen cells are larger and made individually, pointing downwards like small acorns from the surface or bottom of the comb. The relative numbers of these three kinds of cell seem to depend on the time of the year, the temperature, the abundance of food and condition of the colony. Normally, the worker cells predominate.

Eggs are laid by the queen in the brood area. This is where the temperature is about 32° C, kept so by the heat given out by the bees' bodies. The area varies, diminishing in the winter and expanding in the summer. The queen moves over the brood area, laying eggs indiscriminately in any of the three types of cell she encounters, by placing her abdomen in the cell and depositing a single egg. The eggs placed in the larger, drone cells, are not fertilized, and this results in the eggs developing into a male bee or drone. In the queen and worker cells, fertilized eggs are laid.

For the first three days after hatching, all the larvae are fed on a protein-rich, milky secretion, called royal jelly, which comes from the salivary glands of workers of a certain age. The grubs in queen cells continue to be fed on royal jelly for the rest of their lives, but those in drone or worker cells are "weaned" onto a mixture of dilute nectar and pollen. If a one-to-three-day old larva is transferred from a worker to a queen cell, it will receive the diet of royal jelly and develop into a queen. Thus, though there is no difference between the eggs and young larvae in queen and worker cells, their different treatment by the workers results in their becoming quite distinct types of bee.

Exactly what aspects of their feeding cause this is not known for certain. It may be the absence of pollen from the queen's diet, the cessation of royal jelly in the worker's diet, the super-abundance of food placed in the queen cells or a vitamin-like chemical fed to the queen larvae in the early stages. After three days, worker grubs cannot be reared as queens, even if they are placed in queen cells and fed on royal jelly.

Drones, then, develop from unfertilized eggs in wide cells, queens and workers from fertilized eggs which are fed differently as larvae.

**Life of a queen.** When a new queen emerges she is fed by the workers. She bites a hole in any other occupied queen cells that she finds and some observers believe she stings the occupants. In any event, the workers usually tear down the other queen cells that have been bitten into and destroy the occupants.

For a few days the queen leaves the hive for short flights lasting, at first, only a minute but gradually lengthening to about 15 minutes. During these flights she learns the geography of the district around the hive. On one of these flights she is pursued by drones, but not necessarily from her own hive; in fact, they

do not follow her from the hive but are already waiting outside. One of them catches the queen and mates with her, depositing in her vagina sperms which eventually find their way into her sperm sac. She now returns to the hive, and soon after begins to lay eggs.

From glands in her head, the queen produces a mixture of chemicals called pheromones ('queen substance'). When the workers 'lick' her body, the pheromones suppress their fertility. When, at the end of her life, the queen ceases to produce these pheromones, some workers start to lay eggs which, being unfertilised, produce only drones. They do, however, start building new queen cells.

**Division of labor.** The tasks undertaken by a worker bee depend partly on its age and partly on the immediate needs of the colony. Generally speaking, the worker's life follows the course described below, although the times given are very approximate and in many cases may not apply.

After hatching, she is fed by other workers and spends a good deal of time standing still on the comb. She does, however, clean out cells from which bees have recently hatched by removing the cast larval cuticles. On the fourth day she feeds on honey from the store cells and eats a good deal of pollen. Between the third and fifth day she feeds older larvae by placing nectar, water and pollen in their cells.

The pollen that she eats is rich in protein and helps her salivary, brood food glands to become active, so that by the fifth day they can secrete the brood food or royal jelly which is fed to the younger larvae. After ten or twelve days these glands cease to function effectively but wax glands on the underside of her abdomen begin to secrete wax which the worker uses for comb-building and repair. By this time she is also beginning to leave the hive for short flights during which she learns the position of the hive and the topography of the surroundings.

Between the twelfth and twenty-first days these reconnaissance flights continue; while in the hive, the worker collects pollen and nectar from the incoming field bees and stores it in the cells. She also processes the nectar and begins its conversion to honey, and cleans the hive by removing the dead bees and detritus from its floor.

After three weeks of hive duties the worker becomes a forager and spends the daylight hours collecting water, nectar, pollen and propolis and carrying it back to the hive. This work she may continue for about three weeks before she dies.

The "schedule" given above is by no means rigid, and observers have recorded bees doing several of the duties mentioned at the same time, as well as old bees performing "nurse" duties, and young bees foraging. Some of the duties may be missed out altogether. For example, only a few of the young foragers do duty as guard bees, protecting the hive from invasion by robber bees.

**Food.** The foraging workers collect nectar from the nectaries of flowers. The nectar is drawn off from the nectaries by the long labium. It is pumped up and swallowed into the honey sac, a region of the gut from which it can be regurgitated on reaching the hive. Nectar is a watery sugar solution when collected, but it is processed by the house bees to whom it is passed. These workers repeatedly swallow it, mix it with enzymes and regurgitate it. The enzyme action and the evaporation of water result finally in its conversion to honey. Nectar contains very little protein, and the pollen collected by the foragers makes up this deficiency.

Pollen is collected by combing off with the legs the grains which adhere to the bee's body after it has visited a flower. The pollen collected on the head, and removed by the front legs, is mixed with a little nectar and passed to the back legs which have combed pollen from the abdomen. The rows of bristles on

the legs assist this combing action. The pollen press, in the joint between the tibia and tarsus of the hind legs, squeezes the pollen which is passed to it from the pollen comb of the opposite hind leg. The pollen and nectar paste is thus pushed by the press into the pollen basket on the tibia, where it is retained by the fringe of setae. All this may be done while the bee hovers in the air or while hanging from the flower. The forager returns to the hive with the two packs of pollen and pushes them off into an empty cell or into one with some pollen already in it.

The younger house bees then break up the pollen masses and pack them down into the cell. When the cell is full it may be covered with a little nectar and sealed over. Both pollen and honey sealed in the store cells are eaten by the bees in the winter months when no other food is available. Water is collected and used to dilute the nectar with which the larvae are fed, but there is no evidence of water being stored.

Propolis is a resinous substance that the bees collect from trees and sticky buds. They use it for sealing small cracks and gaps in the hive.

**Swarming.** When the size of the colony reaches a certain stage, usually in Spring or Summer when the nectar flow is at its greatest, the queen and a great many workers, leave the hive in a swarm. The swarm comes to rest in a great cluster on a tree branch or similar situation. Scout bees, who may have left the hive some days before, seek out a suitable situation for a new nest and return to the swarm and communicate this information, whereupon the whole swarm moves off to the new site. In the old hive, one of the new queens hatches out, mates, and takes over the colony that is left.

**Senses and communication.** The senses of touch and smell, particularly through the antennae, are very important to bees in finding sources of food, in identifying members of their own colony, and sometimes in finding their way home. Their compound eyes are sensitive to certain groups of colours though colorblind to red. In the darkness of the hive they must depend on touch and smell to carry out their activities. They find their way to and from the hive by learning the landmarks in the vicinity and steering by the position of the sun.

A bee which has found a rich source of food will return to the hive and execute a dance on the surface of the comb. It takes the form of a figure eight with a straight section in the middle. The length of the straight section is proportional to the distance of the flowers from the hive, and the angle it makes with the vertical represents the angle between the position of the sun, the hive and the source of food. In addition, the dancer may make wagging movements of her body on the straight section, which indicates distance. Some of the foraging bees in the hive follow the dance, touching the dancer with their antennae. From time to time the dancer stops and, regurgitating a little of the nectar she has collected from the flowers, she feeds the attentive workers. The dance pattern, the taste of the nectar and sometimes the scent of the flowers on the dancer's body enable the workers to find the feeding ground from which the dancer has just returned.