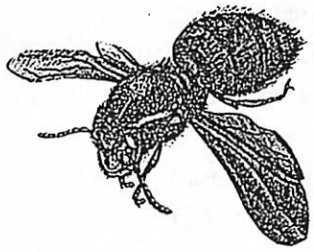
THE HISTORY OF THE HONEY BEE



The honey bee (*Apis mellifera mellifera*) is one of the oldest forms of animal life still in existence from the Neolithic Age. The oldest bee remains known to exist are those preserved in a tiny piece of amber. This fossil is believed to be over 80 million years old and is kept at the American Museum of Natural History in New York. The earliest record of man interacting with this fascinating insect comes from a rock painting in Spain, which is thought to be around 6,000 to 8,000 years old. Paintings have also been found in other parts of the world and an ancient papyrus from Lower Egypt dating back to 256 BCE tells of a beekeeper who had 5,000 hives. Honey was a component in more than 500 Egyptian medicines and beeswax and propolis were also used in the embalming process.

Early Greeks and Romans were known to keep bees, and Greek athletes used honey—they called it the nectar of the Gods—to boost their performance. The philosopher Pliny used to drink a glass of honey and cider each day to cleanse his system and promote good health.

The Bible, ancient scrolls of the Orient, the Talmud, the Torah and the Koran all mention the honey bee and the healing food that it produces. Many ancient Greek myths also refer to honey and its producer; for example, the nymph Melissa cared for the infant Zeus while he was being hidden from his father, with nectar plundered from hives. However, while protecting her infant, Melissa was turned into an insect. Zeus took pity on her and turned her into a honey bee so she could make honey for eternity.

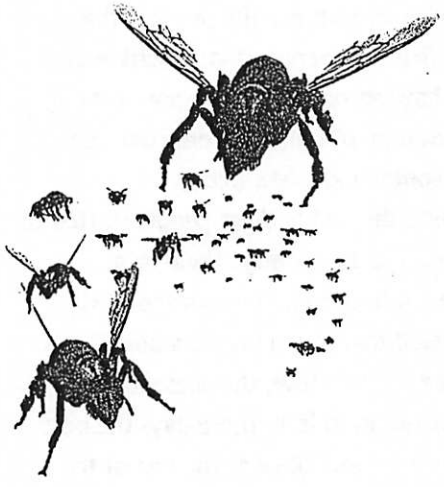
During the Dark Ages in Europe, it was common for monks to keep bees, using their wax to make candles for the monastery. The alcoholic drink, mead, is possibly the earliest known fermented drink of any kind. Mead is, simply put, fermented honey and water, and can be created naturally without the help of man. So it is quite possible that man's first experience of intoxication could easily have sprung from the spontaneous fermentation of honey in some old tree trunk containing a bee colony.

During the Middle Ages people started to cut the trees and arrange them into apiaries. A few hundred years ago it was discovered that if you placed a box of straw over the top of a hive, the bees would start to store honey in it. In those days the bees would have been killed at the end of the

season so the wax and honey could be taken.

Honey bees did not exist in North or South America, Australia or New Zealand until the Europeans settled there, but by the 1600s, records show that the honey bee population was widespread on the east coast. They expanded into North America with the aid of man during the 18th century. Many Europeans who were fleeing war, poverty, strict land laws or religious persecution brought with them extensive beekeeping skills.

The 19th century saw a leap forward in beekeeping as this was the first time that it became commercially viable. The movable frame hive, the smoker, the comb foundation maker and the honey extractor were all invented at the beginning of this century. A fifth invention—a queen grafting tool—allowed beekeepers to control genetic lines for the first time.



In 1922, the United States passed the Honey Bee Restriction Act, in an effort to protect bees against the tracheal mite (*Acarapis woodi*), which attacked the respiratory system of adult honey bees. European beekeepers were losing as much as 50 to 80 percent of their colonies to the mite and the United States was anxious to avoid its introduction on home soil. The ban was partially rescinded in 2004, although the movement of bee colonies was still under supervision.

Freedom of movement and attempts to mix different bee races has caused major problems with one race trying to eliminate another. The honey bee is able to adapt to minor changes in global warming, but Colony Collapse Disorder (CCD) is a bitter reminder that mankind is upsetting the balance of this delicate little worker. CCD is a phenomenon in which worker bees from a colony suddenly disappear. This first became a problem in North America toward the end of 2006, and it is economically significant because bees are needed to pollinate agricultural crops throughout the world. European beekeepers observed similar problems and it has now become a global problem. The cause of the syndrome is not yet fully understood, but it is believed that mites, genetically modified crops and global warming in general could all be significant factors. It is now up to us to help protect our environment by rebuilding honey bee colonies and providing them with a safe, natural habitat.

THE SUPERFAMILY

A single honey bee could not live for very long without the support of its colony or family. A worker bee cannot reproduce, the queen is unable to produce the wax comb, collect pollen or even feed herself, and the drone's only role is to mate with the queen. That is why the honey bee family needs to work as a single unit.

Bees belong to the insect family *Hymenoptera*, a group that includes ants, wasps and sawflies. Although the creatures are regarded as pests by many humans, they are in fact extremely beneficial to the environment, either as natural enemies of insect pests or as pollinators of flowering plants.

A newcomer to beekeeping will probably look inside a hive and see thousands of bees just moving around randomly. Although the actions of a colony may seem like chaos, in fact every move has a purpose and as you learn more about keeping bees you will start to understand that it is a highly organized society. As you get used to handling the frames, you will soon be able to assess if there is a problem within your colony. For example, is the queen laying sufficient eggs, are the bees collecting enough pollen and is the colony building up in numbers as you would expect?

Before you can fully understand the workings of your beehive, you should learn about the inhabitants and their various roles—the queen, the worker and the drone.

BEE DEVELOPMENT

Each bee starts its life as a small egg that is laid by the queen in the bottom of a wax cell built specifically for this purpose in the comb. The egg will hatch after just three days and the bee begins its larval stage inside an open cell. The larvae will constantly be fed by nursing bees first on royal jelly and then on a mixture of pollen and honey. If the egg is destined to be a queen, then it will be fed solely on royal jelly. After a further five days (six for the drone), the worker bees will cap the cell, and the larvae will start to spin a cocoon around itself. This is the start of the pupal stage, or the time when the larvae gradually changes into an adult bee. Once the bee is fully formed it will start to chew its way out of the cell cap, to emerge as an adult. The time it takes for the egg to develop into the adult bee differs considerably between each class. The queen will emerge after 14 to 17 days, the worker 16 to 24 and the drone 20 to 28 days, depending on the environment and the quality of food available.

A colony normally has a single queen, 50,000 to 60,000 workers at its peak, and several hundred drones during late spring and summer.

THE QUEEN

There is generally only one queen bee per colony and her only role is to mate and lay eggs. She is only fractionally larger than a worker and in a very busy hive she can be quite difficult to detect. This is something that becomes easier with experience, and it is a very important part of beekeeping. Her body is usually longer than either that of the worker or the drone, especially during the egg-laying period when her abdomen is greatly elongated. Her wings cover only about two-thirds of her abdomen, whereas the wings of the other bees nearly reach the tip of the abdomen when folded. Her stinger is curved and longer than that of the worker and has fewer and shorter barbs.

The mating ritual

After the virgin queen emerges from her cell, with a little encouragement from the workers and weather permitting, she will make her maiden flight within a few days. She will not leave the hive if the weather is windy or very wet. As she needs to fly some distance to locate the drone congregation area (DCA), she will first circle the hive to orient herself to its location. She leaves the hive on her own and is usually gone for around 15 minutes. She will usually mate in the afternoon and this occurs on the wing with approximately 15 to 20 drone bees. Her pheromones will only attract the drones if she is flying at an altitude above 20 feet (6 meters). Each one waits its turn, then flies up to the queen and grasps her from behind before the final act of mating. As each drone completes the act, its body will literally rip apart from the effort and it dies on the spot. Then the next drone takes over and so on. The queen's time outside the hive is rife with danger because of predators, such as birds, and also the risk of bad weather, so the queen only makes one flight.

The queen is a vital element to the bee colony as they depend totally on her chemical production and egg laying. It is her genetic makeup, along with that of the drones she has mated with, that determines the quality, size and temperament of the colony.

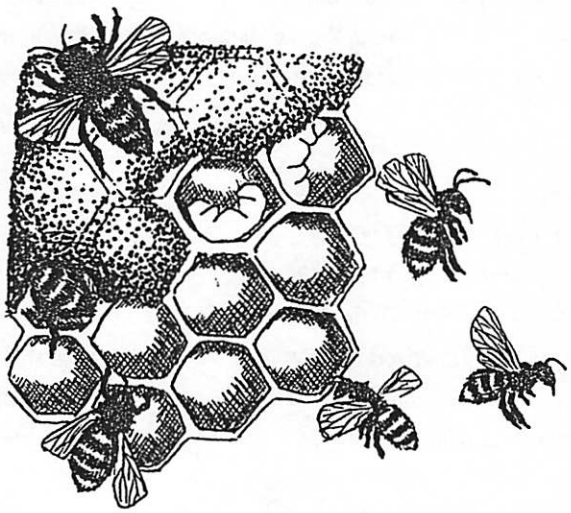
Laying the eggs

As soon as the queen feels she has accumulated enough sperm in her sperm sac (*spermatheca*), she will return to the hive and start her life as queen of the colony. This sperm will last her for the remainder of her life, which is first and foremost the function of an egg-laying

machine. She will start laying within 48 hours of her return to the nest, and may lay as many as 50,000 eggs during her prime. She produces both fertilized and unfertilized eggs. Queens lay the greatest number of eggs during spring and early summer, gradually starting to slow down production in early October, and do not begin laying again until January.

The queen measures the size of the cells with her antennae before laying one egg at the base of the cell. If the cell is worker size, then the queen will fertilize the egg as it passes out of her. Around 21 days later, the worker bee emerges, having inherited the genes from both the father and mother. If, on the other hand, the cell is drone size, the queen will not fertilize the egg and drone bee larvae will therefore form (see page 16 for more details).

The queen will be constantly attended and fed royal jelly by the worker bees. This is a vital role for the worker bee, as the number of eggs the queen lays will depend on the amount of food she receives and the size of the worker force capable of caring for her brood.



The queen bee can live for as long as five to seven years and after the first couple of years her sperm supply will start to slow down and the colony will make the decision to replace or supersede her.

Supersedure

When the queen's sperm supply begins to slow down, the workers prepare to replace her; this procedure is called supersedure. This process begins when the workers construct special cells called queen cups to hold the replacement queen bee larvae. This larvae is identical to that of the worker bee at first, but the workers start to feed the larvae with a steady diet of royal jelly, which allows them to mature into queens. As soon as the new queen emerges from its cell, she will immediately look for any other rival queens and kill them before they can emerge. If the old queen is still in the hive, she may kill her as well in one-to-one combat. Alternatively, the worker bees may kill the old queen themselves, surrounding her with their bodies until she overheats and dies. After the old queen has been removed from the colony, the new queen embarks on her mating flight and the whole process repeats itself.

Emergency queens

If the queen dies unexpectedly, the workers will not have time to go through the supersedure process. However, as the queen larvae are initially identical to the worker bee larvae, the workers can quickly turn these larvae into emergency queens by feeding them royal jelly and making their cells larger. The first emergency queen to emerge from her cell will sting the others to death while they are still inside their cells, to ensure that she has the prominent position in the colony.

THE WORKER

The worker bee is an incomplete female that lacks the full reproductive capacity of the queen. The workers are the busiest bee in the colony, as the name suggests, and are the ones you will most commonly see as they collect nectar and pollen from flowers. Worker bees pass through various task-related phases as they age.

Worker duties

When they emerge from the cell as adult bees, the workers start immediately on their household chores. Their six-week lifespan in summer is devoted to carrying out the many tasks necessary for colony development and survival. Many of these duties are the result of the physiological changes that take place during the worker's life. The most important of these are the production and secretion of royal jelly and beeswax.

In addition to their numerous household duties, worker bees also forage for nectar, pollen, water and propolis. Propolis is the resinous substance collected by bees from the leaf buds and bark of trees, especially poplar and conifer trees. Bees use the propolis along with beeswax to construct their hives. Workers also serve as scouts for finding these materials and are responsible for finding new homes for a swarm.

Workers are in charge of maintaining the temperature of the brood chamber, which must be kept constant at around 95°F (35°C) to incubate the eggs. If it gets too hot, the workers collect water and deposits it around the hive. Then they fan the air using their wings, causing a cooling effect by evaporation. If the brood chamber becomes too cold, the workers cluster together in order to generate body heat.

The three distinct phases in the worker bee's life are as follows:

1. The nursing stage lasts about one week. At first the worker bee assists in the incubation of the new broods and in the preparation of new brood cells. Next comes the feeding of the older larvae with a mixture of honey and pollen. About three days later the special brood

food glands in the head of the worker bee come active. The concentrated milky solution from these glands is called royal jelly and is fed to the queen larva in its pure form, while the other worker and drone larvae are fed with a mixture of pollen, honey and royal jelly.

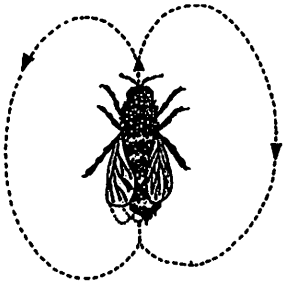
2. Next, the young worker bee will take on the domestic phase of its life, which will last for about one week. During this phase it has various duties such as storing honey, building and repairing the comb and keeping the hive clean by removing any debris, including dead bees. It is also during this period that the young worker bee takes its first orientation flight and may also carry out guard duties at the entrance to the hive.

3. The final stage is that of the forager, when the bee is about 14 days old. Foraging can last for two, three or even four weeks according to the amount of energy expended on each trip. Worker bees forage for four different products—nectar, which is converted into honey; pollen, which is the protein and fat portion of the bees' diet; water; and propolis or bee glue, as it is used to close small openings in the hive. The nectar is stored in the crop or honey sac where enzymes start the conversions, while pollen and propolis are carried in the pollen baskets, which are located on the bee's hind legs. At this final stage of its life, usually at around six to eight weeks, most worker bees will die in the field—that is, if they haven't already been eaten by a predator or been killed in combat.

The number of worker bees in any one colony will vary throughout the year. During the height of the active season, however, it is estimated that there will be as many as 50,000 to 60,000. The lifespan of the worker bee can be anything from 15 to 38 days, depending on the time of year. In the winter they can survive as long as 140 days as they do not have as much work to do and can live off the stores built up in the hive.

THE WAGGLE DANCE

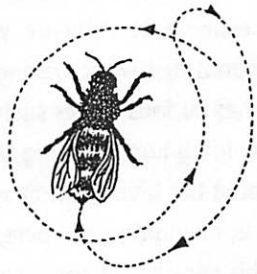
Bees are such efficient pollinators because they have learned a sophisticated method of passing information from one to another. As soon as a colony forms, scout bees are out looking for the closest and richest sources of pollen and nectar. When they find a good supply, these scouts return to the nest with samples and they begin to tell the other foragers about the location and how to get there. They do this using a symbolic dance language, which is based on movement and sound.



Scientists have studied this for decades and have given it the name waggle dance because the body of the bee waggles from side to side. The dance takes the form of a figure of eight and is performed by worker bees on the vertical surface of a comb. The worker moves in a straight line in a figure eight and waggles its body from side to side. When this waggling phase is complete, the bee circles off to one side and returns to the point where it all started. This sequence can be repeated as many as 100 times, with the direction of the final circle alternating each time.

It is believed that the number of circles performed is correlated to the size and distance of the food supply. For example, if the worker performs ten cycles in 15 seconds it means that the food is approximately 330 feet (100 meters) away. The bee measures the distance in terms of how much energy she has used in travelling. Therefore, the further the foraging site, the longer the duration of the waggle, and the bigger the supply the greater number of dance circles.

The dance also transmits details on the direction as well as the distance by using the sun and gravity. By dancing on top of the vertical honeycomb, she can describe the angle needed to locate the food. An upward tail waggle means go toward the sun, while a downward run means fly away from the sun. As the position of the sun changes position throughout the day, so the bees change the angle of their dance, too. While carrying out this intricate dance movement, the bee will often stop and give out small samples of the nectar she has collected to those who are watching. The attending bees are able to glean a good deal of information from this sample, which can also give them a clue to the scent they are looking for.

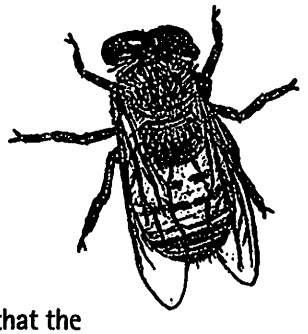


There is another type of dance that the bee performs and this is one with a circular movement. It is believed that this is to tell the attending bees that there is nectar close to the hive and to go and forage in the surrounding area.

The significance of the waggle dance was first discovered by the German professor Karl von Frisch in the 1960s. If you want to learn more about this fascinating subject, Karl von Frisch has written two books describing his findings—*The Dancing Bees* and *Bees: Their Chemical Senses and Language*.

The use of radar has helped to support von Frisch's theory and it is now thought that bees perform tail waggling when the swarm is looking for a new home.

THE DRONES



The drone is the big, butch insect in the bee colony and many novices mistake him for the queen. If you look closely you will see that the drone is characterized by the compound eyes that are twice the size of those of the worker bee. Their wings are also longer than those of the queen and hang below the abdomen, which is blunt, as opposed to the queen's, which is pointed. The drone has no stinger and can therefore be handled quite safely.

Drones are the only male bees in the colony and their sole function is to reproduce. Those that do succeed in mating with a queen during her nuptial flight perish during the act.

Their sex is determined by the queen, and should she come across a larger drone cell, she will not fertilize the egg as it passes out, resulting in the drone—this is the result of parthenogenesis.

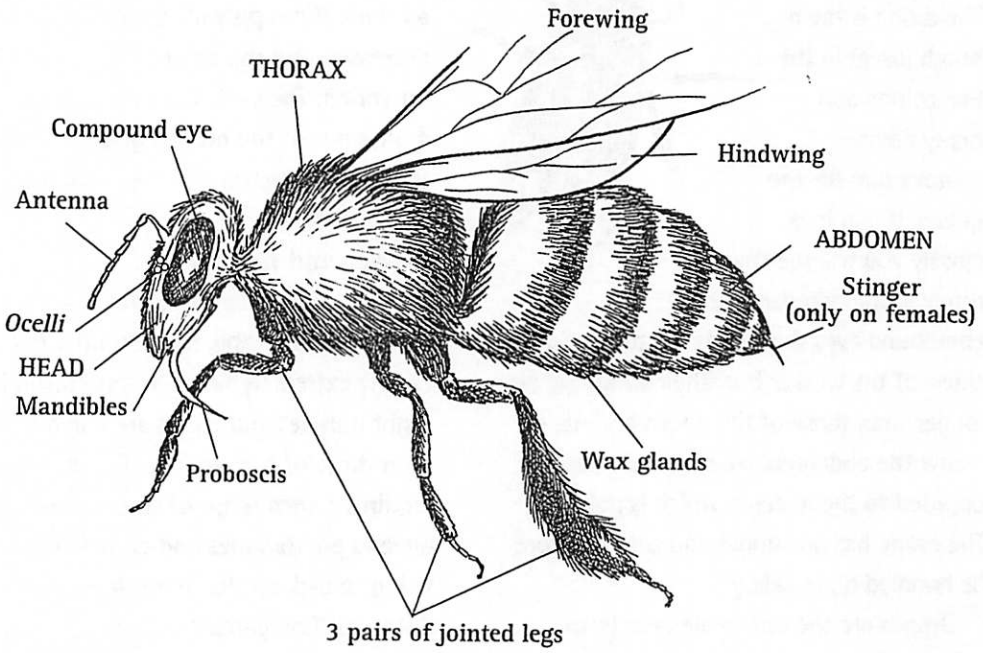
There are usually several thousand drones in a colony, but their life expectancy is only around 90 days and they can be prone to ejection at any time. The young drones are fed by the workers, but as they reach maturity they feed themselves honey directly from the food stores. Should the food supply diminish for any reason, worker bees waste no time in ejecting the drones from the hive. After the first heavy frosts in autumn, the supply of nectar and pollen decreases, and the colony starts to prepare for winter. They will start to drive the drones out of the hive to give the rest of the colony a better chance of survival.

Drones and mating

Because the drone is built for mating, which is done on the wing, it is essential that he can fly extremely fast. For this reason his flight muscles and wings are much larger than those of the workers. The drone also requires a keen sense of smell to pick up the queen's pheromones and extremely sharp vision to pick up the other drones over large distances. Compared to the queen bee, who has 3,000 to 4,000 eye facets and the worker who has 6,900, the drone has as many as 8,600. The drone also has an amazing 30,000 antennal plate organs (sensory organs), compared to the queen with some 1,600 and the worker with around 3,000. The drone is fitted with a special odor receptor that enables him to find a queen in flight, and this receptor can track her down from up to 197 feet (60 meters) away.

Although the drone is a defenceless bee and is unable to defend the hive, he does have one other purpose to the colony. All bees, regardless of caste, will react when they sense a change in temperature in the brood chamber. Just like the workers they can either huddle together for warmth, or fan their wings to cause a through draught.

BEE ANATOMY



The bee, like other insects, has three main body regions—the head, the thorax and the abdomen.

THE HEAD

The bee's head is dominated by two large *compound eyes.* These eyes, like those of other insects, differ greatly from human eyes. For example, they are capable of seeing ultraviolet light, which is invisible to humans. Between these eyes are three smaller *ocelli* or simple eyes, which are responsible for registering light levels. Some flowers that appear totally yellow to us, only appear as yellow around the source of nectar to a bee. This has the effect of drawing the bee directly to the important part of the flower. A bee's vision is believed to be sharp for a distance of only about 3 feet (1 meter).

The antennae are located more or less un the center of a bee's face. Each antenna is controlled by four muscles and act as a specialized organ of sense. Much of the communication between bees is done by the touching of antennae.

The mouth parts of a bee are far more complex. The *mandibles*, or jaws, are suspended from the head at the sides of the mouth. These are used to handle objects, manipulate the collecting of pollen and in times of combat with other bees. Positioned just above the *mandibles* is the mandibular gland, which secretes a substance that was once believed to be softened wax. In fact, it

is this gland on the queen bee that secretes queen substance, the pheromone especially important in the maintenance of colony structure. These glands are almost completely reduced in the drone.

The front part of the mouth is composed of a wide plate called the *labrum*. It is here that a *proboscis* (the tube used for feeding on nectar) is formed by bringing together several parts of the lower mouth. The two *maxillae* and the *median labium* (a movable flap) form the *proboscis*, which, when not in use, is folded up underneath the head.

The bee's tongue is covered with fine hairs and the tip is a small spoon-shaped lobe or *flagellum* that is smooth on the underside, but covered with branched spines on the edges and top. Muscles associated with the tongue allow the bee to lap at liquids, and a sucking pump assists when they are feeding. They have special salivary glands that help moisten the food and a special opening in the mouth area for the brood food glands.

THE THORAX

The thorax is the central part of the bee's body, where the legs and wings are attached. Each pair of legs has a different function. The front legs are used to clean the head, eyes, mouth and antennae. The middle pair are used to clean the body, loosen pollen from the pollen baskets, clean the wings and move wax plates that are secreted from glands in the abdomen. The hind legs are specialized for collecting pollen. Each leg contains long fringed hairs that form the pollen basket. Pollen grains that sticks to the hairs of the body are then brushed back to the inside of the hind leg where they are stored in the pollen basket for transportation back to the hive.

There are two sets of wings attached to the thorax. They are membranous and strengthened by veins. The wings are powered by large flight muscles located in the thorax, and when not in flight the wings fold back neatly along the body.

THE ABDOMEN

The abdomen contains the digestive and reproductive organs. It also contains the wax-producing glands that are most productive during the 12th to 18th days of the bee's life. These produce tiny wax scales, which are paramount to comb building.

On the upper part of the abdomen are seven scent-producing glands. These glands are responsible for producing pheromones, which are used at the entrance of the hive or when the bees are swarming, to guide other workers to the right spot.

At the end of the abdomen is the sting, which, when not in use, is completely retracted into the body. The sting consists of an upper *stylet* and two lower *lancets*. The *stylet* has a wide bulbous end that connects with the poison sac. When the bee stings, the entire sting apparatus works its way into the wound and continually discharges venom.

Watching honey bees pour out of a hive by the thousands and then form a great swirling tornado is perhaps one of nature's most spectacular sights. However, a swarm of bees is quite capable of causing the bravest person to suffer a panic attack. Although bees are relatively harmless while swarming, it can still cause alarm to someone who is not used it and the noise itself can be pretty scary.

So what is swarming all about? It is important to understand that this is a completely natural process and that the bees are only trying to propagate their own species. Swarming generally occurs because of one of the following:

- The colony is opulent—i.e. rich in bees, food stores and general health
- The hive is too cramped and the colony has no room to expand
- The queen is getting old
- The queen is sick or dead
- The hive is diseased and not a safe place for the colony
- The hive has insufficient food supplies

A normal honey bee hive will survive the winter with a population of approximately 12,000 bees. The queen will start laying her eggs in January with the purpose of building up a workforce of about 50,000 bees, to ensure maximum