

History and context

Bees have existed for millions of years and have always lived in harmony with all other species. Throughout this time they have survived great changes on the planet, like the extinction of dinosaurs and the end of the cretaceous period.

The first indications of honey collection by humans date back 10,000 years, to the Mesolithic period. In Spain there are cave paintings in the Cueva de las Arañas, in Valencia, in which honey collection by humans is recorded. These paintings are believed to be between 7,000 and 8,000 years old. Similar paintings from the same period have also been found in Africa, in the Eland Cave in South Africa. However, bee keeping started later, in the Neolithic period, when agriculture and pastoralism began.

Honey bees reached the Americas in the 18th century. They were introduced with the aim of increasing wax production.

Currently there are about 20,000 bee species which may be classified into stingless bees, honey bees (among them the *Apis mellifera*, the well-known western honey-producing bee) and the subspecies of the *Apis mellifera*.

Bees need pollen to feed on and nourish their offspring and thus ensure the survival of the hive. For this reason they collect pollen, nectar, water and propolis. With such pollination they also guarantee the perpetuation of the plant species, which is why their role is so critical in our ecosystem.

Albert Einstein said: "If the bee disappears from the surface of the earth, man would have no more than four years to live. No more bees, no more pollination, no more plants, no more animals, no more humans."

HOW DO BEE COLONIES WORK?

Bees are insects which belong to the hymenopterous order, *Apis* genus, and they have a system for determining the sex called Haplodiploidy. In other words a bee's sex is determined by the number of chromosome sets an individual receives. All bees develop from the same type of eggs. The fertilised eggs are diploids and they develop as females, giving way to queens and workers, while unfertilised eggs are haploids and become the males, drones.

They are eusocial insects. This term refers to the highest level of social organisation, which only occurs in certain animals, among them the bee species from the *Apis*, *Bombus* and *Meliponina* genera. This type of social life is characterised by adults caring for their offspring, by a nest in which 2 or more generations live and by a division between individuals in the hive between the "royal" reproducing caste and the Non-reproducing "worker" caste.

So in a beehive there is the queen, the workers and the drones.

The queen is the genetic transmitter for the colony and she is the only fertile female which makes her the "mother" of the entire hive. The queen becomes the queen because from her earliest days as a larva she receives special food, royal jelly, and that continues throughout her life. This food allows her to develop more fully than the rest, which is why she is fertile and able to mate. She produces pheromones which maintain the cohesion of the hive and also inhibit the growth of ovaries in the other females.

Without the presence of these hormones the other females could become fertile. Morphologically the queen lacks the tools that the workers have, such as the baskets for the pollen or the crop for the honey. Fed on nothing other than royal jelly queens may live up to 5 years.

Queens are born in spring and there may be several born at the same time, living together and tolerating one another while they are still virgins. Once one of them leaves the hive for her nuptial flight (which may last 4-10 days, one of the few occasions she leaves the hive) and mates there can only be one female in the hive. Previous to these flights the queen must carry out orientation flights so as to be able to locate the hive.

The queen only mates during her nuptial flight, which usually happens 2 kilometres from the hive, at a height of 8-12 metres and lasts about 20-25 minutes. The queen will try and mate with as many drones as possible in order to optimise her response with a wide genetic variety. The queen keeps all the sperm in her spermatheca which allows her to produce descendants throughout her lifetime. Her capacity for production is very high, being able to lay 1,500 eggs per day.

When the queen reaches a certain age and is considered old she leaves the original hive in order to establish a new colony, taking with her a group of workers and leaving a younger queen in charge of the old hive. This is what is naturally known as swarming, whereas the group of bees with their new queen is called a cluster.

Worker bees are infertile females. There may be anything between 15,000 and 80,000 workers in a beehive.

At first they all look the same, but in fact their size is variable and changes with age, just as their tasks in the hive. In the colony each role is clearly identified and defined, however, the workers are characteristic because their roles change over the course of their lives. They start by constructing the honeycomb, cleaning it (in middle age) or maintaining the correct temperature in the hive (34-35°C), which is achieved by the synchronised movement of their wings. There are also nurse bees (which feed the larvae), bees responsible for receiving the nectar and field bees, which go out and collect the pollen and nectar from the flower, these are the eldest bees. Worker bees feed purely on honey.

Their lifespan depends on their activity, they don't usually live more than 5 or 6 weeks when their work rate is maximum, an average of 65 days in spring and summer. However, in winter their activity is reduced to a minimum and they may live up to 3-4 months.

Workers only consume royal jelly during their first day of life, which explains the great anatomical and functional difference between them and the queen.

Drones constitute the male element of the hive. They are bigger than the workers but they do not have a sting, consequently they have no gland that produces wax and cannot contribute either to defence or to pollen collection. They are fed by nurse bees for the first 5 days, after which they become autonomous. On average there are usually 200-300 drones in a hive.

Their only task is to mate with the queen, they are not equipped to do anything else. Out of mating season, in other words as autumn approaches, they are killed or not allowed back into the hive once they have flown out.

They usually stay in the hive 12 days, by which time they reach reproductive maturity when they leave to carry out the so-called nuptial flights.

This task distribution makes the hive work as a whole, as one big family, as a single brain where everything is decided democratically and in which its members are ready to give up their lives for the safety of the hive.

PRODUCTION IN SPAIN

The main products from beekeeping are honey and wax. The price of honey varies between €7/kg for direct sale to consumers, and €3.50-€3.80/kg depending on whether it is sold to industry or marketed through a coop.

According to the latest official data (Magrama, 2015) there are 27,589 beekeeping operations registered in Spain, of which 20,000 are not professional. Beekeepers are considered professional when they keep more than 200 hives, but in our country the majority of beekeepers are amateurs. They have few hives and very small production which means they do not make their living through this, unlike beekeeping amateurs of other countries, as is the case in France.

Recent data indicates that Spain produces more than 31,000 tonnes of honey per year, of which more than 26,000t are exported to other European countries and about 4000t to countries outside of Europe. On the other hand Spain imports more than 22,000 tonnes per year, mainly from China.

Production systems

Until cane sugar was standardised honey was the only known sweetener and it fetched very high prices. In those days systems of producing honey developed. At first fixed hives, with unmovable panels, were used, but that system didn't fulfil all the requirements of bees, which need corridors or traffic areas to go from one side of the beehive to the other. In current production systems moveable hives are used, these have mobile panels which respect the movement of the bees.

Honey production depends a lot on the weather and the type of hive, whether they are fixed or transhumant, etc. Nevertheless, as has occurred in other sectors, one side of beekeeping has been industrialised and honey production has intensified. It is possible to find recurrent practices such as supplementing the bees, artificial insemination of the queens for purposes of genetic selection and optimising production, killing queen bees when they become old, etc.

Bees may suffer from a high number of disorders. One of the clearest examples is the Varroa parasite, an ectoparasite which causes the disease varroasis and has been identified as one of the main problems in beekeeping worldwide. Another pathogen to note is the Kashmir virus, which presents no specific symptoms and causes death of young and adult bees. Like most viruses it lies dormant in the hive and attacks when the hive is weakened. Sometimes the trigger of the symptoms may be stress.

There are many wide-ranging factors which may cause damage and stress in bees:

1. A badly ventilated hive, in hot or cold weather

The ideal temperature of the hive is 35°C, if this temperature is exceeded the bees beat their wings so as to expel the hot air and cool down the hive. If the temperature continues to rise, some bees even leave the hive in order to cool down in the shade.

On the other hand, when bees detect a drop in temperature, they all gather around the queen creating a kind of barrier which gives off heat with the vibration of their bodies; the lower the temperature is in the hive, the more compressed the barrier becomes.

It is very important that the hive is well situated and can be naturally ventilated because in winter the bees will not resort to the movement of their wings for its ventilation.

2. The availability of water

Bees use water to lower the temperature of the hive in very hot weather by sprinkling water over it. They also use water to maintain relative humidity of the hive at 80%, which is critical to the survival of their offspring, their breathing and their excretion.

3. The availability and quality of food

Pollen provides the colony with all the protein required for their development. This is why when they have sufficient reserves, bees are calm, they behave in a relaxed fashion and don't overwork in winter.

If the hive runs out of reserves (in other words if there are no capped honey cells in storage) it means that they have insufficient quantities of carbohydrates, therefore they cannot produce energy. A sufficient amount of calories is the main thing they need in order to maintain a constant temperature in the hive.

Conversely, the excess of nectar in the hive does not imply an improvement in the life of the bees, indeed it may cause adverse effects. It means the bees are overworked both day and night, tiring them out, causing them stress and aggressive behaviour.

The level of body protein in bees is very important, especially in the autumn, allowing them to stay strong, hibernate in healthy condition and be able to develop the hive when spring comes. An increase in stress produces a drop in the level of body protein, because demand is increased, and if it drops to below 30% the bees' lifespan is reduced and they become more susceptible to contracting certain diseases.

4. The effects of climate change

Bees are affected by climate change for the simple reason that their various activities are related to different times of the year and the associated weather conditions. In some parts of Europe, such as the Mediterranean, the seasons have become shorter and appear without much of a transition period due to the increase in temperature. This affects plant life, bringing forward the time of blooming (in response to the accumulation of hours of cold or hours of heat, depending on the strategy of the plant) thus tricking the bees.

PRODUCCIÓN EN EUROPA

In Europe Spain and Greece are the countries with the highest number of registered beehives. Almost 2.5 million and 1.6 million respectively, out of a total of 15,704,207 beehives registered throughout Europe, of which 6,355,518 are not professional. The total number of beekeepers in Europe amounts to 631,236, of which only 32,829 are recorded in the register of professional beekeepers. Wax production stands at about 1,700 tonnes per year.

OTHER DERIVATIVE PRODUCTS

Propolis

It is a sticky and resinous substance which bees collect from leaf buds of trees, barks and leaves and later is transformed by secretions from their mandibular glands. Inside the hive it is used to repair cracks and hold certain parts in place. Furthermore it serves as a disinfectant and gives waterproofing to some inner areas. There is evidence to suggest that this substance was used by the Phoenicians to preserve mummies,

and for sure they copied the “mummification” that bees practised on the other animals which dared to enter their hive, which, upon dying, could have been the source of different diseases.

The most valuable propolis mainly comes from the following species:

- Myrtaceae: eucalyptus, pitra and myrtle.
- Salicaceae: poplar, willow and conifer.
- Coniferous trees: pine, cypress, thuja, larch, cedar, fir and spruce.

Its translation in Greek means “defender of the city”, which refers to its main property, protecting the hive from external agents. It is widely used in medicine and for a wide range of therapeutic needs.

Royal Jelly

It is a white and creamy substance which nurse bees produce. It is used to feed the larvae for the first three days of growth and the queen feeds on it throughout her life.

This substance as a food base is the main difference in giving the queen her physical structure and her role in the hive as it allows her to fully develop and to be the only fertile female.

It has become very popular in recent years, mainly in the treatment of chronic tiredness and other illnesses such as arthritis, as it increases the level of cortisol in the blood.

Wax

Wax is acquired after harvesting the honey, from the caps or the old broken panels. It is extracted through solar extractors or different types of smelting (pressing, centrifuge or heating). Its application offers a multitude of possibilities and fields. Although beekeepers use it to make their own laminates, industry uses it for several purposes: wax for floors, shoes, electronic devices, sports equipment, etc. It is even used in ointments because of its healing and anti inflammatory properties.