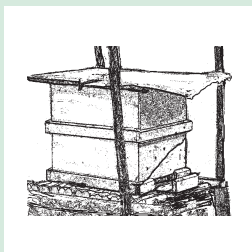
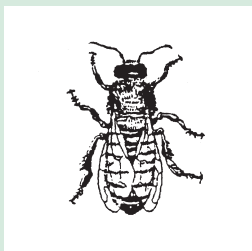


# Beekeeping in the tropics



partageons les connaissances au profit des communautés rurales  
sharing knowledge, improving rural livelihoods



**Agrodok 32**

# **Beekeeping in the tropics**

Leen van 't Leven  
Willem-Jan Boot  
Marieke Mutsaers  
Piet Segeren  
Hayo Velthuis

This volume is published in cooperation with NECTAR, Netherlands Expertise Centre for (sub)Tropical Apicultural Resources. NECTAR is the association of tropical bee-keeping experts in the Netherlands.

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Authors: Leen van 't Leven, Willem-Jan Boot, Marieke Mutsaers, Piet Segeren, Hayo Velt-huis

Editors: Leen van 't Leven, Piet Segeren

Illustrators: Barbera Oranje, Mamadi B. Jabbi

Design: Jeroen Boland

Translation: Revised and translated by Ninette de Zylva

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# Foreword

You can keep bees as an interesting hobby or as a source of income. This booklet provides you with information on how to work with honey bees. In most regions of the world this will be the European bee *Apis mellifera*, although in large parts of (sub)tropical Asia the rather similar species *Apis cerana* is more commonplace. Although the composition of a honey bee colony is basically the same all over the world, the management of bees must be adapted to the species and race, the climate and the vegetation. If you want to start keeping bees it is advisable to start with the existing regional methods. Finer skills of this occupation can only be learnt from experience, step-by-step.

Try to obtain information and assistance from a beekeeper nearby. You could also approach your Ministry of Agriculture or Forestry, which often has a Department of Apiculture that organises demonstrations and courses, offers assistance and sometimes even provides bee colonies. The importance of starting at local level and to experience the profits beekeeping might offer is stressed in this booklet. Low-input techniques, implying the use of local bee races as well as local knowledge and local materials, can be the basis of successful beekeeping for individuals and for large projects.

While the authors who cooperated in the revision of this Agrodok are experts in their field of apiculture, this booklet is not a piece of scientific work, nor are the subjects covered completely. The purpose of this booklet is to indicate that beekeeping is possible also with little means. The chapter *Seasonal Management* by Marieke Mutsaers is new in this revision and is an important approach for sustainable production with hived bees. This publication has been published at the same time as Agrodok 42 : *Bee products*.

On behalf of all the co-authors of this Agrodok,

Leen van 't Leven

Chairman of NECTAR

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# 1 The value of beekeeping

Bees are found all over the world, from the tropics to the arctic, in rain forests as well as in deserts. There are over 20,000 species of bees, some of which are small, others are large, and each species has adapted to the specific conditions of their environment. The vast majority of bees live a solitary way of life, but some species such as the honey bees and stingless bees live in colonies. Honey bees collect large amounts of food, which they store in order to survive the periods when conditions are adverse. Man has harvested these stores of honey and pollen for thousands of years, and just like the honey bees, beekeepers are found all over the globe, although the technology they use varies with the region.

In order not to kill the colony, the beekeeper needs to avoid extracting the honey and pollen at moments when the bees cannot replace it, or he or she should provide them with adequate supplements. Such exploitation of the bees makes the beekeeper a professional. He or she takes care of the bees like a farmer takes care of cattle. Honey bees provide us with honey, wax, pollen and propolis, and are important pollinators of many of our food crops.

## **Species and races of honey bees**

There are altogether eight species of honey bees, most of which are found in Asia. Only one of these species occurs in other parts of the world, either naturally or imported by man. The scientific name for honey bees is *Apis* (hence: apiculture), followed by a second name that is particular to each species. Two species are domesticated and used in beekeeping: *Apis cerana* in South East Asia and *Apis mellifera* worldwide. The Asiatic species *Apis dorsata*, *Apis laboriosa* and *Apis florea* – though living in the wild – are exploited by honey gatherers.

## **Honey**

About 80% of honey consists of sugars that are readily absorbed by the body and it is therefore an extremely suitable food for children,

sick people and those who perform heavy manual labour. It is a pleasant-tasting food and a sweetener for food and drinks as well as an effective medicine for treating superficial wounds and throat complaints. Its economic value is high and hence it is a good trade commodity. In many countries honey is used to make beer or wine, which can be healthy if not consumed in too large a quantity, and it can be preserved and sold.

In 2002 world honey exports totalled 1,250,000 tonnes, 20% of which came from the tropics. About 700,000 tonnes were sold and exported to countries where local production was insufficient to meet demands. Prices vary, but on the world market the price is between 1.00 and 2.00 per kg. Local prices are, however, usually much higher, sometimes even up to 10 times world market prices.

Table 1 shows average yields per colony in some regions.

*Table 1: General averages of annual honey yields per colony*

Continent	Average yield	Continent	Average yield
Europe	11 kg	Oceania	39 kg
North America	24 kg	Asia*	18 kg
Central America	25 kg	Africa	8 kg
South America	14 kg	(* both <i>Apis. cerana</i> and <i>A. mellifera</i> colonies)	

The honey yield largely depends on the climate, vegetation, bee species and the skills of the beekeeper. Bearing these factors in mind and in accordance with their income and skills, beekeepers may choose from the following possibilities:

- Having a few colonies around the house or somewhere else at a fixed place
- Migrating seasonally with the colonies to different forage areas
- Keeping bees as a part-time activity
- Full-time professional beekeeping

Whatever the chosen scale, a beekeeper will be busier at certain times of the year with preventing swarming, collecting the honey and feeding the colonies, for instance.



## **Beeswax**

Wax is used in the manufacture of cosmetics, candles, foundation sheets for hives, medicines, polishes, etc. You will find an extensive list of practical applications of beeswax in Agrodok 42 *Bee products*. There is a good and very stable market for beeswax. World market prices vary between 2 and 3.5 per kg and this variation again is related to quality differences.

Wax production varies between 0.2 and 0.5 kg per hive per year when frames are used and between 0.5 and 2 kg when the honey is pressed and all the combs are melted down.

## **Pollen and propolis**

Bees gather an average of 100 to 200 g of pollen per colony per day: 30 to 50 kg per year! They use the pollen to feed their larvae. You can harvest the pollen collected by the bees using a simple trap at the flight entrance of the hive. You should, of course, only collect a part of it so as not to seriously inhibit the development of the colony. Pollen can contain up to 35% protein and can be eaten dry or added to other foods. Pollen is sold to the perfume industry and also used for consumption and for medicinal purposes.

Pollen must be protected against moisture. It is hygroscopic, which means that it attracts water, and it deteriorates quickly when attacked by fungi. For further details please refer to Agrodok 42.

Propolis is a resin that bees collect from plants and they use it to cover the inside of the hive. The market trend for propolis is increasing as it has some therapeutic and antibiotic characteristics. *Apis cerana* does not collect propolis.

## **Pollination**

The greatest added value of beekeeping lies in the fact that bees pollinate agricultural and horticultural plants. When a bee has found the flowers of a certain kind of plant, it investigates their profitability. If the flowers produce a fair amount of nectar and/or pollen, the bee will

encourage her hive-mates to use this source. The bees will visit these flowers as long as sufficient food can be collected from them. This flower constancy makes bees exceptionally valuable to plants needing to be cross-pollinated. If there are enough bee colonies in the area at flowering time, the plants will give higher yields and the quality of the fruits will also be improved.

In many tropical regions, however, farmers are still unaware of how beneficial bees are to their crops. Of course it is not only the honey bees that pollinate, all bees except the parasitic ones play their part. It is unfortunate that in many regions of the world modern agricultural techniques have caused a decline in the abundance of naturally occurring bee species.

The importance of bee pollination has been demonstrated by a vast range of plant species. Table 2 gives a few examples, but many more have been documented.

*Table 2: Yield effect of bee pollination on tree species (Coleman, Zimbabwe, 1997)*

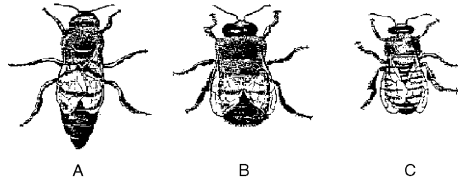
<b>Tree crop species</b>	<b>Hives per hectare</b>	<b>Yield increase</b>
Nectarines and peaches	No data available	85%
Citrus fruits	1	40%
Lychee ( <i>Litchi chinensis</i> )	No data available	35%
Kiwi	3	60%

## 2 Composition of the colony

In a bee colony there are two female castes: the queen and the workers, and a male caste: the drones. See figure 1.

### 2.1 The queen

The queen can be recognised by her long abdomen that extends far beyond the tip of her wings in the resting position. Her thorax is larger than that of the worker. Viewed from the front, her head is round. Queens and workers develop from similar eggs, but larvae that will be queens get much more food than larvae that will develop into workers. Usually, there is only one queen in each bee colony, and in normal colonies she is the only female that lays eggs. When this queen is lost, the bees produce new queens. Newly emerged queens fight until a single queen is left in the colony. Competitor queens are killed using the thick, curved stinger.

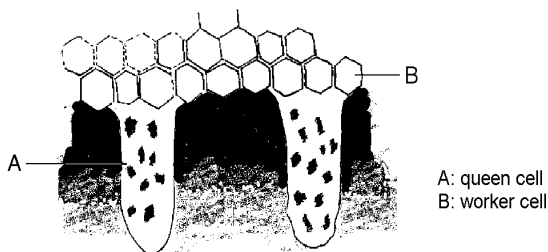


*Figure 1: Queen (A), drone (B) and worker (C).*

Before a young queen starts laying eggs she makes a mating flight. She mates with a variable number of males, from only a few up to more than 40. The spermatozoids that she has obtained during mating are stored and kept alive in a special reservoir (spermatheca) in her abdomen. The queen can lay fertilised eggs as long as there are spermatozoids in this reservoir (enough for 3-5 years). Once she starts egg laying, the queen will never make a mating flight again.

The queen produces the most eggs in the first year of her life. Beekeepers, therefore, often replace queens after 1-2 years. The egg-laying rate of honey bees is high: a maximum of 3,000 eggs in a day

has been reported. Some days after the mating flight the queen will start laying eggs. They are laid in relatively small six-sided horizontal worker cells and in vertical hanging cups from which the bees later build round hanging queen cells (figure 2). Fertilised eggs develop into females: queens or worker bees.



*Figure 2: Part of a comb*

Unfertilised eggs are laid in larger horizontal cells and develop into drones. The queen does not collect any food herself and is therefore fed a special food from the head glands of the workers.

## **2.2 The workers**

A large colony may consist of more than 50,000 workers. Viewed from the front the worker is triangular in shape. The tips of her wings at rest cover the end of her abdomen. She has special structures to collect pollen. She uses brushes on the inner side of her hind legs to clean the body from pollen after a visit to a flower. A rake-like row of hairs is used to transport the pollen from the brushes to the pollen baskets. These are found on the outer side of her hind legs and consist of two rows of long hairs between which the pollen is stored in flight. In the colony, the worker bees empty the contents of their baskets into the cells of the comb surrounding the brood cell area.

Workers have extended mouthparts that come together to form a tube to suck nectar. The bee transports the nectar in her nectar sac, which is the front part of the alimentary channel. When she returns to the col-

ony she passes the contents of this sac to other bees, and it may be stored in cells of the comb. Worker bees further process the nectar into honey. They evaporate water and add enzymes which convert complex sugars to easily absorbed simple sugars or mono-saccharides: glucose and fructose. When the honey has been concentrated sufficiently, the cell is closed with a wax capping. It is then called sealed honey.

The workers are equipped with a straight, slender stinger made up of two small lancets attached to a stiletto. Bee venom is produced in two glands in the abdomen of the bee and is stored in the venom sac. When a bee stings, the venom is pumped into the victim through the stinger. When a bee stings a warm-blooded animal, including man, the stinger cannot be withdrawn because of the barbs on the lancets and stiletto. When the bee tries to escape the sting apparatus with the venom sac break off, so shortly after stinging the bee dies from the damage to its abdomen. If a bee stings you, you should quickly scrape off the sting from your skin, because the loose sting apparatus will continue to pump venom into you. In addition, the sting apparatus is a source of alarm pheromones that will attract other bees to attack you.

The younger house bees work within the colony and perform the following tasks depending on the needs of the colony:

- Cleaning the cells and removing debris and dead bees from the bottom of the hive.
- Feeding the queen, the drones and the larvae that have hatched out of the eggs. This food contains some nectar. The other food component is special brood food. This protein-rich product is made in the head glands of the workers. The nurse bees can only produce this food if they are able to consume enough pollen. The queen needs the proteins to produce the eggs, and the drones to produce sperm. The larvae need protein and sugar to develop into adult bees. A larva becomes 1,500 its size within six days!
- Guarding the flight entrance of the colony.
- Maintaining the temperature of the brood combs at approximately 35°C. They produce heat by vibrating their thoracic muscles.

- Producing wax, building combs and sealing the honey and brood cells (see chapter 8).
  - Converting the nectar into ripe honey.
- When a young bee has been a house bee for about three weeks she starts to make orientation flights and becomes a forager bee. She gets to know the position of all kinds of objects such as a tree, a bush or a house and can therefore always find her way back home. Foragers generally explore an area with a radius of about 3 km, but profitable nectar sources of more than 10 km from the colony are sometimes still visited. In practice, this means that:
- A bee colony cannot be moved at random because the field bees would simply return to the old site. If you want to move the colony a small distance away, move it 50 cm at a time at intervals of several days. If you cannot achieve your aim in this way, then the colony must be placed outside the flight area, meaning at a distance of 5 to 6 km. After three weeks most foragers will have died, and the colony can be placed at the newly selected place within its previous flight area.
  - Do not make any changes to the hive and the immediate surroundings during the time the young queen makes her mating flights. Just like worker bees, the queen orients herself when flying out.
  - A swarm orients itself to the site of its new home. If, however, the swarm loses its queen the bees will return to their original site.

Bees can either find sources of food on their own, a task performed by scout bees, or learn about these from other forage bees through the ‘bee dance’. These sources of food are plants that produce pollen or nectar. Bees also forage for water mainly for regulating the temperature of the hive. If water is not readily available, you must provide them with drinking basins. Put stones in the basins to prevent bees from drowning. Bees collect propolis from leaf buds, for instance, and use it to seal small openings in the hive. The division of labour between young bees working inside the colony and older forager bees is not based strictly on age. If you remove the young bees from a colony, the field bees will take over their tasks, and vice versa.

The life span of the workers depends on their degree of activity. If a colony is very active and has a large brood nest to take care of, the workers live for about 6 weeks. In periods of rest, either in winter or the rainy season when there is no brood (in temperate climates) or little brood (in tropical climates), this life span is longer and can last up to 6 months.

## **2.3 The drones**

You can easily identify a drone by its stout shape. A drone is much broader than a worker but shorter than a queen. The abdomen is not pointed. The eyes touch each other on top of the head. Drones have no stinger. They cannot collect any food and are fed by the workers. Their sole task is to mate with a young queen. Since there are many drones and only a few young queens, most drones will not be that lucky. However, if they mate, they die immediately afterwards as their genitals break off at mating, damaging the abdomen.

During times of food shortage in the colony, the drones are not fed and after a while they are simply dragged out of the hive by the workers. During good foraging conditions when workers can abundantly collect food, colonies will grow rapidly and many drones are reared. When colonies get big enough they will try to split up by swarming. The presence of much drone brood in a colony is therefore a sign that it may swarm within a short time.

## **3 The daily life of a colony**

### **3.1 The swarm**

Most of us have seen a swarm of bees at some time or another. Let us take a closer look at such a swarm and follow it.

After the swarm has settled in a cluster, a few scout bees fly out to look for a new home. If they discover and approve of your hive, the position of the hive is communicated to other bees of the swarm cluster by means of the 'bee dance'. If there is no other attractive home in the vicinity, the swarm will fly to your hive.

A beekeeper can put small boxes or hives around the area in order to collect swarms. Such hives are called bait hives. The inside of a bait hive is smeared with wax or propolis to attract swarms. Once a bait hive has attracted a swarm the swarm can be transferred into another hive. The workers begin to build new combs or repair and clean any existing combs. If it is a swarm with a laying queen, the first eggs will be laid within a few days. If the swarm has a virgin queen she will first have to make her mating flights.

### **3.2 The development of the bee**

The eggs hatch after three days; the larval stage lasts about 5 days. During this period the nurse bees regularly provide the larvae in the open cells with small quantities of food. After this the bees close the brood cell with a porous wax capping. This is called sealed or capped brood. The larva inside spins a cocoon, expels its excreta and then becomes a pre-pupa and later a pupa. This takes a variable number of days for the different bees: see table 3.

The capped phase of the worker brood lasts about 12 days. Then the bee that has developed from the pupa gnaws away the wax capping and appears on the comb. The newly emerged bees are easy to recognise because they are still covered with light grey hairs. The drones



take the longest to develop. Their open brood stage lasts about 7 days and the capped brood stage about 15 days. The young queens, however, are ready to emerge within 7 days after the queen cell is capped. It is important for the beekeeper to know that after a hive has lost its queen he or she can expect the birth of a young queen in about 13 days.

*Table 3: Duration of development stage of European Apis mellifera*

Bee type	Duration in days of development stage of ...			
	Egg	Open brood	Capped brood	Total
Worker	3	5	12	20
Queen	3	5	7	15
Drone	3	7	15	25

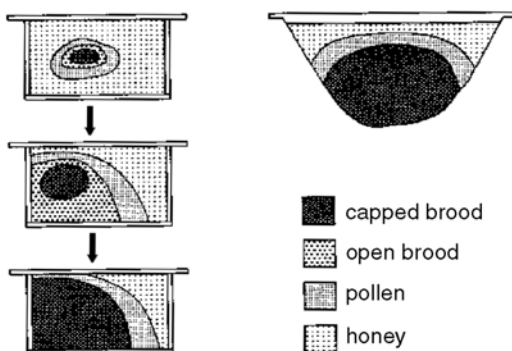
The duration of the approximate worker brood stage of the African species *Apis mellifera* and *Apis cerana* may be one day shorter.

### 3.3 The development of the colony

If the queen is in good condition and the foraging conditions are favourable (many flowering plants, good weather) the brood nest, especially of a large colony, expands very rapidly. *Apis cerana* and *Apis mellifera* colonies build parallel combs hanging from the top of the hive, each comb consisting of a mid-rib with the six-sided cells attached to its lateral sides.

The queen usually begins to lay eggs on a comb and continues egg laying on the left and right of this comb. If you check the first comb after about nine days you will see successively from the centre outwards: capped cells, old larvae, young larvae and eggs. You will find a similar arrangement to the left and the right of this comb. If you look at all the combs of brood together, the brood nest is ball-shaped. The centre combs therefore have a large brood surface and the combs to the sides of these have successively smaller brood surfaces: see figure 3.

As soon as the capped brood in the centre emerges the youngest bees clean the cells and the queen lays eggs in these cells again. Around the brood nest we find cells filled with pollen. This means that the combs bordering the left and the right of the brood nest are sometimes filled mainly with pollen. The young bees eat this pollen. Honey is stored in the cells around the pollen ring, especially above the brood and pollen cells and in increasing quantities in the combs to the left and right of the movable combs of the brood nest. You will find that in a period of strong honey flow the area available for the brood nest will become too small. You can provide more space by placing a chamber with empty combs under the existing brood nest.



*Figure 3: Brood frame at three seasonal stages (left); comb of top bar hive (right).*

### 3.4 Swarming

If a colony grows larger, it can raise new queens in the presence of the old queen. This allows the colony to split itself up into groups with one queen each. Such a separate group of bees with one (or more) queens is called a swarm. The event of a swarm leaving the colony is called swarming. This is the normal way for bee colonies to increase and disperse in the area. It is not known exactly which factors trigger the preparation for swarming. But too little space in the brood nest limiting the number of eggs that can be laid by the queen is often given as an important cause.

At first you will find only worker brood in a growing brood nest. Later, drone brood will usually make its appearance and large numbers of drones are often produced just before the swarming period.

Preparation for swarming starts with the building of swarm cups. These are short bowl-shaped cells with their openings facing downwards. These swarm cups are usually found at the bottom edge of the comb, but also at the front and back edges of the comb. The queen lays eggs in a number of these swarm cups. After the eggs hatch, nurse bees deposit food in these cups, and from this moment on the cups are elongated to become swarm queen cells. Much more brood food is deposited in a queen cell than in a worker cell, and the composition of the food is also different: the queen's food is called royal jelly. The reason why this fertilised egg produces a queen and not a worker is apparently the result of both the amount and composition of the food offered to the larva.

From the moment the queen has laid eggs in the first swarm cup the workers offer less food to the queen. The behaviour of the workers towards the queen alters radically as soon as the first swarm cells have been capped. The old queen is forced to leave the hive and a part of the colony leaves with her. At the moment of swarming thousands of bees will circle in the air.

A swarm usually looks for a resting place in the neighbourhood of the hive. From there scout bees start looking for a nesting place. If the scout bees do not find a suitable nesting place, the swarm leaves. Swarms with a young queen often travel long distances. About a week after the departure of the first swarm with the old queen, the first young queen emerges. The first young queen to emerge on the comb produces a piping sound. The young queens that have not yet emerged respond to this with a lower note. If you tap the hive and put your ear to the wall of the hive you can hear these sounds. You will then know that there are young queens present.

Three situations can now arise:

- 1 The first young queen leaves with part of the colony. If another queen should emerge at the same time, she may fly out with the same swarm. This swarm may be divided afterwards. You can see this happening when the swarm chooses a resting place. The bees

form two connected clusters instead of one. If the cluster remains intact, the queens fight until only one of them is left.

- 2 The young queen kills the sister queens still in the queen cells. There is no further swarming.
  - 3 Several queens emerge in the hive at the same time. After a fight on the comb, only one is left alive. No further swarming occurs.
- In the end there is only one queen in this hive.

One complication is that even when there are mature swarm cells in the colony, this does not necessarily mean that there will be a swarm. Queen cells can be broken down by the colony at any stage of their development. Furthermore, swarming can be postponed if weather conditions are unfavourable.

### 3.5 Absconding from the hive

Occasionally an entire colony leaves the hive, abandoning the brood nest. This is called absconding. In this event no queen cells have been built and it is therefore not a case of social reproduction.

Possible reasons for this are:

- 1 Shortage of food because of reduction in the nectar flow. The cluster of bees will become a so-called 'hunger swarm'. *Apis cerana indica* and *Apis mellifera adansonii* tend to follow the nectar flow from the plains into the mountains and back again. This is called seasonal migration; see also chapter 6.
- 2 Disturbance of the colony either by ants, wasps, termites or even the beekeeper.
- 3 Bad management by the beekeeper: beekeepers may provide unsuitable hives that are too big, too humid or have a bad smell. he or she may also place the hives at unsuitable places: too much shade, indoor hives, lack of shelter from rain or excessive heat, all day exposure to the sun. Beekeepers may have ignored the correct comb spacing, positioning the combs too far apart or too close.

Both *Apis cerana* and tropical *Apis mellifera* are much more prone to absconding than the European *Apis mellifera*. This characteristic be-

haviour allows colonies to escape sudden dearth periods by migration to better forage areas.

### **3.6 Replacement of the queen**

If the queen should die either naturally or by accident while the beekeeper is inspecting the hive, the colony is without a queen.

An important sign of loss of the queen is restlessness and more aggressive behaviour of the bees. Then, emergency queen cells will be built onto a number of worker cells containing young larvae. The hexagonal cell is rounded off and a little awning appears at the top of the cell. The larva receives more food – in this case royal jelly – and the horizontal worker cell is extended with a rounded part facing downwards. Emergency queens develop in these cells. With these adaptations queens can be raised from worker larvae younger than three days old.

A failing queen can also be replaced by the colony before she dies. The bees will build one or a few supercedure cells. A young queen may emerge, mate and start laying eggs while the old queen is still present, but usually she will disappear shortly afterwards.

Should the young queen be lost during the mating flight, eaten by a bird, for instance, there will be no brood in the colony so no new queens can be raised. The colony is irrevocably lost without a queen, as there is no natural solution, and it will die in the end.

However, during extended periods without a queen and without emergency queen cells, workers start to lay eggs. These eggs are not fertilised and can therefore only produce drones. The presence of laying workers can be seen from the large number of eggs per cell: this number varies from 5 to 10. They lay these eggs at the bottom as well as on the walls of the cells. Workers prefer to lay eggs in the wider drone cells and queen cups. Bulging cell cappings will tell you that drones are developing in worker cells.

The following solutions are possible when there is no queen left:

A. If the lost queen was an older, egg-laying queen:

- Remove all emergency queen cells except for one of good form and size; or
- Remove all emergency queen cells and introduce a young queen from another colony with the help of a queen cage; or
- Combine the colony with another that does have a laying queen.

B. If the loss of the queen is irrevocable:

- If there are laying workers, shake all bees off the combs at least 50 metres from the apiary. The bees will return to the hive and often the laying workers will remain behind.

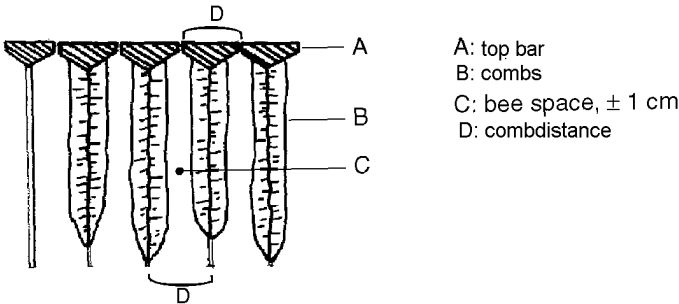
Then:

- Provide a frame with eggs or young larvae (for building emergency queen cells) from another colony with a queen; or
- Introduce a queen; or
- Combine the colony with another colony that does have a laying queen.

# 4 How to start beekeeping

## 4.1 Comb building

Bees build their combs from the top downwards. They usually do not attach combs to the bottom of the hive and to sloping walls. There is a fixed distance between the combs: the bee space. Any space greater than the bee space will be filled up with comb: see figure 4.



*Figure 4: Cross section of top bars and combs*

It is very important in movable comb beekeeping to know that the bee space as well as the comb spacing between adjacent combs is always identical for colonies of the same bee species. They vary slightly from species to species. The same applies to the cell width: distance between two opposite cell walls, and the slot width of the queen excluder. It can be said that, in general, the smaller the bee species, the smaller the bee space, required comb spacing, cell size and nest volume. See table 4.

### Hive choice

Beehives are hollow containers that can be closed and are made to house bees. Under natural conditions bee colonies will choose their own nesting site, which can be any cavity, any hollow tree, a rock cavity or a discarded container.

Table 4: Hive dimensions for two honey bee species

Bee species	Comb spacing (mm)	Cell width (mm)	Slot width of queen excluder (mm)
<b><i>Apis mellifera</i> :</b>			
European	35	5.3	4.2
East African ( <i>Apis mellifera scutellata</i> )	32	4.8	4.4
<b><i>Apis cerana</i> :</b>	30		3.5
Nepal			
India :			
- Kashmir	35	4.8	4.1
- High Himalayas	31	4.9	4.0
- Sub Himalayas	31	4.7	3.8
- Central India	32	4.5	3.5
- South India	32	4.3	--
Philippines	30	4.7	--
<u>Vietnam:</u>			
- North	31	4.7	
- South	26	4.3	

It will be very helpful to any beekeeper to observe the characteristics of such natural nesting sites, because the bees have shown their preference for them. See chapter 5: Equipment for beekeeping.

## 4.2 Hiving a swarm

### Some basic characteristics of bees

A beekeeper should remember the following basic characteristics in all his or her work with bees:

- Bees need sufficient flowering plants as pollen and nectar sources. You can easily detect whether plants are such sources by spotting forage bees on them. Bees also need water nearby which they can bring into the hive.
- If these basic requirements are not available the beekeeper should supply them, otherwise the colony will weaken and die or abscond.
- Bees are base-bound. They always fly back to the place of their own hive, even if the hive has been moved.
- Bees have a nest odour particular to their colony and are not allowed to enter another colony, unless they are carrying nectar.



## **Capturing a swarm**

A newly settled swarm clustered around a branch of a tree is normally very docile. When capturing a swarm, however, it is advisable to protect yourself with suitable clothing. The bees can be quite aggressive particularly if they have been under way for several days.

If you discover a swarm in an easily accessible place, you can first sprinkle cool water over the bees with a brush or with a spray bottle to prevent them from moving away. Hold a small hive without frames, a basket or a box under the swarm. A firm blow on the branch on which the swarm is hanging will make the bees drop into the hive or box. Then cover it with a thin cloth and put it in the shade. If a firm blow does not have any effect you can also drive the bees into the hive with a bee brush or smoke.

As soon as the queen is in the hive the rest of the bees will follow on their own. You must take some of the frames out of a prepared hive in the evening, and shake the bees from the small hive into the big hive. Then, carefully put the frames back into place and close the hive. The flight entrance of the hive can remain open; any bees left in the small hive can be tapped onto the flight board. The bees must be fed on the following day. You will read more about this further on.

## **Baiting a swarm**

Take a small hive that has already been inhabited by bees. In the case of a movable beehive fill this with frames or top bars. Two of the frames should contain combs, the others should have foundation sheets or strips of old comb. Place the hive in a tree or on a roof in such a way that there is some protection from the wind. A piece of wood under the lid prevents complete closing, which is preferred by swarms in tropical Africa looking for a new nesting place.

As soon as the swarm has taken occupation of the hive, the bees will begin to orient themselves to the position of the hive. It is therefore advisable to place the hive in its desired place the very day that the swarm has taken occupation of it. If the hive has already been occu-

pied for some days, the bees will already have oriented themselves to the hive. So you will have to move the hive to a spot about 5 km or more and only then move it to the desired place some weeks later.

Some old beehives or even an empty chamber with a cover and a bottom board will do. Keep one of these at hand around the home to bait a swarm. Carton boxes (about 30 x 40 x 40 cm) covered by six to eight top bars, or with some frames inside, will also do perfectly. Make sure these are protected against rain by a piece of plastic sheeting. Make an entrance hole just under the top of the box.

Baiting a swarm is only useful in the swarming season, which is often in spring or at the beginning of the dry season.

For beginners it is useful to know that in some countries the Ministry of Agriculture and/or Forestry has small colonies of bees at their disposal. But the best thing to do is to get your first colony from an experienced beekeeper, together with his or her advice.

### **Providing a bigger hive**

When all the combs in the small hive are filled with brood, it is time to provide more room. When a fixed comb hive is getting too small for a colony it is sometimes possible to make an extension to the hive, thus giving the bees more space. If you are using removable combs move the small hive 50 cm to the side and put the large hive in its place. Blow some smoke over the frames of the small hive. Wait a little and then loosen the frames with the hive tool. Hold the first frame next to the sidewall carefully by the handles and gently place it into the large hive. Transfer the other frames in their correct order, so that the brood nest will retain the same shape. Carefully look for the queen and any eggs. Place additional frames on both sides of the transferred frames filling the hive completely. Blow a little smoke over the frames and replace the cover. Make sure that the flight entrance is open; reduce its size if necessary. You now have your first bee colony in the desired place. Now let us see what will have to be done to manage your bees in an optimal way for a good harvest.

### **4.3 Administration**

You should keep a careful record of the condition of the colony, especially if you have several colonies. Make notes on a card after each inspection of: the date; the presence of brood combs; the food supply; whether there are drone or swarm cells; and also any action you have taken. Also note the honey yield or the absence of yield and any other particulars such as aggressiveness. You can attach the hive card to the underside of the cover of the hive.

Instead of using the card system you could also write all the details in a notebook, or better still a loose-leaf file, which you take home with you. It is difficult to write on hive cards if you wear gloves when working with the bees, so scribble a few notes on a piece of paper and write them up in detail when you are home. For administrative purposes it is useful to number your hives. All the data collected will be very useful at a later date when the number of colonies in the apiary has grown considerably and you want to start selecting the best ones.

### **4.4 Inspection**

Once a week take a quick look into the hive, if possible together with an experienced beekeeper. The bees should not really be disturbed that often, but as a beginner you still have a lot to learn about the life of bees and this will have to be done at their expense. Inspect the colonies during the day when the weather is sunny, and preferably not when there is a thunderstorm on the way. Carefully open the hive and blow a little smoke under the cover, or take away the cover and place a wet cloth over the frames. Wait a while, and then place the cover cloth in such a way that the handles of the frames are free. Use the hive tool to loosen the frames. Blow a little smoke from time to time. Lean the first frame on one handle against the hive and then take the other frames out one by one and inspect them. Make sure that the moist cover cloths cover the rest of the frames as much as possible. Note the following points:

- Are there eggs, larvae, capped worker brood or drone brood? Is the queen present? Is there enough food? Are there any wax moth larvae? Are bees and brood healthy?
- Note the findings on the hive card.
- You must always hold the frames above the hive to prevent the queen from falling out of the hive.

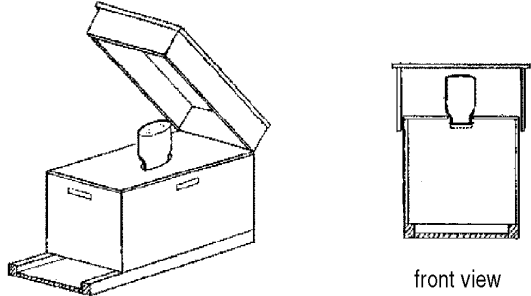
In order to prevent diseases spreading, especially American Foul Brood, it is advisable to sterilise equipment prior to inspecting the hives of other apiaries. Gloves should be washed between use in one apiary and definitely before use in another. Scorching the hive tools in a lighted smoker will also prevent the transfer of spores of this disease between the hives. See chapter 10.

## 4.5 Feeding

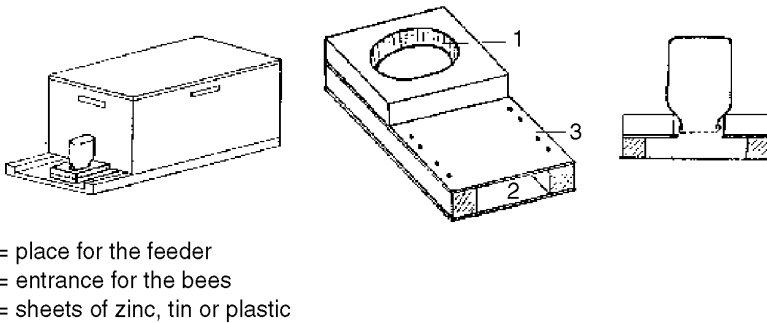
A colony is fed to stimulate development during dearth periods. Regular feeding with small quantities of sugar solution or with diluted honey stimulates the development of brood. The food that is stored in the combs is important for the survival of the bees but does not stimulate them to greater activity. A colony from which you have removed all the honey cannot bridge a dearth period without being fed with a sugar solution. You make a sugar solution by heating equal parts of good quality crystal sugar and water until the sugar is dissolved; never boil the solution. Never use brown sugar as it causes diarrhoea among the bees.

Feeding is done with a feeder; figure 5 shows how it should be positioned.

You can use a large jam jar or a small plastic bucket for this. Make a large number of 1 mm holes in the lid. Use a nail to knock holes in the metal lid of a jam jar. Make an opening a little smaller than the feeder in the inner cover of the hive. Place the feeder with its perforated lid upside down over the opening in the inner cover. Place an empty brood chamber or honey super over the top and replace outer cover of the hive. You can also remove one or two unused frames from the hive and replace with the feeder.



*Figure 5: Positioning the feeder*



- 1 = place for the feeder
- 2 = entrance for the bees
- 3 = sheets of zinc, tin or plastic

*Figure 6: Insertion of feeder in flight entrance*

The feeder can also be placed on top of a small wooden tray placed in the flight entrance as shown in figure 6. Make sure, however, that the bees cannot reach the sugar solution from the outside. The advantage of this method of feeding is that the hive does not have to be opened at all.

- Make sure that there are no openings through which bees, wasps, ants and the like can enter to steal the sugar. You can prevent robbing by making the flight entrance smaller.
- Never prepare more sugar solution than the bees can take up in a few days. A fermented sugar solution is poisonous for the bees.
- Stop feeding as soon as the bees no longer immediately take up the sugar, that is, if it remains untouched for a day. When you remove the feeder you must close the opening in the inner cover.
- If you can sell the honey for a good price, be generous with feeding in times of poor honey flow. You will more than recover the cost of the sugar by the resulting increase of the colony and the higher honey yields.
- To avoid robbing, do not offer food outside the colony!

Feeding with sugar will usually do during dearth periods and will keep your colony strong. However, you may at times find no pollen stored in the hive. Lack of pollen means a serious shortage of food for the brood. This means that fewer bees will develop. In this case you can give the bees soybean flour as a pollen substitute. Mix this with a little sugar to make a protein rich cake and feed it by putting it on top of the bars. Do not make too much cake as it perishes easily.

## 4.6 Handling bees

The beekeeper should take into account that bees react strongly to certain smells such as perspiration, alcohol, soap and perfume. In order not to be stung, avoid carrying these strong smells when you inspect the bee colonies and do not keep any animals near the bees. Bees can also become entangled in hair and in woollen clothing. It is therefore advisable to cover the head and to wear clothes made of smooth fabric. When bees are aggressive they will always go for dark colours first. Wear clothing of the lightest possible colour. This is also better when working in hot climates.

Make sure that you always have some form of smoke at hand when you want to open the hives. Always first blow some smoke into the

flight entrance, especially if you are working with the more defensive kinds of bees in Africa and South America. Lift the cover, blow some smoke into the hive and close the hive again for one minute. Always make sure that you have enough fuel for the smoker at hand.

Some types of bees are easily disturbed when vibrating objects, especially machines, come close to them. Avoid this by choosing the site of the apiary carefully. Weeding or mowing grass with a sickle or scythe can excite the bees terribly. Carry out all activities with slow movements. Bees react strongly to rapid movements. Even if you have been stung, first calmly put the frame back into the hive before paying attention to the stinger. You should especially avoid banging against the hive.

If you are stung you must first kill the bee that has stung you and then scrape the sting out of your skin with a fingernail or a sharp object. When you first start keeping bees the stings will cause swelling. After several stings the reaction will become less. Should you react violently to a bee sting by perspiration or dizziness, it is advisable to stop keeping bees. Fortunately this reaction only occurs in 1 out of about 5000 people, but if it does occur go to a doctor immediately.

## **4.7 The honey harvest**

The time to harvest honey depends on the flowering period of the bee-forage plants and the extent of the honey flow. There are some rules that you should bear in mind when harvesting honey:

- Only remove combs with capped honey; uncapped honey contains too much water and will start to ferment.
- The application of too much smoke should be avoided. Smoke should not be applied on combs after harvest. Unsealed honeycombs absorb smoke and will taste smoky. In sealed combs, the seals will absorb the smoke. By uncapping these before extraction, the smoky taste can be avoided.
- Do not take any honeycombs containing brood. Take only the combs at the sides of the hives from hives with fixed combs. From

hives with loose frames take only the frames out of the honey area and, at the most, the side frames out of the brood chamber.

- Sometimes people pay more for certain kinds of pure honey than for a mixture of different kinds of honey, so it would be worthwhile harvesting this kind of honey separately.

### **Collecting honeycomb**

When dealing with fixed comb hives where only the sidewalls can be removed, you should first blow some smoke into the hive through the flight entrance. The smoke would drive all the bees to one side of the hive after which you could cut away the light-coloured (new) combs, leaving about 1 cm of comb. The bees will rebuild a complete honeycomb on this strip of comb.

Hives that only have a loose bottom board should be carefully turned upside down after quite a lot of smoke has been blown into them. Then loosen the bottom board and push aside a little. When the bees have moved down, cut off the new combs against one side of the hive, leaving about 1 cm of comb. Next move the bottom board so that you can do the same on the other side of the hive. To avoid robbing, you should place the combs you have cut off in a pot or bucket that can be closed. It is advisable to put combs with little or no capped honey into a separate container and process it separately from capped honey combs. This will mean that the rest of the honey harvested will keep longer as it contains less water.

Honey harvesting from top bar hives and frame hives is much easier, but only combs with capped honey must be taken out for extraction. In order not to have brood in the combs, the beekeeper can take precautions during the weeks before harvesting, by repositioning these combs outside the brood centre. In this way the queen is prevented from using them again for egg laying. Also a queen excluder can be used to prevent the queen laying eggs in the honey comb area.

When starting the harvesting first blow some smoke under the lid of the hive. Wait a while and then take the frames with capped honey out



of the honey super and brush off the bees. If you place damp cloths over the other frames, not many bees will fly off. If you want to harvest wax as well as honey, cut off the honeycomb leaving a strip of 1 cm on the top bar. If you only want to collect the honey, then you must spin the combs in a centrifugal or radial honey extractor. You should always either fill up the empty spaces in the honey super, or remove it.

## 5 Beekeeping equipment

Beehives are hollow containers that can be closed and are built to house bees. Under natural conditions bee colonies will choose their own nesting site, which can be any cavity, any hollow tree, a rock cavity or a discarded container. It will be very helpful to any beekeeper to observe the characteristics of such natural nesting sites, because the bees have shown their preference for them.

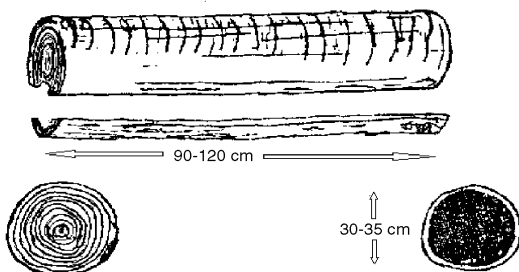
The hive used by a beekeeper must be appropriate to his or her way of beekeeping. There is a large variety of hives, from relatively simple ones to very complicated ones, the latter being quite expensive. In general, the following three types are most commonly used:

- fixed comb hives;
- removable comb hives with top bars;
- removable comb hives with frames.

Other beekeeping equipment is given in Section 5.4 and includes: smoker, spur embedder, hive tool, bee hat and clothing. This chapter also explains how to wire a hive frame.

### 5.1 Fixed comb hives

Fixed comb hives can be made of bark from a hollow log (figures 7 and 8), a wooden box (figure 9), an earthen pot or a metal container. The bees fill all the available space with combs from the top downwards. You cannot remove the combs separately as they are attached to the top



*Figure 7: Log hive or bark hive*

and sides of the hive. The honey can be removed by only removing one wall of the hive and breaking or cutting out the honeycombs.

*Advantages* of fixed comb hives:

- They are cheap and easy to make.
- They are seldom troubled by ants and raccoons etc. as the hives are usually hung up in a tree (figure 8) or covered with a layer of mud.
- The colony is not constantly disturbed by a beekeeper.

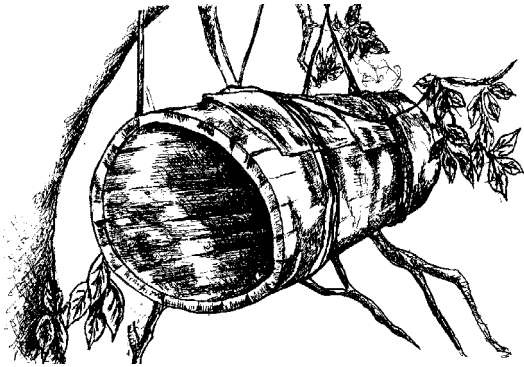


Figure 8: Opened log hive on a tree

*Disadvantages* of fixed comb hives:

- The colony cannot be inspected.
- When cutting out the combs, the combs with brood cannot be put back, and are thus lost.
- It is difficult to prevent swarming or to replace a queen.

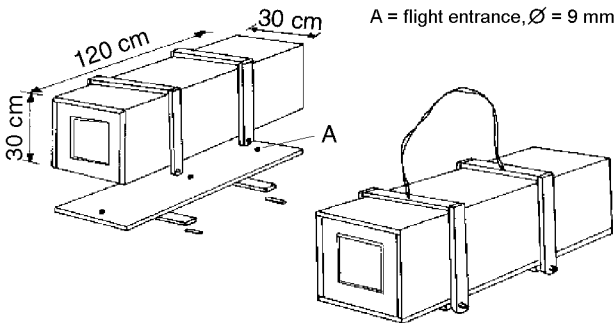


Figure 9: Box model hive

Improved versions of fixed comb hives have one or more removable boards, allowing inspection from one or more sides of the hive, as shown in figure 9. This also allows you to break off those combs that contain honey and to observe the colony's development. The combs with brood are left in the hive; the colony builds new combs and the development of the colony can continue.

Paraffin tins can also be used as box hives with the smaller, narrow side sawn off. These tins must be protected from excessive heating by the sun or cooling in the night, by wrapping straw or similar material around them.

## 5.2 Removable comb hives with top bars

Hives with top bars are used for *Apis mellifera* in Kenya, Tanzania, Botswana and Ghana. In Nepal and Vietnam they are used for *Apis cerana*.

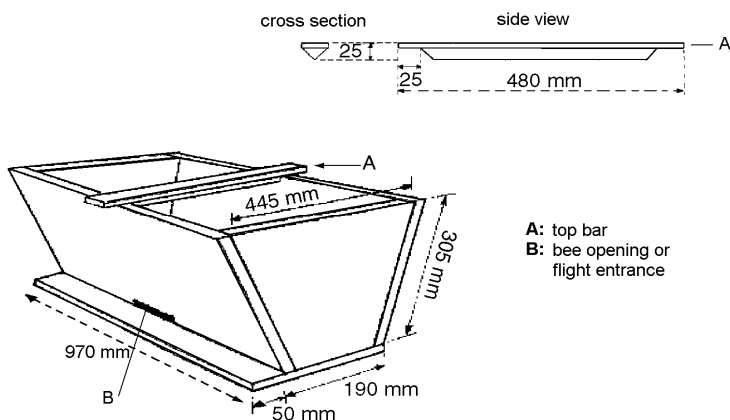


Figure 10: Top bar hive (Kenya)

Figure 10 is an illustration of a top bar hive used in Kenya. It is a long trough-shaped box consisting of a bottom board, two sidewalls and a front and back wall covered with bars or round sticks at a fixed spac-

ing. The sidewalls slope upwards from the base at an angle of about 115°.

Openings of 1×15 cm in the long sides of the hive serve as flight entrances or bee opening. The protruding section of the bottom board is used as a flight board or landing strip for the bees flying out and in.

The bars or sticks should be about 48 cm long. The underside of the bars can be planed down to a V-shape. Rectangular ones can also be made with a hardboard strip hanging down the centre of each top bar. The strip should protrude about 1 cm and can be soaked in melted wax as a starter so that the bees can build the comb on each of the bars. You can also help them by melting a piece of comb of a few centimetres length underneath the bar. The remarkable feature of this kind of hive is that the bees do not attach combs to the sloping sidewalls and thus the bee space is left free.

It is extremely important that the bars or sticks are placed at exactly the right distance from each other. This can be done by means of nails or spacing bars at the sides of the top bars. The centre-to-centre distance of the top bars should be the same as the specific comb spacing of the targeted bee species (see Section 4.1 for exact measures per species). If you need to determine the distance between combs for the local bees, first measure the comb distance of a natural fixed comb nest.

The advantage of placing the bars next to each other is that during inspection of part of the combs, most of the colony remains covered and is therefore not disturbed. The cover can be made from any material to provide adequate protection against light, sun and rain.

The hive should be suspended between two trees or poles using strong wire: see figure 23. This will keep the hive out of the reach of ants, termites and other enemies and threats. Finally the hive should be painted white to reflect sunlight and thus protect it against too much

heat. You can first treat the wood on the outside of the hive with a preservative – containing no insecticide or other poisonous substance!

Top bar hives can be made from wood 2 cm thick. A cheaper construction is a cardboard box hive of the right size to which cow dung, clay or a mixture is plastered. It can be reinforced with wooden sticks. A box hive can also be made from only straight sticks tied securely together with wire and plastered with the cow dung and clay mixture.

Another type of top bar hive used in Botswana, for instance, has parallel upright sidewalls, which makes it easier to construct. This type, which is also called Tanzanian top bar hive, can only be used for bee colonies that do not build combs on the sidewalls.

#### *Advantages of top bar hives over fixed comb hives*

- Each comb can be removed from the hive; this enables you to inspect the development of the colony.
- The combs containing honey can be removed without damaging the brood nest; the colony can develop undisturbed.
- The quality of the honey is better because no brood is harvested.
- You can use one or two queen excluders (see Section 5.4) to separate the brood combs and the honeycombs at one side or both. This enables you to obtain honeycomb with a little pollen in it, but absolutely no brood.

#### *Advantages of top-bar hives over hives with frames*

- They can be made with locally available and inexpensive materials.
- Only two dimensions matter: standard length of top bar (for exchanging bars within the hive and between different hives) and width of the top bar, which should be equal to the bee's natural comb spacing.
- If the combs are used only once, wax production is high. The raw wax hardly needs to be purified.
- Although honey extraction with a centrifugal extractor is the preferred method, you can also press the honey out of the combs.

## 5.3 Removable comb hives with frames

The various types of removable comb hives with frames include: WBC, Langstroth, Dadant or Simplex hives. We will not go into the details of all of them, but serving as examples of the construction of frame hives are the Langstroth hive (North and South America, Africa, Australia) and the East African long hive (Uganda and Tanzania).

The bees build their combs on wax foundation sheets (see Section 5.4) that are fixed in the wooden frames. A foundation sheet is fixed vertically in the middle of the frame. The bees build the cell walls under a slight upward angle on both sides of the foundation sheet.

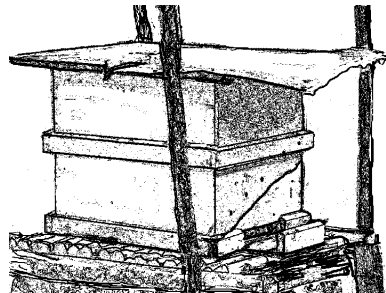
### *Advantages of a hive with frames:*

- Combs with brood can be easily separated from combs with honey.
- As the combs are firmly anchored in the frames, they can be handled quickly and without breaking. Also, the hives can be transported without combs breaking off.
- With the frame system, honey can be extracted rapidly with a centrifugal honey extractor and these combs can be reused.
- If honey production is the main aim, it is advantageous if bees produce less wax and use all their energy for brood care and collection of food.

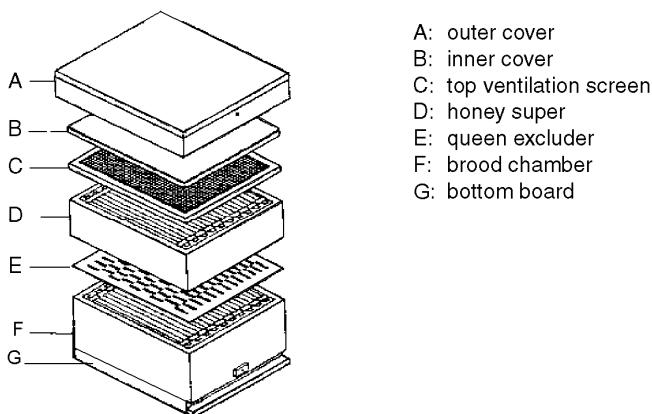
### **The Langstroth hive**

The Langstroth hive (figure 11) is mainly used in North and South America, Africa and Australia.

The most important construction parts of this hive are shown in figure 12.



*Figure 11: Langstroth hive*



*Figure 12: Building parts of Langstroth hive*

The building parts are:

**F:** Brood chamber with a fixed bottom board and flight board; or with a loose bottom board (= **G**), on top of which a bottomless brood chamber is placed. In the bottom board you can leave a ventilation hole of about 15×30 cm covered with fine wire mesh. The brood chamber holds 10 frames, which are kept separated at the correct comb distance by means of sidebars, nails or staples.

**E:** Queen excluder (not absolutely necessary), placed horizontally on top of the brood chamber.

**D:** One or more honey supers with 9 or 10 frames each, placed on top of the brood chamber or on the queen excluder.

**C:** Top ventilation screen for ventilation during transport, consisting of 2-3 mm mesh wire screen.

**B:** Inner cover of 0.5-1.0 cm thick.

**A:** Outer cover made of wood, covered with zinc or aluminium. This should easily fit over the honey super or brood chamber. For better ventilation you can place 4 little blocks of wood 1 cm high on the inside corners of the outer cover, for the air to pass underneath.

You can also use brood chambers for collecting honey instead of the shallower honey supers. The advantage is working with only one size



of box and frame. A disadvantage of a large honey super is that it takes longer for the honeycombs to be sealed. If there are many short honey flow periods with intervening periods of dearth, a super with large combs may not be well sealed, whereas a smaller one would be. Another disadvantage is that a super at the size of a brood chamber that is filled with 10 combs of sealed honey is very heavy to carry.

Figure 13 shows sizes and dimensions of the brood chamber and bottom board. These sizes should be based on the size of the frames. Build the chamber and supers to hold 10 frames. Ensure that a space of about 3 mm is left below the frame and a space of about 6 mm above the frame. Always keep in mind the basic characteristics of the bees for which you are building the hive and the corresponding measurements.

For the honey super a similar construction is made. The depth of the honey super is not 24.1 cm but only 14.6 cm based on frames with corresponding less depth.

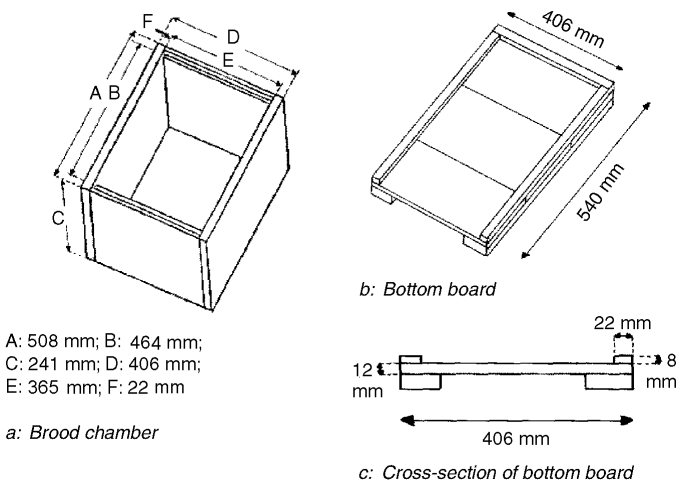
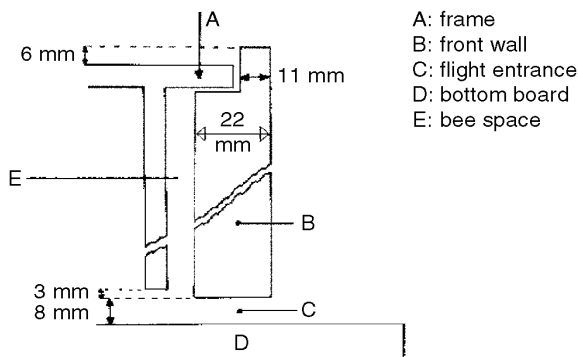


Figure 13: Brood chamber and bottom board sizes

### *Frame of Langstroth hive*

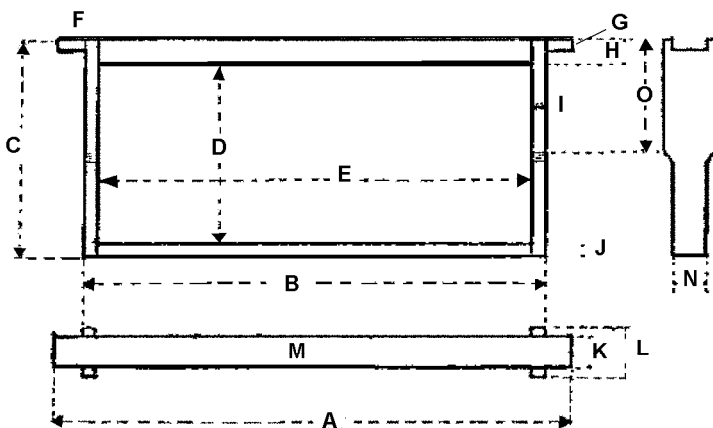
The frames in which the combs are to be built are suspended in the brood chamber and in the honey super. Their cross section is shown in figure 14.



*Figure 14: Cross section of brood chamber with frame*

Figure 15 shows the frames sizes of a Langstroth frame. The top bar must extend some distance on both sides of the frame, thus forming two small handles. The frame rests on these handles in the indentations made in the front and back walls of the brood chamber and honey super.

There are several ways of keeping frames at the correct parallel distance from each other, for instance, keeping bars at a specific centre-to-centre distance. You can insert staples, screws or U-nails in both handles in such a way that they protrude from each side of the frame. A second way is to use extra wide sidebars, which should extend on either side of the frame. To ensure that the bees do not glue the sidebars to each other too tightly, one side of the bar is bevelled so that the area of contact is as small as possible. A third way is to make an indentation on top of the side panels, equal to the required comb distance.



A: 476 or 483 mm	F: 14.3 or 17.5 mm	K: 25 mm
B: 448 mm	G: 9.5 or 11.1 mm	L: 34.9 mm (*32)
E: 429 mm	H: 19.1 mm	M: 28.6 mm
C: 232 mm (**137)	I: 9.5 mm	N: 22.2 mm
D: 206 mm (**114)	J: 6.4 or 9.5 mm	O: 89 mm

\* for *adansonii* bees

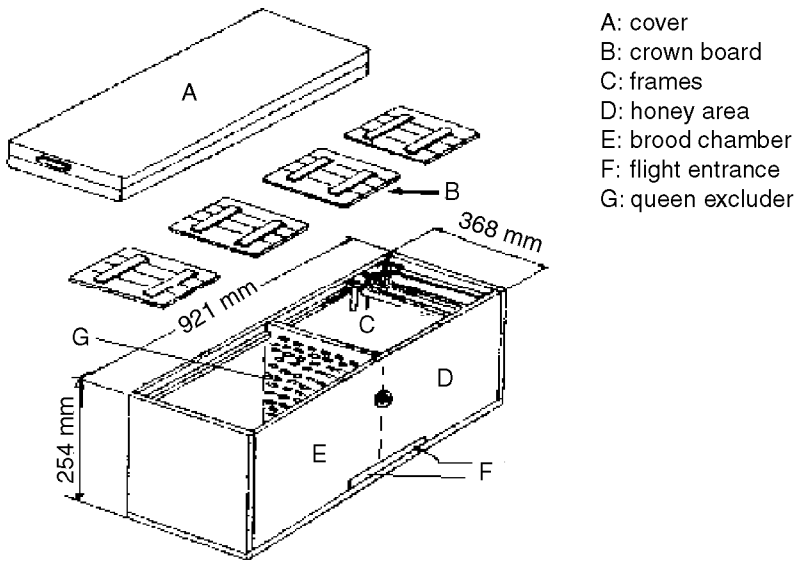
\*\* sizes of the honey super frame

*Figure 15: Approx. frame sizes of the Langstroth hive*

Underneath the top bar make a groove of 2 mm wide and 4 mm deep into which the foundation sheet can be fixed. As the handles of the frames all rest on the sharp edge, the bees can only glue them on this small surface. Bees have the habit of filling up all gaps smaller than 5 mm with propolis. The bottom bar of the frame must therefore be suspended thus permitting a gap of the bee size between bar and bottom board. The bees use this space to move under and past the frames.

### **The East African long hive**

The East African long hive has the honey area next to the brood chamber, and not on top of it, like the Langstroth hive. See figure 16.



*Figure 16: East African long hive*

The frames are hung at right angles to the front of the hive; this is similar to the Langstroth hive. Both brood and honey area will hold 12 frames. The sidebars of these frames are 32 mm wide. This hive also consists of a fixed or loose bottom board, a front with a flight entrance of 1 × 30 cm in the middle, a queen excluder, 4 crown boards which cover the frames, and finally an outer cover. The hive is placed on a wooden stand.

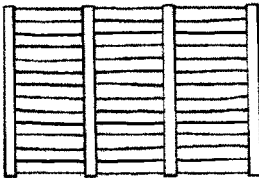
### **Smaller hives**

It is a good idea to keep a small colony of 4 to 6 combs in addition to the large colony. For this purpose smaller hives, holding 4 to 6 frames, are built on the same principles. The frames should always be of uniform size.

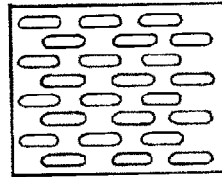
## 5.4 Other equipment

### Queen excluder

To make collecting honey easier, a beekeeper will want his or her bees to produce honey in separate combs as much as possible. A colony, however, tends to collect honey in combs where also brood is present. A queen excluder serves to keep the queen out of certain parts of the hive. See figure 17. One kind is the bar or wire grid. The perforated grid is made of zinc or plastic sheeting.



bar or wire grid



perforated grid

*Figure 17: Queen excluders*

The queen excluder is placed between the honey area and the brood area. The width of the openings must be adjusted to the size of the bees – big enough for the workers to pass through the excluder, but not the queen. In this way the queen can be locked up in the brood chamber. The workers should be able to pass through the grid without any hindrance so that they can store the collected food in the honey area. This explains why the oblong openings should run parallel to the combs. The total surface through which the bees can pass should be as large as possible.

### Foundation sheet

The foundation sheet consists of a sheet of beeswax (2-3 mm thick) into which a hexagonal cell pattern has been pressed. The bees build up the cell walls on this pattern. The use of foundation sheets promotes the construction of a regular comb, provided they are made of pure beeswax and the right cell size is pressed. For cell sizes of various bee species see Section 4.1. Furthermore, bees will then need less

energy for wax production, which is very advantageous for honey production.

Foundation sheets are commonly used in frame and hive beekeeping, but are not strictly necessary. They can be ordered from beekeeping cooperatives or from the Department of Apiculture of the Ministry of Agriculture or Forestry. If they are not available, pieces of so-called burr comb can be used. These are newly built small pieces of comb, usually tongue-shaped. The beekeeper can attach a burr comb to the centre of the frame bar or top bar by melting its top.

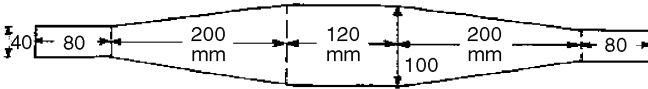
If foundation sheets are available, but expensive, then it is more economical to use small strips of foundation sheets. This can also be done in top bar hive beekeeping.

## **Smoker**

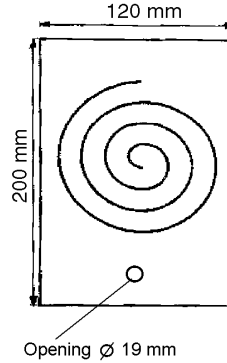
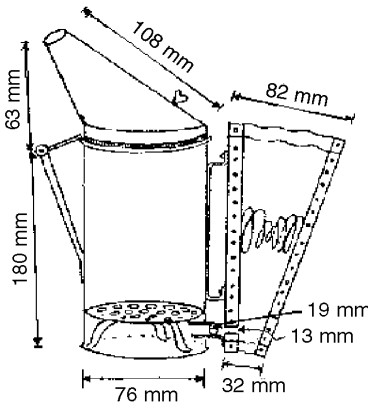
Smoke is a means of driving the bees away. The bees go to the honey and fill themselves with honey, which makes them less defensive. If you only need to inspect a few colonies or if you work with docile bees, you can light a cigar, cigarette or pipe. If you need to inspect a lot of colonies, or if you work with African or Africanised bees, it is always advisable to use a smoker. Cow dung, maize cobs, coconut fibres, rags or cardboard can be used as smoker fuel. An open smoker can be made from a fruit tin, for instance. A handle has to be attached to the rim of the open topside, because the tin becomes hot. Make holes in the bottom for air inlet. Attach three or four supports to the bottom.

To construct a smoker with bellows as shown in figure 18, you need:

- Two wooden boards of 12 × 20 cm
- A spring from a chair or bed or a similar spring
- A piece of imitation leather or the inner tube of a motor/car tyre
- A piece of metal tubing with a diameter of 19 mm
- A piece of zinc
- Nails



A piece of leather or the inner tube of a car tire



Wooden board with a spring

Figure 18: A smoker with bellows

### Bee hat

The bee hat (figure 19) protects the head and neck from bee stings. The hat is made of very thin cotton into which is sewn a window (25 × 25 cm) of fine black mesh or black fly screening.

To ensure good ventilation, use as much gauze in the hat as possible. Instead of a pointed hat you can also make a veil that fits onto a broad-brimmed hat. If you work with very defensive bees, a bee hat that is not

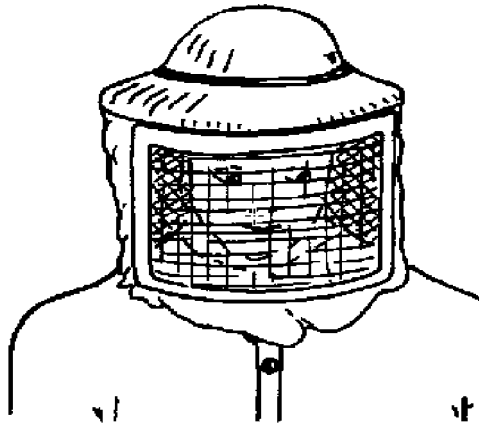


Figure 19: Bee hat with veil

based on a broad-brimmed hat is not good enough, as the bees will be able to sting the head and neck through the thin cotton. The veil of the bee hat should fall onto the shoulders and be tucked into the shirt or overalls. You should use black mesh or gauze for the window, as it is very difficult to see well through light-coloured gauze.

### **Overalls and gloves**

The use of a bee hat, overalls, high shoes and gloves (figure 20) is essential when working with some African and Africanised bees. It is best to wear white overalls with a zip fastener. If you are working with defensive bees the sleeves and the trouser legs must be tied around the wrists and ankles with elastic, rope or sticking tape. Wear high shoes or boots.

An extension piece 20 cm long with elastic in the ends is sewn onto the ends of the gloves. The gloves should be regularly cleaned with a brush and water, as the smell of the stingers in the gloves will stimulate aggressive behaviour in the bees.



*Figure 20: Full body protection at honey harvest*

### **Bee brush and hive tool**

To sweep the bees from the combs you can use a small, oblong brush, a strong feather or the whole wing of a bird. Defensive bee races do

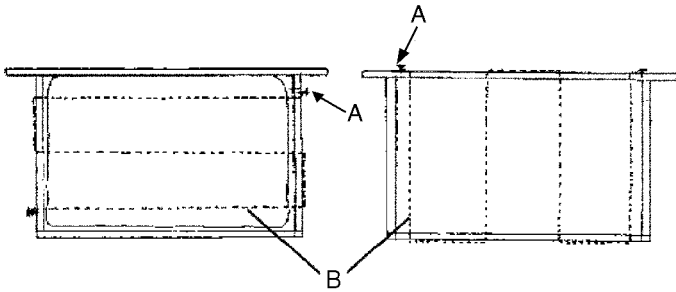


not need a bee brush because the bees can easily be shaken off the combs.

A hive tool is used to loosen the cover, the honey super(s) and the top bars that have been glued together by the bees. A piece of hard metal, crowbar-like, bent at one end and sharp at the other end will do. You can also use a screwdriver or knife.

### Wiring a foundation sheet frame

If you use a honey extractor you should reinforce the combs with thin galvanised wire, to make sure that they do not break during spinning. figure 21 shows how a frame can be wired.



*Figure 21: Wiring a brood chamber frame: A=nails, B=wire*

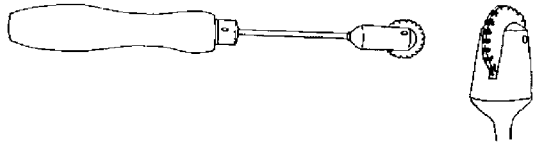
Fairly strong copper wire from broken transformers, for example, can also be used for this. The added advantage is that copper does not rust.

The groove in the underside of the top bar of the frames is used to attach the foundation sheets firmly to the frames. The grooves may be filled up with liquid wax after inserting the foundation sheets to prevent the wax moth from laying eggs in them. Make holes through the sidebars with an awl. These holes should be reinforced with metal eyelets to prevent the metal wire from cutting into the wood. The wire is strung through the holes horizontally, tightened, and secured with two small nails.

### Spur embedder

Once the foundation sheet has been attached to the top bar of the frame, the wire is melted into the wax with a spur embedder: see figure 22. Heat the spur embedder – which has a little groove in it – in boiling water or above a spirits flame and use it to press the wire into the foundation sheet. You can also heat the wire by running a weak electric current through it (from a battery or doorbell transformer).

A third method is to use a soldering iron. Instead of using the soldering bit, use a thick nail that has been filed flat at the end and has had a groove deep enough to cover half of the wire filed into it.



*Figure 22: Spur embedder*

It is important to ensure that the foundation sheet is at least 0.5 cm smaller than the frame at the sides and bottom. This allows the foundation sheet to expand without buckling. If you are not planning to use a foundation sheet or cannot get hold of one, you could also use a 2 to 3 cm strip of comb, which you melt to the top bar of the frame, so that the bees can build on this pattern. You could also use strips of firm paper, 3 cm wide and a little shorter than the frames. Dip these in liquid wax and then attach them to the top bars of the frames, to serve as a starter for comb building. The bees will then at least build their combs in the right place.

Bees can build on a foundation sheet or a strip of comb both in the brood nest and in the honey super. The bees will only build combs during good honey flow periods and definitely not when they are preparing to swarm.

## 5.5 Choice of hive site

The site must be in an area where there are several sources of nectar within a 1 km radius. Although bees can cover a 3 km radius, it is preferable to place bees in the middle of the forage (figure 23). The shorter the distance the bees have to fly, the less energy will be lost and the higher the honey production.

The site must not be waterlogged in the rainy periods. There should be enough suitable drinking water for the bees in the immediate surroundings. If this is not the case, you will have to set up a drinking place for the bees; for example, a container (in the shade) from which water drips slowly. If you provide an open container with water, always leave some pieces of wood floating on top for the bees to land on. Otherwise they will drown.

When working with defensive African or Africanised bees the apiary should not be in the vicinity of inhabited areas or areas where there are regular agricultural or livestock activities. As a rule the following distances are considered safe: 100 m in forested area, 200 m in shrubbery, 300 m in open land.

The apiary should not be too far from the home of the beekeeper so that regular inspection of the hives is possible without it costing too much time and money. There should also be a good path leading to the apiary.



*Figure 23: Apiary of top bar hives hanging between trees*

# 6 Seasonal management

## 6.1 Natural development of a bee colony

It does not matter which type of hive you use, what does matter is the bee colony inside it. If the bee colony is thriving, it will produce a lot of honey, it will not be affected much by diseases and will not abandon the hive because of drought or lack of brood. This means that the beekeeper will need to take the best possible care of the bee colony during the different seasons. It may substantially increase production.

### Bee seasons

Bee seasons are determined by the bloom and nectar production of the vegetation. Bee seasons are also determined by the geographical seasons of spring, summer, autumn and winter, which on the calendar in the northern hemisphere do not occur at the same time as in the southern hemisphere. Table 5 gives an indication of the activities of a bee colony in a complete season's cycle alongside the vegetation.

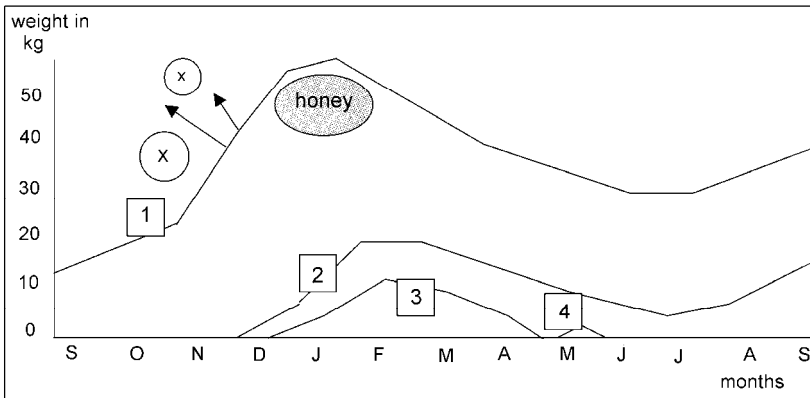
*Table 5: Development of the bee colony during one honeyflow*

Bee season	Vegetation	Activities of the bee colony
Upgoing season, 1 <sup>st</sup> half	Flowering beginning	More flights, more brood, more young bees, first drones and then queen cups
Mid-season	Full bloom	More foraging bees, drones, young queens, swarms
Upgoing season, 2 <sup>nd</sup> half	Full bloom	First much honey in old combs, then new combs with honey and finally wide-spaced combs (see 6.3)
End of the brood period	Bloom ends or reduces drastically	Fewer flights, ripening of the honey
Downgoing season, 1 <sup>st</sup> half	Few flowers	Fewer flights, less brood, no drone brood, less and less honey and more empty combs
Middle	Few flowers	Few or no brood, little or no honey in combs, many empty combs, wax moth and small hive beetle, absconding
Next upgoing season	Flowering beginning	Recovery, more flights, more brood

The seasons play a role in the development of a bee colony. The tendency to swarm is greater when the day length is increasing fast as in springtime at higher degrees of latitude. There is a lesser tendency to swarm when the day length is constant as it is in the tropics. The character of the bee species or bee race also plays a role here. Also climatic conditions and the weather have an effect on the performance of a bee colony. We will mention these where necessary.

### Weight of bees and combs (WBC)

The weight of a bee colony during the course of a year is also determined by the seasons. It is thus a measurable parameter of the progress of the seasons. The weight of a bee colony constitutes the total weight of bees and combs or rather ‘WBC’. To determine this, one has to weigh the beehives regularly and subtract the weight of the empty hive from it.



*Figure 24: Weight of an old bee colony and its daughter colonies (swarms) during one year with one honeyflow*

Figure 24 is a schematic diagram of a few realistic examples of WBC and the operations required, taken from data from West Africa and East Africa above the equator.

Explanation of the curves per colony or swarm:

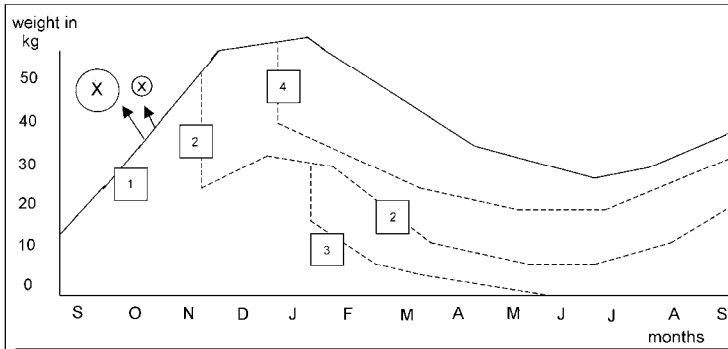
- 1 The old bee colony had a good start in September, has grown and had a spring swarm X (curve 2) and an autumn swarm X (curve 3). It had an abundance of honey in January after which it decreased in weight until July and then began to get heavier again. The colony was heavier the following September than it was at the beginning of the previous bee year (last September).
- 2 The spring swarm increased but hardly had any honey, decreased in weight to about 5 kg and grew again from July onwards. The second year should run like colony in curve 1 did in the previous year.
- 3 The autumn swarm grew in the upgoing season, but decreased to under the critical weight of 3 kg and absconded. The colony ended up as a hunger swarm (curve 4).
- 4 The hunger swarm perished.

## 6.2 Seasonal management

Seasonal management is the way in which beekeepers care for their colonies, guiding and handling them from season to season. They follow the natural development of the colony and make improvements where possible, aiming at a good honey harvest, little absconding and expansion of the number of colonies in the following year. Colonies are generally not big enough for the production of honey in their first season. This is why it is important to ensure that this goal can be achieved in the second year. This is done by keeping large colonies and preventing or reducing swarming and absconding.

### Size of colony

To allow the colony to grow to be big enough at the start of the honey-flow, the colony should emerge from the dearth period in a reasonable condition. This can be achieved by moderate harvesting before the downgoing season begins. The diagram in figure 25 shows the effect of the timing and quantity of harvest on the following season's harvest.



*Figure 25: Effect of honey harvesting*

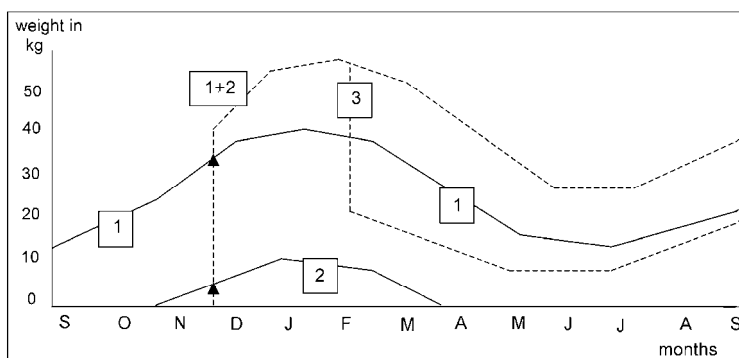
Explanation of intervention per curve:

- 1 The first curve **1** shows the natural weight development of a bee colony. Swarming takes place in the middle of the upgoing season (see arrows), after which honey is stored. The honey can be harvested early (curve **2**) and once again at the end of the honeyflow (curve **3**) or only of after the end of the honeyflow (curve **4**).
- 2 Honey is harvested early before the end of the honeyflow, after which the colony has new honey. This honey is enough to tide them over until the dearth has passed and until the following year.
- 3 Harvesting is done a second time, but the colony now has not enough honey for its own needs. This later results in absconding during the dearth.
- 4 The honey is harvested only after the honeyflow, when more honey can be extracted. However, this would lead to situation in curve **2** or situation in curve **3** (downward curves). In the latter situation absconding occurs later.

The more honey that is extracted, the less honey will be available for the colony to be able to survive the dearth and vice versa.

Apart from ‘not harvesting’ there is another method that would benefit the colony, which would also produce results in the current season. This is by merging smaller colonies, which would make them behave

like one big colony. The diagram in figure 26 illustrates the effect of this on the total weight of bees and combs (WBC).



*Figure 26: Development of separate and combined bee colonies*

Explanation of the curves per colony:

- 1 This bee colony is too small to produce much honey but if a small colony joins it (hence: curve **1 + 2**), it will produce much more honey (curve **3**).
- 2 This colony produces no honey at all and cannot survive until the following year. It leaves the hive and ends up as a hunger swarm. If it is joined to another colony (curve **1**), then **(1 + 2)**, this would substantially help to increase the production of honey of this colony.
- 3 A huge amount of honey can be harvested from **(1 + 2)**, while this last colony lives to see another year.

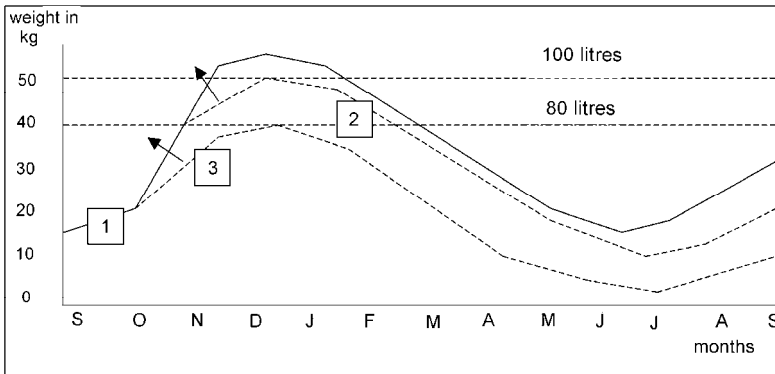
### Effect of the hive size

Bigger hives must be used for bigger colonies. These should be large enough to be able to house a bee colony at the end of the honeyflow; if not the numbers of foraging bees will diminish because of extra swarms of worker bees, resulting in little honey. Weight and measurement results recorded by Mutsaers (*Trichilia ABC*) show that the maximum weight of bees and combs is directly linked to the volume



of the hive. For instance, a hive of 80 litres has a maximum WBC of 40 kg and a hive with a capacity of 100 litres a maximum WBC of 50 kg. If the hive is full before the honeyflow has ended, then more swarming takes place and less honey will be produced.

Figure 27 illustrates how a large bee colony develops in an 80-litre hive and in a 100-litre hive if the beekeeper does nothing to reduce swarming, or split up the colony or collect the honey in time.



*Figure 27: Development of a large bee colony is restricted by hive size*

Explanation of the curves:

- 1 The hive space does not restrict the bee colony so it can develop naturally.
- 2 If the 100-litre hive is in danger of becoming too full, the colony will swarm: see arrow. This limits the honey production.
- 3 The hive has a volume of 80 litres and the colony sends out extra swarms: see arrow. There is relatively little honey at the end of the honeyflow.

### 6.3 Hive size and honey production

As a rule of thumb the volume of the hive and its maximum weight (WBC) are given in table 6.

*Table 6: Maximum honey production in relation to hive size*

Hive volume	Max. weight of bee colony (WBC)	Honeycombs	First yield honeycombs	Honey after extraction
(in litres)	= 50% hive volume (kg)	= 90% WBC (kg)	= 65% honeycombs (kg)	= 70% harvested combs (+ wide-spaced combs) (kg)
60	30	27	18	13
80	40	36	23	16 (+3)
100	50	45	29	20 (+4)
120	60	54	35	25 (+5)
140	70	63	41	29 (+4)
160	80	72	47	33 (+4)

The table shows the maximum honey the beekeeper can harvest in order to give the colony a good chance of success in the following year. This has to do with the weight of the honeycombs harvested. The recoverable share of the honey that is extracted or pressed is usually 60-80% of the total weight of the harvested honeycombs. This percentage is dependent on the type of comb, the type of honey, the extractor or press and the temperature when extracting is done.

The wax, from which the comb is built, mostly amounts to 2-3% of the total original comb weight. Cocoons that have been left behind after the brood has hatched and that contain bee bread add to the weight somewhat. Ultimately about 15-35% of the honey is left in the comb.

#### **Impact of the timing of harvesting**

For good quality honey and to promote good further development of a bee colony, one should leave harvesting to as late as possible, for example, until after the end of the honeyflow. At this point in time there is also less brood in the combs. Often harvesting is done earlier because the hive is full, but this honey is not always ripe. Moreover, the

moisture content of honey in the comb is often higher than at the end of the honeyflow, even if this has already been sealed.

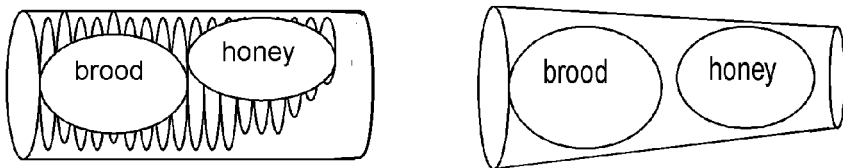
Furthermore, the moisture content of the honey is determined by the size of the colony. A bigger colony may be able to achieve a lower moisture content than a smaller colony, which is a good reason to keep larger colonies and, of course, in larger hives. At the end of the honey season the bee colony builds wide-spaced combs, which are extra thick combs containing a lot of honey. The extraction percentage from these combs is much higher than from other combs, containing 'old' brood combs that still contain bee bread and membranes from hatched brood, for instance. The extra harvest from increased comb size from wide-spaced combs is given a value of (+) in table 6.

## **6.4 Seasonal management and hive type**

Development of a bee colony is dependent upon the size and the shape of the hive and how it is used during the different seasons. Increase of hive size by using attachments or supers, reducing hive size by using dividers, or the use of two similar hives with different sizes are means of adjusting the hive size to the seasons. This works out differently for various hive types.

### **Traditional hives and baskets**

In a traditional hive or basket the brood are found near the flight hole in the front of the hive, while the honey is at the back of it: see figure 28. If the hive can be opened at the back, the beekeeper will not disturb or damage the brood when removing the honeycombs. Therefore, cone-shaped pointed hives are less suitable, unless the bee entrance is at the narrow end. But even so, cone-shaped hives are relatively small compared to cylindrical hives, which of a comparable length and diameter offer about twice the volume.



*Figure 28: Division of brood and honey in traditional hives*

### **Measuring the hive size**

The volume of a cylindrical hive 40 cm in diameter and 1 metre in length is 125 litres. A hive 30 cm in diameter and 1 metre long has a volume of 70 litres. The latter is too small for good honey production, so it is advisable to use hives with a larger diameter. The volume of a hive has more to do with its diameter than its length. Building an extension on to the hive during the honeyflow can increase its volume.

When harvesting you ought to ensure that some honeycombs are left in the hive for the bee colony to use. A rule of thumb is to harvest no more than half of all the combs or two thirds of the honeycombs, which in bigger hives turns out to be the same number of combs.

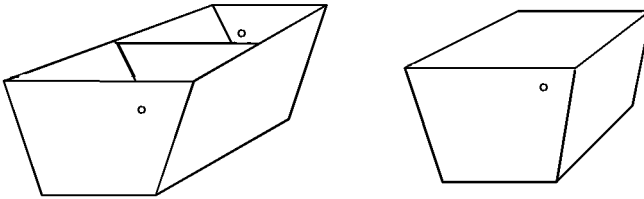
To avoid the bee colony having too much room during the dearth, one can place a board in the middle to divide the hive after harvesting the honey. This divider board can then be removed in the upgoing season. To bait or attract swarms reducing the space will also prove to be helpful. In times of drought the bees should be provided with a supply of water inside or close to the hive to prevent the bees from flying over long distances to find it. This is called water feeding if it is provided inside the hive, or a bees' pub if it is outside.

### **Kenya top-bar hive**

The use of top-bar hives (see section 5.2) is in principle the same as traditional hives. The advantage of the top-bar hive is that it allows the beekeeper to remove the combs attached to the top bars without any breakage and move them to a spot either inside the hive or to another hive. Top-bar hives and frame hives like Langstroth are therefore

called movable-comb hives. It offers even more possibilities if, for instance, one uses a divider board, or - if two hive sizes are used - half of a hive in combination with a whole hive (figure 29). Halfway through the honeyflow the colony is transferred from the smaller into the bigger hive. A half-size hive is also useful as a harvest hive.

A divider board with the same measurements as the front and back of the hive can be used to reduce the space to attract swarms, to split up a colony or to join two colonies, or to reduce space after harvesting at the end of the honeyflow. A second flight hole can be provided if necessary. The bees close it off with propolis if they do not need it. A divider board or a queen excluder of the same size can be used for the production of bee bread and royal jelly.



*Figure 29: Top-bar hives; left: divider board and extra flight hole; right: half-size hive*

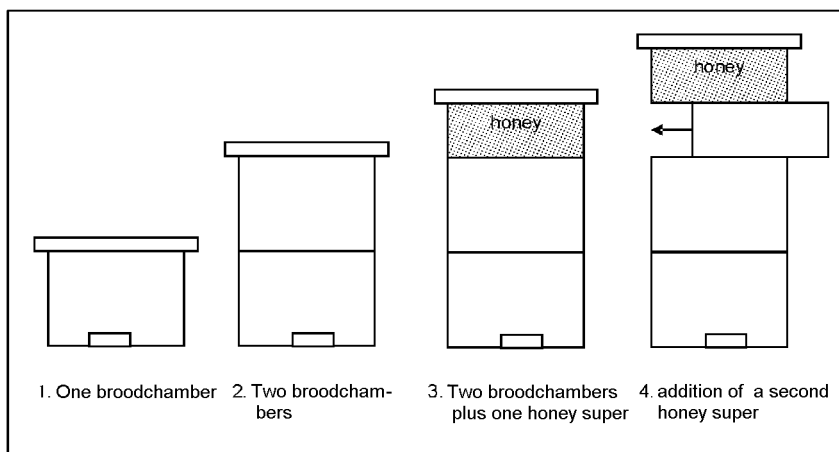
This half hive can be used for catching swarms and as a harvest hive. It is just big enough to harvest half of the combs. Transferring the combs hanging from the bar to a harvest hive is better than cutting off the combs in the field. It prevents bees and dust from getting stuck to the raw edges.

A standard Kenya top-bar hive has a capacity of about 80 litres. For larger volumes you can make the sides vertical. The combs would then be built on the sidewalls, especially at the top, but they will be easy to cut loose. Beekeepers can increase the volume substantially by widening the top of the hive to perhaps 50 cm. This would then alter the size of the top bars so that the beekeeper would not be able to exchange them with the former hive. The effect of widening the hive is better

than lengthening it. It is also better than making the hive deeper because this would only lead to bigger combs. These would thus be more susceptible to breakage from the top bar, as they are heavier and longer.

### Modern hives

The name modern hive is often used for Langstroth; see section 5.3. It is a modular type of hive, consisting of super-imposed chambers with frames to hold the combs. It is called a frame hive, although long-frame hives also exist. One usually works with one brood chamber and one honey super smaller in height, or two brood chambers of the same size. Beekeepers usually lay a queen excluder between the chambers to prevent brood rearing in the honey super. The disadvantage of this is that it limits the brood nest, which leads to extra swarming, less honey production and more absconding later. A hive like this is too small for large colonies to develop in. This is why it is advisable to work with more than two chambers.



*Figure 30: Use of a Langstroth hive for honey production*

The hive can be enlarged during the upgoing season by first placing a second brood chamber on the lowest brood chamber, and then a honey super with optionally a queen excluder underneath. Figure 30 shows

the building of the hive during the honeyflow. If harvesting is done at the end of the honeyflow, then most of the brood in the honey super would have hatched out.

When the first honey super is full, a second one can be placed under the uppermost one. This is better than on top of it, because up there is the best place to ripen the honey. The bees bring the newly arrived nectar to the uppermost part of the hive and use the empty combs underneath for spreading the honey out to ripen. If the empty honey super is placed on the first, it is possible that the bees will carry the honey up. Lack of extra brood and honey supers can lead to management problems.

The capacity of a brood chamber is about 40 litres and a honey super about 30 litres. The capacity of the hives in figure 30 from left to right is 40, 80, 110 and 140 litres. Using frames without artificial combs can reduce the effective volume. The bee space would then not only be free on the outside of the frames but also on the inside. There would also be unused space between the chambers. In a vertically constructed hive these free spaces will function as chimneys for draught, especially if the top of the hive has a leak. It is therefore most important to seal the top of these hives well and cover them with insulation material. It will allow the bees to regulate the temperature more easily.

Following the harvest the beehive can be reduced to one or two brood chambers, or one brood chamber with a honey super underneath. In the upgoing season the beekeeper can remove the honey super and store it until it needs to be set back again.

## **6.5 Good seasonal management practice**

Given below is our advice for the development of the bee colony and the production of plenty of honey from season to season.

### *Upgoing season*

- Keep the colony in a small space when it is still small, for instance, in a small hive or big hive with divider board.

- Enlarge the hive when the colony grows by removing the divider board, by hanging the combs in a bigger hive or by adding a chamber.
- Ensure that you have enough small hives to bait swarms.
- Put late swarms and smaller colonies together.
- Prevent absconding occurring later in the downgoing season by keeping bigger colonies for example by merging them.

### *Harvesting of honey*

- Do not harvest honey from small colonies.
- Harvest as late as possible when there is enough space in the hive.
- For *top-bar hives*: hang the combs in a harvest hive, if possible also do this with traditional hives. Do this so that damage to the combs is kept to the minimum and then extract the honey.
- For *Langstroth hives*: remove an entire honey super, using a bee outlet if necessary.
- Do not harvest honeycombs from the undermost brood chamber. These are for the colony.
- Harvest in moderation so that there is enough left over for the bee colony and to limit absconding.

### *Downgoing season*

- Prevent absconding by removing empty combs.
- Limit the space by using a divider board, hanging the combs in a smaller hive or reverting to fewer chambers.
- Provide a supply of water inside or close to the hive.
- Open the hives as little as possible.
- Cover the top of the hive well to avoid heat loss.

By keeping healthy and large colonies and by adjusting the size of the hives to the seasons, beekeepers can prevent absconding later in the dearth period. Then more colonies can be kept in the following season with the result that even more honey can be harvested from each colony. The size of the colony must, however, have priority over the number, because a few big colonies will produce more honey than many small colonies.



# 7 Honey extraction

Honey should be processed in a closed environment where bees and other insects cannot enter. All ventilation openings have to be screened with fine wire mesh. Using a tent well sealed at ground level, is an option.

Best for quality is to extract the honey as soon as possible after collecting the combs from the hive. If it is however necessary to store the combs it should be done in a well-sealed container.

Sometimes the water content in capped honey is too high. You may dehydrate it a bit by placing the honey supers, after uncapping the combs, on top of each other and blowing dry air from below up through the combs. The honey will lose moisture but more importantly it will lose some of the fragrance.

## Uncapping honeycombs

Before extracting the honey the capped cells in the comb should be uncapped. This can be done with an uncapping fork or knife (figure 32). Uncapping with a fork is more accurate but slower than uncapping with a knife. Uncapping knives must be filed well and be razor sharp.

At temperatures below 25 °C you can make uncapping easier by pre-heating the uncapping knife in hot water. With a preheated knife try to cut away the cell cappings in one movement. Irregularities in the comb will result in some of the cells remaining capped. It is best to uncap

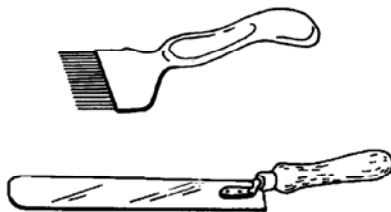


*Figure 31: Honey packing*

over an uncapping tray with a wooden bar on which the frame rests. You can leave the wax cappings to drain and later melt the wax cappings to obtain first-grade wax.

### **Floating**

Extracting honey by floating the combs is the simplest way, but takes the longest. The honey will absorb water from humid air, so it is not a good thing to do in the rainy season unless you work with closed containers.

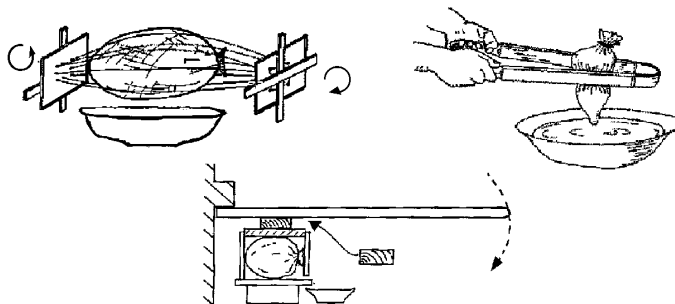


*Figure 32: Uncapping fork and knife*

Break the combs into small pieces and place them in a pot or container. Seal the container to make it airtight. After a few days the wax will have floated to the top and can be skimmed off. Strain the honey through a clean cloth, nylon stocking or special honey sieve and again put it away for a day. Any foam and wax particles that have floated to the surface again can be skimmed off and the honey can then be put into jars.

### **Pressing**

Figure 33 shows various ways of honey pressing.



*Figure 33: Various ways of honey pressing*

Uncap the combs, break them into pieces and tie them up in a clean cloth: e.g. cheese cloth, sheet or pillow case. Knead the combs in the cloth and then press the honey through the cloth. You can wring out the cloth with two people or with a wooden press.

After pressing, pour the honey through a clean cloth into a pot or maturing vessel and leave it to stand for a few days. Skim off any remaining wax particles and pollen grains that float to the top, before putting the honey into jars.

### **Centrifuging**

The advantage of centrifuging is that you can extract the honey very quickly and you can use the combs again. Requirements for centrifuging honey are:

- honey extractor,
- uncapping knives or forks,
- one or two basins 15 cm deep made of aluminium, tin, galvanised iron or plastic, in which a few uncapped frames can stand,
- an uncapping tray,
- a honey strainer or nylon stocking,
- cheese cloth and a vessel.

The centrifugal honey extractor (figure 34) consists of a cylindrical kettle in which a square or triangular cage made of a frame covered with strong wire mesh turns on an axle. A radial extractor (figure 35) is different in construction because of the radial placement of combs, but in principle its function is of course the same.

In the honey extractors two or more frames can be extracted at the same time. The cage in which the frames are placed is turned by means of a handle with gears.

#### *Positioning the combs in the centrifugal extractor*

All combs must be uncapped before you centrifuge the frames. Place the combs inside the square cage against the wire mesh sides.

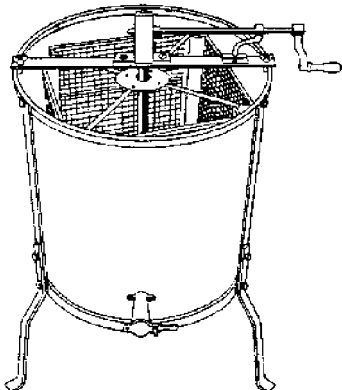
Turn in the direction of the bottom bar (as the cells face the top bar). Make sure you turn the handle slowly, otherwise the weight of the honey inside the comb will press the comb through the wire mesh of

the cage. Girate the cage till about half of the honey has been centrifuged from the exposed side.

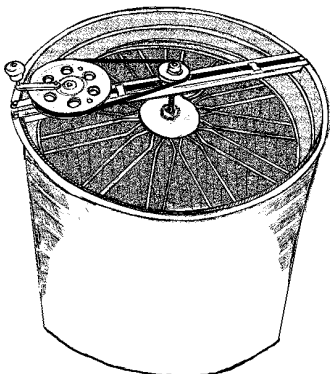
Then position the frames in reverse and turn the handle until the cells on this side of the combs are completely empty. Finally turn the combs once again and turn the handle until the cells on the first side of the combs are also completely empty. Empty combs are put into a honey super and given back to the colony, so that they can lick the cells clean. If the honey flow stops, the empty combs must be removed.

After every round of extracting, tap the honey from the extractor and pour it in a maturing vessel. Leave the honey in the maturing vessel for a few days so that air bubbles and wax particles can float to the top. Skim these off and pour the honey into airtight pots or containers.

It is even possible to centrifuge comb parts or top bar combs in a centrifugal extractor. In that case you must make wire baskets in which the comb pieces are tightly enclosed. The baskets are handled as if these were frames. The pieces of comb can be reused again in the hive, re-attaching them to top bars with pieces of string or straw. Alternatively, the remaining comb can be used for wax processing.



*Figure 34: Centrifugal extractor*



*Figure 35: Radial extractor*

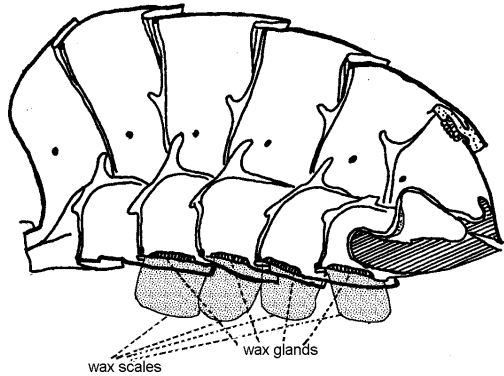
The advantage of a radial extractor is that, because of the radial placement of the combs, these can be emptied in one position and do not have to be turned around. Combs of top-bar hives cannot be centrifuged in a radial extractor.

# 8 Production of beeswax

Beeswax is a complex mixture of hydrocarbons (sugars) and lipids (fats). It is a non-crystalline, chemically inert and impervious wax. In the evolution of the honey bee the ability to produce wax has probably been a major factor in bringing the honey bee to the top of the eusocial insects.

Beeswax is produced by quiescent hanging bees of 10 to 14 days old. They possess four pair of ventrally located wax glands (figure 36).

The wax is made in the wax glands and is secreted through eight porous wax 'mirrors' in the underside of the abdomen. The wax sets on the surface of the wax plates into transparent wax scales, which are taken off with the legs and worked with the jaws.



*Figure 36: Position of wax glands (after Snodgras, 1956)*

The development of the wax glands depends on the pollen feeding of the young bee, just emerged from the cell. Rich pollen consumption in this early stage of their existence provides for an optimal building capacity.

Beeswax is very valuable to bees because much nectar is lost as food when converted into comb material. For this reason beeswax is removed, moulded and used over and over again within the nest. Bees can construct a 20 cm<sup>2</sup> two-sided comb area from one gram of beeswax. It requires about 55 grams of beeswax built into combs to store 1 kg of ripened and capped honey.

Due to the complex biochemistry involved in the glandular synthesis of beeswax, a conversion ratio from sugar to wax of 17-20 to 1 is given in the literature. It means that for producing wax the bees need a lot of ripened honey.

Beeswax is also valuable to man. Though world market prices are always fluctuating, a value of 2.50 per kg was obtained in spring 2004. Locally even higher prices might be possible. Therefore beekeepers should try to produce beeswax as well as honey.

Sources for production of pure beeswax:

- Nests from feral colonies often contain some good pure wax.
- Old combs from beekeeping are generally not a good source. It is difficult to separate the wax from the cocoons left in the cells by the larvae. Furthermore, old combs contain much propolis and this makes the wax difficult to clean. However, if the comb had been fitted up with an artificial comb foundation it would always be worthwhile melting such a comb.
- Wax scraps from cleaning frames and hives can be collected during the season and melted down at the end of it.
- Wax cappings obtained during the honey harvest are a source of the purest beeswax of high quality.

Wax can be obtained by encouraging the building of temporary combs in a super above the brood nest. It may help to reduce the swarming tendency and to secure additional wax.

Before an expected flow of honeydew honey, which is often not marketable as honey, supers may be put on the hives containing starter strips of comb only. When the flow is on, the bees will build combs, which could afterwards be melted. Much of the honeydew is thus used in the production of wax. Any honeydew stored may be fed back to the bees for building more combs.

Processing and cleaning of beeswax are described in Agrodok 42.

## 9 Collecting pollen

Pollen is the male genetic material in flowers of all higher plants. Stamens in flowers hold pollen as minute grains. Pollen is essential for normal growth and development of individual bees, as well as for reproduction of colonies. It contains proteins, fatty substances, minerals and vitamins, and its nutritive value varies depending on the plant species. In general, fruit tree pollen has excellent nutritive value, while the pollen from coniferous trees has poor nutritive value.

Pollen is the principal source of the essential nutrients bees need for production of royal jelly, which nourishes the larval queen and other young larvae. A strong production colony will collect about 35 kilograms of pollen for its own development in the course of the season. The pollen collecting bees crawl among the stamens biting them with their mandibles to dislodge the pollen grains. Pollen grains stick to the mouthparts and become thoroughly moistened. In doing so the bees also catch dislodged dry pollen on the branched hairs of their bodies and legs. After the bee has crawled over a few flowers it brushes pollen from its body using its legs and packs it onto the concave shaped part of its hind-leg known as the pollen basket. This is done several times till the pollen basket is loaded or till no more pollen can be obtained.

After returning to the hive the worker bee strips off the pollen loads in an empty or partly filled cell. Another, generally younger bee breaks the loads and stamps them down firmly into the bottom of the cell. A small layer of honey is deposited on the pollen to prevent spoiling. This store of pollen is called bee bread. In the stored pollen enzymatic processes and a lactic-type metabolism take place. These inhibit the germination of the pollen and contributes to the stability and conservation of pollen as a food source.

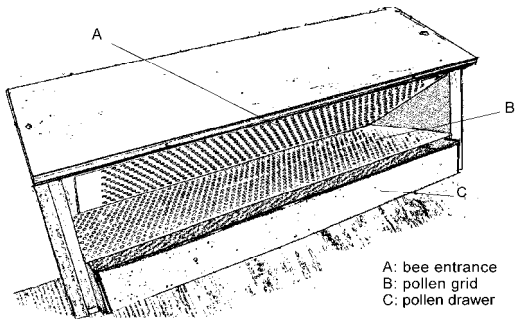
Pollen is not only necessary for larval food, young adult bees also require pollen within the first two weeks of their lives. About 10,000



bees can develop on 1.5 kg of pollen. Pollen supply and colony size independently influence brood-rearing capacity. Therefore the bee-keeper should always look for a site to keep his or her bee colonies in the neighbourhood of plenty pollen-producing plants.

Many benefits have been attributed to the inclusion of pollen in man's diet. In times when a lot of pollen is available and the bees collect ample supplies of it pollen can be harvested for human use. A pollen trap (figure 37) can be used for this purpose.

It should be noted that collecting pollen with a pollen trap induces protein shortage in the hive, resulting in intensified collecting activity by the bees at the expense of nectar collecting. In times of dearth in the nectar flow this may not be a problem. But care should be taken not to extend the trapping period too long. Intermittent use every other day is recommended.



*Figure 37: Pollen trap*

For storage and future use the pollen should be dried, cleaned and frozen or covered with a layer of honey. Do not trap for pollen if raining, as the trap could get wet and mould will easily develop and decrease pollen quality.

In humid tropical countries it is difficult to store fresh pollen outside the refrigerator without rapid deterioration of quality. If no reliable freezing capacity is available pollen can be better stored as bee bread. However bee bread will also deteriorate after a few months of storage.

# 10 Diseases and pests

## 10.1 Prevention and correct diagnosis

In this section we describe the most prevalent pests and diseases. Note, numerous other less harmful or less known pests and diseases may also attack the bee colony. However, bees have been able to keep themselves relatively free from affliction for millennia.

The beekeeper should therefore think about the following:

- The beekeeper may be responsible for spreading diseases and pests from country to country through importing queens and nucleus colonies from all over the world.
- The beekeeper may spread pests and diseases from apiary to apiary through breeding programmes and exchange of colonies.
- The beekeeper may spread pests and diseases from colony to colony through exchanging combs from one colony to the other.
- Beekeepers can greatly enhance the health of their bees through good management. Strong colonies are less susceptible to diseases, and if faced with disease can generally overcome it without help.
- Large numbers of dead or dying bees in front of the hive is very often not a sign of disease. It may very well be poisoning from pesticides. Keep in touch with the farmers and prevent the bees from flying out on spraying days. Provide them with a ventilation screen and water on these particular days.
- Shrinking and dwindling colonies are not necessarily caused by disease. Perhaps plant growth regulators or herbicides killed the foraging plants. Keep in touch with authorities and farmers and try to convince them not to use these agents or move the bees to another area.

## 10.2 Varroasis

### Characteristics

Varroasis can be positively identified when many deformed bees are seen stumbling about in front of the hive. This deformation is caused by viruses introduced into the broodnest by the parasitic bee mite *Varroa jacobsonii* or *Varroa destructor*, as it is now known. The female *Varroa* mite is brown and oval-shaped and is a parasite of adult bees and brood. It regenerates in the closed brood cells of the honey bee. It must feed on larvae before being able to lay eggs at a rate of about one every 25 to 30 hours. The first egg develops usually into a male the later ones into females.

Mites like to travel with young housebees and not with the flying bees. At least twice as many mites can mature in drone brood than in worker brood, since the drone brood takes three days longer to mature.

Not all mites can produce offspring. Factors influencing this are:

- *Bee species*: reduced development time of bee brood and strong grooming behaviour makes a race less vulnerable.
- *Season*: availability of suitable brood cells and colony size influences the reproductive chances of the mite.
- *Environment*: higher than optimal temperatures prevent the mite from reproducing.

Parasite-infested worker bees are less able to feed the brood. Their physical condition deteriorates rapidly: their lives will be shorter, they become forage bees sooner, do fewer flights per day, bring less pollen or nectar per flight and fewer come back to the hive after the first flight. So it is important to avoid having too many mites in the colony.

### Chemical treatment

Varroa can be treated with a range of synthetic chemicals (including their active ingredient) which act as biocides. These include Amitraz, Apistan (fluvalinate), Apitol (cymiazol HCL), Bayvarol (flumetrin), Folbex VA (bromopropylate), Perizin (coumaphos) and Malathion (1%); or with natural acids such as formic acid (60%), lactic acid

(15%), oxalic acid (5%), etheric oils and natural camphors or mixtures of these.

After some years of use synthetic chemical compounds may result in resistance building in the mite. It also leaves harmful residues in wax and honey. The compounds of Amitraz and Perizin leave residues in hive products that may be carcinogenic. In Europe, therefore, these compounds have long been banned from use. Use of synthetic chemical compounds is strongly discouraged.

### **Biotechnical treatment**

Since the mites enter drone brood more easily, they can be caught there. This is done in spring when colonies start building, by placing a frame in the middle of the brood nest onto which drone brood cells can be built. Every time when most of the drone brood cells are closed, the frame is taken out, cells decapped, larvae shaken out and the comb washed out, dried and replaced in the hive.

Advantages of this method:

- Mites are caught.
- Infestation does not build up.
- Mite population does not increase.
- Bees build fewer drone brood cells in other combs.

Drone brood in other combs should be cut out and removed wherever possible. If a swarm without brood is given a comb with open drone brood, all mites will be caught and this colony will be mite-free for the time being.

Formic, oxalic and lactic acids are natural substances normally found in a beehive. If used properly, these acids are not harmful to the bees and kill mites. Mites cannot build up a resistance against natural acids. Formic acid vapour can kill mites inside the capped brood cells. For this reason it is best used in August when the long-living winter bees have to be formed. A vaporiser is placed one comb apart from the brood nest. In every brood chamber 15 to 20 ml formic acid (60%)

should vaporise lasting at least 10 days. Repeat the treatment after one week. If vaporisers are not available, use a sponge tissue 0.5 x 20 x 20 cm. As this is less effective, the treatment has to be repeated 3 to 4 times. Use of formic acid should not be done when day temperatures are above 25°C and night temperatures below 5°C. When using the sponge tissue the night temperature should not drop below 12°C.

Oxalic and lactic acid are only effective if the colony has no brood. The solutions must be sprayed directly on the bees. Oxalic acid 3 ml per side of the comb and lactic acid 5 ml per side of the comb. Night temperatures should preferably not be below 5°C during treatment. Oxalic acid can also be used as a vapour and as a solution in sugar syrup. Organic acids can damage human skin, eyes and lungs, so use protective clothing during treatment and do not inhale the fumes.

It is possible to combat the *Varroa* mite without using chemicals if drone combs with open brood or eggs are given to colonies with no brood during swarm time. A description of the method is given by Calis et al. in *Apiacta* 32: 65-71 (see Further reading).

### **10.3 Wax moth**

The pest second in nuisance value to the *Varroa* mite is the wax moth. Several species are known, but the most common is the greater wax moth *Galleria mellonella*. The larvae of the moth feed on the unprotected combs, larval skins in the cells, pollen and honey. Warm conditions favour the development of the wax moth. This makes unprotected combs especially in (sub) tropical areas prone to attack. Declining bee populations during dearth periods leave combs unprotected when the moth larvae can destroy the combs within weeks. Weak colonies will abscond because of the constant disturbance and attack by the growing population of wax moth larvae.

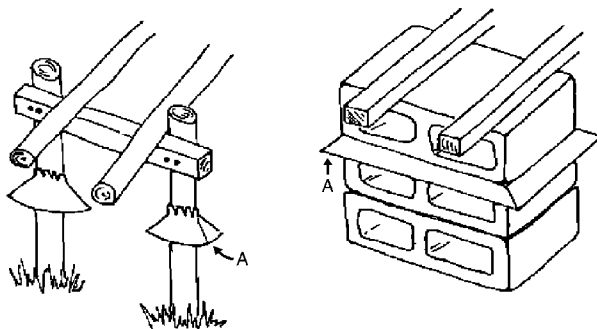
In warm climates empty combs can best be stored above strong colonies or, if available, open places in a constant wind. If these conditions

cannot be met it is often better to render the combs into pure wax than store them.

Freezing temperatures in temperate climates kill all exposed stages of the moth. Empty combs stored in the open air will stay free of moths. If combs are stored protected from freezing temperatures the combs can be protected from the moth by creating an environment of fumes of formic acid, glacial acetic acid or para-dichlorobenzene in a hermetically closed compartment.

## 10.4 Ants and termites

Ants try to rob the bees from their supplies or eat the bees. Termites often damage the wooden materials of the bee stand. Both pests often disturb colonies so much that the bees abscond. Provide a barrier between the ground and the hives to prevent these pests reaching the hives and the supports. See figure 38.



*Figure 38: Elevated and protected bee stand; A = greased caps*

Make sure that no weeds, which could form a bridge for the ants to reach the hives and their support ledgers, grow around the bee stands. Regular weeding is therefore necessary. As weeding can upset the bees, it is better to take the necessary precautions when preparing the apiary. A spacious roof over the apiary usually suffices to prevent strong weed growth.

The columns on which the ledgers rest are best made of stone or steel. If placed in a basin of water or oil the basin should be covered and regularly checked and filled if necessary. Grease caps between the ledgers and the columns can also be very effective if the grease is regularly prevented from drying out or completely renewed. You can also place old rubber mats or linoleum under the hive stands.

## **10.5 American Foul Brood (AFB)**

The cause of American Foul Brood (AFB) is the bacteria *Bacillus larvae*. The disease can be identified when brood cell cappings are sunken and are perforated. The spores of *Bacillus larvae* can initiate the disease after digestion by bee larvae. Only young larvae are susceptible. The spores remain viable indefinitely on beekeeping equipment. The disease spreads from colony to colony by robbing and drifting bees, by beekeepers' practices and by contaminated tools.

### **Treatment when diseased**

If you notice that a colony is developing AFB this colony should be isolated from other hives immediately. The affected frames can best be burned to avoid robber bees carrying the spores to other colonies. Then strengthen the colony with healthy closed brood frames. Mix Terramycin powder with powdered sugar and dust this mixture on the ends of the top bars. Do not apply the dust to the face of the brood combs as this can kill open brood. Strong colonies can overcome AFB infection.

When a colony is badly affected no cure will help. All frames should then be burned and the hive and used tools rinsed with hot soapy water and dried in the sun. The hive should be scorched afterwards.

### **Preventive treatment**

If AFB is not seen in the colonies of the apiary it is better not to use any preventive medication. A good precaution is to replace the old black combs regularly with new ones.

If you suspect that AFB is lurking in the apiary, Terramycin should be mixed with the sugar syrup for the spring feeding. Terramycin is not very stable in syrup and may also contaminate the future honey harvest. For this reason all honey above the brood nest should be removed or not harvested. Whenever traces of antibiotics are encountered in exported honey, all honey export from that country will be banned. Stop feeding at least one month before the honey flow starts. Other brood diseases like ‘European Foulbrood (EF)’ and ‘sac-brood (SB)’ are less contagious and less dangerous for the colony. EF can be controlled similar to AFB.

Sac-brood is a virus disease easily overcome by *Apis mellifera*. However, in *Apis cerana* it can become epidemiologically related to the genetic background of the strain. In this case continue beekeeping only with queens from strains that do not show signs of the disease.

## 10.6 Chalk brood

This disease is easily identified: mummies of bee larvae in cells of the brood nest, in front of the hive entrance and on the bottom board. The disease is caused by the fungus *Ascosphaera apis*. The disease is mostly encountered in the spring. Robust colonies easily overcome an infection.

Fungus growth is favoured by humidity and weakness of the colony.

Humidity is caused by:

- High rainfall in spring
- Humid interior of the hives
- Hives in humid places
- Narrow flight openings

Weak colonies are caused by:

- Disruption of the balance between brood and adult bees
- An old queen
- Other diseases first weakening the colony



## Preventive treatment

- Provide good scope for ventilation and a wide-open flight entrance.
- Interior of the hive should be dry.
- Hives should be at least 0.50 m above humid soil.
- Work only with strong colonies.
- Strengthen weak colonies or unite weak colonies with other colonies.
- Regularly renew old combs.
- In sedentary apiaries, where colonies stay all year round, the soil in front of the hives should be turned over and chalked annually.

## Treatment when diseased

There is no available chemical agent to control chalk brood. Sometimes beekeepers use antibiotics as a preventive treatment. However antibiotics can only treat bacteria and not fungi. If the disease is severe and cannot be cured by strengthening the colony before a good honey flow, the best treatment is to burn the bees and combs, disinfect the hive and dry it in the sun. If most of the colonies are regularly severely affected the genetic background of the bees might play a role. Re-queen the colonies with queens from a chalk brood-free stand.

## 10.7 Nosema

This disease is caused by the protozoa, *Nosema apis*, and only affects *Apis mellifera*. It is a disease of the intestines of adult bees. Adult bees are infected if they swallow spores of the protozoa. The spores germinate quickly and the vegetative stage enters the epithelial cells in the walls of the intestines. In these cells new spores are formed. The disease is usually diagnosed when the colonies show signs of diarrhoea. Probably beekeepers do not detect it in less severe stages of incidence because good pollen flows suppress the visible signs of the disease. However, the life span of infected bees is reduced considerably, infected nurse bees are much less able to feed brood and infected queens are less able to lay eggs. It means that slow development of colonies in spring and loss of queens and regular superseding are often signs of nosema infection. Infection peaks occur in the autumn when brood

rearing is reduced and in late winter or early spring after a long period of confinement. Infected colonies are not able to provide the beekeeper with a good honey harvest.

### **Preventive treatment**

- Choose an airy apiary site protected from prevailing winds.
- Provide enough long-living winterbees and a young prolific queen.
- Abundant pollen and food stores.
- Regularly renew combs.
- Keep beekeeping equipment and empty combs clean by fumigation with acetic acid. Stack hive bodies with combs and equipment. Place a pad of absorbent material and 50 ml glacial acetic acid in every hive body. Seal the stacked hive bodies to avoid escape of the fumes. Leave this undisturbed for one week.
- Scrub the bottom board with hot soda water.

### **Treatment when diseased**

When colonies are diseased, it is absolutely vital to avoid taking the disease to other colonies. Hiving the colony over to decontaminated equipment only leads to more contaminated equipment. First bring the disease to a low level before transferring the colony to decontaminated equipment.

- Bring the colony over on decontaminated equipment without their supplies.
- Feed the bees sugar syrup (2 to 1) with a dose of 30 mg active component fumagillin per litre.
- Feed the bees with decontaminated pollen, soy flour or other pollen substitutes.
- Melt down the contaminated combs and decontaminate the equipment the bees came from.

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**Beekeeping in Asia.** FAO Agricultural Services Bulletin no. 68/4, 1987. 112 pp. ISBN 92-5-102518-5

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**Beekeeping in India.** Singh, S., 1962. India Council of Agriculture Research, New Delhi-Publications. 214 pp.

**Beekeeping in the tropics.** Smith, F. G. Longmans, London, 1960. 265 pp. ISBN 0-907908-73-X

# Useful addresses

## Internet sources

**www.beekeeping.com** : virtual beekeeping gallery in four languages; displays a vast range of internet links

**www.fao.org** displays accessible publications and a range of pictures on beekeeping and honey

## Organisations

### **Trichilia ABC**

Noordermeerweg 65 cd

NL - 8313 PX Rutten

THE NETHERLANDS

Tel: +31-(0)527 - 262598

Fax: +31-(0)527 - 2621171

marieke.mutsaers@planet.nl

[www.trichilia.nl](http://www.trichilia.nl)

### **International Bee Research Association**

18 North Road

Cardiff CF 10 3DT

UNITED KINGDOM

Tel: +44 (0) 29 2037 2409

Fax: +44 (0) 29 2066 5522

info@ibra.org.uk

[www.ibra.org.uk](http://www.ibra.org.uk)

**Bees for Development** (+ quarterly *Bees for Development* journal)  
(yearly subscription : ca 35,=)

Troy - Monmouth NP25 4AB

UNITED KINGDOM

Contact: Dr Nicola Bradbear

Tel: +44 (0) 1600 713648

Fax: +44 (0) 1600 716167

info@beesfordevelopment.org

[www.beesfordevelopment.org](http://www.beesfordevelopment.org)

## **NECTAR**

P.O. Box 8030

6710 AW Ede

THE NETHERLANDS

[nectar@wxs.nl](mailto:nectar@wxs.nl) [www.xs4all.nl/~jtemp/nectar\\_index.htm](http://www.xs4all.nl/~jtemp/nectar_index.htm)

The Netherlands Expertise Centre for (sub)Tropical Apicultural Resources is the association of tropical bee-keeping experts in the Netherlands. Members of NECTAR have practical, worldwide, working experience in beekeeping with different bee species and are able to advise on a wide range of topics in (sub)tropical beekeeping.

### Objectives:

- coordinate support to and centralise expertise on (sub)tropical beekeeping in the Netherlands;
- answer questions and give advice on (sub)tropical beekeeping activities to interested parties;
- establish a reference network on (sub)tropical beekeeping that is intended for professional use;
- make expertise available on specific topics by organising seminars and publish the proceedings;
- advise development organisations concerning: beekeeping projects
- emphasise the importance of socio-economic aspects and research in beekeeping development.

# Glossary

This glossary aims to explain some of the beekeeping terms used in this book. Subjects of chapters or sections are not mentioned. It is hence not a comprehensive list of definitions.

*Table 7: Glossary of beekeeping terms used in this volume*

Term	Section	Explanation
alarm pheromone	2.2	natural biochemical (smell) that bees use to attract other bees to defend against an attack
bait hive	3.1	small box or hive meant to collect a swarm
bee dance	3.1	the event of forage bees communicating to other bees the position of new forage area or of a suitable hive
dearth (period of scarcity)	3.5; 4.4; 6.2	period when little or no forage is available for bees, due to rain, drought or time of year
decreasing season	6.1	seasonal decrease in nectar flow
extraction percentage	4.7; 6.3; 7	percentage of the comb weight that is extracted as honey
fat combs	6.1; 6.3	these are extra thick combs containing a lot of honey
forage area	1; 4.7	vegetation food source of bees (for nectar, pollen and propolis), either wild or cultivated flowers (crops) or both
forager bee or field bee	2.2; 3.5	worker bee of 21 days old or older that collects nectar, pollen, water and propolis
honey bee	1	common name for <i>Apis mellifera</i> ('honey bearer'), a highly social insect, living in colonies
honey flow	3.3; 3.5; 4.5; 4.7	period when enough nectar-bearing plants are blooming for bees to store a surplus of honey
mating flight	2.1; 2.2; 3.2; 3.6	the flight taken by a virgin queen while she mates in the air with several drones
monosaccharides	2.2	simple sugars, of which honey consists up to 80%; e.g. glucose and fructose
pollination (cross-, self-)	1	transfer of pollen from male parts to female parts of flower, leading to fertilisation
queen cell	2.1; 3.2; 3.5; 3.6	special elongated cell resembling a peanut shell in which the queen is reared; usually over an inch in length, hanging vertically from the comb
royal jelly		3.4; 3.6; 9
scout bee	2.2; 3.1; 3.5	worker bee that searches for new food sources, or a new home for a swarm of bees
seasonal management	6	method by which management of bee colonies is determined by season, also anticipating the following season

<b>Term</b>	<b>Section</b>	<b>Explanation</b>
seasonal migration	3.6	movement of bee colonies from one location to another during a single season to take advantage of several honey flows (natural migration by bee swarm; hive migration by beekeeper)
stingless bee	1	honey collecting bee living in colonies, but without stinger
supersedure (or: supercedure)	3.6	The process in which a bee colony replaces an old laying queen bee by a new queen without swarming.
upgoing season	6.1	seasonal increase in nectar flow
wax glands	8	eight glands located on abdominal segments of young worker bees that secrete beeswax droplets into transparent wax scales