

Agrodok 32

Beekeeping in the tropics

P. Segeren

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Foreword

You can keep bees as an interesting hobby, or as a main or an extra source of income. This booklet mainly provides information on how to work with honey-bees that nest in cavities. In most of the world regions this will be the European bee *Apis mellifera*, but in large parts of (sub)tropical Asia the quite similar species *A. cerana* is mainly used. 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 recommended to work with an experienced beekeeper for at least one year. The finer skills of this occupation can only be learnt from experience.

You can obtain information from your Ministry of Agriculture or Forestry. In many cases this Ministry has a Department of Apiculture, which organises demonstrations and courses, offers assistance and sometimes also provides bee colonies.

If you want to improve beekeeping in your area, start with the existing local methods and try to improve these step by step instead of introducing an entirely new method.

This booklet therefore stresses the importance of starting at the local level and to experience the profits beekeeping might offer. Low input techniques, implying the use of local bees, local knowledge and local material can be the basis of a successful development of beekeeping for individuals as well as large scale programmes.

The Authors

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1 The value of beekeeping

1.1 Honey

Honey consists mostly (\pm 80%) of sugars that are readily absorbed by the body. It is therefore an extremely suitable food for children, sick people and those who perform heavy manual labour.

- it can be used as a sweetener for food and drink.
- it can be used to treat superficial wounds and throat complaints.
- it is a pleasant-tasting food and an effective medicine.
- it has a high economic value and is therefore a good trade commodity.

In 1984 world honey exports totalled 270,000 tonnes, of which 60% came from the tropics. Prices varied between US \$ 0.7 and 2.5 per kg. However, local prices are usually much higher, sometimes even up to 10 times world market prices. The honey yield depends largely on the climate, vegetation, bee race and the skills of the beekeeper. In view of these conditions beekeepers might, according to their income level and skills, choose from the following possibilities:

- having a few colonies around the house.
- seasonal migration of the colonies to different forage areas.
- beekeeping as a part-time activity.
- full-time professional beekeeping.

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

In many countries honey is used to make beer, which can be healthy if not used in too large quantities. It can be preserved and sold.

1.2 Wax

Wax is used in the manufacture of cosmetics, candles, foundation sheets (for hives), medicines, polishes, etc. There is a good and very

stable market for beeswax. In 1990 World market prices varied between US \$ 2 and 3 per kg.

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

See Appendix 2 for uses of beeswax.

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

continent	Average annual yield	continent	Average annual yield
Europe	11 kg	Oceania	39 kg
USSR	24 kg	Asia*	18 kg
N. America	24 kg	Africa	8 kg
C. America	25 kg	*Both <i>A.cerana</i> and <i>A.mellifera</i> colonies	
S. America	14 kg		

1.3 Pollen and Propolis

With a simple trap at the flight entrance of the hive you can harvest the pollen collected by the bees.

Bees gather an average of 100 to 200 g of pollen per colony per day: 30 to 50 kg per year! You should, of course, only collect a part of this so that you do not seriously inhibit the development of the colony.

Pollen can contain up to 35% protein. It can be eaten dry or added to other foods. Pollen is sold to the perfume industry and nowadays also for consumption.

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. *A.cerana* does not collect propolis.

Pollen must be protected against moisture. It attracts water (hygroscopic) and deteriorates quickly when attacked by fungi. Try to dry pollen in hot weather by spreading it in a thin layer in the shade where a breeze is felt. Store pollen in airtight earthenware pots or closed bottles. Well dried pollen should crack between your teeth like rice.

1.4 Pollination

The greatest 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 she will encourage her hivemates to use this source. The bees will visit these flowers as long as food (pollen and nectar) is available. This flower constancy makes bees exceptionally valuable to plants which need 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. However, in many tropical regions farmers are still unaware of the beneficial effect of bees to their crops.

The importance of pollination by bees has been demonstrated for the following plant species:

Almond	Apple	Apricot	Aubergine
Avocado	Beans	Berries	Cashew
Cherry	Citrus spp	Clover	Coconut
Coffee	Guava	Gourds	Longan
Lychee	Mango	Melon	Mustardseed
Papaya	Passion fruit	Peach	Pear
Plum	Pyrethrum	Rambutan	Rapeseed
Sesame	Sunflower	Tomato	

2 Species and races of bees

Apis mellifera

This honey-bee is the most widespread economic species. It is native in Europe, the near and middle East of Asia and Africa. There are about 25 races, of which the most important are:

A.m.ligustica

known as the Italian bee. This race is very adaptable to different environments.

A.m.intermissa

native to the north coast of Africa, a black race suited to these dry zones.

A.m.adasonii

native to coastal West Africa, and *A.m.scutellata*, native to Central and Eastern Africa: both of these species have a very pronounced, defensive behaviour and are prone to swarming and absconding (meaning: the entire colony leaves the old hive).

A.mellifera bees

have been introduced in many other tropical regions. In the Americas initially European *A.mellifera* was introduced, but some decades ago the African *mellifera* was imported into Brazil and quickly spread all over tropical S.America where it is now known as the African bee. This bee is now moving north and has reached the USA. Its very dominant defensive behaviour and tendency to quick swarming has made beekeeping more complicated in these areas. One implication is that colonies should be kept away from houses and roads where people live or pass.

Apis cerana

This Asian bee is quite similar to *A.mellifera* as it also nests in cavities, such as hives. Similar types of beekeeping can be done with both

species. However, there are also important differences, especially in biology and behaviour. The most productive race is *A.cerana cerana* in China, least productive with much smaller colonies is *A.cerana indica* in India and South East Asia and *A. cerana javana*.

It is useful to know that tropical *A.mellifera* and *A.cerana* races are smaller than European *A.mellifera*. In most literature, however, the European *A.mellifera* is referred to. It is therefore important to note, when you read the descriptions of dimensions of hives, frames, queen excluder, foundation sheet (cell size) and width of the comb spacing (natural distance of the combs), the species and the races to which these descriptions refer.

Appendix 1 gives a list with some of these specific dimensions.

Other bee species

Two other *Apis* species are found in Asia south of the Himalayas and China:

A.dorsata

the rock bee, with a single comb-nest built on rock or a branch of a tree.

A.florea

the dwarf bee, which builds a small single comb-nest around a twig of a shrub or a tree.

In Asia *A.dorsata* has been the most important honey and wax producer. Nests are mainly exploited by so-called honey hunters and honey collectors. Domestication of these bees does not seem possible. Stingless bees (e.g. *Melipona* and *Trigona* species) can be found all over the tropics. They usually live in small colonies in cavities. In Central and South America there is an old tradition of “meliponiculture”. Some species are kept in logs, man-made, boxes or clay pots. Yields per colony are small: 1-4 litres per year, but they can be kept in high numbers and the honey yields high prices compared with *A.mellifera* honey.

These bees cannot sting, but some defend their nest by biting with their strong jaws. Nests are usually built with extensive use of resins, clay and wax. Beekeeping with stingless bees is very different from beekeeping with honey-bees because of their different biology, e.g. nest architecture.

This book deals exclusively with beekeeping of honey-bees (apiculture).

3 Composition of the colony

In a bee colony there are two female castes: the queen and the worker, and males: the drones (figure 1).

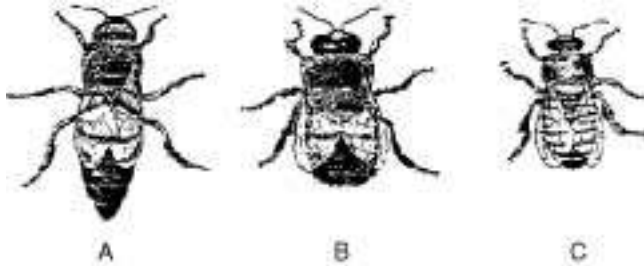


Figure 1: Queen (A), drone (B) and worker (C).

3.1 The Queen

The queen can be recognised by her long abdomen which 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. There is only one queen in each bee colony. As soon as there is a second queen there will be a fight which ends with the death of one of the queens, usually the oldest (weakest). The queen is usually the only female which lays eggs. Because a queen produces the most eggs in the first year of her life the best queens are not more than 2 years old. The maximum egg production is 3000 for the western honeybee and 800 for the eastern honey-bee.

Before the queen starts laying eggs she makes a nuptial flight. For this purpose she is driven outside by the worker bees some days after the new hive has been occupied. While in flight she mates with about ten drones. The spermatozoids which she has obtained from the matings are stored and kept alive in a special reservoir (spermatheca) in her abdomen. As long as there are spermatozoids in this reservoir (with successful matings this can be for 3 - 5 years) the queen can lay fertilised eggs.

Fertilized eggs develop into females, queens or worker bees. Unfertilized eggs which are laid in larger horizontal cells will produce drones. Some days after the nuptial flight the queen begins to lay eggs.

Fertilised eggs are laid in the small six-sided horizontal worker cells and in the round hanging queen cells (figure 2).

The queen cannot collect any food herself and therefore has to be fed with a special food from the head glands of the workers. The queen has a thick, curved sting with which she can kill other queens.

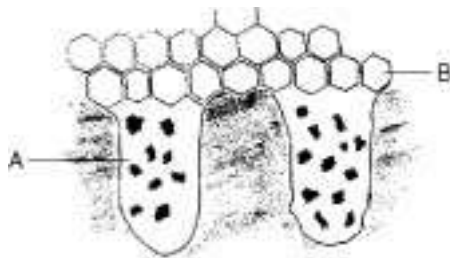


Figure 2: Part of comb. A: queen cell; B: worker cell.

3.2 The workers

A large colony can consist of more than 50,000 workers. Viewed from the front the worker has a triangular shape. The tips of her wings in the rest position cover the end of her abdomen. One segment of her hind legs bears two rows of long hairs between which the pollen is carried. The pollen that covers the bee's body after her visit to a flower is stored and transported in these baskets. She uses the brushes on her legs to clean the body and to push the pollen into the baskets.

The pollen collectors empty the contents of their baskets into the cells of the comb surrounding the brood cell area.

The extended mouthparts together form a tube through which the nectar can be sucked up. The bee transports the nectar in her nectar sac and when she has returned to the colony she passes the contents of this sac to another bee. After the nectar has been passed several times from bee to bee, it is stored in a cell of the comb. During this processing of the nectar the water evaporates and enzymes are added to it which convert complex sugars to easily absorbed simple sugars (glucose and

fructose). When the honey is sufficiently concentrated the cell is closed with a wax capping (sealed honey).

The workers are equipped with a straight, slender sting which is 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 sting. When a bee stings a warm-blooded animal (including man) the sting cannot be withdrawn because of the barbs on the lancets and stiletto. The sting apparatus and the venom sac break off when the bee tries to escape and shortly after stinging the bee dies from the damage to its abdomen. If a bee stings you, first kill it because the behaviour of this bee will incite other bees to sting too. Then quickly scrape the sting from your skin with a clean nail or another sharp object. Do not pull it out between finger and thumb, because you will force even more venom into your skin.

The younger house bees work within the colony. Depending on the needs of the colony, they perform the following tasks:

- Cleaning the cells and removing debris and dead bees from the bottom of the hive.
- Feeding the queen, the drones and the larvae which have hatched out of the eggs. This food contains some nectar. The other food component is brood food. This protein-rich product is made in the head glands of the workers. The nurse bees can only produce this food when they are able to consume enough pollen stored in the comb. 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. Within six days a larva increases its weight 1500 times.
- Guarding the flight entrance of the colony.
- Maintaining the temperature of the brood combs (35 °C).
- Heat is produced by vibrating the thoracic muscles.
- Producing wax, building combs and sealing the honey and brood cells.

- The wax is made in the wax glands and is passed out 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.
- 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. The field bee gets to know the position of all kinds of objects such as a tree, a bush, a house etc. and can therefore always find her way back home. Foragers (field bees) can visit an area with a radius of about 3 km. In practice this means that:

- a bee colony cannot be moved at random. The field bees would return to the old site of the colony. If you want to move the colony a small distance, then 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, i.e. at a distance of 5 to 6 km, for three weeks, after which time the foragers will have died. Then the colony can be put back in any 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, as she orients herself when flying out on the first mating flight.
- a swarm orients itself on the site of its new home. If the swarm loses its queen, however, the bees will return to their original place.

The bees can either find sources of food on their own (scout bees) or learn about these from other forage bees through the 'bee dance'. These sources of food are plants which produce pollen or nectar. Bees need to be able to gather not only food but also water (mainly to regulate the temperature of the hive). If the bees cannot gather water you must provide them with drinking basins. Put stones in the basins so that the bees do not drown. Bees collect propolis from leaf buds etc. and use it to seal small openings in the hive. The division of labour of the workers described above 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 (winter, the rainy season) when there is no brood (temperate climate) or little brood (tropical climate) this life span is many times longer (up to 6 months).

3.3 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 sting. They cannot collect any food and are fed by the workers. Their task is to mate with a young queen. They die immediately after mating as the male genitals break off at mating, damaging the abdomen.

If there is a shortage of food in the colony the drones are no longer fed and after a while they are dragged out of the hive. On the other hand, when much drone brood is present in a colony, it may swarm within a short time.

4 The daily life of a colony

4.1 The swarm

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

A few bees of the swarm cluster, the scout bees, fly out to look for a new home. Should they have discovered and approved of your hive, the position of the hive is communicated to the bees of the swarm cluster by means of the bee dance.

Should there be no other attractive homes, 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 fresh honey to attract swarms. Once a bait hive has attracted a swarm then 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 the mating flights.

4.2 The development of the bee

The eggs hatch after three days; the larval stage lasts for about 5 days. During this period the nurse bees provide the larvae in the open cells regularly 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 pupa. The capped phase of the worker brood lasts about 12 days. Then the bee which has developed from the pupa gnaws away the wax capping and appears on the comb. The newly emerged light-grey bees are easy to recognize. The drones take the longest to develop. The 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. It is important for the beekeeper to know that after a hive has lost its queen he can expect the birth of a young queen after about 13 days.

Table 2: The approximate development phase in days of different stages of European A.mellifera races.

	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 African *A.mellifera* races and *A.cerana* races may be one day shorter.

4.3 The development of the colony

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

The queen usually begins to lay eggs on a comb and continues egg laying on the combs 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 (figure 3).

As soon as the capped brood in the centre emerges the cells are cleaned by the youngest bees and the queen again lays eggs in these cells. Around the brood nest we find cells filled with pollen. This means that the combs bordering on the left and the right of the brood nest are sometimes filled mainly with pollen. This pollen is eaten by the young bees. The cells that become empty are either again filled with pollen, or the queen lays eggs in them. 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 comb of the brood nest. You will find that in a period of strong honeyflow the area available for the brood nest will become too small. You can expand the brood nest by placing a chamber with empty combs under the brood nest.

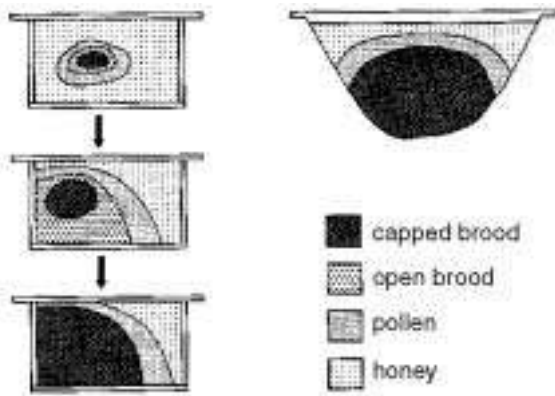


Figure 3: Frame from a brood nest at three consecutive stages in the season (left) and of a top bar hive (right).

4.4 Swarming

Even before a colony has reached its maximum size it can, in the presence of the old queen, raise new queens and the colony can split itself into groups with one queen each. The propagation of a bee colony is therefore called social reproduction.

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. Too little space in the brood nest, thus limiting the number of eggs that can be laid by the queen, is often given as an important cause.

While you will at first find only worker brood in a growing brood nest, drone brood will usually make its appearance before the swarming period.

Preparation for swarming starts with the building of “swarm cups”. These are short bowl-shaped cells which have their openings facing downwards. These swarm cups are usually found at the bottom edge, 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 the 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 (royal jelly). The reason why this fertilised egg produces a queen and not a worker is apparently the result of the amount and composition of the food offered to the larvae.

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 this moment the colony is swarming and thousands of bees will circle in the air.

A swarm usually looks for a resting place in the close environment of the hive. If the scout bees do not find a suitable nesting place, the swarm leaves. Swarms with a young queen usually travel long distances. About one week after the departure of the first swarm (with the old queen), the first young queens emerge. The young queen on the comb produces a piping sound. The young queens which 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.

Three possible situations can now arise:

- 1 The 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. The swarm is divided afterwards. You can see that this is the case when the swarm chooses a resting place; the bees form two connected clusters instead of one.
- 2 The young queen kills the sister queens which are still in the queen cells. There is no further swarming.

- 3 Several queens emerge at the same time. After a fight on the comb, only one stays alive; no further swarming occurs.

The result is that in the end only one queen remains in this hive.

Complications: 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.

4.5 Absconding from the hive

Occasionally an entire colony leaves the hive, abandoning the brood nest. 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 (the cluster of bees is then, incorrectly, called a “hunger swarm”), or reduction in the honeyflow. *Apis cerana indica* and *A.mellifera adansonii* will move to find enough food in the mountain areas and the plains, and the reverse, every year (seasonal migration).
- 2 Disturbance of the colony, either by ants, wasps, termites or even the beekeeper.
- 3 Bad management by the beekeeper: especially in movable comb beekeeping the beekeepers might provide unsuitable hives (too big, too humid, bad smell) unsuitable places (too much shade, indoor hives, no shelter from rain or excessive heat, exposed all day to the sun). Beekeepers might have ignored the correct comb spacing by positioning combs too widely or too narrowly spaced. (see Appendix 1 for correct measures). Contrary to European *A.mellifera*, both *A.cerana* and tropical *A.mellifera* are much more prone to absconding. This characteristic behaviour makes it possible for colonies to escape sudden dearth periods by migration to better forage areas.

4.6 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.

Signs of loss of the queen are:

- the bees are restless.
- emergency queen cells are built on a number of worker cells with 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 that are younger than three days old. A failing queen can be replaced by the colony. Mostly at the end of the honeyflow the bees will build one or a few supersedure cells.

Should the young queen be lost during the mating flight (e.g. be eaten by a bird) there will be no brood in the colony and no new queens can be raised. The colony is irrevocably without a queen (there is no natural solution) and the colony will die. In extended periods without a queen (when there are no emergency queen cells) the 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 (5-10). These eggs are not only laid at the bottom but also on the walls of the cells. Workers prefer to lay eggs in the wider drone cells. The bulging cell caps will tell you that drones are developing in worker cells. Usually such colonies are more aggressive.

Both in *A.cerana* and in *A.mellifera capensis* the ovarioles of some workers are activated immediately after the loss of the queen. These workers start to lay eggs and no queen cells may be built.

Solutions: When there is no queen, remove all emergency queen cells except 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 which does have

a laying queen. In cases of irrevocable loss of the queen provide a frame with eggs or young larvae (for building emergency queen cells) from another colony with a queen. If there are laying workers shake all bees off the combs some meters in front of the hive. The bees will return to the hive and the laying workers that are unable to fly will remain behind. Then you should either give the colony brood (for the building of emergency queen cells), introduce a queen, or combine the colony with a colony with a queen.

5 The practice of beekeeping

5.1 Some basic characteristics of bees

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 (figure 4).

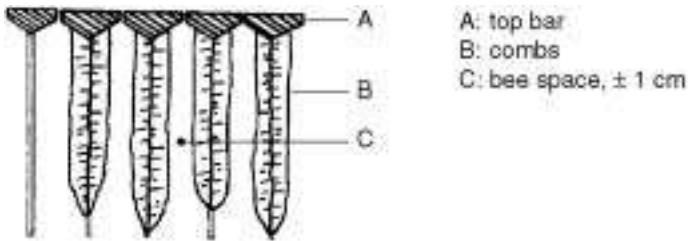


Figure 4: Cross section of top bars and combs.

It is very important in movable comb beekeeping to know that this bee space as well as the comb spacing (i.e. the distance between the centres of adjacent combs) is always fixed for colonies of the same bee race, but slightly varying between the races.

In general it can be said that the smaller the bee race (species) the smaller the bee space, comb spacing, cell size and nest volume will be.

Bees need sufficient pollen and nectar sources: flowering plants.

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.

In case these elementary 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).

N.B.: Remember these basic characteristics in all your work with bees.

5.2 Handling bees

The beekeeper should take into account the fact 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 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. Especially if you work with the more defensive kinds of bees, e.g. in Africa and South America, always first blow some smoke into the flight entrance. Then lift the cover, blow some smoke into the hive and close the hive again for a short while (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 (see also: Setting up the apiary).

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 sting. You should especially avoid banging against the hive.

If you have been stung you must first kill the bee which has stung you and then scrape the sting out of your skin with a finger nail 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 re-

act violently to a bee sting (perspiration, dizziness) it is advisable to stop keeping bees. Fortunately this reaction seldom occurs (1 out of 5000 people), but if it does occur then go to a doctor immediately.

5.3 Beehives

Beehives are hollow containers that can be closed and are purpose 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.

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 way of bee-keeping. 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.

5.4 Fixed comb hives

These can be made from a hollow log (figure 5), a wooden box, 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 and sides of the hive. The honey can be removed only removing one wall of the hive and breaking or cutting out the honey combs.

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, or covered with a layer of mud.
- the colony is not constantly disturbed by a beekeeper.

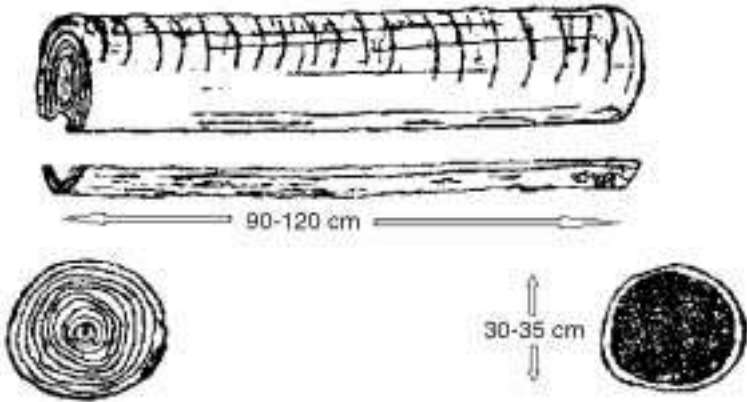


Figure 5: A log hive.

Disadvantages:

- 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.

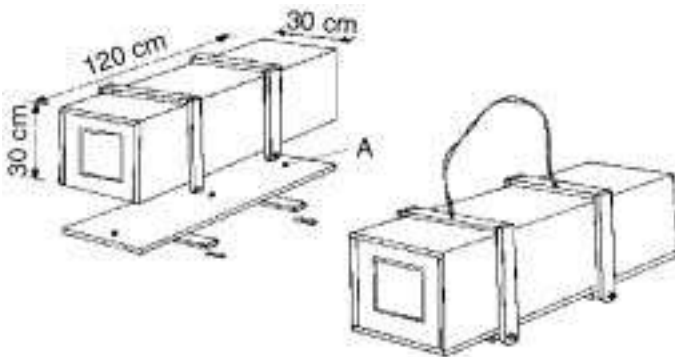


Figure 6: Beehive, box model (Kenya). A: flight entrance, $\varnothing = 9$ mm.

Better versions of fixed comb hives have one or more removable boards, allowing inspection from one or more sides of the hive (figure 6). This also allows you to break out only those combs which 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. The same principle is used in the Kenya box hive (figure 6).

Paraffin tins can also be used as hives. One side is sawn off (figure 7a). These tins must be protected from excessive heating or cooling by wrapping a layer of straw or similar material around them (figure 7b).

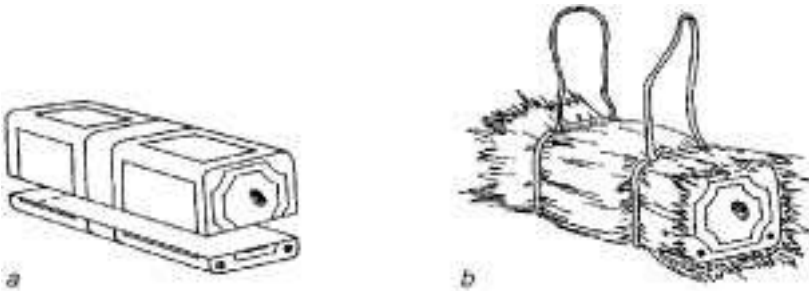


Figure 7: a: Beehive made from a paraffin tin.
b: Insulated against heat.

5.5 Beehives with movable combs (top bar hives)

These types of hives are used in some regions of tropical Africa for *A.mellifera* (Kenya, Tanzania, Botswana, Ghana) and in parts of Asia for *A.cerana* (Nepal, Vietnam).

Kenya top bar hive (figure 8).

A long trough-shaped box with sloping side walls (forming an angle of 115° with the floor) is covered with bars of a fixed width. You can also use round sticks instead of bars, as long as the spacing between the sticks is correct. The advantage of using adjoining bars is that

when you inspect part of the combs, the rest of the colony remains covered and is therefore not disturbed. The bees will build a comb on each of the bars, especially if somebody helps them by melting a piece of comb a few centimetres long to the underside of the bar, or dipping the underside of the bar in molten wax. The remarkable feature of this kind of hive is that the bees do not attach the combs to the sloping side walls, a bee space is left free. The centre to centre distance of top bars should be the same as the comb spacing, which is specific for every bee race. In appendix 1 you can find comb spacings for some bee races of *A.mellifera* and *A.cerana*.

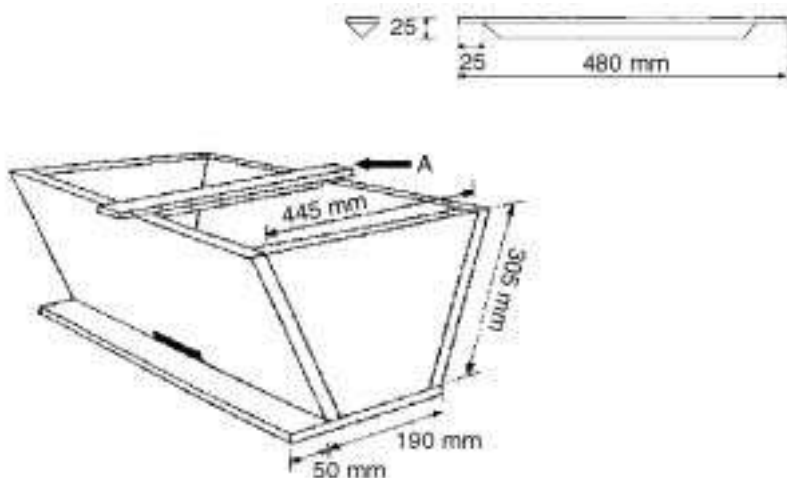


Figure 8: Top bar hive (Kenya). A: top bar.

If you use round sticks these should be placed at similar distances (measuring from the centre of the sticks). If you want to find the distance between combs for the local bees, you can do this by measuring the combs of a colony which has built a natural fixed comb nest.

The hive consists of a bottom board, two side walls and a front and back wall (figure 9). The bottom board can be a little wider than indicated in the drawing. The protruding section can then be used as a

flight board (landing strip) for the bees flying in. Two slits measuring 1×15 cm are made in the front wall to serve as flight entrances.

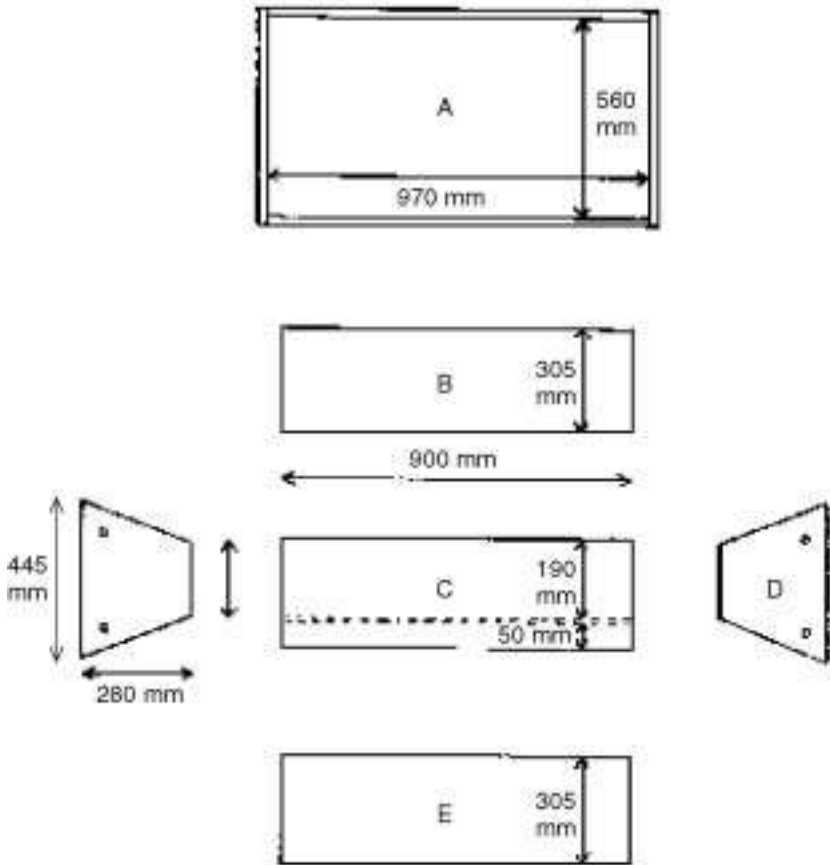


Figure 9: Construction drawing of a Kenyan top bar hive. A: lid; B: back; C: bottom; D: side; E: front.

The cover can be made from any material which gives adequate protection against light, sun and rain. The underside of the bars should be planed down to a V shape. It is extremely important that the bars have the right width, or, where sticks are used, that these are placed at ex-

actly the right distance from each other by means of nails or spacing bars. The bars or sticks should be 48 cm long.

The hive is suspended between two trees or poles with strong wire. This will keep the hive out of the reach of ants, termites and other enemies. Finally the hive should be painted white to protect it against too much heat. You could first treat the wood on the outside of the hive with a preservative (without insecticide!).

The Tanzanian top bar hive

This type is used in other parts of Africa (for instance in Botswana). Unlike the Kenyan type, it has upright side walls, so it is easier to construct. This type can only be used when the bees do not attach the combs to the side walls.

Instead of V shaped top bars you can use rectangular ones, with a hardboard strip hanging down the centre of each top bar. Such a strip should protrude about 1 cm and be soaked in melted wax to make a starter for the bees to build the comb.

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

The advantages of top bar hives over fixed comb hives are:

- 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 to separate the brood combs and the honey combs at one side or both. A queen excluder is a board with openings of a certain width, which allows the worker bees to pass, but not the queen. This enables you to obtain honey-

comb with a little pollen in it, but absolutely no brood (because the queen cannot lay eggs in them).

The advantages of these top-bar hives over hives with frames for the combs are:

- they can be made with other locally available and inexpensive materials.
- the only two dimensions that matter are:
 - 1 the standard length of the top bar in order to change the top bars, within the hive and between different hives.
 - 2 the width of the top bar, which must be the same as the bees natural comb spacing so that they can build combs right below each top bar (see Appendix 1).
- if the combs are used only once, the raw wax hardly needs to be purified. In this case the wax production is high.
- you do not need a centrifugal honey extractor to extract the honey; the honey can be pressed out of the combs.

5.6 Hives with frames

There are various kinds, e.g. WBC, Langstroth, Dadant, Simplex hive etc. It is not the intention to look at all these kinds in detail. The construction of this kind of hive can be explained by using the Langstroth hive and the East African Long hive as examples. The bees build their combs on wax sheet comb starters (foundation sheets) fixed in the wooden frames. A foundation sheet is a 2-3 mm thick layer of beeswax, a little smaller than the inner measures of the frame, on which a pattern of hexagonals (the shape of the bottom of a worker cell) has been imprinted with a press. A foundation sheet is fixed vertically in the middle of the frame. The bees build the cell walls horizontally on both sides of the foundation sheet.

Advantages of a hive with frames:

- combs with brood can be easily separated from combs with honey.

- the combs are firmly anchored in the frames, so the combs can be handled quickly and without breaking. The hives can be transported without the combs breaking off.
- with the frame system the honey can be extracted rapidly with a centrifugal honey extractor, after which the combs can be re-used.
- this is a great advantage if you are mainly interested in the production of honey and not in the production of beeswax. The bees need to produce less wax and can therefore use all their energy for the care of the brood and the collection of food.

Two examples of beehives with frames:

- 1 The Langstroth hive (North and South America, Africa, Australia).
- 2 The East African Longhive (Uganda).

The Langstroth hive

The most important parts are (figure 10):

- a brood chamber with a fixed bottom board and flight board; or a loose bottom board on top of which is placed a bottomless brood chamber. In the bottom board you can leave a ventilation hole of $\pm 15 \times 30$ cm, which is covered with fine wire mesh. The brood chamber holds 10 frames, which are kept separated at the right distance by means of side bars, nails or staples.
- a queen excluder (not absolutely necessary), placed horizontally on top of the brood chamber.
- one or more honey supers with 9 or 10 frames. These are placed on top of the brood chamber or on the queen excluder.
- a top ventilation screen used for ventilation during transport with 2-3 mm mesh wire screen.
- an inner cover 0.5 to 1 cm thick.
- an outer cover made of wood, covered with zinc or aluminium (e.g. old offset plates). This should fit easily 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, so that air can pass underneath.

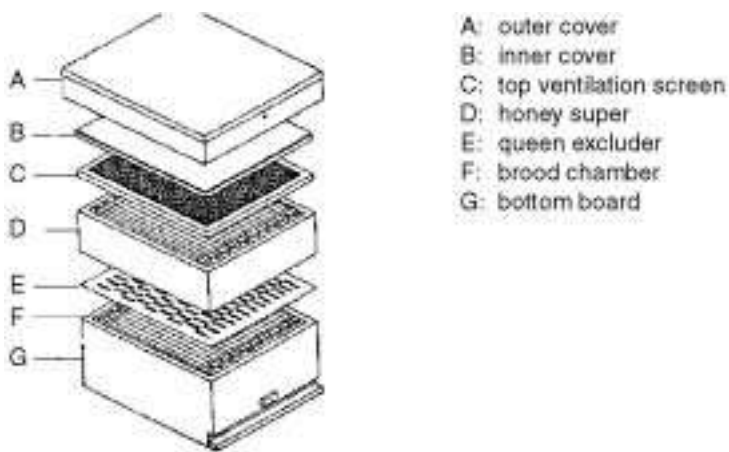


Figure 10: The Langstroth hive.

NOTE : You can also use brood chambers to collect honey instead of using the shallower honey supers. The advantage of this is that you work with only one size of box and frame. The disadvantages of such large honey supers are:

- 1 It takes longer for the honey combs to be sealed. If there are many short honeyflow periods with intervening periods of dearth, a super with large combs may not be well sealed, whereas a smaller one would be.
- 2 a super the size of a brood chamber with 10 combs of sealed honey is very heavy to carry.

See figure 11 for the sizes of the brood chamber, honey super and bottom board. Base the sizes of the brood chamber and honey supers on the size of the frames, so 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. Keep in mind the basic characteristics of bees for which you are building the hive.

For the honey super a similar construction is made. Only the depth of the honey super is not 24.1 cm but only 14.6 cm.

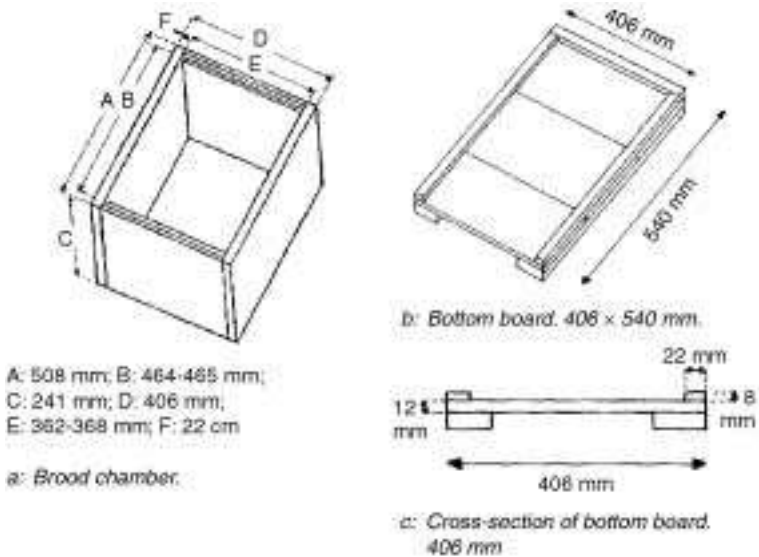


Figure 11: Construction of a Langstroth hive.

Frame

In the brood chamber and honey super hang the frames in which the combs are to be built. A frame consists of: a top bar, 2 side bars and a bottom bar (figure 14). The top bar must extend some distance on both sides of the frame, to form two small handles. The frame hangs by these handles in the indentations made in the front and back walls of the brood chamber and honey super.

There are two ways of keeping the frames at the correct parallel distance from each other i.e. from bar centre to bar centre (figure 13):

- A. By using staples. In both handles, but at opposite sides of the handles, a staple, screw or U-nail is inserted in such a way that it protrudes from each side of the frame (see Appendix 1).
- B. By means of extra wide side bars. These extend on either side of the frame. To ensure that the bees do not glue the side bars to each other too tightly, one side of the bar is bevelled so that the area of contact is as small as possible.

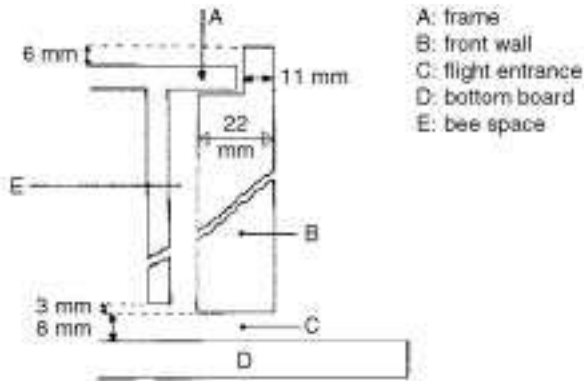


Figure 12: Cross section of a brood chamber of the Langstroth hive.

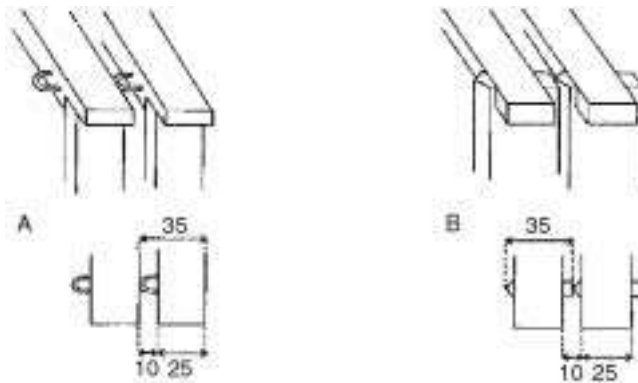
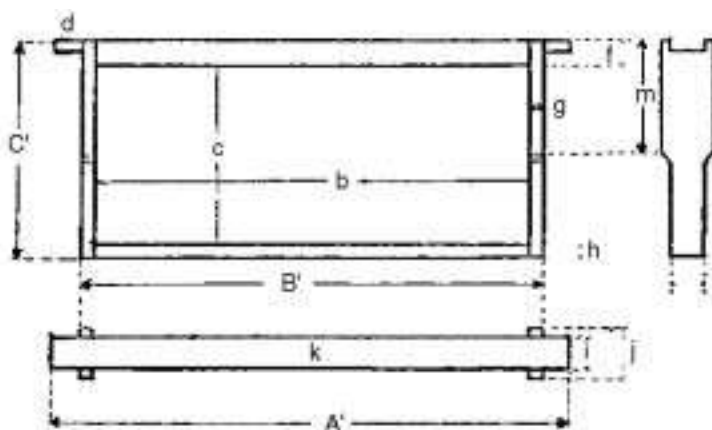


Figure 13: Two ways of keeping the right distance between the frames.

On the underside of the top bar a groove of 2 mm wide and 4 mm deep can be made, into which the foundation sheet is 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 so that there is a gap the size of a bee (1 cm) between it and the bottom board. The bees use the space to walk under and past the frames.



A': 476 or 483 mm	d: 14.3 or 17.5 mm	i: 25 mm
B': 448 mm	e: 9.5 or 11.1 mm	j: 34.9 mm (*32)
b: 429 mm	f: 19.1 mm	k: 28.6 mm
C': 232 mm (**137)	g: 9.5 mm	l: 22.2 mm
c: 206 mm (**114)	h: 6.4 or 9.5 mm	m: 89 mm

* for *adansonii* bees

** sizes of the honey super frame

Figure 14: Sizes of the brood chamber of the Langstroth hive.

The East African Long Hive

Unlike the Langstroth hive, this kind of hive has the honey area next to the brood chamber, and not on top of it (figure 15).

As in the Langstroth hive the frames are hung at right angles to the front of the hive. Both the brood and the honey area will hold 12 frames. The side bars of these frames are 32 mm wide. This hive also consists of a bottom board, either fixed to the hive or not, 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.

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.

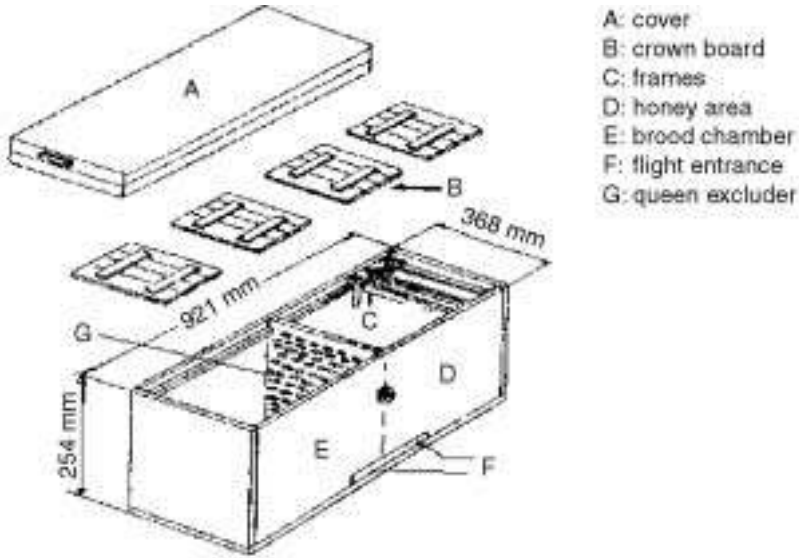


Figure 15: The East African Long Hive.

5.7 Further requirements

Queen excluder

A beekeeper who wants to collect honey, will want his bees to produce honey in separate combs as much as possible, so it makes collecting the honey easier. However, a colony 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. There are two kinds, the perforated grid (a perforated zinc or plastic sheet) and the bar or wire grid (figure 16).

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. The workers, but not the queen, should be able to pass through the excluder. 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 (that is 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.

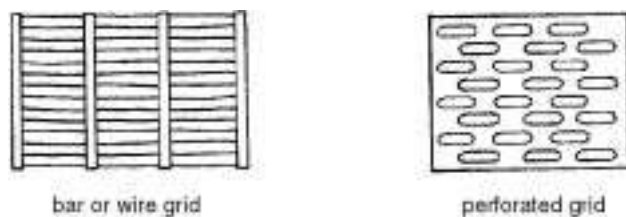


Figure 16: Queen excluders.

Foundation sheet

This consists of a sheet of beeswax (2-3 mm thick) into which a 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. Cell sizes of various bee races are listed in Appendix 1.

Furthermore, the bees need to use less energy to produce wax, which is very advantageous for honey production.

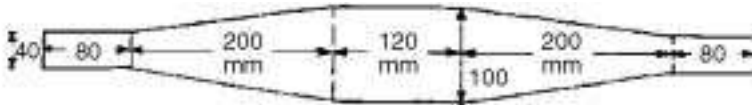
Foundation sheets can be ordered from beekeeping cooperatives or from the Department of Apiculture of the Ministry of Agriculture or Forestry. Foundation sheets are commonly used in frame and hive beekeeping, but are not strictly necessary. If they are not available pieces of so-called burr comb (i.e. newly built small pieces of comb, usually in the shape of a tongue) can be used. The beekeeper can attach burr combs 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 economic to use small strips of foundation sheets only. This type of foundation sheet can also be used in top bar hive beekeeping.

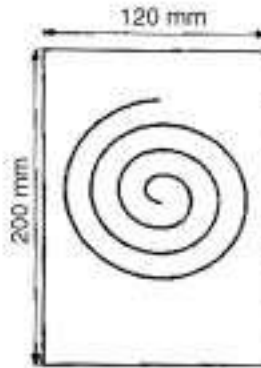
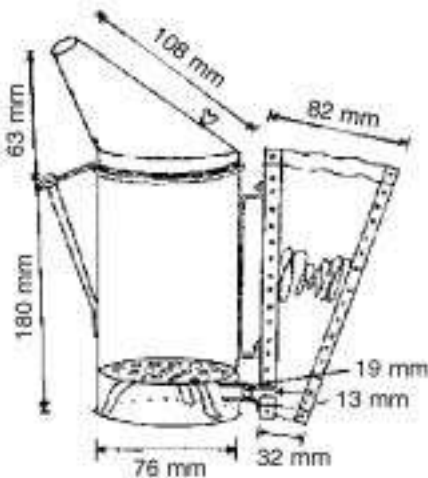
Smoker

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 Africanized bees, it is advisable always to use a smoker. Cow dung, maize cobs, coconut fibres, rags or card-board can be used as smoker fuel. An open smoker can be made for instance, from a fruit tin. 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.



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



Wooden board with a spring

Figure 17: A smoker with bellows.

To make a smoker with bellows you need (figure 17):

- two wooden boards 12 × 20 cm.
- a spring from a chair, bed or 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.

Construction

Cut out a piece of imitation leather of the shape and size shown in figure 17. Fix the metal spring to board 1 with a few nails. In the other board drill a 13 mm hole. First attach the imitation leather to the sides of board 2 and then attach it to the board with the spring. To ensure that the imitation leather remains firmly attached to the sides of the boards it is advisable to knock strips of zinc over the edges.

The fuel container can be made from a piece of zinc sheeting, but you can also use a length of drainpipe. The side and bottom seams should be rivetted. Make a 19 mm hole 1 cm from the bottom of the fuel container. Place a grid 3 cm from the bottom of the container, so that the fuel does not rest on the bottom. The lid is made of 2 pieces of zinc.

The bellows are attached to the fuel container with two brackets. Take care that the hole in the fuel container and the hole in the bellows are accurately lined up. To ensure that the air from the bellows enters the fuel container, you can fix a 2 or 3 cm length of tubing to the hole in the fuel container. This tube should not touch the hole in the bellows, however, as it should not block the flow of air into the bellows when they expand after being pressed together.

Cover sheet

To prevent too many bees from leaving the hive when you are inspecting the combs, and to partly protect the colony from robber bees, you should place a wet cotton cloth over the opened hive. Some beekeepers find it easier to use two cloths, so that the frames on either side of the frame which is being removed remain covered.

Bee hat (figure 18)

This serves to protect 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 which fits onto a broad-brimmed hat. If you work with very defensive bees a bee hat which is not based on a broad-brimmed hat is not good enough, as the bees can still sting through the thin cotton into the head and neck. The veil of the bee hat falls onto the shoulders and is 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.

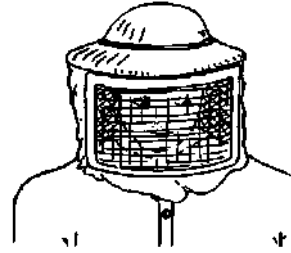


Figure 18: Bee hat/veil.

Overalls

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.

Gloves

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 stings in the gloves will stimulate aggressive behaviour in the bees.

Note: The use of a bee hat, overalls, high shoes and gloves are essential when working with some African and Africanized bees.

Bee brush

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

Hive tool

This is used to loosen the cover, the honey super(s) and the top bars which 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 screw driver.

5.8 Preparing the hive

Putting the hive in order

It is important to make the hives with great care, so that there is (other than the flight entrance) no hole through which robber bees can enter. Robbers create unrest and lower the production of honey by the colony. All the hives and parts of the hives must have exactly the same measurements so that frames can be exchanged between hives. The outside of the hive should be protected with varnish or paint (preferably white). To reduce the chance that bees mistake their hives when they fly home, especially if the hives are neatly placed in a row, you can paint different geometrical figures 10 to 20 cm high above the flight entrance of the hives or paint the flight board in different colours. If the hive is to be inhabited by a small colony, you should temporarily reduce the size of the flight entrance by putting a stick in front of part of it.

Attaching the foundation sheets

If you use a centrifugal honey extractor you should reinforce the combs with thin, galvanised wire to make sure that they do not break during spinning. Fairly strong copper wire, such as can be taken from broken transformers, can also be used for this; with the added advantage 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 laying eggs in them. Make holes through the side bars with an awl. These holes are reinforced with metal eyelets to prevent that the metal wire cuts into the wood. The wire is strung through

the holes horizontally, tightened, and secured with two small nails (figure 19).

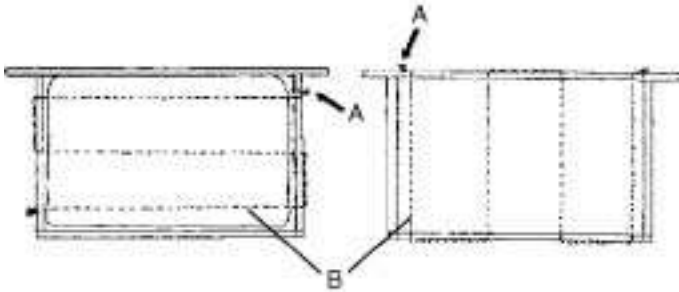


Figure 19: Wiring a Langstroth brood chamber frame. A: nails; B: wire.

When the foundation sheet has been attached to the top bar of the frame, the wire is melted into the wax with a spur embedder (figure 20). 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 (from a battery or bell transformer) through it. A third method is to use a soldering iron.

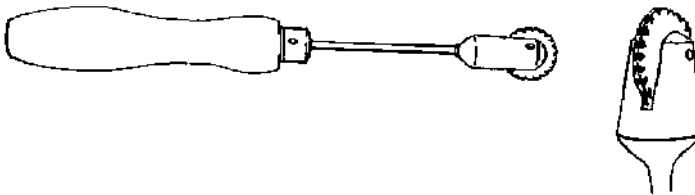


Figure 20: Spur embedder.

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

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 foun-

dation sheet to expand without buckling. If you do not use foundation sheet, you can 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. If you cannot get hold of a foundation sheet, you can 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 comb during good honeyflow periods and definitely not when they are preparing to swarm.

5.9 Setting up the apiary

Good honey production begins with the right choice of site for the apiary, and the correct use of this site. One should pay attention to the following points.

The choice of site.

- The site must be in an area where there are several sources of nectar within a radius of 1 km. Although bees cover an area with a radius of 3 km, it is preferable to place bees in the middle of the forage. The shorter the distance the bees have to fly, the less energy is 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 Africanized 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 this costing too much time and money.
- There should be a good path leading to the apiary so that you do not have to carry the hives and the basins or containers of honey too far.

Protecting the hives

Sun

The hives must always be protected from the hot sun. This is better for the bees and for the hives. There are three ways of doing this:

- 1 Place the hives in or under a tree which offers sufficient shade.
- 2 Place an additional roof made of corrugated iron (straw or leaves) above each one of the hives (if they are widely spaced).
- 3 Put the hives close together and build one extra roof (zinc sheets, straw, reeds, leaves) to cover all of them.

Wind

Place the hives with their flight entrance out of the prevailing wind direction. If the hives are in an open place and there is a continuous strong wind from one direction, it is a good idea to plant a hedge or construct a windscreen (grass, straw, leaves).

Rain

Place the hives at a slight angle so that the flight entrance is 1 cm lower than the rear of the bottom board and the rainwater cannot run into the hive. The hive cover must be waterproof.

Cattle/game

Make sure that cattle or large game cannot walk around the hives. Fence the bee site if necessary.

Raccoons

If raccoons cause too much trouble, it is advisable to suspend the hives from the branches of a tree or a from a home-made pole construction with wire. The hives should hang about 1 m above the ground.

Toads

In the humid tropics toads are notorious bee-eaters. In this case always place the hives at least 50 cm above the ground.

Ants, termites

In many areas ants are a great threat to bees, and care must be taken to protect the bees from them. One solution is to suspend the hives with wires. A second solution is to use hive stands which are protected from ants and termites by grease (figure 21). Fix a collar of zinc or aluminium to each leg of the stand and grease the underside of these collars once a year with old crankcase oil.

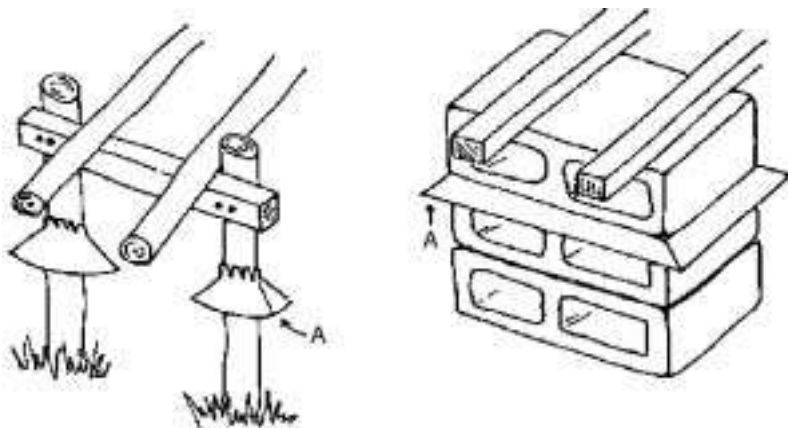


Figure 21: Using greased caps (A) to protect bee stands from ants.

Make sure that no weeds, which could form a bridge for the ants, grow around the bee stands. As weeding can upset the bees, it is better to take the necessary precautions when preparing the apiary. You can also place old rubber mats or linoleum under the hive stands.

If one has a spacious roof over the apiary this is usually enough to prevent strong weed growth.

Thieves

Unfortunately man often is the main enemy of a beekeeper and in some areas the robbing of bee hives is a common hazard. The best way to prevent theft is to keep your apiary within a short distance of a guarded dwelling. If not, hives can be wrapped with a chain and padlock, so it cannot be opened. Make sure that people in the neighbourhood of the apiary have no reason to disturb your bees. Inform them well and act properly in case there are complaints.

Bushfire

In savanna regions and other regions with a long dry spell, the danger of seasonal bushfire might cause problems in setting up a proper apiary. In fact this is one main reason for beekeepers to put their hives high up in trees. If your apiary is on a bee stand then make sure that sudden bushfire cannot affect your colonies. Keep a wide area around the apiary clean and clear away lower weeds and shrubs from time to time.

6 The first season

6.1 Hiving a swarm

Capturing a swarm

A newly settled swarm clustering on a branch of a tree is very docile. When capturing a swarm, however, it is advisable to protect yourself with suitable clothing. The bees can be quite aggressive if they have already 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 a spray bottle to prevent them from moving away. A small hive without frames, a basket or a box is held under the swarm. Sometimes a bee veil can be used for this purpose. A firm blow on the branch on which the swarm is hanging will make the bees drop into the hive. Then cover the hive 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. In the evening you must take some of the frames out of a prepared hive, and shake the bees from the small hive into the big hive. The frames are carefully put back into place and the hive is closed. The flight entrance of the hive can remain open; bees that have remained in the small hive can be tapped onto the flight board. The following day you must feed the bees. 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 bee hive 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. As soon as the swarm has taken occupation of the hive, the bees will begin to orient themselves on 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 occupied for some

days, the bees will already have oriented themselves to the hive. The hive can then only be moved over a long distance and some weeks later it can be moved back to the desired place.

If you have some old bee hives (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. 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 makes small colonies of bees available.

Collecting wild nests

Sometimes you may find “old swarms” in the trees of a forest or elsewhere; these are swarms which have already established themselves and have already build some combs on which you will find brood and honey. Although the chances of such a colony staying in your hive after capture are smaller, you can nevertheless try to move the whole colony into a hive. First you may have to open the tree in order to reach the combs. Use a lot of smoke to drive the bees away from the comb. Use a sharp knife to cut off the comb and trim this to fit the frame, which should have wires but no foundation sheets. Where the wires are to run, carefully cut through a row of cells so that the wire can slot into the comb. As an extra precaution also attach a string around the comb and frame in such a way that it can later be removed easily. In this way the combs are fixed to the frames one by one and then hung in the hive. Finally the bees are also swept or driven into the hive. Because these bees have already oriented themselves, the hive must immediately be placed about 5 or 6 km from the area where they were found.

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 side wall 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 (look carefully for the queen and any eggs). Place additional frames on both sides of the transferred frames filling the hive completely with frames. Bring a little smoke over the frames and replace the cover. Make sure that the flight entrance is open (you should reduce it if necessary). You have your first colony in the desired place.

Now let us see what will have to be done during the first season.

6.2 Administration

You should keep a good record of the condition of the colony, especially if you have several colonies. You should note on a card, after each inspection, 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 etc. You can attach the hive card to the underside of the cover of the hive.

Instead of using the card system you can also write all the details in an exercise book (or better still, a loose-leaf file), which you take home. If you work with gloves on, it is difficult to write on hive cards and it is then simpler to scribble a few notes on a piece of paper and to write these up in detail when at home. For administrative purposes it is useful to number the 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.

6.3 Inspection

Once a week take a quick look into the hive. The bees should not really be disturbed that often, but as a beginner you still have a lot to learn about the life of the bees and this will have to be done at their expense. Inspect the colonies during the day, when the weather is sunny, but preferably not when there is a thunder storm 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. Use 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 the bees and brood healthy?

The findings are noted on the hive card. You must always hold the frames above the hive so that the queen does not fall outside the hive. In order to prevent diseases spreading, especially regarding American

Foul Brood: it is recommended to sterilize 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 between the hives.

6.4 Feeding

A colony is fed to stimulate development during dearth periods. Regular feeding with small quantities of sugar solution (or 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 already removed honey cannot bridge a dearth period without being fed with sugar solution. You make a sugar solution by heating equal parts of sugar (good quality crystal sugar) and water until the sugar is dissolved (do not boil). Never use brown sugar as it causes diarrhoea among the bees.

Feeding is done with a feeder (figure 22). 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. On top of this place an empty brood chamber or honey super and put the outer cover of the hive on top of this. You can also remove one or two unused frames from the hive and put the feeder in their place. The feeder can also be placed on top of a small wooden tray (figure 23) which you place in the flight entrance. **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.

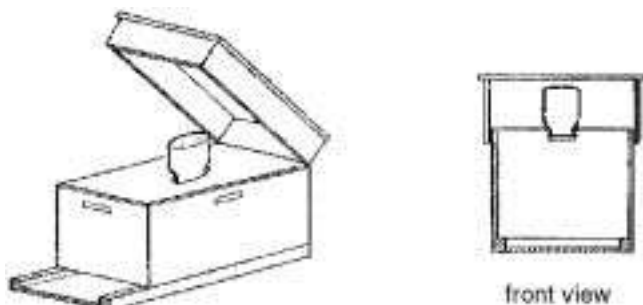


Figure 22: Positioning the feeder.

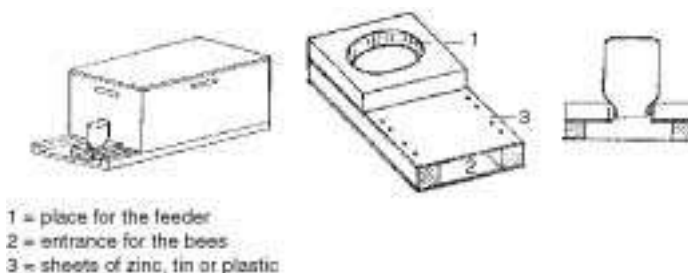


Figure 23: Feeder which is inserted in the flight entrance.

- Make sure that there are no openings through which bees, wasps, ants etc. 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 honeyflow. 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!
- In dearth periods feeding with sugar will usually do 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 less bees will develop. In this case you can give the bees a pollen substitute, which is soybean flour. The substitute can be mixed with a little sugar to make a protein rich cake that can be fed by putting it on top of the bars. Do not make too much cake as it is easily perishable.

6.5 Management during the growth of the colony

The brood nest is now gradually spreading over the various combs. Combs are being built on foundation sheets and strips. The cells of the frames are filled from the centre outwards with brood, pollen and honey. Building costs much energy and if you notice that not much nectar is being collected (bad weather, poor honeyflow) you must feed small quantities of sugar solution. When the bees have filled all the frames with food and brood, it is time to provide extra room (by adding a honey super, for example). The way to provide extra room depends on the kind of beehive you use. In long hives or top bar hives where the honey area and brood chamber are next to each other, the honey area will have been separated from the brood chamber by a par-

tition made of hardboard or similar material. The flight entrance of the honey area will have been closed.

It is very important to keep on adjusting the size of the hive (number of chambers) to the size of the colony. The bees should be able to occupy all the frames. Only then can the total comb surface be protected from intruders (e.g. the wax moth) and kept at the right temperature.

For tropical bee races such as the *African mellifera* and *Apis cerana* in Asia this rule is vital. All combs should be covered with a dense “curtain” of bees and no combs should be left unoccupied. Therefore, a beekeeper in sudden times of dearth must also be able to decrease the number of combs when the colony gets smaller. If not the wax moth may seriously attack the nest and soon the whole colony will abscond.

Other reasons for absconding might be:

- attack by ants.
- other bees robbing.
- a too wide or too narrow comb spacing.
- regular and rough disturbance (e.g. by the beekeeper).

To prevent brood from developing in the honey chamber, place a queen excluder between the brood and the honey parts. This is not absolutely essential.

To encourage the workers to build up the honey super rapidly, place one or two frames with capped brood (make sure the queen is not on the frames) in the honey super. Replace the frames you have removed from the brood nest with the same number of frames with comb or foundation sheet. Frames can only be exchanged between the honey area and the brood chamber if they are of the same size.

The rate of development depends greatly on the honeyflow and the weather. If there are many bee-forage plants in the area, and if the weather is favourable, a young colony will expand very rapidly. If a colony develops poorly, check whether there is enough food in the colony and drinking water in the surroundings, and also check for bee diseases.

The honeyflow

We speak of honeyflow when many plants which provide nectar, flower at the same time. The source of honeyflow can be one kind of plant (e.g. pure Eucalyptus honey) or many different kinds. There are several mechanisms in the plant world which trigger flowering. In the temperate zones this is mainly temperature and length of daylight. In the tropics, where temperature and daylight length do not vary much during the year, flowering is often determined by rain and drought. In the humid tropics most plants begin to flower after a few fairly dry weeks. There are, of course, exceptions, such as the citrus varieties which flower after the rains have started. In very dry areas flowering usually occurs at the start of the rainy season.

The beekeeper must note the plants to which the bees fly. The beginner will find it useful to note, for the first few years, the times when bee-forage plants flower. In this way you will get a good overview of the “honey year” and you can make better preparations for the honeyflow.

The harvesting of honey can start 3 or 4 weeks after the start of a good honeyflow. You can then remove the sealed combs and extract the honey. If you use a hive with frames, you can also leave the full frames till the end of the honeyflow. You will have to provide a new honey super in good time, however, so that there is always enough room for the bees to store the honey.

Honey is usually not taken out of the brood chamber. The little honey that is stored in the brood chamber should be left for the bees to use during dearth periods.

The rest period

At the end of the honeyflow check how much food is left in the combs for the bees. If you have not yet removed any honey from the combs, there will be enough food for the bees in the dearth period. If you have harvested honey, or if the colony has been too weak to provide the hive with a good supply of honey, you will have to keep on providing small quantities of sugar solution. In this period you should also check

whether the bees are troubled by ants, termites and especially wax moths. You can close the flight entrance with coarse mesh or nails in such a way that mice and lizards cannot get in but the bees can always get out. All combs that are not occupied by bees must be removed, as the bees do not defend these against wax moths. The presence of unoccupied combs allows the wax moth to develop into a plague, which will eventually cause the colony to abandon the hive.

Storing frames with comb

In the tropics it is difficult to keep empty combs stored in good condition. Frames with comb can best be stored in a well-protected and well-ventilated space. It is best to cover the pile of empty combs with mosquito netting, so that there is at least 20 cm spacing between the netting and the combs. Only store new honey combs that have a light colour, dark combs will be destroyed by small mites. The frames should be loosely packed on racks, or strung on a wire. Never store frames with combs in an empty hive because within a month they will have been destroyed by wax moths.

7 Preparing for the honey harvest

The natural development of a bee colony during the season has been described above. Now we will look at the most important interventions the beekeeper makes in this development. The purpose of these is to bring the colony to maximum strength at the time of the greatest honeyflow. The general measures discussed here are only applicable to hives with loose frames. It is difficult to intervene in fixed comb hives.

7.1 Thorough inspection

At the end of the rainy season (in the humid tropics) or the dry season (in the dry tropics) the activity of the colony increases. The new bee season has started. You start the new season with a thorough inspection of the bee colony.

First check whether the queen is still present and whether she has produced any drone brood in worker cells (bulging cell cappings). A queen inclined to breed drones (either through age or an insufficient number of matings) is removed and killed. The colony without a queen is united with a colony with a queen. If only a handful of bees from the original colony remains, it is better not to unite them with another colony. It is very likely that the bees are diseased and if they are, they should be killed and burned. If the floor of the hive is covered with wax crumbs and sugar crystals, this should be cleaned away (think of wax moths and ants).

Cleaning a loose bottom board is no problem. In hives with a fixed bottom board you must put the frames into a clean chamber. Now that the colony is relatively small, there will be no problem looking for the queen. One of the queen's wings should also be clipped (why this should be done will be explained in the section on the prevention of swarming).

Make sure your hands are clean. Take the queen by the thorax (never by the abdomen!!) and carefully cut off half of one of the front wings

(figure 24). It is best to first practise this on a few drones. To make sure that you do not clip unfertilised queens (which must still make their mating flights) this clipping should only be done if there is capped worker brood!! When you put the queen back on the frame where you found her, make sure that she is not bothered by the other bees on account of the foreign smell she has acquired from being handled. If necessary apply a little smoke. If the bees become very troublesome, it is better to put her into a little queen cage, which you close with a plug of sugar dough (sugar kneaded with honey), and to place this on or between the frames (figure 25). The workers will eat up the candy, thus freeing the queen. If you cannot get hold of a queen cage, simply use an empty match-box in which you have made a few holes. The bees again will release her from this.

Note down all your actions and observations.

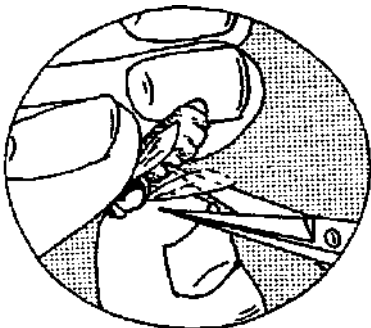
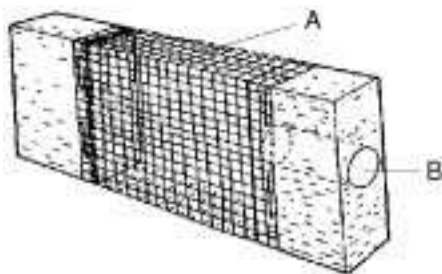


Figure 24: Clipping the queen.
(Source: *Imkers Encyclopedie*,
B.van Aarst).



A: wire mesh
B: entrance

Figure 25: A queen cage.
(Source: *Imkers Encyclopedie*,
B.van Aarst).

7.2 Enlarging a colony

There are various ways to enlarge a colony. It is important to know that one large colony collects more honey than two smaller colonies (it can work much more economically).

You should therefore try, if it is your intention to harvest as much honey as possible, to aim for the largest possible colonies and not the greatest number of colonies.

A bee colony can be enlarged by:

1 Stimulating the increase of brood nest size

This can be done by feeding when the circumstances are not favourable, by exchanging frames (between the brood chamber and the honey super) and providing additional frames.

2 Uniting colonies

At the start of the season you can unite small colonies quite easily by sprinkling some sugar water over both colonies in the evening and then hanging the frames of the two small colonies alternately in one large brood chamber. The oldest or worst queen is removed. If it does not matter to you which queen remains, simply unite the colonies. The next day there will be only one queen alive, usually the younger.

Superfluous frames with food are stored in such a way that they are safe from ants and bees (in a closed brood chamber, box, paper, or plastic bag).

3 The newspaper method

On top of the frames of the first colony place a newspaper in which you have pricked some holes so that the exchange of smells is possible (the bees of the two colonies to be united must develop a common smell). On top of this place the hive, without bottom board, of the second colony. The bees will slowly gnaw away the newspaper and so become peacefully united. If you see pieces of newspaper appearing on the flight board it is clear that the bees are very busy. Later you can remove the rest of the newspaper.

4 Wire mesh

You can use a ventilation screen to allow two colonies to get used to each other in a controlled manner. This frame consists of a wooden frame, which has the same outside dimensions as the inner cover. The frame has a fine wire mesh stretched over the underside. In one of the four bars make a notch 5 cm wide and 0.7 cm deep. This opening will serve as the flight entrance (figure 26).

If you want to be able to close the opening in the ventilation screen, hinge a piece of wood the same size as the notch to the bar. In the open position this little door serves as flight board. For hives where the honey chamber is next to the brood chamber (and not on top of it) make a similar frame to separate the two. In this case it is not necessary to make a flight entrance in the frame, as the honey chamber has its own flight entrance.

Place the ventilation screen on top of the hive of the first colony, and then put the hive of the colony which is to be united with it on top of the travelling frame. After a week you can remove the screen and unite the brood nests. Do this in such a way that you again have a more or less ball-shaped brood-nest.

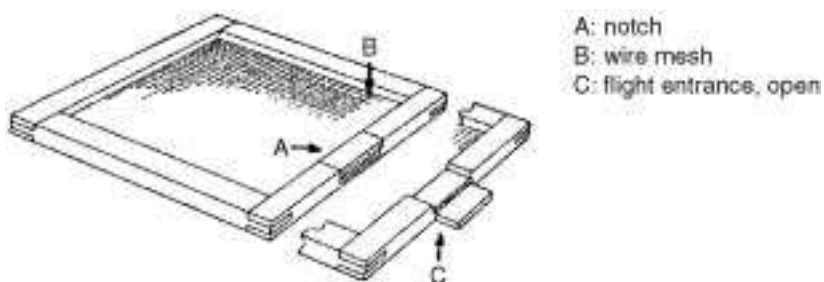


Figure 26: Ventilation screen, also used to unite 2 colonies by stacking hives. (Source: Imkers Encyclopedie, B.van Aarst).

5 Partial uniting

The size of a honey producing colony can also be increased by:

- Adding frames with capped brood from other colonies (after you have brushed or tapped off the bees). Do not add too many frames of capped brood; the receiving colony should be able to occupy all the frames with brood to keep it warm, otherwise the brood will die.
- Driving foraging bees of a neighbouring hive towards the colony to be strengthened (figure 27). The hives that have to be united, must have been standing next to each other for some weeks. Then move the hive of the colony from which you want the flight bees to fly off some 5 meters away and move the hive of the colony

you want to increase halfway to the position of the first hive. The flight bees of the first hive will now be able to enter the second hive, that is, if they are carrying nectar or honey. If not, they are blocked by the guards of the second colony. Therefore only let bees fly in during periods of good honeyflow. The colony which has been deprived of its flight bees will have to be fed for a while if its store of honey is too small.

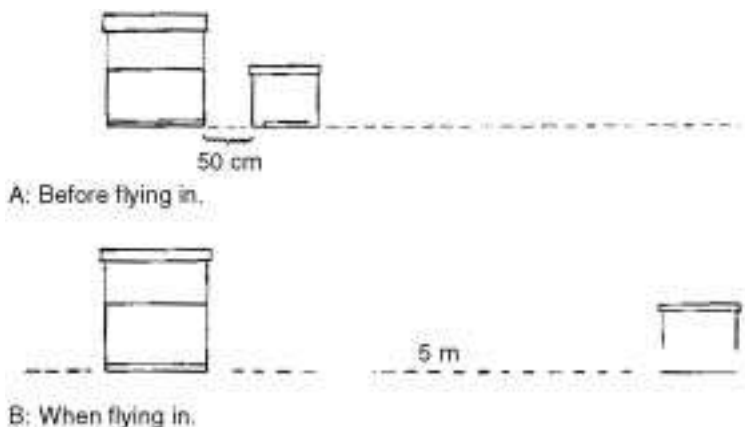


Figure 27: Position of the 2 hives before and when flying in.

7.3 Migratory beekeeping

The various bee-forage plants which can provide a good harvest of honey are usually spread out over the countryside. If these all flower at the same time you cannot profit from them all, unless you have spread out your hives over the whole area. If these bee-forage plants flower consecutively, however, you can obtain more honey by traveling with your bee colonies. It must be stressed, however, that **you can only travel with hives which have wooden frames**. Choose a site which is, or can be, well protected against mischief, theft, cattle, game and fire. You will also have to make sure that these bee-forage plants will not be sprayed with chemicals which are toxic to bees.

Preparing the colonies for travel

Just before the journey the chambers and the frames should no longer be loosened. The bees will have glued together the various parts of the hive and this is an advantage during transport. A queen excluder can be placed between the brood and honey chamber in advance. You can also take along an extra brood chamber or honey super. The day before you leave, replace the crown board with the ventilation screen. Bind one or two strong straps or ropes firmly around the hives so that the chambers or bottom board cannot move during the journey. These straps are best made from plaited jute or sisal, but you can also make them from 10 cm wide strips of the discarded inner tube tyre of a car or tractor.

Close the flight entrance in the evening or early morning when it is still dark and the bees are not flying. You can use a little wooden board for this or (better still) a piece of wire mesh that you nail over of the entrance. A strip of foam rubber jammed into the flight entrance will also do very well. If there are many bees hanging on the flight board you can sprinkle them with water mixed with a few drops or vinegar, or smoke them, to drive them into the hive. During transport the hives should be positioned in such a way that the frames run parallel to the length of the vehicle. This is to ensure that the frames do not bang against each other during abrupt changes in speed. The hives must be firmly fastened to the vehicle. Obviously you should accelerate and brake slowly, and also drive slowly. Take along a bee hat, smoker, hammer, pliers and some nails, as well as some water. It is possible that colonies will become overheated during transport and you can avoid this by spraying with water. It is best to transport the bees during the coolest part of the day. You can also hang wet jute bags over the hives in such a way that the hive is cooled but the air supply is not cut off. Also take along something (clay, foam rubber) with which to close up any small holes that you may discover during the journey.

When you arrive at the site, place the hives under a tree or roof so that they are protected from sun and rain. Then place the crown board on top of the ventilation screen. The bees will walk downwards. When

the bees have come to rest you can open the flight entrance. Some time later you can remove the travelling frame and replace it with the crown board. Provide drinking water if necessary.

7.4 Swarming

Swarm cells are built during the period when the brood nest develops rapidly. The bees become less active, fewer bees fly out to forage, and no more comb is built. The colony is preparing to divide itself, and may do this even several times ... unless you intervene. A good bee-keeper follows the development of the colony and tries to prevent swarming in time, although this will certainly not always succeed.

Note: Note that you do not necessarily have to prevent swarming, especially in areas where it is not difficult to capture swarms. By uniting these at the right time you can obtain strong colonies which ensure a good honey harvest.

Colonies which have swarmed are “lazy” and collect little honey, and such colonies are of little use for the season's honey harvest.

Ways to postpone swarming.

- 1 Provide enough space in the brood chamber. One of the major causes of swarming is lack of space. By providing extra space (hanging empty combs in the brood chamber; providing an extra brood chamber), the brood nest can again be expanded, so keeping the queen and the workers active.
- 2 Remove capped brood. Take away some frames with capped brood, tap the bees from the frames into the brood chamber, and hang some frames with empty combs in their place. The removed frames with brood can be given to weak colonies. In this way you limit the growth of the colony and at the same time provide more space in the brood nest.
- 3 Let the bees fly in (see Partial uniting) This is good way to weaken a colony inclined to swarm and to enlarge another colony with flight bees.

4 Clip the queen. If you clip one of the queen's wings at the beginning of the season when the colony is still small she will, at her first attempt to leave with part of the colony, fall on the ground and die. As soon as the swarm realises that it has no queen, it will return to the hive. As the old queen is only driven from the hive when the first queen cells are sealed, there will be one or more new queens in the colony within a week. The result is that one or more secondary swarms will fly off. If you have noticed the old queen attempting to swarm, you can break off all the queen cells but one the next day. To make sure that you do not leave more than one queen cell, you must examine all the frames very carefully, by brushing or tapping off the bees. First you must mark the frame with the queen cell which you wish to keep, and handle it very carefully. When tapping the bees off the frame you could damage the young queen in her cell.

Ways to prevent swarming

To prevent swarming you should be one step ahead of the bees, by making an artificial swarm yourself. Do this when there are enough drones, but just before there are swarm cells. With the following measures you will be able to regulate the number and the size of the swarms. By doing this the chances that you will lose a part or all of the colony will be considerably reduced. If you make an artificial swarm 6 weeks before the major honeyflow you will then have a colony with many flight bees at the time of the honeyflow. At the same time you will have a small colony (with the old queen) in reserve.

There are several methods for making such artificial swarms, but the principle is the same: the colony is divided into two, one with the old queen, the artificial swarm and one without, but with queen cell(s) or brood combs with eggs and young larvae from which the bees can produce new queen cells.

When dividing a colony it is important to plan the activity carefully and to consider the following points: what conditions are needed for both new colonies and where to position them, which one in the old place, where all flight bees return and which one in a new place, where only the young bees will stay.

In general there are two possibilities:

1 The old queen stays in the old place and this will be where all the flight bees will stay.

In this case the beekeeper must take all open brood combs and also the capped brood combs, except one or two and put them into a new hive, a few metres away. In this new bee hive the bees will make queen cells out of some the cells with newly hatched larvae. No empty combs are needed here, nor foundation sheets, as there is no queen yet to lay eggs nor flight bees to collect nectar or pollen. Only one or two frames with honey and a frame with some pollen are needed in this hive for survival until the new queen lays her eggs and young bees have developed into flight bees. In the old colony the queen will continue to lay eggs and empty combs and foundation sheets are needed. Young bees will emerge from the capped brood which has remained and these will nurse the larvae. In the meantime flight bees will continue to bring pollen and nectar.

2 The old queen is moved to a new place.

In this hive she will stay with young bees that must be shaken from the brood combs. The easiest way to do this is to hold the frame in one hand over the new hive and then tap it firmly with your other hand with your other hand, so that the bees fall off. Two thirds of the combs must be treated in this way. Remember that most of the flight bees will return to the old hive and therefore the new hive must be overcrowded. Put foundation frames and empty comb frames in this new hive together with pollen and honey frames so that the queen can continue to lay eggs. Do not put brood combs in the hive. These must stay in the old hive where the colony will make new queen cells.

With both methods several queen cells will be produced in the hive without a queen. In order to eliminate the chance of swarming, it is best to check these colonies 9 - 10 days after dividing and then to take away all queen cells except the biggest one, from which the queen will emerge. The queen cells that have been removed can be used in other colonies to replace old queens. Take care to handle a mature queen cell with care and keep it upright. With a simple pin or a needle the

cell can be attached to the comb of a colony without a queen. Take care that the colony into which you introduce the queen cell, has been without a queen for more than one day, but not longer than 3 days. Only then will the colony accept the new cell.

If you want to divide the colony and you cannot find the queen it is possible just to divide the colony in two equal parts. The one colony in a new place with more young bees (purposely shaken off by the beekeeper) and the other one in the old place with all flight bees. After 4 days the beekeeper can inspect both colonies and see where the queen is present (look for eggs!) and then re-arrange the two colonies according to the above principles. While re-arranging you must make sure not to transfer the queen by mistake. The latter method is a good solution where queens are difficult to find in big or defensive colonies.

Absconding

African bees often depart from their hive by absconding instead of the normal swarming process. They abscond simply because there is not enough food or water or because of disturbances caused by the beekeepers; they are for instance, particularly sensitive to their brood frames being removed. Disturbances by ants, other pests or animals, can lead to absconding. The bees simply try to find a better place to overcome their difficulties.

This behaviour also has an advantage for the beekeeper. The colonies travel mostly in considerable numbers every year at the same time along certain paths from one area to another. The beekeeper could try to find out how, where and when the main stream of absconding bees is moving. By placing beehives in the path of the absconding bee colonies the beekeeper will be certain of catching as many colonies as needed.

The best way to avoid absconding is to protect the bees from disturbances and to ensure a certain amount of food (at least four or five combs full of honey) is provided.

8 The honey harvest

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

- Only remove combs with capped honey; uncapped honey contains too much water and will start to ferment.
- Do not take any honeycombs containing brood. In the fixed comb hives only take away the combs at the sides of the hive. In hives with loose frames only take the frames out of the honey area and, at the most, the side frames out of the brood chamber.
- Sometimes more is paid for certain kinds of pure honey than for a mixture of different kinds of honey and it is then worthwhile harvesting this kind of honey separately.

8.1 Collecting honeycomb

In fixed comb hives, where only the side walls can be removed, you should first blow some smoke into the hive through the flight entrance. You then drive all the bees to one side of the hive with smoke, and then 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 are carefully turned upside down after quite a lot of smoke has been blown into them. The bottom board is loosened and pushed 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. Then 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. This will mean that the rest of the honey harvested will keep longer as it has a lower water content.

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

the weeks before the harvest the beekeeper can take precautions in order not to have brood in the combs he wants to extract by repositioning these combs outside the brood centre. In this way the queen is prevented from using them again for egg laying. This can be done in a simple way by means of a queen excluder.

When starting 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 honey extractor. You should always either fill up the empty spaces in the honey super, or remove it.

8.2 Extracting the honey

There are three ways of extracting honey:

1 Floating

Floating is the simplest, but takes the longest, which is especially disadvantageous in the rainy season (honey is hygroscopic and will absorb water from the air in times of high humidity) unless you work with closed containers.

2 Pressing

Pressing honey is more work, but takes less time.

3 Centrifuging

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

Honey should be processed in a space where bees cannot enter (all openings must be closed with fine wire mesh). It is also possible to work in the evening. You can also spin honey in a tent which seals well with the ground so that there are no gaps. If necessary you can store well-capped frames in a well-sealed container. If your honey contains too much water, you can “dry” your uncapped honey by making a chimney of the honey supers and blowing air through them with

a ventilator. If you place newspapers on the floor of the room you can easily remove spilt honey.

Floating the wax

Remove the wax caps of the capped honey cells with an uncapping fork or knife (figure 28 and figure 29). Uncapping knives must be well filed and razor sharp. At temperatures of less than 25 °C you can make uncapping easier by holding the uncapping tool in a basin of hot water for a short while (but do dry it before use).



*Figure 28: Uncapping fork.
(Source: Imkers Encyclopedie, B.van Aarst).*

The combs are broken into small pieces and placed in a pot or other container. The container is sealed to make it airtight. After a few days the wax which has floated to the top can be skimmed off. The honey is strained through a clean cloth, nylon stocking or special honey sieve and is again put away for a day. Any foam and wax particles which have floated to the surface can be skimmed off and the honey can then be put into jars.



*Figure 29: Uncapping knife.
(Source: Imkers Encyclopedie, B.van Aarst).*

Pressing the honey

Scrape open the combs, break them into pieces and tie them up in a clean cloth (cheese cloth, sheet, pillow case). Knead the combs in the cloth and then press the honey through the cloth. You can wring out the cloth (you need two people for this, or one person and a fixed point), but it is faster to work with a wooden press. There are various press constructions (figure 30).

Pour the honey through a clean cloth or sieve into a pot or maturing vessel and leave it to stand for a few days. Any remaining wax particles and pollen grains will float to the top and can be skimmed off.

Then pour the honey into a storage jar (airtight). If you want to be able to fill small pots and jars easily you could use a container with a tap (figure 31).

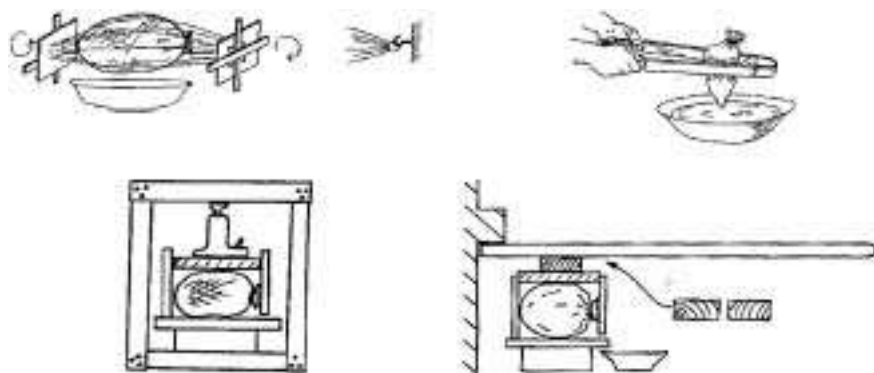


Figure 30: Simple honey presses.



Figure 31: Container made from a petrol tin, for filling jars (left) and a plastic container with tap (right).

Centrifuging the honey

Requirements: centrifugal 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 combs must be uncapped before you centrifuge the frames. With a knife (preheated if necessary) cut away the cell caps in one movement. Irregularities in the comb, however, will mean that some of the cells will remain capped. It is slower but more accurate to work with an

uncapping fork. It is best to uncap over an uncapping tray with a wooden bar on which the frame rests. You can leave the wax caps to drain. If you later melt the wax caps you will obtain first-grade wax. The centrifugal honey extractor consists of a cylindrical kettle in which a cage made of a frame covered with strong wire mesh turns on an axle (figure 32).

In this kind of centrifugal honey extractor 2, 3, 4, 6 or 8 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. The honey is thrown out of the combs against the inside walls of the kettle. A handy blacksmith can make these centrifugal honey extractors using, for example, some cogs from an old gear box.

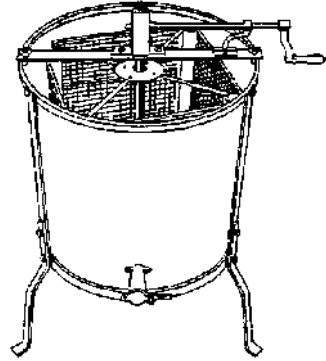
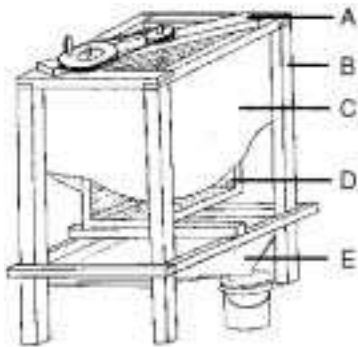


Figure 32: Modern centrifugal honey extractor for 3 frames.

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

You can also make a simple centrifugal honey extractor from a few wooden beams, a few wheels, strong wire mesh and plastic (figure 33). Make a square cage into which you can fit four frames placed on their side. This cage is covered with strong wire mesh. Fix an axle in the centre of the cage. Make a wooden frame in which the cage can turn easily, and high enough to hold a bucket or pot beneath the cage. The inside of the frame is covered with a sheet of plastic against which the honey is collected. Plastic is also stretched under the cage in such a way that the honey all runs to one side and can be collected in a

pot or bucket. A beam is fixed diagonally across the top of the frame and the driving mechanism is attached to this beam. Make the big wheel as big as possible and the small wheel as small as possible. One can use good quality rope, with the ends plaited together, as drive belt. One can also use the peddling mechanism of an old bicycle.



- A: wooden frame
- B: beam with driving mechanism
- C: cage with wire mesh
- D: plastic wall (partly removed)
- E: collecting tray (plastic, zinc)

Figure 33: Simple centrifugal honey extractor made from wood.

There is a tap at the bottom of the kettle. Beneath this tap place the honey sieve or the nylon stocking through which the honey runs into a bucket or straight into the vessel. Turn in the direction of the bottom bar (as the cells face the top bar). First turn the handle slowly, otherwise the weight of the honey inside the comb will press the comb through the wire mesh of the cage. 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. The empty combs are put into a honey super and given back to the colony, so that they can lick the cells clean. If there is no longer any honeyflow the old combs must be removed. New ones can be stored. 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.

8.3 Storing the honey

Store the honey in glass jars or plastic buckets with well-sealing lids or in metal containers which have been coated on the inside with a layer of liquid paraffin or plastic, or which have been treated with acid-resistant varnish. In humid areas the honey must be stored in airtight containers within a few days after extraction.

The honey can start to ferment during storage if the water content is too high ($>19\%$).

Fermentation can be prevented by heating the honey to a temperature of 55 or 60 °C over a period of 8 hours, followed by rapid cooling. However, heating the honey for too long will cause both the taste and smell of the honey to deteriorate. Heated honey is of an inferior quality as the enzymes are broken down.

9 Processing the wax

Beeswax melts at temperatures between 63 and 65 °C. Overheated or burnt wax is worthless. Wax that has been melted in iron, copper or zinc pots loses its smell and colour. Slow heating over a long period has the same effect. The quality of beeswax is judged from its colour and purity. Light wax has the highest value.

Old combs are dark and must be processed separately, but they yield very little wax and are hardly worth the trouble.

The wax must be washed before it is melted. Put the combs in clean water. Do not use tap water if you know that it is very alkaline, or add a tablespoon of vinegar to every litre of water. The wax must be melted down to purify it further. Of the various possible methods of doing this, only the straining method and the solar wax extractor will be described.

9.1 Straining the wax

- Place the combs and cell capping in clean water and leave them to soak for several hours so that any remaining honey is dissolved. Use an enamelled, aluminium or plastic basin or bucket.
- Tie up the wax in a clean cloth. Put this in twice its volume of clean water and heat this until the wax has melted (70-80 °C). Do not let the water boil! The wax should not touch the bottom of the pot so you should jam a piece of wood in the bottom of the pot. Place a heavy object on top of the bag of wax so that it remains submerged. The wax will filter through the cloth and float to the top.
- Pour the warm water and wax mixture through a strainer or a clean cloth and use two sticks or something similar to squeeze the last of the wax out of the first cloth.
- Leave the water and wax mixture to cool. If you have first rinsed the pot with soapy water you will be able to remove the wax cake without any further trouble. If not, cut the wax cake loose from the sides of the pot.

To obtain even purer wax, you must first let the wax set, scrape off the dirt at the bottom of the wax cake and then melt the wax again. To do this use a double boiler or a pot floating in a second pot of water (figure 34). Then you can again scrape the impurities from the bottom of the wax cake.

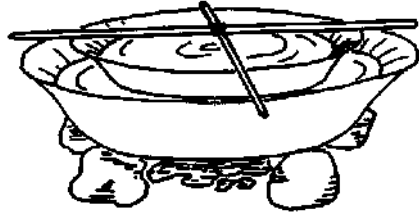


Figure 34: Heating wax indirectly.

9.2 Solar wax extractor/uncapping tray

This consists of two basins which fit on top of each other, and a lid made of a wooden frame and two sheets of glass or transparent plastic with a space of 5-10 mm between them (figure 35).

The top tray is 20 cm high and wide enough for a frame from the honey super to be suspended by its handles from the sides of the tray. The bottom is made of fine wire mesh. In this tray you put the frames or the cell capping which are to be melted. The bottom tray has sides about 7 cm high and a bottom made of zinc. This tray collects the molten wax. To ensure that the trays and the lid do not move apart you should fix protruding metal corners on two sides of both trays. To obtain a high temperature in the solar wax extractor you should paint it black and make sure that it closes well. It might help to put a flat stone on top of the wire mesh. This will absorb even more solar heat and then the combs or frames can be placed on top. Prop the solar wax extractor at a slight angle, facing the sun, so that the wax runs to one side. The wax can be melted again in hot wa-

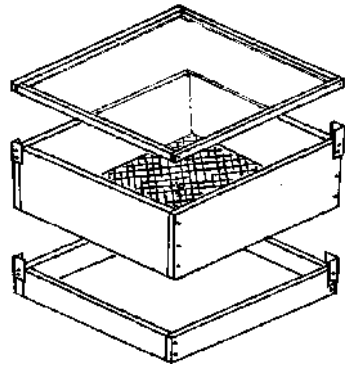


Figure 35: Solar wax extractor/uncapping tray.

ter so that it can be formed into cakes. This solar wax melter can also be easily used as an uncapping tray when spinning honey. For this purpose, the lid is removed and two bars are placed over the top tray. The frame that is to be uncapped can rest on these bars. During uncapping the cell capping fall onto the wire mesh at the bottom of the top tray and the honey drains through this into the bottom tray. Frames that have been uncapped on both sides can be placed against the side wall of the top tray until they can be put into the centrifugal honey extractor.

You can melt the wax once again to purify it further (see above). For beeswax to retain its smell it should be wrapped in plastic and kept in a cool dark place. Always check your storage for the presence of wax moth.

10 Collecting pollen

When the bees are collecting a lot of pollen you can use a pollen trap, placed in front of the flight entrance, to collect the pollen pellets. After a few days move the trap to another hive so that the colonies are not deprived of too much of their protein supply. The pollen trap is a simple box (figure 36) open at the front and back.

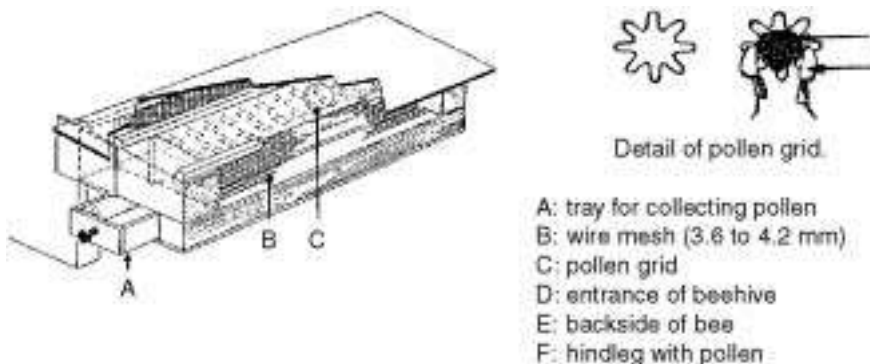


Figure 36: Pollen trap. (Source: Imkers Encyclopedie, B. van Aarst).

In this box you place a grid (two layers of 5 mm wire mesh spaced 8 mm apart, or a perforated board) through which the bees must crawl. When passing the grid they loose their pollen pellets which fall through a layer of wire mesh (3.6-4.2 mm) in the bottom of the box, into a collecting tray.

The pollen trap is moved up against the flight entrance and the flight entrance on either side of the trap is closed with a little piece of board or foam plastic. Make sure than no rain falls into the collecting tray. It is best to empty the pollen trap every day to avoid mould.

The pollen can be dried in the sun (for some hours) and stored in closed jars in a cool place. For the pollen to retain its nutritional value it must be stored in the deep freeze or covered with a layer of honey. You can eat the pollen yourself or save it to feed to the bees in dearth periods.

11 Diseases and pests

11.1 Diseases

Nosema

(only in *A. mellifera*)

Symptoms:

The bees show no external symptoms. This disease is often accompanied by diarrhoea. There is poor brood nest development.

Description:

This is a disease of adult bees, which is caused by a single-celled organism which affects the sides of the intestines. It can be detected by microscope. The disease often occurs after a long rest period. If sufficient pollen can be collected the disease has little effect.

Treatment:

- All the frames of afflicted colonies should be replaced with clean frames. The frames can be disinfected by placing them in a box with a saucer of glacial acetic acid on top of them, or the combs can be melted down.
- Replace the bottom board and clean it thoroughly.
- Do not unite weak colonies (they may be diseased) with strong colonies.
- Supply clean drinking water if this is not available near the bee colonies.
- Strengthen diseased colonies by feeding them with soya flour or skimmed milk etc. Watch out for robbing, as this can spread the disease.
- Chemical: with fumigator (e.g. Fumidil). Dosage: 75 to 100 g active component to 3.5 l sugar solution (sugar to water = 2 : 1).

European foul brood

Symptoms:

- The larvae die before the cells are capped (pupation).
- The diseased larvae turn from white to a dirty yellow and then to brown.
- There is a sour smell in the hive.
- There are many open cells in the combs with capped brood.
- The workers drag out the dead larvae.

Description:

The disease is caused by bacteria which attack the larvae at an early stage. When there are no larvae the disease cannot persist.

Treatment:

- Remove the severely affected frames and melt them down. Provide frames from unaffected colonies.
- Lock up the queen in a queen cage in the hive for 5 to 10 days so that the workers have a chance to remove all the diseased larvae. When this has been done release her again.
- Chemical: (in combination with the above) treat with an antibiotic (tetracycline, sulfathiazole etc.) mixed with sugar solution (sugar:water = 1:1).

American foul brood

(not present yet in most parts of S. America, sub-saharan Africa and Asia)

Symptoms:

- The bees die in the larval or pupal stage (capped brood).
- The cell capping of the affected larvae are indented.
- The brood nest is irregular.
- In the affected cells you will find a sticky mass, which forms threads when you remove it from the cell with a matchstick.
- There is a smell of glue (glutton) in the hive.
- Affected larvae are dark brown to black.

Description:

The disease is caused by spore forming bacteria and is very contagious. The bacteria infect the larva and the disease is transferred through infected frames and hives, but also through honey.

Treatment:

Burn all the bees and frames of an infected colony in a hole in the ground. Scorch the chambers, bottom board and lids clean, and then wash them with water and washing soda. Prevent spreading of the disease by not feeding any honey, and by not exchanging combs, frames or hives.

Sac brood

Symptoms:

- In general quite similar to European foul brood, but without a sour smell.
- Larvae die in an early stage, leaving a watery sac at the bottom of the cells.
- The watery sac turns into leatherlike scales.

Description:

This disease is caused by a virus. In *A.mellifera* the disease is not serious, but in *A.cerana* a certain strain causes a hazard to many colonies. This strain is called Thai sacbrood virus. There is a genetic base for this disease. Initially only few colonies are resistant, but new generations show more resistance.

Treatment:

- Continue beekeeping with colonies that show no disease. Take new queens from these colonies only.
- Do not exchange frames, combs, hives among your colonies.
- Lock up the queen in a cage in the hive for 5 to 10 days in case of slight infestation.
- Do not let your colonies migrate into other areas.

11.2 Pests

Varroa mite

(only a pest in *A. mellifera*, not present yet in sub-saharan Africa)

Symptoms:

- On the flight board and against the hive you will find bees that can no longer fly, with deformed wings.
- You will find reddish brown spots the size of a pinhead on the adult bees.
- You will see patches of dead capped brood, sometimes gnawed open (= heavy infestations).

Diagnosis:

You can use the following method to find out whether a colony is infested or not: Cut a piece of thick white paper of cardboard the size of the bottom board and slide it into the hive through the flight entrance. Then blow a fair amount of tobacco smoke into the hive and close the hive for 5 minutes with a piece of board or foam plastic. After an hour or more remove the paper or cardboard carefully from the hive and examine it for Varroa mites (**NB**: there may also be other mites in the hive).

Description:

Adult female Varroa mites are dark reddish-brown and about 1 mm long and 1.5 mm wide. They are roughly egg-shaped (use a magnifying glass 10x!), unlike other mites which are oblong or round in shape. The females enter the brood cells just before these are capped and produce eggs during the capped brood stage. The larvae of the mites suck the bee pupae which either die or emerge as deformed adult bees. A colony will usually have been infested for one or two years before you will suspect, from the weakness of the colony, that it has been infested.

Treatment:

- Isolate the severely infested colonies in a separate apiary.

- If the infestation is still at an early stage, you can keep it under control by regularly (once every two weeks) cutting out all the capped drone brood. The mites have a preference for drone brood. Drone brood comb can be obtained by introducing frames with a strip of comb shortly before the swarming period.
- Tobacco smoke. This is a cheap but only partly effective method. For each colony burn up between 3 and 6 g of tobacco and blow this into the hive. Then close the hive for 5 minutes. Repeat this treatment four times at intervals of 5 days. It is best to carry out the treatment in the evening when the bees are all home.
- Longer broodless periods with a queen caged for about 2 weeks in the colony, combined with destroying combs with brood, can be fairly effective. This should be done in the dearth season.
- Try to get information on the Varroa treatments from your Ministry of Agriculture or any other beekeeping agency.

Wax moth

Symptoms:

- Grey caterpillars 0.5 to 2.5 cm long can be seen scrawling over the top bars when you remove the inner lid.
- Combs are affected and the spaces between the combs are covered in spider webs.
- Whole combs are eaten up and changed into a grey-black mass spun together with webs.

Description:

This pest occurs in weak colonies which cannot occupy all the frames, and in supplies of unused frames with comb. There are two kinds of wax moth, the larger and the smaller wax moth, 2 and 1 cm long respectively and both grey. They lay their eggs in cracks and grooves. The eggs hatch into caterpillars which move to the frames.

Treatment:

- Always remove frames from the colony which cannot be occupied by bees and store these in a protected place.

- Transfer lightly affected frames to the strong colonies. The bees will clean them and repair them.
- Put the affected frames in a closed area and treat them with glacial acetic acid or smoke of burning sulphur.
- Store frames with good comb in an airtight container or box which you disinfect from time to time as mentioned above. Watch out for mould.

Ants and termites

Symptoms:

- The presence of ants and termites in and around the hive.
- Extremely restless bees and a buzzing sound near the flight entrance.
- Dead and half eaten bees around the hives.
- The hive has been abandoned by the bees.
- Wood with holes (only soft wood will be affected).

Description:

Brown or black insects, 0.5 to 2 cm long, which operate in groups and attack weak colonies by consuming honey and dragging out brood. Some kinds of ants operate only at night.

Treatment:

- Provide a good barrier between the ground and the hives. You can do this by placing the legs of the stands in basins with a cover to protect them from the sun and to prevent bees from falling into them. You can also apply a layer of grease to the legs of the bee stands which are protected by a cap of plastic, zinc or aluminium.
- Make sure that no weeds grow below the hives, allowing the ants to climb up to the hives.
- Suspend the hives with wire.
- Make the bee hives and stands of fairly hard wood known to be resistant to termites.
- Treat the wood with creosote.

Cattle and game

Symptoms:

Knocked-over hives, brood that has been pulled out of the frames, hoof or paw-prints.

Description:

Bears, cows, etc. can cause considerable damage and also suffer considerable damage themselves when they come too close to or get into the hives.

Prevention:

If you experience disturbances of this kind, fence in the apiary with a fence of poles, wire or bamboo or a hedge.

Robbing

Symptoms:

- Flights between bees at the flight entrance.
- Dead bees under the hive.
- The colonies are restless and irritable.

Description:

In dearth periods when the bees detect honey or sugar solution in the hives of other colonies, they attempt to remove these. Strong colonies can defend themselves against this, but weak colonies will not be able to do so and are either killed in their attempt to defend the hive or abscond after a while.

Prevention:

- Never spill honey or sugar solution outside the hives.
- Feeding must always be done in the hive so that the bees only have access to the sugar from inside the hive. It is best to give the sugar solution in the evening.
- In weak colonies always make the flight entrance small (5 cm).

- Ensure that the hives are well closed and have only one flight entrance.

Loss of queen

Symptoms:

- Bees are restless in the hive.
- There is a wailing sound in the hive.
- There is either no brood or drone brood in worker cells.
- If there are eggs there is more than one egg to a cell.

Pesticide poisoning

Symptoms:

There are many dead bees on the ground in front of the hive. The bees are not damaged. If the bees are not all dead, they are very quiet.

Description:

If the bees are in an agricultural area which is regularly sprayed with insecticide, the beekeeper runs the risk of having his bees poisoned when they visit the sprayed plants.

Prevention:

- Keep in touch with the farmers and make them aware of the detrimental effects. Together try to find a less toxic insecticide.
- Ask the farmers to let you know when they are going to spray. If they let you know:
 - Provide the hives with a ventilation screen, sprinkle water over the screen and close the flight entrance. The hives must remain in the shade and be watered every day. Open the hives again after 2 days.
 - Temporarily move the hives from the area.
 - For information on the toxicity of various pesticides, we refer you to Agrodok 29: Pesticides; compounds, use and hazards.

Appendix 1: Sizes and dimensions

Table 3: Sizes and dimensions relating to beekeeping for several races of honeybees (*A.mellifera* and *A.cerana*)

	comb spacing(mm)	cell width(mm)	slot width queen excluder(mm)
<i>A. mellifera</i> European	35	5.3	4.2
East Africa (<i>A.m. scutellata</i>)	32	4.8	4.4
<i>A. cerana</i> Nepal	30		3.5
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	-
Phillippines	30	4.7	-
Vietnam:			
North	31	4.7	-
South	26	4.3	-

Appendix 2: Uses for beeswax

Adapted from Peace Corps publication; Small scale beekeeping; Appropriate Technologies for Development by C. Gentry, Washington. USA.

- 1 Grafting wax for horticultural purposes.
- 2 Treatment for cracked hooves.
- 3 Furniture/wood polish.
- 4 Floor polish.
- 5 Leather waterproofer

Further reading

IBRA, **Source Materials for Apiculture**. 1985. A series of 10 leaflets.

Crane A, **Bees and Beekeeping**. 1990. Science, practice and world resources; 614 pages, Heineman, London.

FAO, **Tropical and Subtropical Apiculture**, 1986. FAO Agric. Service Bulletin no. 68; 283 pages.

FAO, **Beekeeping in Asia**. 1987. FAO Agric. Service Bulletin no. 68/4, 112 pp.

FAO, **Honeybee diseases and enemies in Asia: a practical guide.**, 1987. FAO Agric. Service Bulletin 68/5; 51 pages.

Claus B., **Beekeeping Handbook**, 1982. 87 pp. Botswana.

Adjake S., **The Golden Insect: a handbook on beekeeping for beginners**, 1984. 2nd. edition; 104 pp. Ghana.

Villières B. **Le point sur l'apiculture en Afrique Tropicale.**, 1987. GRET, Paris; 220 pp. Available at GRET, 213 Rue la Fayette, 75010, Paris, France.

Espina D., **Beekeeping of the assassin bees.**, 1986. 170 pp. Costa Rica.

Ordetx G.S., **Apicultura tropical** (Spanish), 1986. 506 pp. Costa Rica.

Useful addresses

The **ministry** which concerns itself with beekeeping in your country.

IBRA: The International Bee Research Association,
8 North Road,
Cardiff CF1 3DY,
United Kingdom.

IBRA has collected information on all aspects of beekeeping in the tropics. You can order the section of the “Bibliography of Tropical Apiculture” relevant to your area from the above address. In the Bibliography you will find listed: the literature on bees and beekeeping plants, beekeeping projects and organizations which concern themselves with the promotion of beekeeping. IBRA has an extensive library. Some information leaflets and posters are available free of charge to persons in the tropics.

NECTAR (Netherlands Expertise Centre for Tropical Apiculture Resources), NECTAR is a group of persons who have experience in all types of beekeeping in the tropics. They can support beekeeping developments for groups of organized beekeepers with technical assistance.
P.O.Box 141,
6720 AC Bennekom,
The Netherlands.