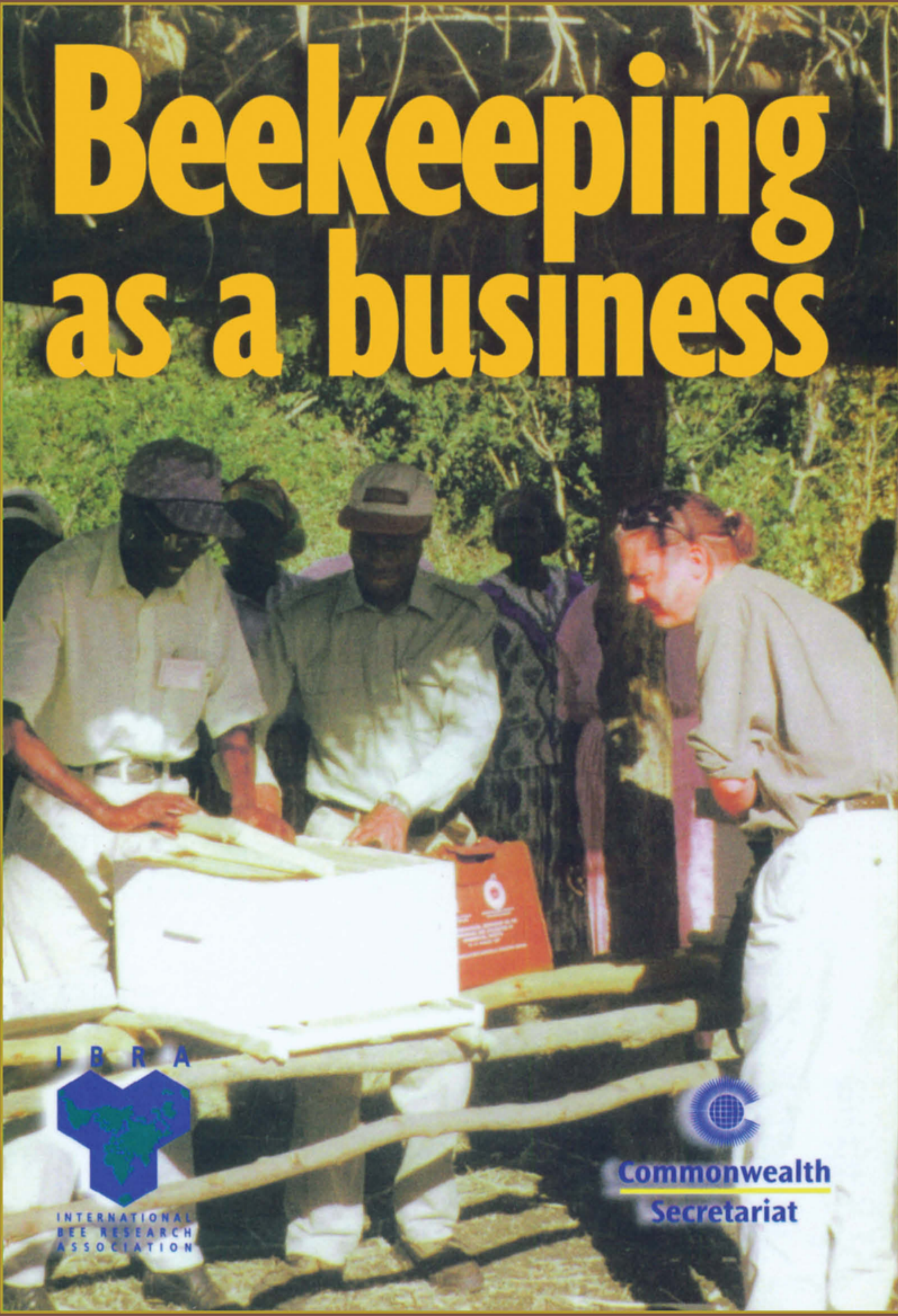
Beekeeping as a business



IBRA
INTERNATIONAL BEE RESEARCH ASSOCIATION

Commonwealth Secretariat

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The **International Bee Research Association** (IBRA) is a not-for-profit organization with members in almost every country in the world. It exists to increase people's awareness of the vital role of bees in agriculture and the natural environment. IBRA promotes the study and conservation of bees which in themselves are indicators of the world's biodiversity.

The **Commonwealth Fund for Technical Co-operation** (CFTC) is the principal means by which the Commonwealth promotes economic and social development in member countries. Administered by the Commonwealth Secretariat in London, the CFTC operates on the principle of mutual assistance with governments contributing financing and skills on a voluntary basis and obtaining technical assistance as needed.

Commonwealth Secretariat
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Cover photo: delegates attending a beekeeping workshop in East Africa

INTRODUCTION

In order to overcome the economic and social malaise experienced in some developing countries, many people are looking to the private sector and the growth of small-scale enterprises as a way to salvation.

The engine for economic growth is strongly influenced by the performance of the local, usually rural, population. These are the people that produce the raw materials and in fact constitute a large part of the domestic market. This sector, therefore, needs to have some, albeit limited, real spending power. A financial power which, although small for the individual, does not depend on or contribute to the destructive downward spiral of debt – loan – debt. There is one very obvious activity that could offer families and individuals the micro-enterprise that tips the economic balance in favour of constructive growth as opposed to at best stagnation or, all too often, decline. That activity is beekeeping.

Beekeeping provides rural people in developing countries with sources of income and nutrition. It is a sustainable form of agriculture which is beneficial to the environment and provides economic reasons for the retention of native habitats and potentially increased yield from food and forage crops.

There is an export market ready and waiting for beeswax, while honey is rather more dependent on the quality of the product offered and the vagaries of currency exchange rates. Other hive products could also be considered for marketing in due course, while ultimately the bees themselves, as queens and packages, can be traded. The range, quality and potential of the products grow in line with the development of apicultural skills.

Complex processing methods are not required and the whole industry can be highly cost-effective. The main item required is the dissemination of information in order to develop skills amongst those interested in making a success of 'Bee Businesses'.

The term micro-enterprise normally refers to family businesses operating in the informal sector. They may have as many as 10 workers although the usual number is one or two. In this way, micro-enterprises provide a living, or a modest but vital margin above mere subsistence, for millions of working poor and their families.

Many developing countries at present face a number of difficulties and challenges. The biggest must be to generate enough work to keep pace with population growth as young people flood into the labour market each year. In these countries, as much as 25% of the overall labour force is employed in micro-enterprises and this is the most dynamic sector of the economy growing at the rate of up to 15% per year.

Against this background, traditional donors are re-assessing their policies in regard to rural development. The focus is on encouraging a range of activities which secure rural livelihoods and which allow individuals and communities to build on their own strengths and realize their potential. Fundamental to this approach is the ability to earn some revenue. Beekeeping provides a good example of one activity which has a strong local tradition in many African countries, where there is a market, and which is environmentally beneficial. However, in the short term, aspiring beekeepers are suffering. There are many men and women keen to improve their apicultural skills. They do not ask for hand-outs of cash, they want the opportunity to acquire knowledge and this is repeated again and again almost everywhere in the developing world.

The joy of the beekeeping business is that it does not need expensive ongoing aid. There is no need to expose well-meant donations to misappropriation or any other reason to divert such money from the intended purpose. The demand is for information and this publication is an attempt to make a start in meeting that demand.

This text replaces an earlier publication entitled *Beekeeping in Rural Development*, which is now out of print. Requests for this text are still regularly received by both the Commonwealth Secretariat and the International Bee Research Association. Therefore it was considered timely to revise the information and produce a text for use at field level. Funding for the work was provided by the Commonwealth Fund for Technical Co-operation. We are grateful to all those who, over the years, have been prepared to share their experiences and whose contributions make up the bulk of this book. Particular mention must be made of Dr Eva Crane, founding Director of IBRA, whose tireless research started and helped to accumulate the vast fund of knowledge stored in the IBRA library. Also, to Dr Margaret Adey and Dr Nicola Bradbear who, during their time at IBRA and since, have done so much to promote beekeeping as a sustainable economic activity. Also, to Peter Paterson for his generous and ready help in sharing his East African beekeeping experiences. Access to such information can only benefit beekeepers wherever they may be.

Finally, thanks to Dr Pamela Munn and Maxine Hopkin for their editorial and production assistance.

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June 1999

SECTION 1 – WHY BEES?

Bees are familiar insects to most people and it is likely that people have hunted and robbed their wild nests since the beginning of his existence. Cave paintings, drawn around 8,000 years ago are early proof of this activity.

Today, in many parts of the world, honey hunting still takes place. Bees are robbed of their honey, nests are destroyed and all too often the bees are killed in the process. However, beekeeping techniques have evolved which conserve the bees and allow regular harvesting of crops of honey and wax. Indeed, people started creating homes, or hives, for bees about 6,000 years ago.

Bee species and races

There are over 20,000 species of bees (Apoidea) in the world. Most of these are solitary bees where each female makes her own nest and lays her eggs but does not usually live in it. A few bees are social, they live in a community known as a colony. Social bees make honey which is their food store. Bees that produce enough honey to make harvesting worthwhile belong to two sub-families – honey bees (Apinae) and stingless bees (Meliponinae).

Apinae has only one genus – *Apis* – of which the species *Apis mellifera* is of much the greatest economic importance.

Apis mellifera in Africa are smaller than in Europe. Their colonies produce many more

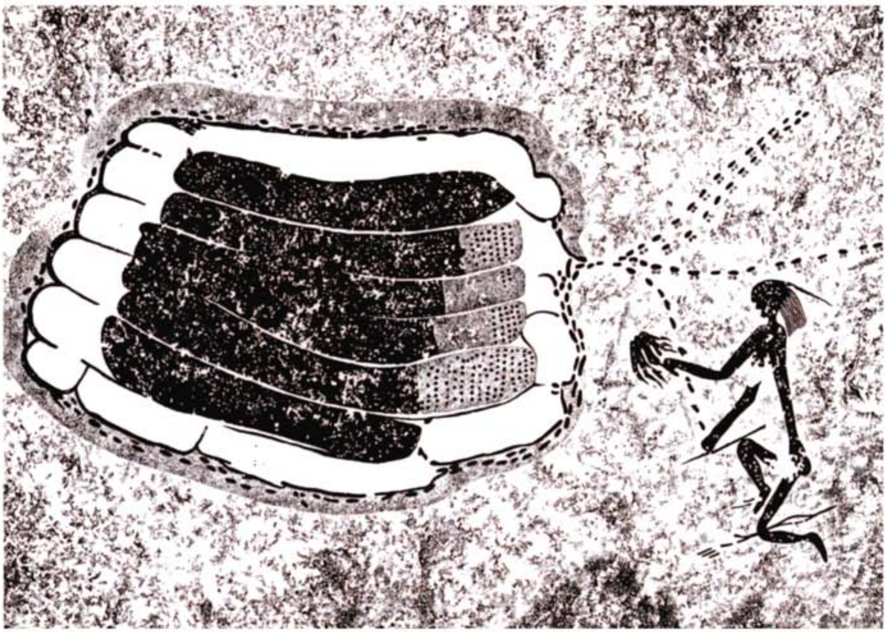


FIG. 1. Rock painting of a honey hunter using smoke to drive bees from their nest. Matopo Hills Zimbabwe, date unknown. (drawn by: Harald Pager).

swarms and are easily alerted to sting and attack. There are two main races of African honey bee – *Apis mellifera adansonii* which predominates in West Africa, and *Apis mellifera scutellata* which dominates in East Africa from Ethiopia to Southern Africa. There are other races but these two are the most important to beekeepers.

Habitats

Bees flourish wherever there is sufficient pollen, nectar, shelter and water to fulfil the needs of the colony. The climate can vary enormously and bees are found in habitats ranging from deserts to forests. However, they do have difficulties in rain forests where humidity and the rain keep them sheltering most of the time.

Pollination

Bees have a vital role in increasing food production and overall agricultural productivity. This is often forgotten but is important in tropical countries where beekeeping can provide pollination. Honey and beeswax are but a bonus to the added value bees can give to crops. It is estimated that more than 75% of the crops in warmer countries benefit from bee pollination.

Pollination is a vital step in the reproduction of flowering plants and involves the transfer of pollen from the male part of a flower to the female part of a flower. It is necessary for all seed and fruit production. In some crops, it is the seed that is harvested for food, for example: oilseed crops, nuts, legumes such as beans and peas, and cereals like rice and maize. In other crops we eat the fruit which develops with the seed, for example: citrus, mango and tomato. Seed is also required for production of the next generation of annual crops and seed production allows plant breeding programmes to select improved varieties.

All seed production and most fruit production thus depend on pollination.

Plants require pollen to be transferred from the anthers (the male parts of the flower) to the stigmas (the female parts) either on the same plant or on a quite separate plant which may be some distance away. Each plant species has evolved its own technique for this important transference of pollen and many species depend upon insects to transfer pollen from one flower to another as they forage. Of these pollinating insects, bees are recognized as the most generally efficient because bees have hairy bodies which easily pick up grains of pollen as they move about in flowers.

During a single day, one honey bee may visit several hundred flowers of one plant species, collecting nectar and/or pollen and transferring pollen grains from one flower to another as it goes. Furthermore, bees are consistent foragers and tend to work one kind of flower at a time.

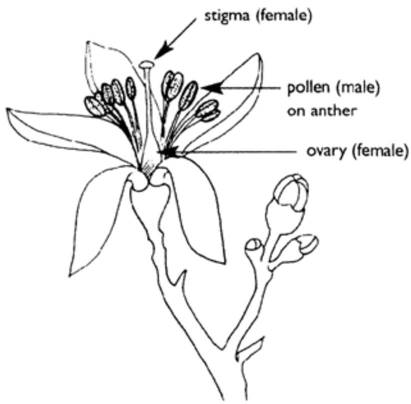


FIG. 2. Flower structure. Pollen from the anthers is trapped in the hairs covering the bee and carried to the stigma of the same plant or another of the same species. This is the first step towards fertilization and the production of seeds and fruit.

FIG. 3. Bee foraging for nectar and pollen.

Crops vary in the extent to which they benefit from cross-pollination brought about by insects. Some crops can be self-pollinating but give better yields if pollinated by insects (for example field beans, coffee, mango); many give a substantially increased yield when pollinated by insects (for example passion fruit, cowpea, sesame, lychee, mustard, cashew) and others are completely dependent on pollination by insects and will not otherwise produce crops (examples are clovers, runner beans, almonds, melons).

An important point, often overlooked, is that adequate insect pollination affects the quality of the crop: uneven and small fruit are often an indication that pollination has been insufficient. Adequate pollination by insects also ensures that early flowers set seed; this results in a uniform and early harvest and gives the crop the maximum possible length of time to mature.

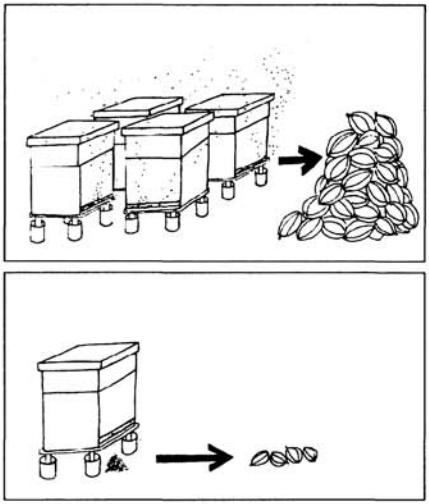


FIG. 4. Bees are important to crop growers. On many crops more bees mean better pollination and higher yields. If bees are killed the value of crops will be reduced.

Certain types of modern agriculture result in monocultures. If such crops require insect pollination it is unlikely to be adequate unless special arrangements are made – usually the introduction of hives of bees. Similarly, crops grown on irrigated desert land will have no wild bees or other native insects to serve as pollinators.

It is in everyone's interest to maintain strong populations of honey bees and other pollinating insects. Some honey bees are managed in hives by beekeepers but they can also be found living in the wild.

Farmers can help by:

- Selecting and using pesticides with great care. If wild pollinating insects are destroyed, there is the risk of losing good crop yields in the future.
- Never use pesticide when flowers are open. Foraging insects work on open blossoms and will be killed if sprayed at this time. If pesticide must be used, it is best sprayed early or late in the day when crop flowers are closed.
- Allow wild plants to flower on waste pieces of land. These will help support populations of wild foraging insects when cultivated crops are not flowering.

FIG. 5. The toxicity of a pesticide (how poisonous it is) is different for different pests. Always try to choose a pesticide that attacks the pest but will not harm bees.

FIG. 6. A pesticide is more likely to kill bees if it is applied to flowers during the day while the bees are on them. If spraying has to be done it is best carried out at dawn or dusk and when there is no wind to drift the spray onto other flowering plants or onto the beehives.

Everyone can help by:

- Being aware of, and teaching others, the important value of pollination by insects.
- Increasing local forage by making sure that nectar-bearing bushes and trees are included in planting schemes.

FIG. 7. Everyone needs to know about the value of pollination.

- Preventing unnecessary use of pesticides.

The forage available to bees in an area changes. Bees harvest what they can but are unable to control what is available to them except by migrating. Sometimes, it is possible for beekeepers to move their hives to different bee forage in order to maximize honey flow and to improve crop pollination.

Most foraging is done within one or two kilometres of the hive (about one mile), although much greater distances have been recorded but this is not efficient if the hives are properly managed. Also, the foraging area is not a neat circle with the hive at the centre. The area will be highly irregular and will depend on the lie of the land, the vegetation (bees have their likes and dislikes) and the weather.

Honey bee pollination has been proved to increase the seed or fruit yield of these crops:

- almond
- apple
- apricot
- asparagus
- avocado
- *Brassica* species such as cabbage, cauliflower, Chinese cabbage, mustard, oilseed rape, sarson, swede and turnip
- buckwheat
- cardamon
- carrot
- cherry
- clover species such as ball, crimson, Persian, red, sweet, white
- coconut palm
- coffee
- coriander
- cotton
- cucumber/gherkin
- dill
- eggplant
- feijoa
- field bean
- gourd species such as pumpkin and squash
- grape
- hairy vetch
- horse gram
- kenaf
- kiwi
- lespedeza
- longan
- lucerne, alfalfa
- macadamia
- mandarin orange
- mango
- melon
- niger
- onion
- papaya
- peach
- pear
- pimento (allspice)
- plum
- radish
- rambutan
- runner bean
- safflower
- sainfoin
- soyabean
- strawberry
- sunflower
- sweet chestnut
- sweet vetch
- water melon

Honey bees and other insects are involved in the pollination of these crops:

- *Acadia*: various species
- acerola
- adzuki bean
- angelica
- anise
- arrowroot
- artichokes: various species
- ash gourd
- ber
- beet, sugar
- bergamot
- berseem
- borage
- box elder
- butter bean
- bottle gourd
- carambola
- caraway
- cashew
- celery
- cassava
- castor
- chayote
- cherimoya
- chestnut, Japanese
- chicory
- chives
- citrus fruits such as lemon varieties, satsuma, pomelo, orange, grapefruit, citron, tangerine
- clove
- clover, strawberry
- cluster bean
- cocoa
- coconut palm
- cress, rocket
- date palm
- derris
- durian
- endive
- Eucalypt: various species
- fennel
- fig
- flax
- granadilla, giant
- groundnut: some varieties
- guava
- haricot bean
- hemp
- henequen
- horse bean
- indigo
- jujube, Chinese
- kudzu
- leek
- lettuce
- loofah
- lupin
- lychee
- marjoram
- medick, black
- mesquite
- milkweed
- mint, garden
- mung bean
- nutmeg
- oil palm
- okra
- parsley
- parsnip
- passion fruit
- pawpaw
- pea: various species
- peppermint
- persimmon
- pili nut
- potato: some varieties
- potato, sweet
- pyrethrum
- quince
- quinine
- rice bean
- rosemary
- rubber, para
- saffron
- sesame
- silk-cotton tree
- sisal
- sword bean
- tamarugo
- tea
- tephrosia
- tobacco
- tomato
- tonka bean
- toria
- tung: 2 species
- vetch, kidney
- wattle, black
- willow
- yam
- yucca

FIG. 8. Migratory beekeeping is a way of providing pollinators where they are most needed to give good crop harvests.

Honey can only be made after the bees have collected the nectar from the plants. If the nectar is inaccessible, not sweet enough or the plant is difficult for the bee, then they will not wish to work those plants but will look elsewhere.

An area may be over or under-populated by bees at any one time. The increasing trend to grow one crop on a large scale can mean that an area could support 50 colonies for a short period and not provide enough for one or two colonies for most of the year. In some places, beekeeping is becoming more dependent on migration and many countries could do yet more to exploit their nectar sources by using this method of apiculture.

SECTION 2 – THE BEE COLONY

The colony

Honey bees are social insects and live in a colony consisting of one queen, a few hundred males (drones) and, in a strong, healthy colony, up to 80,000 workers.

Honeycomb

The honey bee has evolved one of the cleverest systems of nest-building of all insects. Worker bees have four pairs of wax glands located on the underside of their abdomens. Drones and queens do not have these glands.

The building of the comb begins from an irregular pattern of wax spots that the bees make on the surface above them. In the wild this can be the roof of a cave or the inside of a hollow tree. In a hive, it will be along the top side of one of the frames. One of the spots is then built on and grows. It grows as a pattern. Bees working out from the centre stop when they encounter another bee working on a cell. The pattern is hexagonal (six-sided).

The hexagons are very strong. When the comb is finished, about 50 g (2 oz) of beeswax will hold 2 kg (4½ lb) of honey.

The combs are developed vertically downwards and parallel to one another. The hexagonal cells are not horizontal but slope slightly downwards from the outside to the inside. When the queen lays her egg in the cell it does not roll out. The honeycomb consists of two sets of cells 'back-to-back'. For even greater strength, the walls of the one set of cells cross the mid-point of the other cells. Scientists have recently found that the hexagonal-shaped cells are the strongest possible shape that could be used.

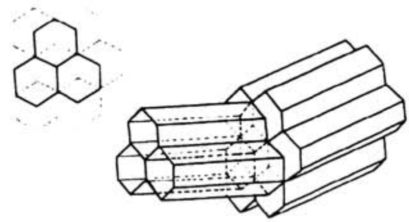


FIG. 9. Comb cells on one side of the central wall have their centres where three cell walls from the other side of the central divide meet. This helps to give the comb strength.

FIG. 10. Comb that has become established on a top bar from a hive with sloping sides.

They give maximum storage space and use the least amount of wax.

Drone cells are slightly larger than worker cells. Queen cells are totally different and are always built downwards.

FIG. 11. Worker, queen, drone.

Anatomy of a honey bee

Bees have an external skeleton (exoskeleton) consisting of layers of cuticle which provides a hard protective casing over the body. It is waterproof and much of it is covered with hairs to provide insulation and further protection. Some hairs are important in the gathering of pollen and for certain sense organs.

Like any insect the body is divided into three parts – head, thorax and abdomen.

The thorax has four segments of which three are recognized as true thoracic segments and each of these supports a pair of legs; two segments each carry a pair of wings. The two wings on the same side of the bee's body are joined to each other by a row of hooks on the front edge of the rear wing which engage in the rear edge of the front wing.

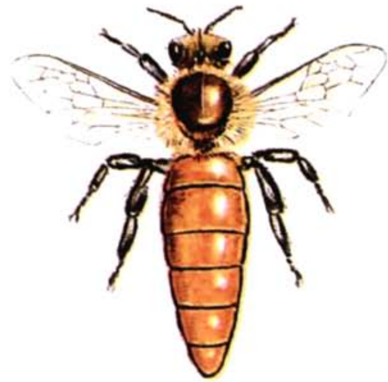


FIG. 12. Queen.

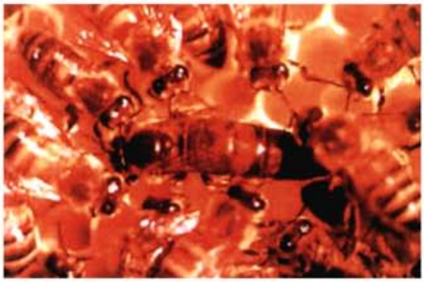


FIG. 13. The queen is surrounded by her attendant workers. She is an egg laying machine laying one egg per cell.

The queen

There is one bee bigger than all the rest, she is the queen and it is her task to lay eggs. She has a sting which is used only against males and rival queens. About five days after emerging from her cell, the queen takes a series of flights during which she mates with a number of males. The males' sperm is stored and the queen never mates again. A further five days after these flights, she starts to lay. She can live for several years and lays up to 2,000 eggs per day. Older queens do not have the egg-laying capacity of younger queens, which are therefore preferred by beekeepers. She does not feed herself and is fed by the workers.

Several of the queen's glands produce complex chemicals, or pheromones. These chemicals are distributed throughout the nest and serve to control the other individuals and harmonize the behaviour of the colony.

The drones

These are male and are bigger than the workers but not as big as the queen. They have large eyes that cover practically all of the head. The end of the abdomen is rounded but there is no sting. At any one

FIG. 14. Drone.

time there may be between 200 and 300 drones in a colony. Their only job is to mate with a queen. Mating takes place in the air away from the colony. Mature males gather in certain areas where they wait for a virgin queen to fly by. When resources are limited and times are hard for the colony, the drones are thrown out of the nest and die as they cannot look after themselves.

The workers

There can be as many as 80,000 workers in the colony. They are all female but do not lay eggs. They do a number of different jobs including: cleaning the hive, feeding the larvae and the queen, building the honeycomb, defending the hive, collecting pollen and nectar.

FIG. 15. The honey bee worker.

Workers have special glands and organs to help them do these various tasks. Glands on the front of the head produce brood food and royal jelly. Wax glands under the abdomen produce the material for the comb. Odour glands on the upper part of the abdomen produce a scent to communicate with other bees when, for example, the colony is disturbed.

At the tip of the abdomen there are glands associated with producing venom for the sting which the bee uses to defend the colony. In the head is a long tongue used for gathering nectar.

A part of the intestine is enlarged to form the honey sac or honey stomach where nectar and water are carried.

On the back (hind) legs are pollen baskets. Pollen is combed from the body and pressed into pellets and carried in these baskets back to the hive. Propolis (see page 17) is carried in the same way.

How a worker grows

Each honey bee in the course of its life passes through four stages:

egg – larva – pupa – adult

The workers develop in the near horizontal cells that form the comb from fertilized eggs that have been laid in response to the queen's reaction to worker-size cells.

In the egg, the embryo develops by absorbing the rich source of protein that is the yolk. The larva hatches from the egg after three days and feeds on the provisions put into the cell by the nurse bees. Feeding continues for about five days. Thus, after a total of about eight days' development the cell is sealed.

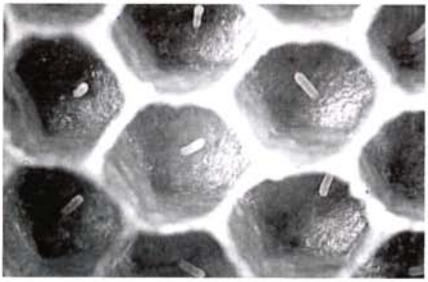


FIG. 16. One egg laid in each cell. The cells slope towards the centre so that the eggs do not fall out.

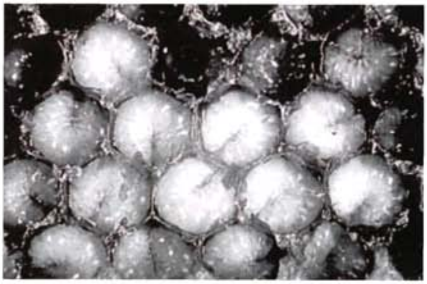


FIG. 17. Brood, otherwise known as larvae, developing.

The worker brood occupies most of the brood nest in the central, most protected and thermally regulated part of the cluster of bees — that is, where the temperature is best controlled.

The newly formed adult worker nibbles away the cap of the cell and emerges as a rather soft greyish bee. From egg to emergence takes between 18 and 20 days.

How a queen bee grows

Queens, like workers, develop from fertilized eggs. They become queens as a result of a different diet secreted and placed in the cells by nurse bees.

The queen cell is very different from other cells. It hangs vertically and may be built between the combs thereby interfering with the bee space. The exterior is mottled in colour with a tapered shape.

There are two types of queen cell. One is made by enlarging a worker cell and allowing the worker larva to migrate into the enlarged portion where it will be specially fed to become a queen. This is an emergency queen cell, built when a colony becomes queenless. The other type of queen cell is built as part of the normal reproductive process. Again vertical and often at the bottom of the comb.

The larva hatches after three days. It is fed on royal jelly for approximately five days when the cell is capped. The queen emerges about 15 days after the egg was laid.

How a drone grows

Drones develop from unfertilized eggs laid by the queen in drone cells which, although still almost horizontal, are slightly bigger than the cells of worker brood. The queen controls whether an egg is fertilized or not as she lays it.

Again after three days, the egg hatches. The larva is then fed for approximately seven days and so receives much more brood food than the larvae of worker bees. The cell is

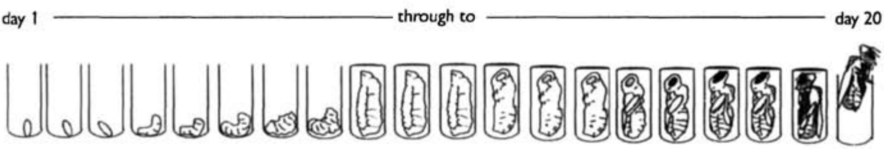


FIG. 18. Developmental growth of the worker honey bee – day by day.

FIG. 19. A ripe or capped queen cell.

sealed and the cap is domed to make enough room for the larger drones. The drones emerge after 25 days. Most drones are produced during the reproductive (swarming) phase of the colony's cycle.

By the time the bee emerges from the cell, the adult body form is defined and fixed. However, full development of the glandular and reproductive systems takes place afterwards.

A short but busy life

Bees live for about six weeks and then die from overwork. In this short time, they perform many different tasks within the hive at different ages: cleaner, nurse, stores' manager, builder, guard and food gatherer. Most worker activities within the nest are social but what each bee does depends on the development of its various glandular systems. This is linked to age and to the needs of the colony.

During the first days of life it is essential that the worker bee feeds in order to develop her different glands to their full potential. When the worker bee emerges from her cell in the comb, she finds a cell full of pollen and eats well. She can then start her working life as a cleaner. The honeycomb cells are cleaned so that they can be reused by the egg-laying queen or for food storage. The worker bee does this job for about four days, gaining strength all the time.

From day five to about day nine in her life she has the job of nurse. Glands in her head secrete food which becomes part of the royal jelly that nurtures larvae, some of which may be destined to be queens. She also makes a mixture of honey and pollen – bee bread – and feeds it to the older larvae.

By about the ninth day, the glands on the bee's head have become inactive. However, the glands on her abdomen now start to produce wax. Therefore, from the 10th to

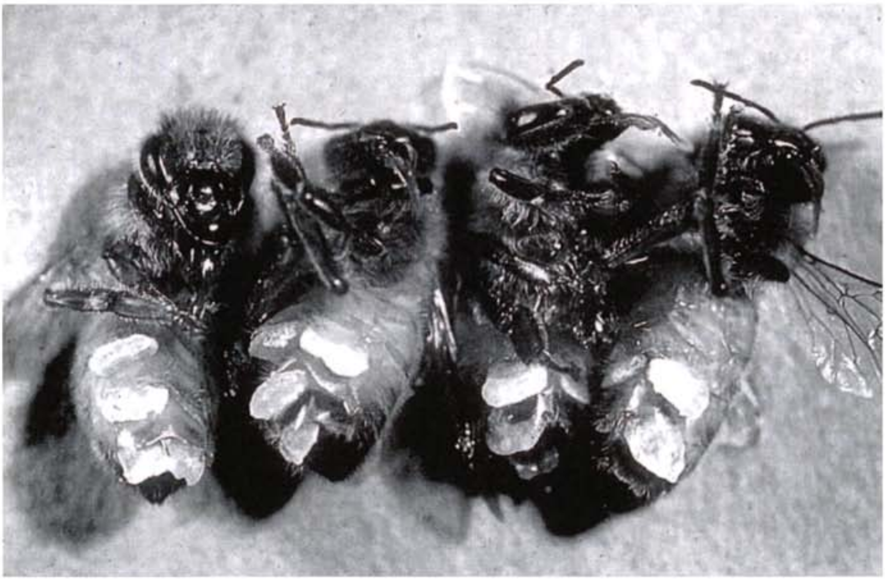


FIG. 20. Wax glands producing wax scales.

FIG. 21. Pollen collected in the pollen baskets of foragers.

the 16th day she is busy using wax to build comb.

When the wax glands cease to secrete, the worker becomes a stores' manager. The 17th to 19th days are spent taking pollen and nectar from bees returning to the hive and carefully packing it as a food store in the comb. During this period she also helps to ventilate the hive by flapping her wings. This allows the air to circulate, it also strengthens the muscles that work the wings in preparation for the first flights from the hive.

There are always workers to attend to the queen. As she gets on with the business of laying eggs there are workers to feed her and groom her. While touching her, these workers pick up her 'messages' through chemicals called pheromones. They then pass the message on to other bees as they make contact crawling round inside the hive. In this way, the queen can control a colony of 30, 50 or even 80 thousand bees.

Before taking flight in search of nectar and pollen, there is another job to perform – that of sentry. Around the entrance to every hive there are guard bees whose duty it is to keep out wasps, moths and other intruders. At times of food shortage they will kill off the drones (male bees) by preventing them from returning to the hive.

The rest of the worker bee's life is spent seeking food. This main work of the bee is known as foraging, that is to go out and collect nectar and pollen.

Nectar is the sweet liquid plants produce to attract insects for pollinating. The bees suck up the nectar from the flowers and store it in their honey sacs and carry it back to the hive. There they regurgitate it and pass it to another bee. During these processes, enzymes are added to the nectar which start to change it into honey. The honey is stored in the honeycomb.

Pollen is the fine dusty material that collects on bees as they collect nectar. They carefully comb their bodies and collect the pollen in special pollen baskets on their back legs. It is taken back to the hive where it is pressed into the comb by hive bees using their heads like hammers. Pollen is always stored near the larvae so that it is readily available and most of it will be used to feed the young.

Bees collect other materials on their foraging trips. Like all living creatures, they need water to satisfy their own thirst but also to control the atmosphere within the hive. During very hot periods, bees will carry water back to the hive where it can evaporate and so help control the temperature.

Bees also produce propolis (this is not a food but a building material). It is a sort of bee glue and is used to seal cracks in the hive, to strengthen the comb and to mummify any intruder such as a beetle or even a mouse which has been killed and is too large to move. Propolis is plant resins collected from the buds of various plants, some trees, sometimes mixed with beeswax. The bees carry it in their pollen baskets. It is very sticky and so the workers need the help of other bees to remove it when they return to the hive.

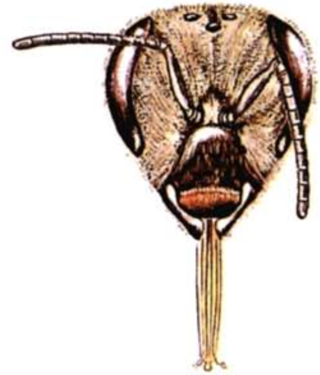


FIG. 22. Bee senses: head of worker.

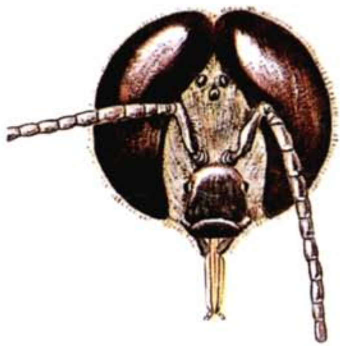


FIG. 23. Head of drone.

Bee senses

In comparison with other insects, the bee has an unusually large brain in relation to the size of its body.

Bees have two large compound eyes and three simple eyes. The compound eye is made up of very many tiny lenses. These eyes may not see things clearly but are sensitive to small movements. They also recognize colour but not the same colours that are seen by the human eye. Bees do not see red but can see ultraviolet which is not visible to humans. Ocelli or simple eyes on top of the head react only to light intensity.

The antennae provide sensory information on movement, taste and humidity. They also respond to smells and the presence of carbon dioxide.

Bees also react to sounds which they perceive as vibrations felt by the antennae and the legs. The hairs on the bee's body are sensitive to touch.

Communication and control of the colony

Living in a large group or community, bees need to communicate with one another. They do this in a number of ways, not all of which are understood by science. They may communicate by making various noises

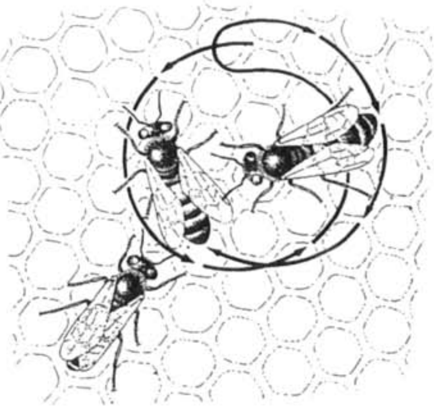


FIG. 24. The round dance tells other bees the nectar is not far away (less than 100 metres).

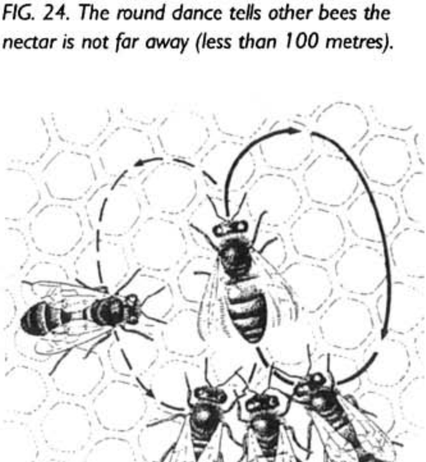


FIG. 25. The waggle dance tells other bees the nectar is further away. The bee moves around the figure-of-eight and waggles its body as it moves along the middle.

perhaps by drumming of feet or flapping of wings. They may also communicate by touch and food exchange.

Although the life of the colony centres on the queen, she does not rule it. Colony 'decisions' are taken by the collective behaviour of the bees, and many factors are involved. Pheromones play an important part in control of the colony. These are chemical substances produced by bees to convey precise messages to other bees. Honey bees have a number of pheromone systems controlling their behaviour, but the methods by which these chemicals exert control are extremely complex.

Queens, drones and worker bees, including brood, all produce pheromones. Queen pheromones attract workers to her, stimulate foraging, brood-rearing and comb-building, and inhibit queen-rearing. The presence of the queen has a profound effect upon the workers. If the queen is removed from a hive then a change in behaviour of the colony can be detected very quickly. This communication is brought about by important behaviour – food-sharing. When two bees meet in the colony they are likely to exchange food: one offering nectar, the other drinking it. Thus, every bee in the colony is constantly giving and receiving food and all bees within the colony share the same odour. This is very important in aiding guard bees to detect intruder bees from other colonies. Minute traces of pheromones are mixed in with the food, and the absence of the queen and her pheromones will quickly be realized by every bee. This explains why a colony swarms when its population becomes very large: workers are no longer in close enough contact with the queen and begin to rear replacements.

The waggle dance

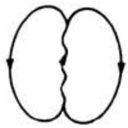
The most studied form of communication is the waggle dance. This is generally believed to be the way in which bees tell one another of the location of food, although odour is also important.

The returning bee will give the other bees a taste of the nectar she has collected. It is almost as if she is saying: 'This is good, watch me and I will show you where to get more'.

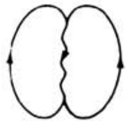
There is a round dance which tells the other bees that there is nectar not far away – probably within 100 m (100 yards) of the hive. The bees fly off and look around the hive.

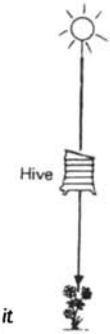
The waggle dance tells the other bees the nectar is further away. The bee moves in a figure-of-eight and waggles her abdomen when she moves up the central line.

If the dance goes straight up the honeycomb, then the nectar is in the direction of the sun.

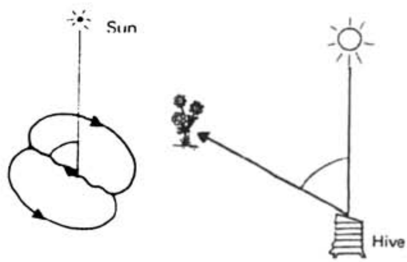


If the bee dance goes straight down, then the nectar is away from the sun.





When the dance is at an angle, it shows the angle to the sun the bees must fly to find the nectar.



The waggle dance also tells other bees how far away the nectar is. The longer she waggles while dancing, the farther away the nectar, while the faster it waggles the nearer the nectar.

FIG. 26. Explanation of the waggle dance.

SECTION 3 – WILD BEES, NESTS AND TRADITIONAL HIVES

Bees have produced honey long before humans appeared on the Earth and continue to do so with or without human help or interference. The wild bee colonies that are diseased or weak tend to die out and the strong healthy ones remain by a process of natural selection.

In the wild, bees will establish themselves in any suitably-sized cavity which could be located in a hollow tree, a rock crevice or hole in the ground. Such a home will be at a favoured height, suitably sheltered, dry, well ventilated so as not to get too hot or too cold. The entrance will be small enough to be easily defended.

FIG. 27. In the wild, honey bee colonies can be found in rock crevices, trees or buildings.

The cavity will be quite dark and this encourages the bees to start making comb. However, once they have started to make comb they will continue even if the light intensity increases.

The combs are always built vertically downwards and are two-sided. They are comprised of hexagonal (six-sided) cells which will contain the stored honey at the top of the comb. This is often followed by a band of stored pollen and below this cells will be filled with brood. The distribution of stores and food always follows this plan. This is important when it comes to harvesting the honey.

A swarm of bees will start to make a honeycomb provided a queen is present and they are in a position of low light intensity. Comb construction starts from one point. The comb will develop downwards in a curve similar to that taken by a bicycle chain held at two points approximately 450 mm (18 inches) apart. Further combs will develop on each side of the first one at a space of about 32 mm (1¼ inches) from the centre of one comb to the centre of the next.

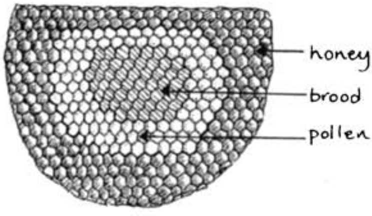


FIG. 28. Whether they live in hives or in the wild, bees build nests made of wax cells in vertical sheets (comb). In some cells brood develops into young bees and in other cells pollen and honey is stored.

FIG. 29. Comb developed by bees in a box without frames or top bars. Combs are always constructed parallel to one another but may curve. The distance between the surfaces of the comb is the 'bee space'.

Eventually, in the wild there can be five or six roughly parallel combs. The largest comb will be in the middle and will measure about 350 mm (14 inches) in width and 280 mm (11 inches) in depth. The combs each side of the central one get progressively smaller. However, this is an ideal situation and bees will make their combs fit the cavity.

Combs are always constructed parallel to one another but may curve. The distance between the surfaces of the comb is the same. This is the 'bee space'.

The bee space, or bee way, is the path or corridor bees need to move between the combs and around the nest. It is between 6–10 mm (¼ inch and ⅜ inch). If there is a space less than 6 mm (¼ inch) bees will fill it with propolis (bee gum). If it is more than 10 mm (⅜ inch) then burr or bracing comb is constructed. These do occur in wild colonies but also in hives that have been constructed by humans, particularly if insufficient attention has been paid to construction and accurate measurement.

Anyone making a hive must make sure that the correct bee space is provided or the hive will not work efficiently. This is very important in the construction of frame hives which must be machine-made by highly skilled craft workers from well-seasoned timber. Construction of top-bar and fixed-comb hives is easier.

Colonies of honey bees reproduce by division of the adult population and the migration of a part of the colony (a swarm) to a new place. Each swarm carries the adult queen from the parent colony where she is replaced by a new queen reared there before or after the swarming.

Reproductive swarming is not the only type of swarming as bees are sometimes forced to migrate for other reasons. For example, if they are seriously disturbed, or disturbed too often, they will abscond. Similarly if there is not enough food in an area they will be forced to migrate (hunger swarming).

Wild bees are increasingly having their habitats destroyed by new farming methods

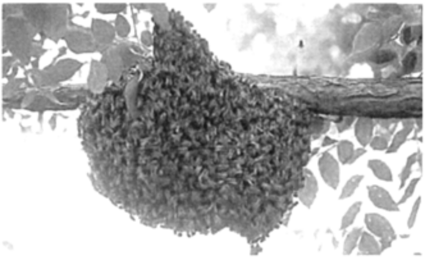


FIG. 30. A swarm that has settled in a shady tree.

and often suffer the ultimate destruction of being smoked out or killed for the short-term gain of just one honey crop. Often the larval and pupal stages are also eaten and any bees that survive are doomed. This is destructive not only to the bees but to the whole environment. If, instead of being destroyed bees are encouraged to settle into pots or bark hives, then just the honey is harvested and the brood survives. This does not require any knowledge of the biology or management of the colony but at least ensures that the bees continue to exist.

Traditional hives

This is an intermediate step between hunting, robbing and killing bees in a nest and keeping bees in a totally managed environment. The traditional hives are made from any suitable material easily available in the area.

Bees have been kept in hives for at least 4,500 years and traditional hives are simple, purpose-built containers for the bees and their combs. In many there are no fittings, such as the frames associated with modern beekeeping, and bees secure their combs to the interior of the hive. These hives are now referred to as 'fixed comb' in order to differentiate them from movable-comb hives.

In fixed-comb hives the beekeeper can remove the combs for harvesting, or any other purpose, only by cutting them away. With movable-frame and movable-comb hives any comb can be removed, replaced or exchanged with another as a unit without any cutting or breaking.

Bark has been used for centuries to produce cylindrical hives. It is stripped from the tree and fastened together to form a pipe. However, this process is very destructive. The debarking kills trees which have already been much reduced in numbers and so alternatives should be found which do not further degrade the environment.

Hollowed logs can be taken from dead or already felled trees.

Another alternative is to make a light framework of rings and to cover them with a thatching material, grass, reeds or banana fibre, which may be plastered with mud or cow dung.

Metal drums or cylinders made out of hammered corrugated-iron sheeting have been used but unless well shaded they must be covered with some insulating material in order to avoid excessive heat. Sometimes a wooden hive can be protected by being placed inside an old oil drum.

The most common type of traditional hive is a cylinder, or even a box with a square cross-

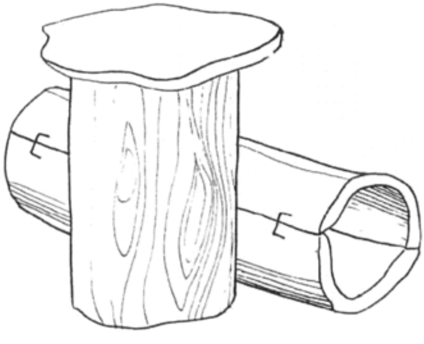


FIG. 31. Traditional fixed-comb hives made from hollow logs.

FIG. 32. Close up of a log hive suspended from a branch.

FIG. 33. Hive made out of woven materials which can be plastered in mud or dung.

FIG. 34. A box hive placed inside an old oil drum for protection.

section, laid horizontally. In its most basic form, only one end of the hive can be opened. In more developed forms, both ends can be removed to give access. A skilled beekeeper can perform a great number of management operations, even with such a basic hive.

The flight entrance for the bees is at one end of the cylinder near the edge of the closure. To harvest the honey, the beekeeper removes the back end closure and blows smoke through the opening into the hive to drive the bees towards the front. The brood is at the front of the hive and the honey is stored towards the back. The back combs of honey, once relatively free of bees, can be cut out one by one, while the brood, which is the next generation of workers, can be left almost undisturbed.

From very early in their pursuit of honey, people learned to use smoke to repel the bees and reduce their aggression. Smoke has a subduing effect and induces the bees to feed. Bees full of honey are generally easier to handle.

Skilled beekeepers open the front closure and can, after smoking, remove the brood combs and inspect them. It is then possible

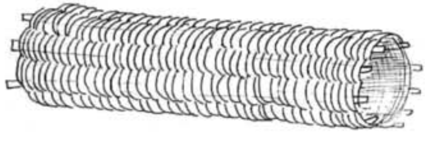


FIG. 35. Woven canes covered with mud or dung.

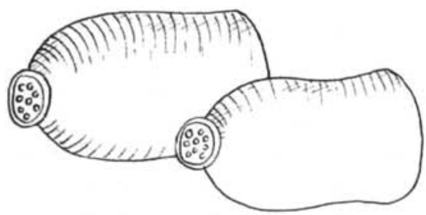


FIG. 36. Gourds, clay pots or calabashes.

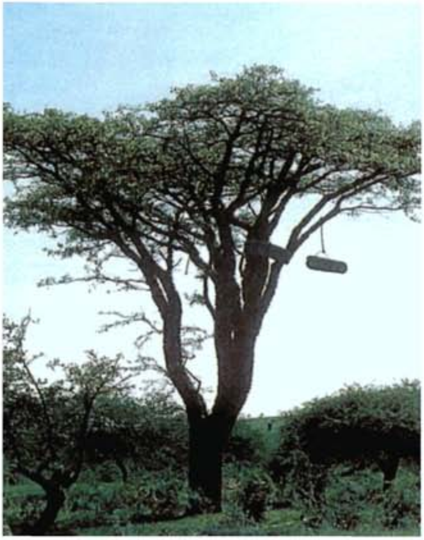


FIG. 37. Traditional log hive suspended from a tree where it is safe from most predators.

to place this young brood along with some adult bees in an empty hive and so start a new colony. Alternatively, they could be cleaned of bees and used to prime an empty hive to receive a swarm. Of course, it would be necessary to fix each comb with a stick or twig ensuring that the correct bee space is maintained.

Many beekeepers in East Africa use a horizontal hollow log for a hive suspended from a tree to protect it from enemies. Some beekeepers cut the log lengthways at or below the centre line and tie the two parts together with vines, ropes or wire. When harvesting honey, the log is forced apart, the upper part usually having the combs attached to it. The combs are cut away and the log tied together and once again returned to the tree.

When developing beekeeping as a micro-economic activity with tropical bees, the

FIG. 38. Harvesting from a traditional hive . Note the many dead and unconscious bees overcome by smoke.

FIG. 39. Hives with movable frames have many advantages over traditional fixed-comb hives. The top-bar hive is one of the simplest movable-frame hives. It is a single long box that can be constructed from locally available materials such as straw.

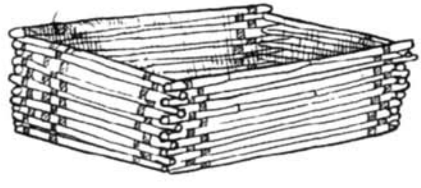


FIG. 40. Bamboo.

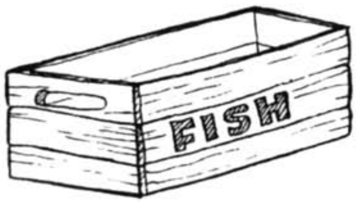


FIG. 41. Wood which can come from old packing boxes or crates.

introduction of modern upright hives is not the only alternative. Upright hives were developed in temperate countries where bees have to survive winters and periods of cold weather. Thus, by storing honey above the brood and bee cluster, these winter supplies provide insulation by retaining the heat of the cluster.

In tropical and sub-tropical areas, retaining heat is not a problem, indeed it is usually warm enough for bees to forage all year. Bees in the horizontal hive may help to avoid overheating by spreading out to the ends. Much progress can be made whether the hives are of the traditional kind or with top bars or frames.

Modern beekeeping with movable-frame box hives often involves operations which change and swap frames and boxes with bees between hives or even movement from one part of the country to another. There are benefits to be obtained from this but there are also dangers. Diseases and parasites, new to an area, can be brought in and spread. When they reach fixed-comb hives such pests and diseases go undetected and so go untreated with disastrous consequences.

In areas where there are only fixed-comb hives, the causes of bee ill health may not be understood but there is less chance of transmission from one colony to another.

Traditional hives give a modest amount of honey (and about 10% of the honey weight in beeswax). This is achieved at a minimal cost in materials and labour. Improvements in yield can be brought about but require a certain investment in time, labour and, to a lesser degree, materials.

Modern hives consist of a series of boxes (tiered boxes) stacked vertically. Each box is fitted with appropriate-sized, four-sided frames in which the bees build their comb.

It is possible to have movable combs without these complexities and materials. Such hives only have a top bar. The bees build down from the bar therefore the beekeeper can remove any comb from the hive just by lifting the top bar. A long single box is commonly used for such a hive. The top bars fit closely together so that the bees cannot pass between them. Often, boxes originally constructed for another purpose can be successfully adapted into this type of hive.

SECTION 4 – TOP-BAR HIVES

The top-bar hive is a relatively cheap and simple hive that allows beekeepers in the tropics to manage their bees in a more efficient way than with the traditional fixed-comb hives. As the name suggests, bees build their comb from the top bar not from the ceiling of the hive as in traditional fixed-comb hives or within wooden rectangles as in a frame hive.

Top-bar hives offer the following advantages:

1. The only exact dimensions required in construction are those of the top bar itself. Other measurements are not too critical, so that hives can be made with simple tools from relatively cheap local materials.
2. The size of the hive can vary to suit local conditions.
3. Every comb is accessible without removing the others. This one-bar-at-a-time technique causes less disturbance to the colony and greatly reduces the number of bees flying around when the hive is open.
4. The brood can be inspected easily, which gives the beekeeper real control over the management of the hive.
5. The beekeeper can judge the exact time when combs are ready for honey-harvesting without disturbing the brood. The honey is also of higher quality as the combs can be selected to be free of pollen and brood.
6. The top-bar hive makes it possible to gather good quality beeswax for which there is always a ready market.
7. No lifting is required other than the combs. The top-bar hive can be managed by those who cannot lift heavy weights.
8. All top bars are at the same level, which can be chosen to suit the individual. This and point seven above mean that this form of beekeeping can be carried out by the physically disabled and not just those who are fit and strong.
9. If there are predators, hives can be suspended by wires above the ground at a height convenient for operation.
10. The better management techniques promoted by these hives help protect, preserve and increase the bee population. This then benefits the economy through increased pollination as well as honey and wax production.

How to make top-bar hives

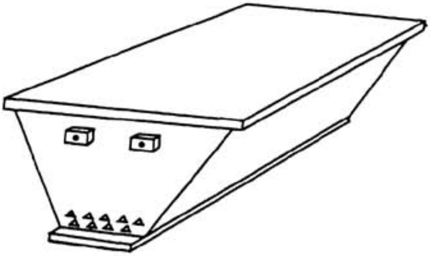
A hive can be made of any wood providing it is:

- Not warped or twisted.
- Resistant to the rotting effects of sun and rain.
- Very few woods are termite proof and so all hives have to be protected from termite attack.

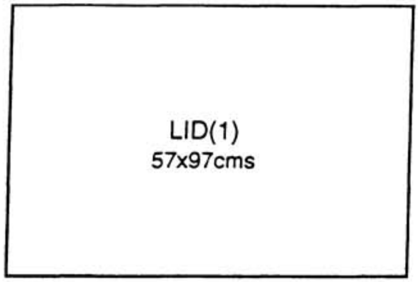
The hive itself consists of just six parts the dimensions of which are not very critical and so construction does not require highly skilled labour.

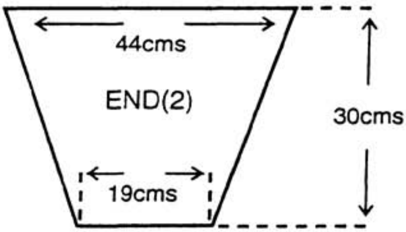
In the wild, bees develop their comb downwards in a gentle curve. Therefore, the sides of the hive need to be at an angle which approximates this curve. This limits the inclination of the bees to attach the comb to the side walls.

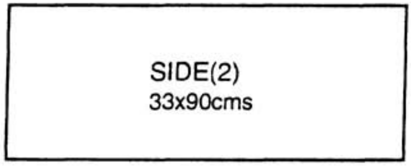
The top bars themselves do require critical measurements and uniformity. Here there are advantages to be gained from machine-cutting which can ensure constancy and

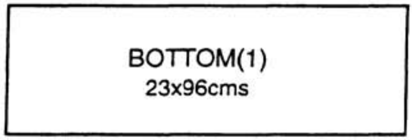


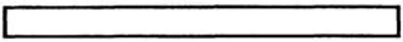
The hive is made from wood approximately 19mm (3/4 inch) thick. The front will require about 10 small holes.



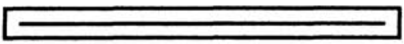








Top bar viewed from above 32mm x 480 mm (1¼ in x 19 inches). The length is just a guide but it must be 32 mm (1¼ inches) wide.



Top bar viewed from below with groove cut in lower surface.

Alternative cross-sections: (a) groove as above into which beeswax is placed to encourage comb formation (b) 'V' shaped cross-section to encourage comb formation.

FIG. 42. Making a top-bar hive. The dimensions are only given as a rough guide and can vary according to local needs. All surfaces need to be smooth and all joints free from cracks and gaps.

FIG. 43. A top bar taken from a hive with straight sides.

FIG. 44. A top bar taken from a hive with sloping sides.

accuracy. However, the same effect can be achieved with hand tools as long as time is taken to ensure absolute accuracy. The bar must be 32 mm (1¼ inches) wide. This is important as the tropical honey bee builds a comb which has a thickness of 25 mm (1 inch). The comb is attached to the centre of the bar thus leaving a space of 3.5 mm (⅛ inch) on each side. When two neighbouring top bars develop combs the gap is 7 mm (¼ inch) (3.5 mm + 3.5 mm, ⅛ inch + ⅛ inch). This inner space (bee space) is vital to allow the bees to walk freely on the comb. A hive of this kind needs to hold between 20 and 33 top bars. It is strongly recommended that the top bar should be 480 mm (19 inches) long, as there has been an attempt to make this standard and so enable interchange with other top-bar hives.

It is very important to create a starter of wax along the centre of each top bar. This encourages the bees to build their comb along the bar. If accurate cutting equipment is available the bars can be made with a groove that can be filled with wax strips.

It is also very important that all the top bars fit tightly together – hence the need for extreme accuracy. Tropical bees readily fly off the comb when the hive is opened and may sting the beekeeper. However, the merit of having tightly fitting bars is that the only opening through which they can come out is that where a single top bar and comb has been removed and this gap can be constantly smoked.

The hive entrance can be a slot or a set of small holes 8–10 mm (5/16–⅜ inch) in diameter. Another alternative is a small triangular shape with 8–10 mm (5/16–⅜ inch) sides. This is easier to cut and can protect the colony from attacks by beetles and other pests.

Scrap blocks of wood can be used to reinforce secure points on the ends of the hive if it is to be suspended above the ground.

Getting started – the apiary

In most places it will be necessary to mount or suspend the hive to protect the bees from pests and predators.

FIG. 45. The hive can be hung from wires so that animals cannot push it over to reach the honey.

FIG. 46. An apiary of top-bar hives.

When constructing a hive stand there is a need to remember the height of the beekeeper. The hive should be at the optimum working level for the individual that manages it but in general at least 450 mm (18 inches) from the ground.

If a stand is used it needs to be of solid construction and every effort made to prevent ants using the legs as ladders to the hive. Various methods can be employed such as standing the legs in cups of old motor oil, putting bands of grease around the legs and spreading ashes around the stand to discourage grass growth.

None of these are totally satisfactory, although the best alternative is to suspend the hives from solid poles – at least 150 mm (6 inches) cross-section – or from trees. Again consideration needs to be given to the working height as the comb structure within is fragile and can easily break if the hive or bars are moved roughly or excessively.

Always keep the apiary tidy, cut the grass short and remove any stones that would cause the beekeeper to stumble while working.

FIG. 47. Keep hives in the shade under trees.

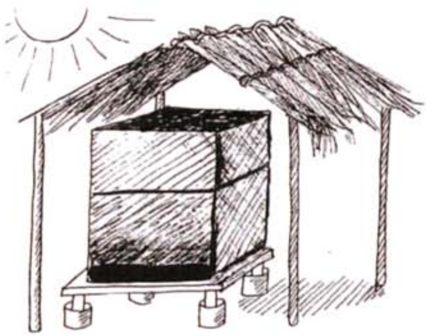


FIG.48. Shade can be provided by a shelter, made out of banana leaves, which does not have sides so that the air can keep the hive cool.

Where to put top-bar hives

Location can sometimes be a problem. The ideal site should be a little way from dwellings as bees can be aggressive.

- The site should be quiet – away from areas where children play or any source of continual noise.
- Near a fresh water supply – this can be a river, pond or even a dripping tap.
- Near food sources and cash crops that need pollination. However, the hives should not take up fertile land but can be placed on rocky outcrops and on the poorest soil for which the farmer has no use. Bees sited about 150 metres away from the productive area allow workers to tend the crops and avoid annoying the bees so they feel their colony is not 'under threat'.
- Hives need to be away from marsh or land liable to flooding. Humid conditions encourage fungal growth and prevent honey maturing.
- The hives need to be sheltered from strong winds and shaded from strong sunlight.
- Finally, the bees will appreciate being away from smoke, fire, vandalism and unfriendly neighbours.

SECTION 5 – HOW TO ATTRACT THE BEES

Any prepared hive must be clean – no dirt, spiders, cobwebs or insects that might capture a scout bee and prevent it returning to fetch the swarm.

Catching a swarm with a bait hive

Using bait hives to catch swarms is a traditional part of rural life in much of Africa. If a swarm is looking for a new home then why not provide a suitable container in which a nest can be established?

Ideal situations for bait hives or 'catcher boxes' are the same as those where an apiary could be set up. In some areas, swarms of bees fly along the same route during the same season each year.

Many bait hives may be a long way from villages and are liable to get damaged or stolen. Therefore, to minimize costs, boxes, baskets or gourds can be used.

If such simple equipment is used then the catcher box must be inspected every few days as a new swarm quickly builds comb and becomes established. It is then difficult to transfer it into a more permanent home.

FIG. 50. A catcher box or nucleus box with top bars or frames the same size as the hive into which the bees will be transferred.

It costs more to build a proper catcher box which would have bars from which the bees could build their comb. These bars should be the same size as those to be found in a permanent hive and this makes transfer easy.

A few small pieces of empty comb taken from an established colony and stuck in the catcher box increases its attraction for a swarm. Rubbing beeswax and/or certain aromatic plants on the inside of bait hives can also make them more attractive. Lemon grass, which contains chemicals similar to the markering pheromones of honey bees, is one such example. The residue of honey, wax and propolis after processing – slumgum – is also very good bait.

Transferring a colony from a wild nest

Wild colonies are another source of bees. In some cases the colony may not be easily accessible but it is essential that combs are taken out without breaking them. These combs are then placed in a bee-proof container and brought near to the new hive. Large areas of brood are carefully removed, trimmed if necessary and tied into the frames or onto the top bars of the new hive. Strips of cloth, string or plant fibres (e.g. strips of dried banana stalk) can be used to hold the brood in place.

When the combs have been removed, the bees still in the nest are smoked so that they walk (not fly) out. The queen is probably still amongst them so much care must be taken. They will cluster outside the nest entrance so that if the frames with tied-in comb are placed close by they will walk over the comb. When most have done so place the comb, covered with bees, into the hive

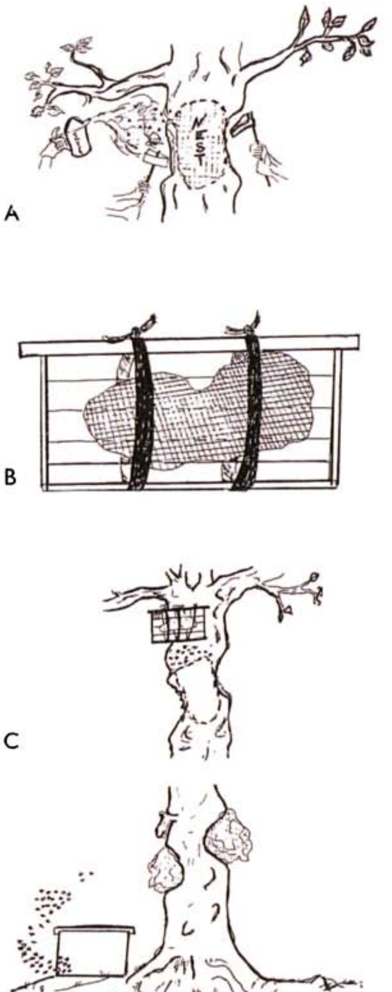


FIG. 51. (A), Colony in a tree is smoked while wood on each side is cut away to give access to the nest; (B), Wired empty frame, or even just a top bar, with a piece of brood comb tied in place; (C), Comb is fixed above the cluster of bees; (D), The colony is transferred to the hive and all the holes and entrances to the nest closed up with rags, sacking or newspapers. (After Bianco 1985)

brood box. If possible, place a frame or two with honey comb in the box as well. Place the box close to the previous nest site so that foraging bees will return to it, but close the entrance to the original nest securely.

The best time to do this task is shortly before sunset. If you can recognize the queen then it is best to capture her in a matchbox and introduce her to the hive when the rest of the transfer is complete. She should be placed close to the brood.

If there is little brood and no food the queen may be tempted to fly away (abscond) taking the colony with her. To prevent this, the hive entrance can be reduced to prevent the queen passing through. A simple method of doing this is to use a 4 mm (3/16 inch) paper clip held in position with soft wax (coffee wire with a similar-sized mesh is also effective). This is only a temporary measure and should not be in place for more than a few days. If the bees are unhappy they will fly off and cluster nearby. However, as their queen cannot go with them they will return to the hive. The bees will have accepted their new home when workers return carrying pollen.

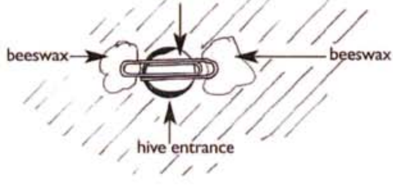


FIG. 52. The use of paper clips with an inside measurement of 4mm as temporary queen includers. (After Clauss 1991)

Basic management

Once the hive is occupied and the bees are busy, then the following simple guidelines need to be remembered:

- Do not stand in the flight path of the bees.
- Work quietly without excessive talking or drumming noises.
- Work quickly but smoothly. Remove lid carefully and puff smoke gently around the entrance of the hive.
- Remove a few empty bars to create a gap at one end of the hive. This should not disturb the bees. Thereafter, remove one bar at a time. Smoke the gap gently and hold the bar vertically so as not to break off the comb.
- Keep the bars in the same order and try not to squash any bees when replacing them in the hive. Squashed bees release a smell (alarm pheromone) that sets other bees on the attack.
- Do not visit the hive in the warm part of the day – about six o'clock in the evening is a good time.
- Do not try and work with too many hives at any one time. Certainly for not more than 45 minutes in an apiary as bees from the first hive worked on will become agitated and attack which will lead to further commotion amongst all the bees.
- Always wear light coloured clothes. Ideally protective clothing should be worn, especially a veil to protect the eyes and face.
- Make sure the top bars are pushed together as they are replaced, so that no gap exists. Finally, gently replace the lid on the hive.

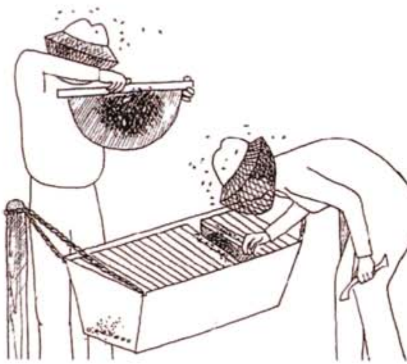


FIG. 53. Opening and working with a top-bar hive.

- Always keep the grass cut and the area around the hives tidy.

True beekeeping only takes place when there is some understanding of the bee and its ways so that predictions can be made about behaviour and management techniques developed.

Beekeeping can be lucrative but it is important that the level of technology used fits in with the local culture and local knowledge. It should be achieved naturally and not through pressure. The technology required is, in comparison with other branches of agriculture, very simple and quite cheap. In most cases it can be generated locally. The main limiting factor is a human one – lack of knowledge. This can be remedied by education and the sharing of information.

SECTION 6 – IMPROVED HIVES

The purpose here is not to set out one hive as the single answer to all the aspirations of the potential beekeeper but rather to take an unbiased look at the different improvements that have been tried. Thus, enabling the individual to make a reasoned choice on the type that best suits his or her needs, skills, location and materials available.

Improved hives and hive management

In some countries, and regions within countries, wood is very scarce. In such places it is often tempting to use wood which is unseasoned. The result is that the wood twists, warps and splits. This destroys the accuracy of fit required between boxes and frames with the result that the hive is at best inefficient at worse unmanageable.

FIG. 54. A modern box hive, complete with brood box and supers

There are some suitable tropical softwoods. Even these have to be seasoned which can take a year. They are strong, without being too heavy, as well as being reasonably easy to work. Another source of materials is timber which can be recycled. Plywood and blockwood from packing crates may offer cheaper alternatives. It is important that whatever is used, including any glue, has not been treated with pesticide or fungicide poisonous to bees.

Costs can be lowered if the life of the hive can be extended. So it is worth trying to prevent decay. This is caused by dampness penetrating the wood and the growth of fungi. Certain insects – like termites – can also be a problem.

The outside of the hive can be treated with preservative. Some preservatives are water repellent and others are fungicidal with the ability to deter termites and beetles as well. However, great care must be taken in selection so that the product used is (a) not noxious to bees and (b) does not leave odours which are repellent to bees. Creosote is one of the most readily available preservatives.

Once applied, the preservative must be left to be absorbed and to dry in a well-ventilated position. After this, the outside can be painted.

Painting should be done several days after the application of preservative. At least two coats should be applied to exposed parts. Light colours, particularly white, help to reflect the sun's rays and so keep the hive cool.

The most important way to preserve a hive is to ensure that it is kept off the damp ground on a hive stand or better still, suspended.

Do not dip the hive as this will be the same as painting the inside. The inside should be left in its natural state.

The hive consists of precision-made rectangular boxes which fit one on top of the other. This is why the upper boxes are called supers – because they are superimposed one on the other. The number of boxes varies according to requirements. Each box contains a set of framed combs. These hang in the box like files in an office filing cabinet. The rectangular frame is made with the top bar extending beyond the sides of the frame to create two lugs by which the frame is suspended from runners on each side of the box.

For any one type of hive the dimensions of the box depend on the dimensions of the frame and the number of brood frames it is required to hold. The width of any gap in the hive where bees move around between two facing surfaces must be equal to the bee space for the worker bees. The bee space for most African *Apis mellifera* is 7 mm (¼ inch).

The bees require this space between the sides of each frame and the walls of the hive, and between opposite surfaces of completed worker brood comb. It therefore dictates the distance at which the beekeeper spaces the combs. When one hive box is placed on top of another, a bee space is needed between the top of the frames in the lower box and the bottom of the frames in the upper box.

Following general rules, it is possible to build boxes. However, it is more practical to conform to existing patterns, particularly to that which is most common in the locality. In this way, advantage can be taken of help from neighbours and the interchange of equipment. Similarly, the possible communal operation of extracting equipment which accommodates a standard size of frame.

FIG. 55. A modern movable-frame hive with two supers in place.

1. The floor of the hive with a landing board and entrance.

2. Brood chamber – this is where the queen lays her eggs.

3. Frames – the beekeeper encourages the bees to develop the honeycomb on orderly frames by using foundation made of beeswax. This has the honeycomb pattern on which the bees will build.

4. Queen excluder – this is a mesh which is too small to allow a queen to pass but which allows the workers through easily. This means that only honey is stored in the combs above.

5. Super – this contains shallow frames which, when full of honey, can be removed so that the honey can be harvested.

6. Super – this is a second box which is needed when there is a lot of nectar and the bees are busy making honey. In a good season, even more supers can be added.

7. Roof – this keeps the bees dry. A crown board fits under the roof. This makes a bee-proof seal with the top box.

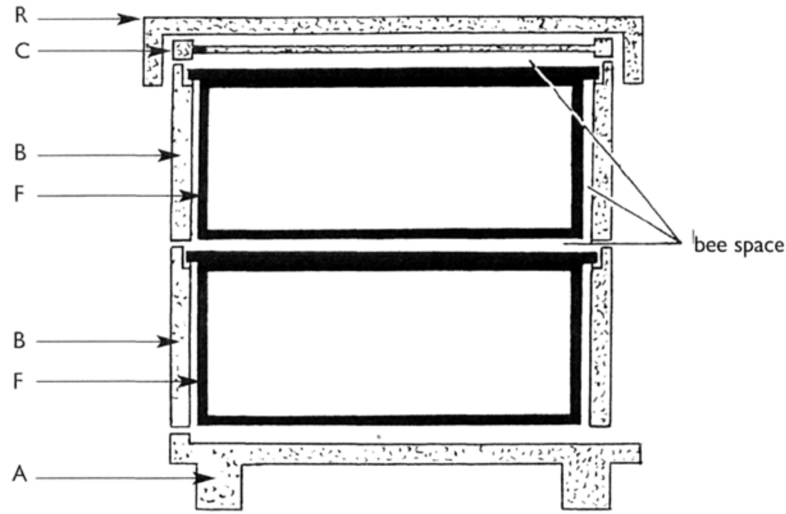


FIG. 56. The hive shown has a floor (A), two boxes (B), frames (F) a crown board (C) and a roof (R). It does not have a queen excluder which would normally go between the boxes. (After Walton, G M, Bee World *Vol 56, pp 109).*

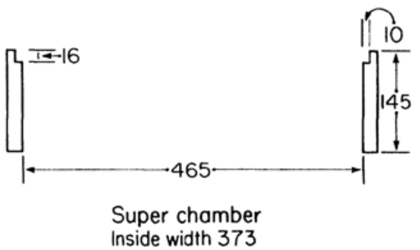


FIG. 57. Possible dimensions for a movable-frame hive. All measurements in millimetres. (After Voges, K, South African Bee Journal Vol. 55, pp 64–66, 1983).

Dimensions of even the same hive type can vary considerably from place to place. Whatever type of hive a beekeeper uses, all hive parts, frames and accessories (roof, inner cover, floor, excluder) must be compatible and conform to the same set of dimensions. For this reason, if the hives are being purchased, all parts should be bought in the same country, ideally from the same manufacturer. If the equipment is being built locally, the greatest care must be taken in the choice of materials and absolute accuracy and precision taken in the making of all the parts.

Frame measurements are critical:

	Length of top bar	**Length of bottom bar**	**Lugs on each side**	**Depth from top of top bar to bottom of bottom bar**
Brood (deep)	482 mm (19 in)	448 mm (17½ in)	17 mm (11/16 in)	233 mm (9 3/16 in)
Super (shallow)	482 mm (19 in)	448 mm (17½ in)	17 mm (11/16 in)	137 mm (5⅜ in)

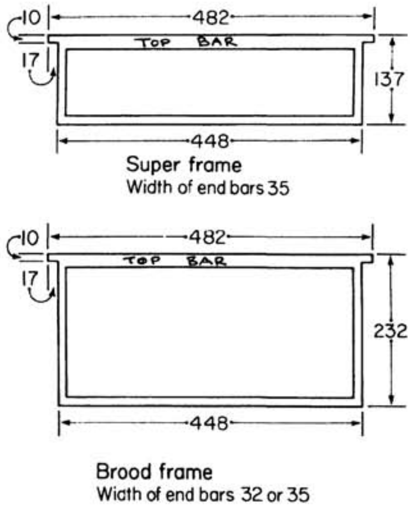


FIG. 58. Possible dimensions for frames. All measurements in millimetres. (After Voges, K, South African Bee Journal Vol. 55, pp 64–66, 1983). It is not necessary to have a four-sided frame. Such boxes can be perfectly satisfactory with just a top bar in place and worked like a top-bar hive. It is difficult to transport the hive if the combs are not in four-sided frames as they will break from top bars alone.

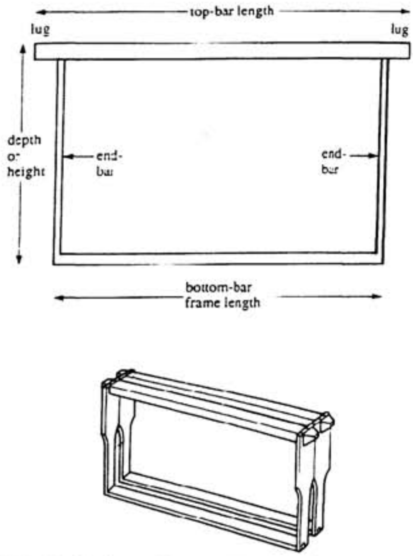


FIG. 59. Hoffman frames. Upper – Frame showing component parts. Lower – Two frames with Hoffman self-spacing end bars. The top bars have short lugs for a Langstroth hive.

The hive body consists of boxes which are open at both ends. There are two depth sizes but the length and width are the same for all boxes. The bottom box is the brood chamber (which has deep sides) and supers or 'shallows', because the sides are not so deep, fit above the brood chamber with the queen excluder in between.

Typical internal measurements in millimetres for these boxes as used in a South African Langstroth hive are:

	Length	Width	Height
Brood chamber	465 mm (18 5/16 in)	373 mm (14 11/16 in)	241 mm (9 1/2 in)
Super	465 mm (18 5/16 in)	373 mm (14 11/16 in)	145 mm (5 11/16 in)

The thickness of the timber for the walls should be approximately 20–22 mm (13/16–7/8 inch). Queen excluders should be framed so that there is a gap of 4 mm (3/16 inch) above and below the surface to ensure the retention of the bee space.

The bars must be arranged in the hive so that the distance from the centre of one top bar to the centre of the next is 32 mm (1 1/4 inches).

A typical Langstroth hive built on these lines has 10 frames in the brood chamber and eight with slightly wider spacing in the super.

A Dadant box hive is very similar but usually bigger with at least 11 frames in the brood chamber and 10 in the super.

The top bar of the frame is designed so that the foundation can be secured to it while the bottom bar usually consists of two strips so that the foundation can be slid into place between them. End bars are straight, narrow pieces of wood, sometimes having a groove to help with the location of the foundation.

The comb-spacing or frame-spacing in a hive box is the distance between adjacent comb midribs or the foundation in the frame.

In the brood box, spacing should be the same as the centre-to-centre distance between adjacent worker brood comb in wild nests built by similar bees. The distance is equal to the thickness of the comb (the depth of two cells on adjacent sides) plus the bee space required by the adult bees to move between opposite comb faces. If the spacing is too narrow the bees cannot rear brood on both facing sides of the comb. If it is too wide then burr comb is built and this makes frames difficult to part and remove.

One way to maintain this space is for the top part of the end bar to be cut to this width so that when the frames are placed in contact they are the correct distance apart. Self-spacers of this type are often referred to as Hoffman frames.

The frames in the super, which have the honey storage combs, can be further apart. During a honey flow, bees increase the depth of the cells to hold more honey until only a bee space is left between the capped combs. Where perhaps 10 frames are used in a brood box it is customary to have nine or even eight frames in a super.

Hoffman frames are not suitable in supers as it is difficult to uncap the honey. It is more usual to have top and bottom bars with the same width (30 mm, 1¼ inch) so that an uncapping knife can slide down resting on them. The end bars should be 40 mm (1⅝ inch) wide, giving a closed frame.

The hive floorboard or bottom board is often made of planks of durable wood about 20 mm (13/16 inch) thick and the same dimensions as the brood box with the front protruding by about 50 mm (2 inches) to give a landing board. The upper side of the base has a rim about 20 mm (13/16 inch) high on three sides – the fourth side constitutes the entrance so this has a gap at least 8 mm (5/16 inch) high. An 18 mm (⅝ inch) gap or more enables workers to fan within the entrance. At higher temperatures it is important that they fan just outside the entrance. However, if the entrance is more than 50 mm (2 inches) high, it is likely to increase the temperature in the hive. The better ventilated the hive the less work falls on the bees and so more effort can be devoted to more productive activities. Good ventilation is also important in the ripening of honey.

As the floor is at greater risk of rotting, fungal decay or attack by termites, sometimes other materials are used. Framed aluminium or galvanized or stainless steel mesh is an expensive alternative. Such floors help to keep hives cool and can help in controlling varroa in those regions where bees are affected by this parasitic mite.

The use of concrete is increasing and this is a much cheaper alternative, although its weight does tend to make moving the hive difficult.

The top box on the hive will have an inner cover or crown board. This is normally a rigid piece of plywood the same dimensions as the box. Sometimes, a cloth cover or quilt is used, as the purpose is to enclose the bees in the box. The plywood covers sometimes have a slot (80 × 40 mm, 3⅛ x 1 9/16 inches) in them which serves as a feed hole. The board has a rim around it to give the necessary bee space between the surface of the board and the top of the frames.

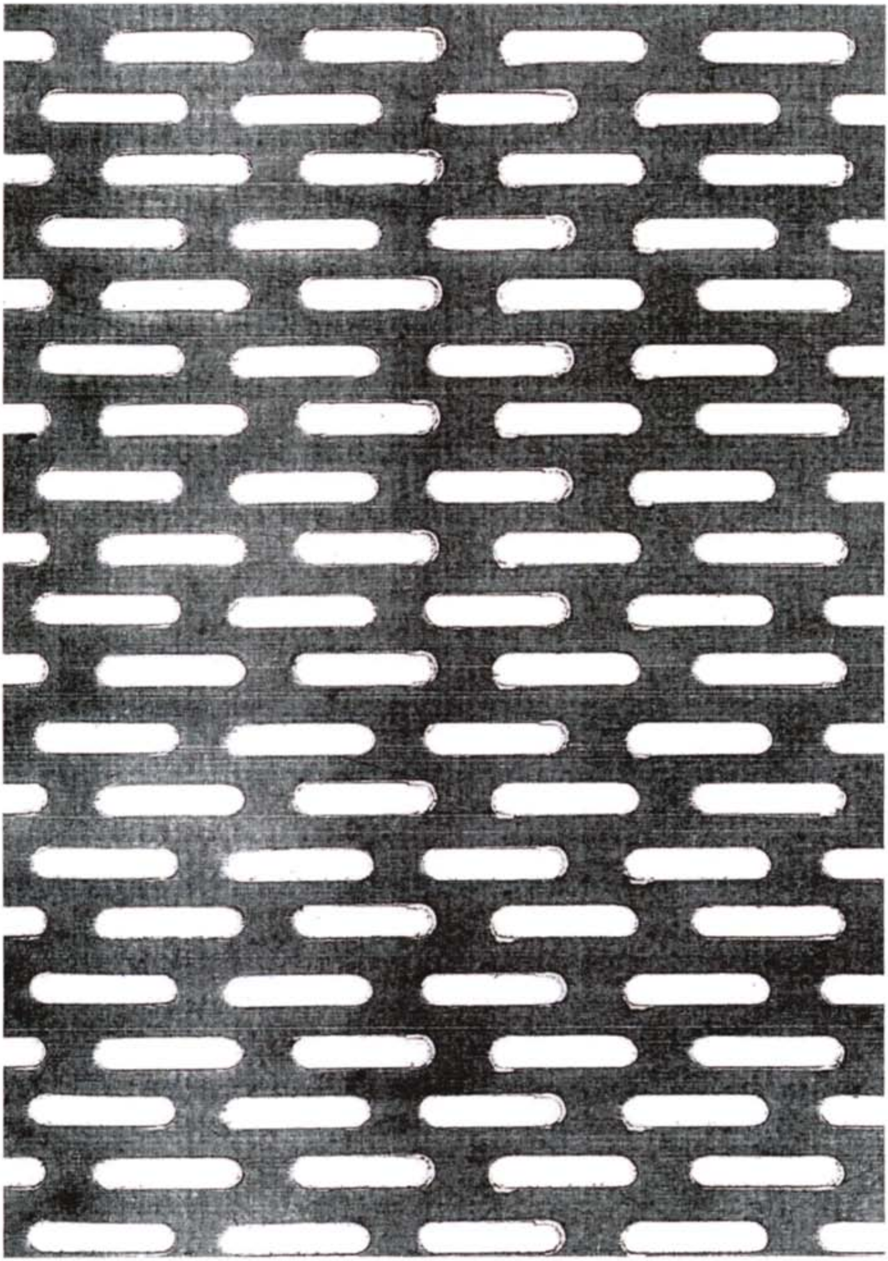


FIG. 60. Queen excluder (actual size). A sheet of thin metal with holes that allow worker bees to pass through but not the queen. This prevents the queen laying eggs in the super and so it becomes the honey store.

Usually a weather-resistant roof is placed over the inner cover. This can be a wooden frame which fits over the top box (telescopic) and is covered with metal to protect it from heavy rains. If the bee space is at the bottom of the box then it is satisfactory to use a flexible cover. Such a cover can be turned back little by little as the hive is opened. Also the propolis seal made by the bees can be broken more gently than with a rigid board. Suitable materials include jute sacking or canvas-type material not plastic sheet which prevents ventilation.

The last part of the hive is the queen excluder. This is a flat grid the same dimensions as the hive. The holes or slots are large enough to let a worker bee pass but prevent the queen getting through. It is placed in the hive above the box that the beekeeper wants as a brood nest so that no eggs can be laid in the boxes above which are the honey supers.

Sometimes, queen excluders need a frame or rim. This prevents the thin metal from sagging and also maintains the bee space above and below the frames. The correct size of slot depends on the queen's body size (about 4.4 mm, 3/16 inch).

Stands to support hives off the ground are not part of the hive. The simplest way is to raise the hive on concrete building blocks or bricks. More elaborate stands can be made from wood or concrete. These cost money but do help to keep the hives level, especially if the ground in the apiary is uneven. Even if the hive is only raised 100 or 200 mm (4 or 8 inches), the air flow is improved, helping to preserve the floor and improve ventilation in the hive.

The height, design and materials of the hive stand can vary with the ingenuity of the beekeeper. The main concern is that the hives are at a comfortable height to work and the materials used can be anything that is convenient – old railway sleepers (ties) – even the rails have been put to excellent use in the past. It is essential to discourage ants from climbing the stands and getting into the hives. Methods used with traditional hives can be used.

The movable-frame hive is complicated but brings some advantages to the beekeeper. These are:

- The comb is fixed within a frame facilitating and maximizing harvesting and

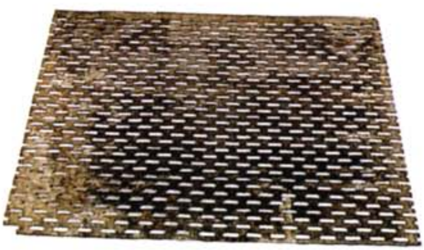


FIG. 61. This excluder has holes punched in a thin metal sheet that has the same dimensions as the brood box that fits below and the super that fits above.

FIG. 62. Another type of excluder uses thin metal rods that have been welded the exact distance apart that allows only workers to pass.

the added strength means less chance of damage to combs.

- The frame/comb strength allows the hive to be transported even on rough roads, and so the beekeepers can cash in on the pollination market or move bees to another area when forage is short.
- Easier to handle, fewer bees are crushed and so the colony is less antagonized.
- Supers contain just honey while brood is undisturbed in the lower box.
- Standardization of parts makes for much easier large-scale and commercial operation.
- Honey can be extracted by means of a centrifugal extractor and empty combs returned to the hive where they will be refilled. This maximizes the honey harvest.

There are some serious disadvantages. These are:

- Costly to buy from a supplier or even to buy the high quality timber necessary to make the hives.
- There are few, if any, local craftsmen who have the skill, equipment and precision to consistently make parts that fit exactly and are compatible with each other time after time after time. The description and dimensions given in this text have been simplified but they must be adhered to. Even if they are, the whole thing could be spoiled by the use of green timber (unseasoned timber). The writer has seen a wonderful row of Dadant hives, all brand new, yet it was impossible to remove the empty frames as the new timber from which frames and boxes had been constructed had warped and twisted. If there had been combs they would have become fixed combs and virtually useless, as they would not have been accessible without completely destroying the nest.
- The need to keep a supply of spare frames and supers for use at appropriate times is an expensive investment.
- Frames really need to have proper foundation, otherwise the bees are unguided in their construction and so the whole purpose of the frames is defeated. The making or buying of foundation is another expense and may be impossible to obtain in some areas.
- In order to capitalize on the frames, a centrifugal extractor is essential. This is difficult to make or has to be purchased from a commercial supplier. It is expensive and often requires hard currency as it is imported.
- The frames do not fit together as top bars do and so it is more difficult to control the bees.

SECTION 7 – BEEKEEPING EQUIPMENT

Protective clothing

The beekeeper should be protected from bee stings, although in a warm climate this can present problems and make work in the apiary very hot.

It is most important that the face and head are protected because a sting in the mouth could impair breathing or a sting in the eye could permanently affect vision. Many beekeepers, of long standing, do not take these precautions. Certainly no beginner or interested observer should be allowed near an open hive without a hat and veil as the minimum protection.

Various patterns and designs are available but essentially the headgear needs to be of a cool material and the veil should be kept clear of the skin.

The lower edge of the veil must be fixed so that bees cannot get inside. There are various kinds of ties for this and sometimes the veil is fastened to a bee suit or coverall.

FIG. 64. Another way to keep the veil away from the head is to wear a hat with a wide rim.

FIG. 63. Suits can be purchased or made using local materials. It is important that the veil is kept away from the head. Here this is done using hoops of wire.

FIG. 65. Suitable protection can be made by imaginative use of local materials — here a vegetable net bag over a sun hat makes a good veil.

If a coverall is worn, again the material needs to be light in colour, light in weight and of a smooth texture, but still thick enough to prevent the sting of a bee penetrating it and the skin. Nylon material can be used but this is hot when compared with cotton and can rapidly melt if accidentally brought into contact with a hot smoker, thus cotton is much better.

Many general-type overalls are usable providing all openings are dealt with – here zips or velcro fasteners are much better than buttons – and wrists and ankles need to be elasticated. In a confined space bees tend to move upwards, so shorts, skirts or loose legged trousers can cause problems.

Whatever is worn it should be washable and washed frequently to remove dirt, possible infection and any odours that could aggravate the bees.

Many beekeepers prefer to work with bare hands. Others, particularly beginners, are prepared to sacrifice 'feel' and some fine manipulatory ability for the protection of gloves. These should be of the gauntlet type so that there is an overlap with the overall sleeves and again the top should be elasticated to prevent bee penetration. The 'hands' of the gloves should be made of leather or canvas. However, it is difficult to get the right thickness for protection without making them too thick which leads to awkward and clumsy operations.

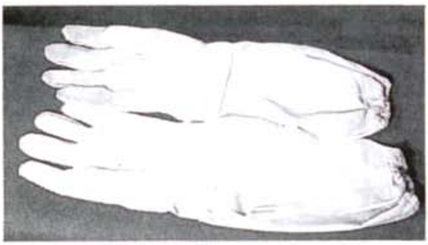


FIG. 66. Gloves need to be thick enough to give protection but thin enough to allow a sense of touch for fine jobs.

Gumboots of the type that are not too wide at the top are appropriate beekeeping gear whatever the weather. Trouser legs, which are ideally elasticated, should be tucked into the gumboots. If there is still a big gap around the top then it may be worth inserting something additional such as material or dry grass, to prevent entry by the bees.

Remember you cannot adjust your protective clothing or put more on once you have started working with the bees. Get it right to start with. It is better to over-estimate your need for protection than to underestimate. It can be hot. Do not work for too long in the apiary.

The smoker

The first piece of equipment necessary when thinking about opening a hive is the smoker. Smoke has been used as a pacifier all over the world for thousands of years. The reasons for this are:

- At the first whiff of smoke the bees become deeply occupied eating honey (engorging). A bee with a full honey sac is less likely to sting than a bee with an empty one.
- The smoke pacifies them in that fewer fly off the comb or behave as guards so making them less inclined to sting.
- Smoke repels them, they move away from it.
- Smoke masks certain odours and so reduces the reaction of the bees to this form of communication.

In its simplest form, the smoker is just a handful of dry, smouldering vegetation which can be blown to give off smoke in a certain general direction.

FIG. 67. The Smoker. This is an important piece of equipment as it helps to keep the bees calm during hive operations.

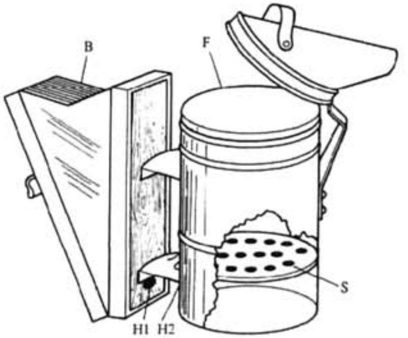


FIG. 68. Diagram of a smoker. B – Bellows; H1 and H2 – Air holes; F – Fire box; S – Shelf for fuel. This is the most vital piece of equipment for opening hives and removing frames that have been stuck in with propolis.

It is not difficult to manufacture some equipment which produces a more constant and efficient stream of smoke. The basic design, which has been around for over one hundred years, consists of a fire box which has a hinged lid shaped like an offset cone. There is a hole in the lid through which the smoke can be directed. A metal mesh provides a shelf at the bottom of the fire box on which the fuel can stand. Air is blown into the small area below and, afterwards, through the fuel by a simple bellows attached to the side of the fire box.

Often smokers are too small and run out of fuel in the middle of a task which is not a satisfactory situation. The minimum size for a fire box is 250 mm (10 inches) high, and 100 or 120 mm (4 or 5 inches) in diameter but when working with particularly aggressive bees requiring much smoke, a fire box 400 mm (16 inches) high and 150 mm (6 inches) wide has much to commend it.

A huge variety of materials can be used to create the smoke, providing they fulfil the following requirements:

- Easy to ignite.
- Open texture to ensure even burning.
- When the smoker is left upright, the fuel continues to burn.
- When the bellows are operated, a steady stream of smoke is given off.
- It does not have a smell to which the bees or beekeeper might object.
- It must not be of any chemical or toxic nature.
- Does not have a high tar content which blocks the nozzle of the smoker and creates smuts in or on the comb.
- Has not been treated with pesticide or insecticide.
- Is not plastic.

Hive tool

The other essential piece of equipment is the hive tool. This is a strong metal bar about 250 mm (10 inches) long. One end is chisel-shaped and can be used for separating boxes glued together with propolis and loosening

FIG. 69. The hive tool.

top bars. The other end is slightly turned up and sharpened for scraping propolis and wax off wooden surfaces. A slightly different type has a chisel end while the other end is stepped with a hook so that it can be used as a lever on one frame and under another. It is tempting to use a screwdriver but these are too narrow and damage the wood of frames and boxes.

The first operation when harvesting honey is to get the bees from the comb. In any movable-frame hive the bees should be removed by jolting the comb so the bees fall back into the hive. This is the practice with frames but not so easy with top bars where it is all too easy to break the comb. Remaining bees can be brushed or smoked off. Excessive smoke does leave a taste on the honey and therefore can reduce its value.

Every effort must be made to keep the combs bee-free before placing them in a clean container which can be covered with a tightly fitting lid. In this manner, the harvest can be removed from the apiary and taken away for honey extraction and rendering of wax.

Brush

Bees can be removed from a comb by brushing them back into the hive. Soft brushes are available for this; a handful of very soft grass or the large wing feathers from big birds can serve just as well and at little cost.

Containers

In all beekeeping it is essential to have a number of clean, uncontaminated plastic buckets, pots or containers that have fitting lids. These are necessary to put the honeycomb or frames into when removed from the hive and the apiary. Even bits of wax and propolis scraped off when examining the hive should be collected, not thrown on the ground as this encourages robbing and can spread infection amongst colonies.

Uncapping knife

The first stage in extracting honey from the combs is to uncap them. Combs can be uncapped by using a long-bladed knife which has been heated, by dipping it in boiling water. A tray needs to be placed below the combs that are being uncapped to collect all that falls as this is the best beeswax and must be saved.

The extractor

A honey extractor removes honey by rotating the combs at high speed so that the honey is thrown out of the comb on to the wall of the extractor and then runs down to the bottom of the drum. Honeycomb built inside a wooden frame is not damaged by this process and when empty can be returned to the hive. The extractor consists of a metal drum containing holders in which the frames are placed. There is a tap at the base of the container so that honey can be run out. Honey should always be strained as it runs out of the extractor so that any pieces of wax capping are removed.

Honey can be extracted faster and more completely at higher temperatures but the combs become soft and break.

FIG. 70. Honey extractor. This provides a mechanical method for removing honey from combs. In this device two, three or four combs are placed in the drum with their surfaces towards the walls. When the handle is turned they spin and the honey from the uncapped combs is thrown onto the walls of the drum. It runs to the bottom and then can be poured out using the tap. It usually stands on a bench so that a bucket can be placed under the tap.

FIG. 71. When a bee stings the stinger is left in the skin and should be removed straight away as it continues to pump venom. Removal is best done by scraping with a finger nail or the edge of the hive tool.

Stings

Hives should be sited so as not to cause a nuisance to neighbours. As stated earlier, anyone working with the bees or close to the hives should wear protective clothing. Bees may burrow into hair that is not covered, while some scents and cosmetics can provoke a sting. The best way to avoid stings is to walk calmly away from the bee or bees and seek shade and vegetation or enter a building. Excited or wild flapping only serves to attract more bees and present a better target.

When a worker honey bee stings the sting only just penetrates the surface but as it is barbed the bee cannot retract it. The bee pulls free and the stinging apparatus is torn from her body so that she dies shortly afterwards. The venom bulb is left pulsating on the sting so it is best to remove it straight away. This is done by scraping it away with a finger nail or the edge of the hive tool.

Normally the sharp pain at the site of the sting only lasts a short period. It is followed by some itching and perhaps some local swelling.

The severity of the reaction will depend very much on the individual. Some beekeepers build up a resistance and totally ignore being stung. However, if a non-beekeeper or learner is stung this should be treated sympathetically. Any sting in or near the mouth or eye should have medical attention as vision or breathing can be impaired.

There are some simple treatments that can be used immediately. These usually involve the application of a cooling agent to the area of the sting – cold clean water, very dilute vinegar or ice. Antihistamine creams, sprays and tablets are becoming more widely available. If nothing else is available then a little honey could be applied to the area.

When a bee stings an alarm pheromone is released. This encourages other bees to sting and attracts them to the site of the first attack. Tropical African bees can react very rapidly to this pheromone, and as more and more sting, the pheromone can even be noticed by humans as there is a smell in the air similar to that of ripe bananas. Before this situation is reached, the beekeeper should close the hive and take cover until the bees are calm and all traces of the pheromone have disappeared.

For people that are hypersensitive, or have an allergy to stings, just one sting can cause major problems. Multiple stings can be dangerous for anyone and an excessive number of stings can be fatal.

SECTION 8 – HIVE PRODUCTS
HONEY

Honey production

Probably the two most important factors in the production of honey are:

- The bees
- The beekeeper

Generally the bees do a very good job and it is the beekeeper that spoils the quality of the product with poor harvesting, extracting and marketing techniques. It is essential that the product being sold retains its properties, is of good quality and well presented.

These simple objectives do not need complicated and expensive equipment or great knowledge of management techniques.

Letting honeycombs drip on a wire mesh can give good results. The honey is pure and clean but the process is slow. A press can be used when the combs are too small to go in an extractor. The honey should be stored so that it can allow particles, which will be present even after a first straining, to settle.

Improved extraction techniques will result in improved product quality which in turn will lead to better prices for the honey.

Often development projects invest much of the money available in buildings, vehicles and sophisticated equipment. Ironically, the bigger the structure the more the farmers can feel isolated, and those for whom the help was intended are the ones that benefit least. A village collecting centre can be run by one local person who has had some brief training in the use of simple processing equipment. Such a focal point can, if properly organized, give strength to a group of beekeepers and get them a better deal for their produce.

Similarly, other equipment can often be overrated. A wooden movable-frame box hive may cost 30 times more than a traditional hive. It is unlikely that it will produce 30 times more honey. It is essential, therefore, that any technology used is appropriate and ultimately fulfils the aim of providing a genuine source of income for the person who has decided to keep bees.

Honey

Bees prepare honey mainly from the nectar of flowers, but other plant saps and honeydew are also used to a minor extent. After visiting a flower, the foraging honey bee flies back to the hive with the collected

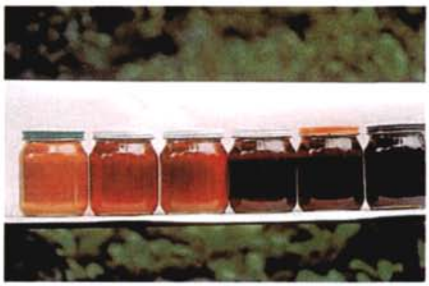


FIG. 72. Liquid honey showing a wide range of colours.

FIG. 73. Set honey showing a wide range of colours.

nectar in her honey sac, a modified part of the gut. On arrival at the hive she passes the fluid through her mouth to one or more 'house' bees. These, in turn swallow it and regurgitate it to pass to other house bees and on through a chain of bees before the liquid is finally placed in a cell of honeycomb. As each bee sucks the liquid up through her proboscis and into her honey sac a few proteins become added and water is evaporated. The proteins are enzymes, which convert sugars in the nectar into different types of sugars. After the liquid has been placed in the cell of honeycomb, bees continue to process it, and more water evaporates as they do so. The temperature of the hive near the honey storage area is usually around 35°C (95°F). This temperature and the ventilation produced by fanning bees, causes further evaporation of water from the honey. When the water content is less that 20% the bees seal the cell with a wax capping. The honey is now considered 'ripe' and will not ferment. The bees have prepared for themselves a concentrated energy source, packed in minimal space and free from problems of fermentation during storage.

A very minor, but important component of most honey is pollen. Pollen is carried to the hive and stored inside it quite separately from nectar, but nevertheless a few pollen grains find their way into honey. The pollen in honey can be identified using a microscope, and gives a guide to the plants that bees have been working on.

Beekeepers are often asked about the difference between liquid and set honey. Liquid and set honey are like ice and water: different forms of the same substance. Set honey is also known as granulated or crystallized honey. All honeys are liquid when produced by bees, but most honeys will granulate eventually. The speed with which honeys granulate depends upon which sugars the particular honey contains. Granulation is a natural process and there is no difference in taste or nutritional value between solid and liquid honey. Some people prefer one type to the other.

To turn a jar of granulated honey to liquid, stand it up to its neck in a container of warm water (60°C, 140°F): it will liquefy after an hour or so.

A jar of liquid honey can be made to granulate by stirring in a small amount of honey that is already granulated. Crystals in the granulated honey serve as 'seed crystals' and after a few days the whole honey will become granulated.

Honey is a delicious food. It is high in carbohydrates and adds useful variety to diets. As most sugars in honey are fructose and glucose, it is more readily digestible than cane sugar. Honey varies in taste, aroma and colour according to its plant source.

In many societies honey has an important place in traditional food preparation, and is also viewed as a source of special nutrition for children although it should not be fed to young babies. Honey is widely used as a medicine and is highly prized for this reason. It is often regarded as a special tonic food to be eaten at times of illness. Honey has three biological factors which account for its antibiotic activity. These are:

- Honey absorbs water and so is capable of killing bacteria by dehydrating them. It also means that honey is sterile as most micro-organisms cannot survive in it.
- There are enzymes in honey which produce hydrogen peroxide which kills bacteria.
- Honey is acidic.

Therefore, honey has long been associated with healing. It is used not only to treat coughs and stomach ailments but applied externally to burns, ulcers and wounds. Honey is a food and a medicine but in many parts of the world it is used primarily to produce an alcoholic drink – honey beer.

Honeycombs from top-bar hives or traditional hives

● Cut-comb honey

Honey in the comb is untouched and is readily seen to be pure. Therefore, honey presented in this way always fetches a good price. Honey which has not been open to the air has a finer flavour than honey which has been subjected to processing in any way. Only sealed and undamaged comb should be selected. The pieces cut neatly and packaged wrapped in clear film or placed in jars that are topped up with clear, well-filtered honey.

FIG. 74. Cut comb.

● Strained honey

To prepare strained honey, remove the wax cappings of the honeycomb with a knife and break the combs completely into pieces. Make sure that you do not use unsealed combs containing unripe honey or pollen. Use a cotton cloth to strain the honey from the pieces of honeycomb. Collect the honey that strains through in a clean and dry container. Finally squeeze the combs inside a bag made from the cloth to remove as much honey as possible. Hands should be washed before, and frequently during this work. All

FIG. 75. Combs collected, crushed and then strained to remove the honey.

FIG. 76. Straining honey through cotton into a plastic bucket which can be fitted with a lid.

cloths and containers must be perfectly clean.

Honeycombs from frame hives

● Cut-comb honey

If using foundation, then it should not contain strengthening wires. The wax foundation should also be thinner than that normally used in wired frames. Portions of cut comb can be prepared for sale in the same way as those from a top-bar hive.

● Strained honey

Remove the wax cappings from the honeycombs with a long, sharp knife which

FIG. 77. Uncapping frame comb.

has been standing in warm water. Hold one end of the top of the frame and rest the other end on a piece of wood placed across a dish – the frame is therefore held at right angles to the dish. Start cutting at the bottom of the frame and with a zig-zag movement of the knife, cut off the thin layer of wax cappings and allow it to fall into the dish below the frame. Turn the frame around and cut off the cappings on the other side, and then place the frame in the extractor. Some honey will stick to the wax cappings; do not waste this, but strain it out of the dish. Honey drains very slowly from cappings and this process may take over 24 hours.

Honey quality

The aroma and taste of honey are its most important features, but honey is often judged according to its colour. The colour of honey depends mainly upon the source of the nectar, plant sap or honeydew that the bees have gathered. Usually dark-coloured honeys have a strong flavour while pale honeys have a more delicate flavour. The popularity of dark and light coloured honey varies from country to country, but generally light coloured honeys are more highly valued than dark. Colour can sometimes be a useful indicator of quality because honey becomes darker during storage, and heating will also darken honey. However, some perfectly fresh, unheated and uncontaminated honeys can be very dark.

It is impossible to give a comparable value to the flavour and aroma of a honey, but the following methods are used to measure honey quality.

Colour

Colour is very important, for it is this that does more than anything else to determine its commercial use and value. Darker honeys are more often put to industrial use, while lighter coloured honeys are marketed directly for consumption. Colour descriptions range from water white through shades of amber to dark.

Water content

If the water content of honey is greater than 19% then the honey is likely to ferment. A low water content is therefore most important. Water content can be measured using a honey refractometer, a small instrument which measures the refraction of light as it passes through a glass prism on which a few drops of honey have been smeared. In areas with a very high humidity it can be difficult to produce honey of sufficiently low water content.

HMF

HMF stands for hydroxymethylfurfural. This is a break-down product of fructose (one of the main sugars in honey) formed slowly during the storage of honey, but formed very quickly when honey is heated. The amount of HMF present in honey is therefore used as a guide to the amount of heating which has taken place: the higher the HMF value, the lower the quality of the honey is considered to be. HMF is measured by various laboratory tests.

Enzymes

The levels of enzymes present in honey are sometimes assayed and used as a guide to honey quality. These tests are also carried out in a laboratory.

Other constituents

Some honeys have a very high pollen content which makes them appear cloudy; honey extracted from combs by squeezing often contains a relatively high level of pollen. Such honey is considered to be of low quality. The presence of any other contaminants in honey

Beekeeping methods which may have negative effects on the quality of the honey

Beekeeping method	Possible damage to honey
Location of hives in densely urbanized or industrialized zones or areas of strong environmental pollution, including agricultural pesticide use	Contamination of honey with noxious or toxic residues, possibly damaging to human health, or with sugars not of nectar or honeydew origin
Inappropriate use of antibiotics and other drugs or chemicals to treat or prevent honey bee diseases or control pests	Contamination of honey with the same substances
Use of organic chemicals like naphthalene, ethylene dibromide or paradichlorobenzol for comb protection during storage and treatment against wax moths	Contamination of honey with the same substances
Use of chemical repellents during honey harvesting	Contamination of honey with the same substances
Excessive use of smoke or poor choice of combustion material	The honey has a smoky odour, odd taste and contamination with microscopic soot
Use of old and dark combs and/or brood combs	Honey of darker colour, comb odour, higher acidity and faster ageing
Use of combs with residual honey from a previous year	Honey high in yeasts and possibly faster fermentation; premature crystallization of susceptible liquid honeys; a contamination of unifloral honeys
Harvesting of incompletely sealed combs, particularly during the nectar flow	Excessive water content in honey

After Krell from the Food and Agriculture Organization of the United Nations Bulletin 124, Value-added products from beekeeping (Rome 1996).

(e.g. particles of wax, bees, splinters of wood, dust) will make the honey of very low value indeed. If colonies of bees are located in industrial or urban areas which have a high degree of pollution then hive products can be affected as heavy metals and other pollutants can accumulate in them – particularly in pollen but also in honey. Contamination can also result from dirty water sources.

Problems arise from honey bee diseases. Some may be prevalent in an area, others may be brought in if bees are introduced to an area from elsewhere. Where bees lack a resistance to new infections they may need help from the beekeeper. There is then a danger that untried chemicals may be used or even approved products used in excess or at inappropriate times, leading to contamination of the honey and/or beeswax crop.

Preparing honey for market

- Process honey as soon as possible after removal from the hive. Honey-processing is a sticky operation, in which time and patience are required to achieve the best results.
- Honey is a food, and it must therefore be handled hygienically. Always wash your hands and your equipment thoroughly at all phases of the process.
- Honey is hydroscopic and will absorb moisture. All honey-processing equipment must be perfectly dry. Too much water in honey causes it to ferment.
- Some dishonest people add cane sugar syrup or corn syrup to their honey. This is a corrupt practice and should always be discouraged.

Containers for marketing honey must be lightweight, of low cost and preferably see-through so that customers can see the product. Glass is often used as a container for selling honey but glass jars are heavy, breakable and cannot be stacked together when empty. Plastic containers are much lighter and stack well, but in many countries they are difficult to obtain. Recycling containers that have held other products is possible. Honey is a food and any container used should have been used for food in the first place.

Labels for your honey

In addition to attracting customers to your product, the label you put on your honey should give the following information:

- Contents: Pure honey.
- Source of the honey: e.g. sunflower, mixed blossom, tree honey etc.
- The country and district it was produced in.
- Your name and address.
- The weight of honey in the container.

You may wish to add other information for the consumer. For example, if you are packing comb honey, you could remind the purchaser that the whole comb including the wax is completely edible, or if you are selling strained honey, you may wish to provide an explanation of granulation.

SECTION 8 – HIVE PRODUCTS

BEESWAX

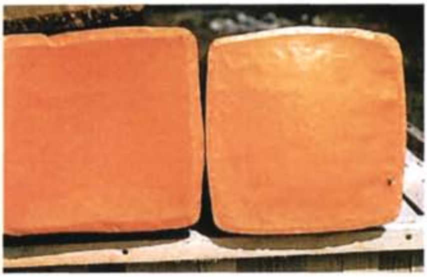


FIG. 78. Blocks of beeswax for the commercial market.

New pure beeswax is white in colour but the presence of pollen, propolis and impurities cause it to become yellow and it darkens even more with age.

It is a valuable product which can provide a worthwhile income in addition to honey and, unlike honey, beeswax does not require careful packaging; this simplifies transport and storage.

Beekeeping using movable-frame hives results in the harvesting of relatively little beeswax, as empty honeycombs are returned to the hive after the extraction of honey. Beekeeping using traditional hives or movable-comb (top-bar) hives results in greater yields of beeswax since the delicate honeycomb is broken during the extraction of honey, and cannot be returned to the hive. Beeswax can be a valuable export crop and there is strong demand on the world market. In some countries wax, rather than honey is therefore the most valued product of beekeeping.

In areas where most or all of the honey produced is consumed locally, and where there is no local use for beeswax, honeycombs are often simply discarded. The development of a wax-collecting system can, by encouraging each beekeeper in the area to save beeswax, and by organizing the sale of the combined crop, provide a source of income from an otherwise wasted resource. Both honey-hunters and beekeepers should realize that beeswax is a valuable product in addition to honey.

Beeswax is valued according to its purity and sometimes its colour (light-coloured wax is often more highly valued than dark-coloured).

Among insect waxes, beeswax has a comparatively low melting point (about 63°C, 145°F). It is an unusual material in that it remains supple and plastic at temperatures as low as 35°C (95°F) – the temperature of the brood chamber. At temperatures between 25°C and 35°C (77°F and 95°F) the comb is so strong that a few grams of comb can support several kilograms of honey.

Beeswax is secreted from four pairs of glands to be found on the underside of the worker's abdomen. These glands function when the bee is between nine and 17 days old.

On contact with air the wax hardens and forms scales, which can be seen as small flakes of wax on the underside of the bee. Bees use the stiff hairs on their hind legs to remove the scales of wax and pass them on to the middle legs and so to the mandibles (jaws) where wax is chewed before it is incorporated into honeycomb. Bees are stimulated to produce wax when there is surplus honey to be stored and a lack of honeycomb in which to store it.

The wax is an inert and largely indigestible material which can retain its shape and quality for many hundreds of years. Beeswax does not mix with or absorb water and can form a protective layer impermeable to water.

The process by which wax from combs is converted into blocks of clean wax by melting is known as rendering.

Cappings give the best quality wax, but fresh comb recently removed from wild nests or broken from top bars is also satisfactory. Dark combs are of least use because with increasing age they contain more propolis and render little wax. Light and dark comb should not be mixed as this will reduce the value of the end product.

Wax-rendering can be a messy undertaking and so the task is only performed once or twice in a year. Specialist equipment is available but it is an expensive investment for something which receives so little use.

All methods of rendering involve melting the wax. Since beeswax is a very inflammable material care must be taken not to start a fire. It is particularly dangerous to heat beeswax over an open flame indoors.

Therefore, methods which heat the wax in water are much safer than using heat alone.

Vessels used in processing beeswax should be made of: stainless steel, aluminium, unchipped enamel or galvanized iron NOT zinc, brass, copper or iron as these discolour the wax.

To begin the rendering, make sure the comb is clean and as much honey as possible has been removed. This can be done by washing or soaking in warm water. The water must be clean. Rain-water is ideal as it is very slightly acid and this helps in the cleaning process.

The wax can be broken into small pieces and put into a pan. At this point there are two alternatives. Water can be added to the broken comb and the whole mixture heated

FIG. 79. Straining wax. Beeswax, which has been melted in water, is scooped up and put through a bag of coarse fibres that can be squeezed using two parallel sticks as well as wringing the bag with the hands.

GENTLY until the wax melts. Alternatively a small pan containing just the pieces of wax can be placed in a bigger pan containing water – a water bath. The big pan is heated, again gently, and as the water warms it melts the wax in the inner pan.

Beeswax melts at about 63°C (145°F) so never overheat the water; certainly do NOT boil it as this could ruin the wax.

The melted wax or wax and water mixture must now be strained. A number of materials can be used for this as the aim is to produce something equivalent to about a 3 mm (⅛ inch) mesh. This can be a long bag of cotton material or even closely woven vegetable fibres. Specialist and cooking sieves are also available but remember to choose a material that will not contaminate the wax and to ensure that everything used is clean.

Sometimes it is worth repeating the process with a finer mesh.

The wax or wax/water mixture is collected in another pan which may have had the sides smeared with non-scented soapy water. It is then allowed to cool in a place where it will not become recontaminated with dust or insects. The wax will harden as a layer on the water. Do not disturb it until completely set which may be in 12 or even 24 hours. Then knock the wax out of the pan or bowl and scrape off any remaining impurities which may be stuck to it. The block of wax obtained in this way will reflect the shape and size of the container in which it was collected. It is ready for sale but do not be surprised if the buyer wants to break it into small pieces. This is because people sometimes cheat and put stones or sand into the setting beeswax to increase the weight.

This is evil and reduces the value of beeswax for all good honest beekeepers.

Solar wax extractor

The solar wax extractor provides a simple and safe way of melting beeswax and costs nothing to operate because it uses the heat of the sun. Again, only clean wax should be used and then one melting will produce a satisfactory block of wax.

The solar wax extractor is a box with a glass or clear plastic lid. It has a floor or shelf of metal. The box is tilted at an angle to catch the sun. Pieces of honeycomb are placed on the metal sheet and, as they melt, wax runs down the metal slope to a container. The sheet of metal can be bent at the edges to funnel wax towards the container. A screen of wire mesh prevents pieces of comb and debris from slipping down into the container. Impurities in the wax tend to remain on the metal, and others can be scraped off the final solidified block of wax.

There are commercially made extractors but many have been produced using local materials and ingenuity. Often, two pieces of glass or perspex are used about 5 mm

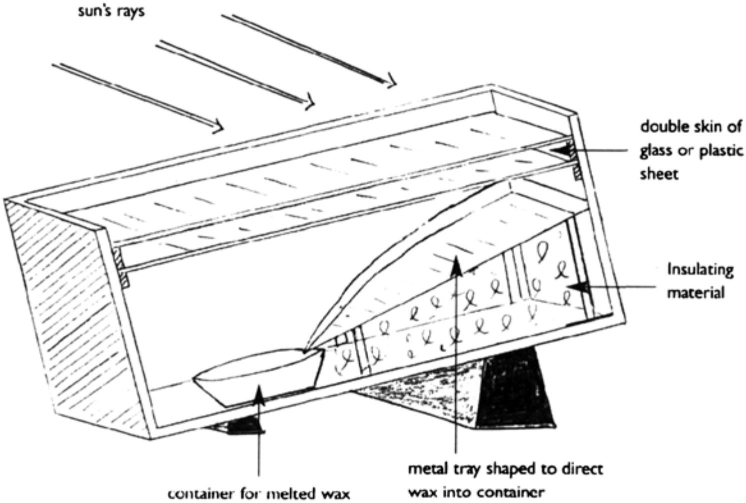


FIG. 80. Drawing of solar extractor.

(3/16 inch) apart to help retain a high temperature in the box. It is now possible to use insulated polycarbonate sheets which are produced as two skins separated by isolated channels of trapped air. Painting the walls of the box in a dark colour helps heat absorption. Insulating material underneath the metal sheet will also help to retain heat. However, most important is to gain maximum exposure to the direct rays of the sun for the maximum period. There must be no draught-creating cracks or gaps in the box, as these will encourage heat loss and, if large enough, would allow robber bees into the box. The extractor also needs to be ant-proof and set up in such a way that ants cannot gain access to it.

A simple way to melt down small scraps of comb is to place them on a piece of shiny metal foil and leave in the sun. In strong sunlight the wax will soon melt and can be poured into a container.

The residue left after beeswax has been rendered is sometimes referred to as 'Slumgum'. This is often thrown away but it has value to the beekeeper. Large amounts can be sold to commercial wax-rendering firms. But if only limited quantities are available it can be used as swarm bait if daubed inside catcher boxes.

Beeswax has a far wider range of uses than any other bee product.

If hives with movable-frames are in common usage then a major application of wax is in the production of foundation. Even with top-bar hives the use of a 'starter' strip of beeswax, or molten wax dribbled along the bar is important.

Foundation is made commercially by a continuous process in which a long sheet of beeswax is passed between two rollers which make a hexagon pattern on each side of the sheet. The pattern is offset so that the base of a cell on one side is opposite the junction of three walls on the other. These sheets are then cut into standard sizes to fit frames. When the frames are placed in the hive, the correct distance apart, the bees will set about constructing cell walls on the foundation. This process is referred to as 'drawing out foundation'. The resulting comb is said to be 'drawn out'.

Commercially-produced foundation can be sold in several thicknesses according to the number of sheets per kilogram. For example, about 13 sheets, suitable for Langstroth deep frames, weigh approximately one kilogram.

The beekeeper can make his own foundation using a mould. Such a cast has two opposite surfaces on which the hexagonal pattern is incised. These surfaces are usually hinged to ensure that when brought together the exact pattern where the base of the cells on the one side coincide with the point where three walls join on the other side is maintained. Wax, only just at the point of being molten, is poured over the lower surface. When this is covered the upper surface is closed upon it and sufficient pressure applied to emboss the hexagons.

The correct size of hexagonal brood cells varies according to the size of the bees that are to use it. Drone cells are slightly bigger than worker brood cells and so are sometimes used in supers as they hold more honey.

FIG. 81. A simple press to make wax foundation.

FIG. 82. Dipping – board method of making foundation.

Some beekeepers find it satisfactory to insert plain sheets of beeswax into their frames. Such a practice does not guarantee any regular construction of cells. Producing sheets of wax is not difficult. All that is needed is a wooden board just larger than the sheets required. It helps to have a handle of some kind on the short side, it is then wetted and dipped into molten wax and withdrawn. Practice will soon lead to sheets of the required thickness (about 1.5 mm, $\frac{1}{16}$ inch) being deposited on each side of the board. When cool they can be peeled off and trimmed to size.

FIG. 83. Candles made by dipping wick into molten wax.

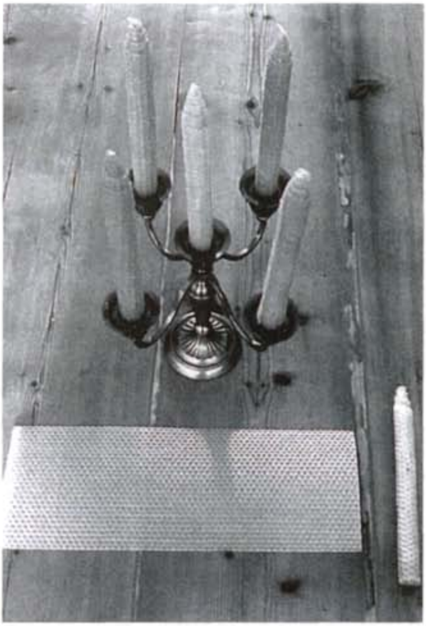


FIG. 84. Candles rolled from foundation or a sheet of beeswax.

Beeswax is still important in candle-making. It is a material that burns with a bright, steady flame and, as it has a higher melting point than cheaper waxes, the candle

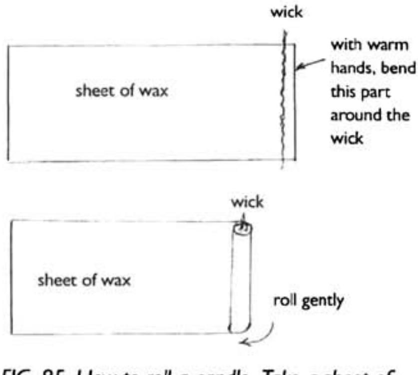


FIG. 85. How to roll a candle. Take a sheet of beeswax. Place a wick, which is longer than the wax, about 5mm from one end. Gently turn the edge to cover the wick. Then roll gently.

FIG. 86. Decorations can be made from beeswax.

remains upright in hot weather and does not smoke. Candles can be made in several ways.

Molten wax can be poured over a wick or the wick dipped into molten wax. Either way, the process is repeated until a candle of the desired thickness is acquired. Sheets of beeswax produced in the same manner as foundation can be carefully rolled around a wick until the desired diameter is achieved.

Many attractive candle moulds are available or can be made from local products like gourds or hollowed out fruits. The wicks are fixed in them before topping up with molten wax. Beeswax shrinks by about 10% when it solidifies and needs to be carefully removed from the mould when cool. Candles or small ornaments and plaques made this way have an appeal, particularly to tourists.

Beeswax can be an important ingredient in polishes and protective coatings. In its simplest form, polish can be made by dissolving wax in turpentine. The paste

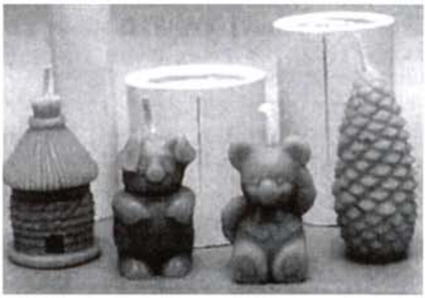


FIG. 87. Examples of moulds.

produced should spread easily and leave a very thin film when the solvent has evaporated. This film is then rubbed to give a smooth shining finish.

Between 60% and 70% of all the beeswax that is produced is used for cosmetics and pharmaceutical preparations. There is therefore a ready export market for the top quality product. This is another important reason to make sure that all operations are carried out with clean equipment and clean hands.

SECTION 8 – OTHER HIVE PRODUCTS

Honey and beeswax have been the main harvest from beekeeping and remain the mainstay of the activity. However, there are other hive products which can provide an income.

Pollen

Beekeepers need no specific skills to harvest pollen providing there is a plentiful supply. Pollen collection is more successful in dry areas as humidity increases the danger of contamination of collected pollen with moulds (fungi).

The composition of pollen varies according to the plant source. As it is collected by the bees, they moisten it with a little honey or nectar when packing it into pollen loads on their hind legs. In this way it gains some antibiotic properties. Unlike honey, pollen is not stored in the hive in quantities greatly in excess of the colony's needs. It can be harvested by fitting a pollen trap across the hive entrance. This is a restriction which knocks off the pollen loads as the bees scramble through.

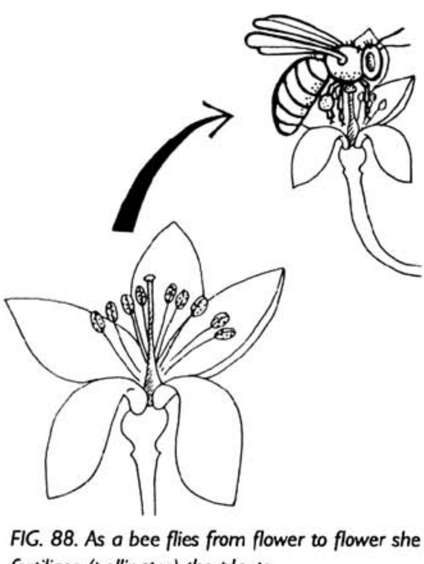


FIG. 88. As a bee flies from flower to flower she fertilizes (pollinates) the plants.

FIG. 89. The bee puts pollen in the baskets on her hind legs (see fig. 21). This pollen can be collected at the hive entrance in a pollen trap.

The trap consists of a grid which can be made from 5 mm (3/16 inch) wire mesh under which there is a pollen-collection tray covered by a finer mesh (4.2 mm, 1/6 inch) to prevent the bees getting to the fallen pollen pellets. The floor of the pollen tray must be designed so that any water can escape and air circulates to prevent deterioration of the product. For the same reasons it needs to be checked and emptied frequently. The bees need pollen stores to feed their brood so traps should be removed at regular intervals otherwise the colony will be short of food.

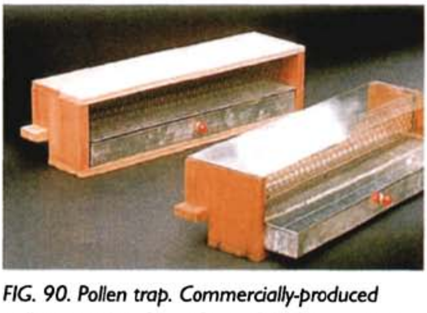


FIG. 90. Pollen trap. Commercially-produced pollen trap that fits in front of the hive entrance.

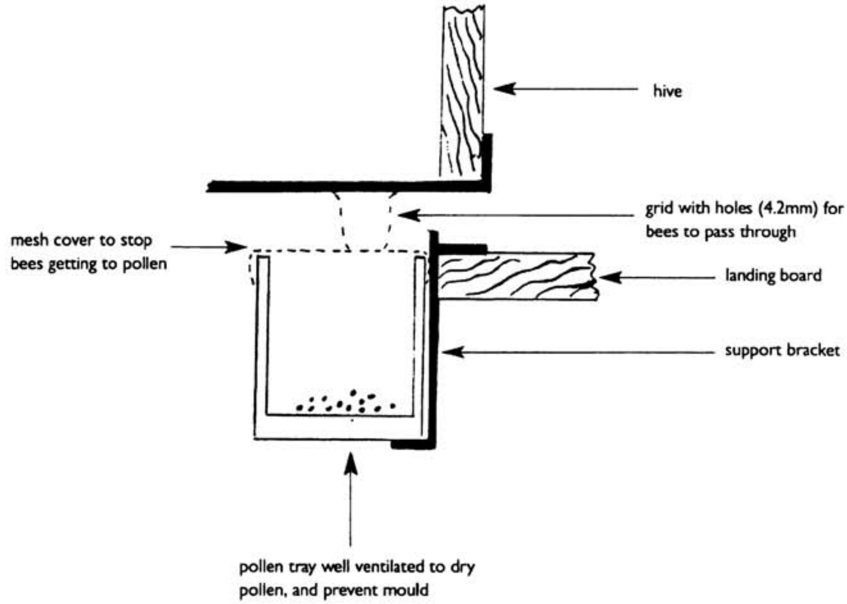


FIG. 91. Diagram of a pollen trap.

Air-dried pollen can be kept at a cool temperature for a short period but it can be difficult to store, soon absorbing moisture, coagulating and fermenting.

Bee pollen is bought by traders who may prefer pollen that is yellow or orange as it is said to have a better flavour than dark pollen.

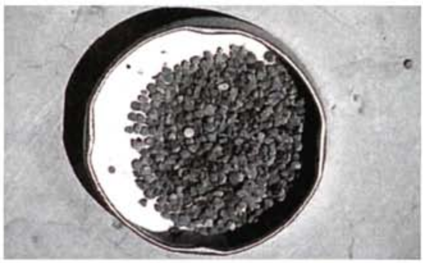


FIG. 92. Pollen that has been collected at the hive entrance.

There are many claims made for the effects and benefits of pollen which is used in traditional medicines and food supplements. However, one should be aware that the majority of reports are not from specific studies but from personal experiences unsupported by analytic evidence.

Claims include improved physical performance, increased vitality and appetite, reduction of high blood pressure, curing of colds and acne. There is some scientific evidence that shows pollen to be effective in treating prostate cancer. However, making unsubstantiated medical claims or using suggestive labels and descriptions to market pollen is wrong, untruthful and unethical. It must be totally avoided.

The nutritional benefits of pollen should be of interest to all those who have an unbalanced or deficient diet. However, there is a problem in incorporating pollen into food and that is that it can aggravate the widespread allergies that there are to the substance.

Finally, pollen collection by bees and subsequent analysis is used as a method of monitoring environmental pollution. This may not be of great significance to the rural beekeeper but it does show that pollen can contain contaminants and therefore pollen, or any hive product, should not be collected in heavily industrialized areas or where crops have been sprayed with pesticides.

Propolis

This is resin that honey bees collect from living plants and use alone, or with beeswax, in the construction or modification of their nests. However, beekeepers harvesting propolis should be aware that occasionally other substances such as paint or tar may be collected.

Propolis is sticky and soft when warm but hard and brittle when cold. It is entirely plastic between 25°C and 45°C (77°F and 113°F). It has been found that purer propolis is deposited at the top of the hive than on the hive floor. Beekeepers can use this to advantage by placing a sheet with slots or holes smaller than the bee space at the top of the hive or down the side. The bees will consider this the boundary of the nest and will proceed to close the holes with propolis.

The propolis can then be harvested by scraping it off or, if available, placing the complete sheet in a freezer for 24 hours.

FIG. 93. Propolis is the substance used by bees to seal the gaps around the edges of the hive or frames. It is used to fill any gap smaller than a bee space.

The brittle propolis will then fracture off. Flakes and pieces of propolis can be stored in the dark in airtight containers away from excessive heat. A simple purity test is to crunch up a sample and shake it with some warm water in a glass jar. Any waste material present will float to the surface.

Propolis is bought and sold by specialist traders. Traditionally, it is used for waterproofing, stopping leaks, an adhesive, drum-tuning, bow-string preparation and in herbal medicines. It can also be used as bait in catcher-boxes to trap swarms.

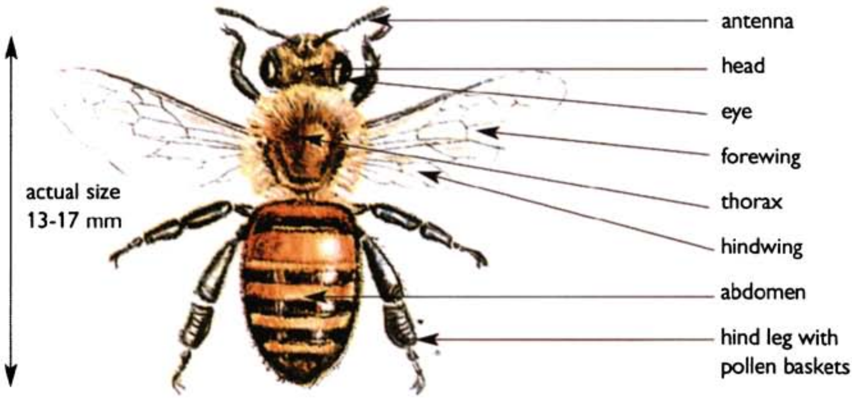
Generally speaking, most uses require it to be in liquid form. It therefore has to be dissolved. The most common solvent for food, medical and cosmetic applications is ethanol (ethyl alcohol). For home-made extracts it is possible to use gin, vodka, rum or whisky as the solvent. Even water extracts show some of the bactericidal and fungicidal effects, and wound-healing properties associated with this product.

However, extraction needs a great deal of care and some practised skills in order to obtain a standardized and quantifiable product with some degree of quality control. Propolis extract has several uses as a food preservative, anti-fungal additive, ingredient of cosmetics and as a medicine. However, care should be taken when marketing the product not to make unsubstantiated claims or to present hearsay as fact.

More specialist hive products

Other hive products are royal jelly, bee venom and bee brood. However, these can be very specialist areas which are best left to the beekeeper who is already extracting the maximum profit from the colonies in the products already discussed and has, through practice and experience, developed skills to a high level.

SECTION 9 – AN EXPLANATION OF COMMON BEEKEEPING TERMS



Abdomen The hind (back) part of a bee (or any insect).

Absconding Absconding occurs when all adult honey bees leave the hive or nest.

Adulteration To add a substance to another and so destroy the quality of the original. For example to add candle wax to beeswax and sell as beeswax, or to add sugar or corn syrup to honey.

Agroforestry The use of both trees and agricultural production on the same piece of land to encourage economic and ecological benefits.

Alighting board A landing board for the bees at the hive entrance.

Alimentary canal The digestive tract or gut.

Antenna (plural antennae) Sensory organ found in pairs (two's) on the head of a bee (and other insects). The antennae are sensitive to touch, taste and smell.

Anther The part of a flower's stamen that produces pollen. The male part of the flower.

Apiary The location of a number of honey bee colonies.

Apiculture The science and art of bees and beekeeping.

Apis The genus to which honey bees belong.

Bait hive An empty hive placed so that it will be occupied by a swarm of bees.

Bark hive	A hive made from the bark of trees.
Bee	An insect belonging to the superfamily Apoidea. Over 25,000 species of bees have been described.
Bee bread	The name given to pollen stored in the comb – usually around the edges of the brood. It has some honey and moisture added to it during collection.
Bee milk	A liquid produced by worker bees and fed to larvae.
Bee space	A gap large enough for bees to walk and work, for example, the space between two parallel combs or between a comb and the wall of the hive.
Beeswax	Wax produced by honey bees and used to build comb.
Bio-diversity	The number of species (plant and animal) in any given area.
Brace comb	Also known as burr comb. Comb that links combs together or to the side of the hive. Usually built when the bee space is too big.
Brood	All stages of immature honey bees; eggs, larvae and pupae.
Brood nest	The area of the colony where brood is being reared.
Cappings	The almost pure white wax used to seal cells.
Catcher box	See Bait hive.
Cell	A single hexagonal wax compartment, the basic unit of comb. Each honey bee develops within a single cell, and honey and pollen are stored within cells.
Chunk honey	Natural comb honey that is placed in glass jars that are then filled with liquid honey.
Colony	Honey bees are social insects. Each honey bee can only live as part of a colony and not individually. Each colony of honey bees contains one queen bee who is the female parent of the colony, a few hundred drone bees (males) and thousands of worker bees.
Comb	The wax structure made of hexagonal (six-sided) cells in which honey bees rear young and store food.
Corbicula	See Pollen basket.
Creosote	Colourless oily fluid distilled from wood-tar used as a wood preservative.

Cross-pollination	The transfer of pollen between flowers of different plants of the same species. Plants that are not self-fertile must be cross-pollinated before they can develop seeds. Many crops depend upon cross-pollination by insects.
Crown board	A name given to the inner cover of a hive – placed on the top box of the hive to act as a ceiling for the bees. It is covered by the roof.
Cut-comb honey	Pieces of comb containing honey and presented for sale in this way. Honey which has not been extracted.
Dadant hive	A design of American, single wall, frame hive.
Dance	Waggle dance and round dance – methods by which bees communicate the location of suitable forage to other workers.
Desertification	Decline in the productivity of land until is it biologically useless.
Drone	A male honey bee. Drones undertake no work within the hive: their sole function is to fertilize the queen.
Drone congregation area	Drones and virgin queens fly to specific areas to mate – these are known as drone congregation areas.
Extractor	The centrifugal machine in which honey is spun out of cells within comb.
Feeder	A device for giving food in the form of sugar syrup to honey bees.
Fixed-comb hive	A hive in which bees build their nests with the combs attached to the wall of the hive, and therefore fixed.
Food transfer	Worker honey bees give to, and receive from other workers substances from the honey sac or honey stomach. It is thought to be another form of communication.
Forage	Flowering plants which provide nectar and/or pollen for bees.
Forager	A worker honey bee that collects pollen, nectar, water or propolis for the colony.
Foundation	A thin sheet of beeswax usually embossed with the hexagonal pattern of comb placed in each wooden frame where it serves as a base upon which honey bees build their comb.

Frame	A wooden rectangular frame that holds a sheet of wax foundation. A number of frames hang parallel to one another inside the hive.
Frame hive	A hive which contains frames. The honey bees are encouraged to build their comb within these frames. The frames then enable combs to be lifted from the hive for examination.
Granulated honey	Honey in which sugar crystals have formed.
Guard bees	Bees that stand at the colony entrance facing outward, front legs raised and pass their antennae over bees entering the hive. They attack other insects, wasps and strange bees.
Herbicide	A chemical formulation that is designed to help increase crop yields by selectively killing weeds and other unwanted growth. Can be poisonous to bees.
Hive	Any container provided by humans for bees to nest in.
Hive tool	A simple tool used to open hives, remove frames and scrape off wax and propolis.
Honey	Nectar or plant sap ingested by bees, concentrated by them and stored in combs.
Honey bees	Species of bees belonging to the genus *Apis*.
Honey hunting	Plundering wild bee colonies for their honey.
Honeydew	Insects such as aphids feed on large quantities of plant sap which they excrete almost unchanged. This sap collects on the leaves of plants and if collected by honey bees is know as honeydew.
Insecticide	See Pesticide.
Kenya top-bar hive	A design of top-bar hive with sloping sides.
Langstroth hive	A design of frame hive. The inventor, the Rev L Langstroth recognized the importance of bee space and this allowed him to design the movable-frame hive.
Life cycle	The four stages a bee passes through: egg – larva – pupa – adult bee.
Low-technology hive	A hive which is simple, cheap, reliable, mendable.
Lug	A projection at the end of the top bar of a frame. This rests on a runner and so suspends the frame in the hive.

Mandible The jaw of an insect.

Manipulation The skilled management of a hive by the movement, addition or removal of combs at certain points in the development of the colony.

Mead An alcoholic drink made from fermentation of honey.

Meliponinae The sub-family to which all stingless bees belong.

Migration Seasonal movements of whole honey bee colonies, leaving no brood behind in the nest.

Migratory beekeeping Beekeepers moving colonies of honey bees in hives to take advantage of honey flows in other areas.

Mites These are not insects but are more closely related to spiders having eight legs. There are some mites that live on or in bees and spread disease.

Movable-frame hive A hive containing frames.

Nasonov pheromone A substance produced by a bee's Nasonov gland to attract other bees.

Nectar A sweet liquid secreted by flowers, a watery solution of various sugars.

Nectaries The glands within plants that produce nectar.

Nest The place where the comb or combs of a bee colony are sited.

NGO Non-governmental organization, usually a non-profit group working for development.

Nucleus A small colony of bees created by a beekeeper from an existing colony or colonies.

Pacifier A substance used to calm bees.

Package bees Supplies of bees produced for sale. Sold by weight, including a caged queen but without combs. Supplied in a box with wire mesh forming two sides.

Pesticide A chemical formulation that is designed to increase the yield of crops by attacking pests which damage that crop. Often these are not selective and kill beneficial insects as well.

Pheromone A chemical substance produced by a bee (or any animal) to convey a precise message to another of the same species.

Pollen	The fine dust-like substances which are the male reproductive cells of flowering plants. Collected by bees as a source of protein.
Pollen basket	Areas of stiff hairs on the hind legs of worker honey bees where they carry pollen.
Pollen trap	A device for harvesting pollen from bee hives.
Pollination	The transfer of pollen from the anther of a flower to the stigma of that of another flower.
Proboscis	The mouth parts of an insect.
Protective clothing	Body protection from stings.
Queen	The female parent of the colony, the only sexually developed female.
Queen excluder	A sheet, usually of metal, with holes that permit only workers to pass through, thus excluding the queen. It is placed between the brood box and the super to prevent eggs being laid in the honey storage area.
Refractometer	An instrument which can be used to measure the refractive index of honey (from this the sugar concentration of the honey can be calculated).
Royal jelly	Glandular secretions of worker honey bees mixed with some regurgitated carbohydrates and fed to developing bees.
Scout bees	Worker honey bees that are responsible for locating new sources of forage, or a new home for a swarm.
Smoker	A device for generating smoke to subdue bees. Often made from a metal can with bellows attached.
Smoker fuel	Material which can be burnt in the smoker, ideally to produce cool smoke over a long period.
Solar wax extractor	A piece of equipment in which the sun's heat is used to produce clean wax from used combs and odd scraps from the apiary.
Stamen	The male reproductive organ of a flower. It consists of a stalk on the end of which is the anther.
Stigma	The receptive part of the female reproductive organ of a flower which receives the pollen.
Super	Any hive box placed above the brood nest. Usually contains combs in which bees will store honey.

Sustainable beekeeping	Beekeeping to benefit humans while also ensuring the safe conservation of the bees and their habitat.
Sustainable development	Improvement which will continue supporting life in the future.
Swarming	When a honey bee colony becomes large enough to divide into two, swarming takes place.
Top-bar hive	A low-technology hive in which the bees are encouraged to build their combs suspended from bars placed across the top of the hive.
Traditional beekeeping	Beekeeping methods which were already in use prior to the invention of modern frame hives. Many traditional methods are highly skilled and in use today.
Transitional hive	A term sometimes used for top-bar hives referring to them as mid-level technology between traditional beekeeping (low-technology) and frame-hive beekeeping (high-technology).
Venom	The poison of a bee's sting.
Wax moths	Species of moths which destroy combs.
Worker bees	Female honey bees that make up the bulk of the colony and undertake all the work of the colony except for mating and egg-laying. Workers are sterile females.

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Further information on beekeeping in the tropics and elsewhere can be obtained from the International Bee Research Association.

IBRA is a not-for-profit organization established in 1949 to promote all aspects of beekeeping and bee science. It depends on membership subscriptions and donations for its funding.

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