Eva Crane Trust

ECTD_078a

TITLE: The Honeybee

SOURCE: Entomology Leaflet No. 6
[Leaflet for British Museum (Natural History) exhibition]

DATE: 1974

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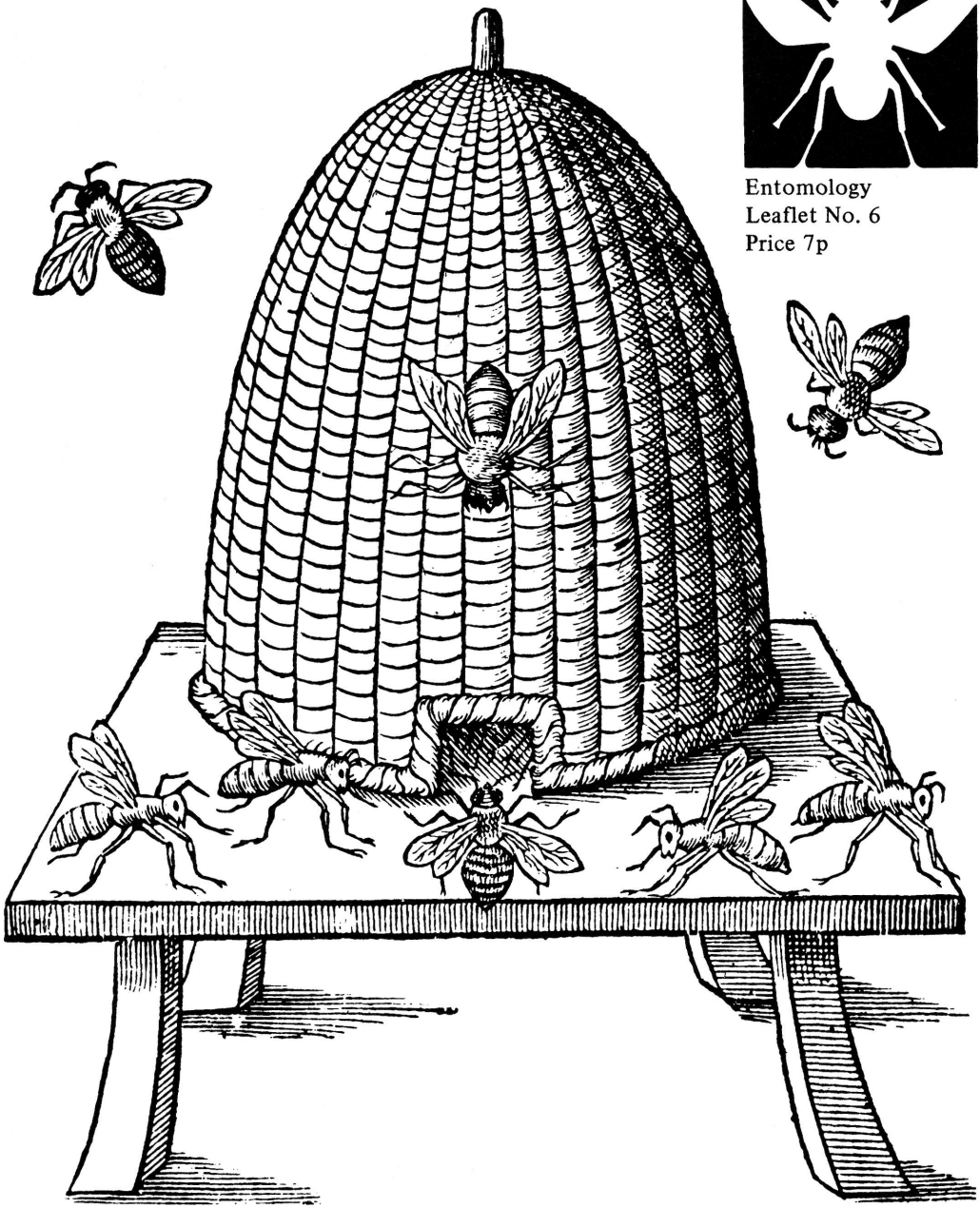
The Honeybee

78a

Entomology
Leaflet No. 6
Price 7p

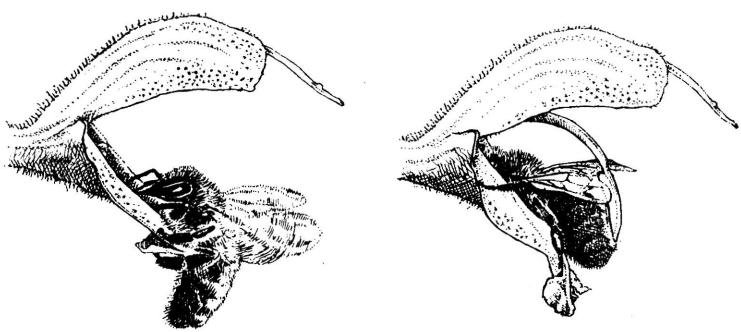


Adapted from a 16th century woodcut

Honey is prepared by bees from nectar which they collect from flowers and use, together with pollen, as food for their young. Nectar is a sugary liquid secreted by special glands in flowers and seems to have the function of attracting insects of various sorts, but especially bees, so that the flowers may be fertilized by the transfer of pollen through the agency of the insects. It appears that certain insects and many flowering plants have evolved together, and many special mechanisms, particularly in the flower structures, have arisen to ensure fertilization.

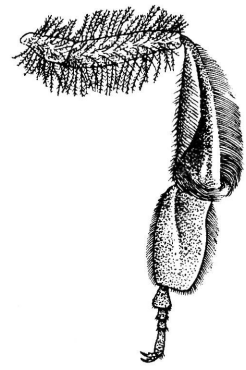
Honeybees on flowers showing pollen baskets.

There are a great number of different kinds (species) of bee and all are dependent on nectar and pollen for food. The vast



Bee entering sage flower (Salvia).

majority of bee species are solitary, that is, each mated female makes and provisions its own nest, consisting of relatively few cells either in a tunnel in soil, or in wood or in some other suitable habitat. A comparatively small number of species, however – the bumblebees and honeybees – have evolved a social way of life, i.e. they form colonies which are headed by an egg-laying 'queen' and include a 'worker' caste. The 'workers' are subordinate, unfertilized female bees whose main functions are foraging for food and maintenance of the nest.



Hind leg of worker.

Honey gatherers may be men or other animals. To interest them the honey must be of the right kind and in sufficient quantity, which only the social species of bees produce. Of these, only the true honeybee, *Apis mellifera*, is really of great importance, except in parts of South East Asia where another species of *Apis* is used. Here we are concerned solely with *Apis mellifera.* In passing, mention should be made of the fact that a few species of social wasps in Central and South America have secondarily taking to storing nectar (they lack the enzyme that converts nectar to honey) and this is gathered by the local human population.

Honey has always been of interest to man, especially in Europe before sugar was known; beekeeping was once an important branch of farming, though obviously it is much less so nowadays. In addition to honey, bees produce beeswax from which they make their honey combs, and this was formerly used for candles, polishes and other purposes. Honeycomb refuse could be fermented to make an alcoholic drink called mead. The earliest known reference to honey gathering is a rock painting in Spain of about 7000 BC showing the robbing of a bees' nest. A carving on a tomb of about 600 BC shows that the Egyptians practised a simple form of beekeeping very similar to that in general use until about 100 years ago.

Prehistoric rock painting showing honey gathering.

The honeybee *Apis mellifera* existed in Europe and much of the Old World, including Africa, long before man appeared on the scene, varying in habits and coloration in different areas. Early man hunted the nests and robbed them of their honey, and this method of honey gathering is still found in some primitive societies. Beekeeping started when man began to keep and look after the colonies either where he found them in hollow trees, or else in simple hives made from hollow logs or pottery, or woven from straw or wicker and then known as skeps. This kind of beekeeping may still be found in some of the less advanced communities all over the world. It is only in the last century or so that more complex hives have been developed.

The honeybee colony consists of three kinds of bee. At the head is the queen, a mated female, whose prime function is to lay eggs

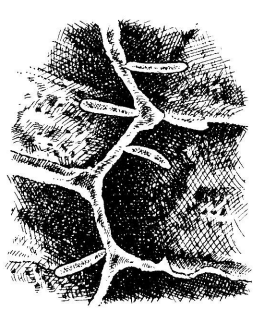
– sometimes as many as 1000–2000 a day – but she also maintains the cohesion of the colony by a secretion of the mandibular glands known as 'queen substance', without which the bees cease to act as a unit. The vast majority of the colony, as many as 60000 bees, is made up of workers, that is unfertilized, subordinate females who maintain the nest and forage for food. In addition there are a few drones, the only males in the colony, whose function is to fertilize the virgin queens as described below.

The nest itself consists of a series of vertically hung 'combs', each composed of horizontal hexagonal cells made of beeswax; there are cells on each side of the comb. The cells may contain 'brood', that is, eggs, larvae and pupae, or else food stores in the form of honey or pollen. There are three types of cells: (a) the smaller size used for brood destined to be workers and for food stores; (b) the larger size, still hexagonal, for brood that will produce drones; and (c) large thimble-shaped cells which hang vertically from the combs and are used for rearing queens.

Work in the colony is divided amongst the worker bees generally speaking according to their physiological age, except during the winter when their ageing is held more or less in suspense. For instance, a bee emerging from the pupa in June spends her first three days cleaning out cells, and then she feeds the older brood still in their cells. At about the eighth day the worker is able to make 'milky' food for the younger larvae. When two weeks old she performs other indoor tasks including the production of wax from special glands on her abdomen, comb-building and general cleaning operations. Later she guards the nest against enemies. It is not until she is three weeks old that she begins on the tasks that are going to occupy the rest of her life: the field work of carrying nectar, pollen and water. The total adult life of a worker bee in the summer is about 6–8 weeks but much longer over the winter when all processes slow down. The hind legs of the worker bee are specially modified so that they can act as 'pollen baskets' when foraging, and her crop is enlarged to hold nectar.

Part of a comb showing: 1. honey cells capped with wax; 2. uncapped honey stores; 3. worker; 4. queen; 5. worker larvae; 6. drone larvae; 7. sealed cells containing worker pupae; 8. sealed drone cells; 9. drone; 10. queen cell.

Eggs laid by the queen are of two kinds: fertilized and unfertilized. The former produce only females, either workers or queens; the unfertilized eggs, laid in the larger hexagonal cells, produce only males (drones). The fate of the larvae from the fertilized eggs is determined by their diet. Those larvae fed almost entirely on honey and pollen develop into workers while those larvae destined to become queens are fed exclusively on 'royal jelly', which is a



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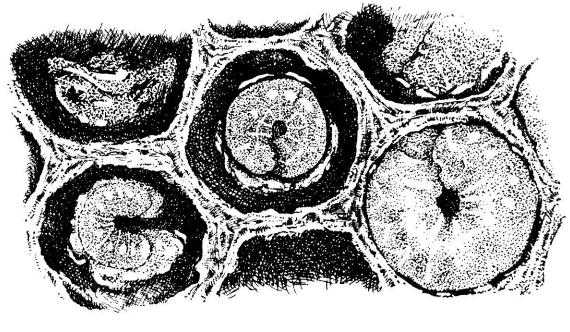

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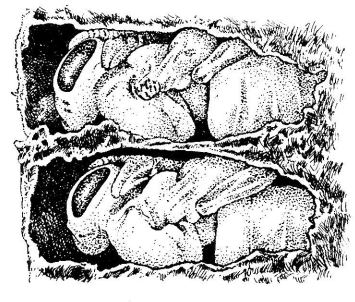

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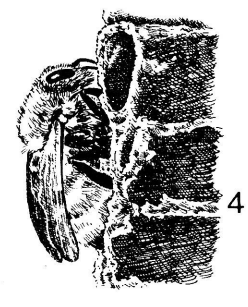

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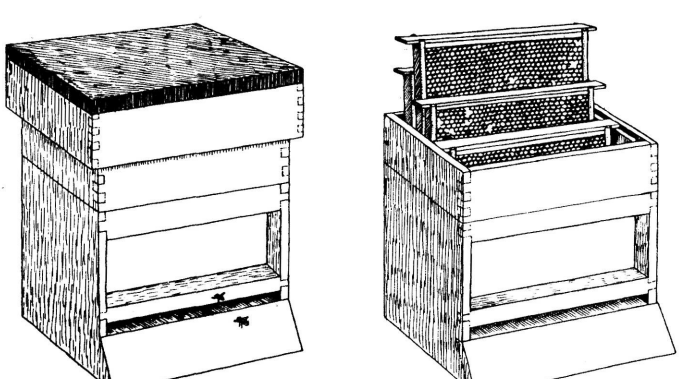
Stages in development: 1. eggs; 2. larvae; 3. pupae; 4. newly emerged worker.

protein-rich food produced by glands in the mouths of the workers. It is also fed to the other larvae but only when they are very young. Any eggs that may be laid by the workers themselves in the larger cells, in the absence of the queen, being unfertilized, produce only drones.

Colony increase is brought about by 'swarming', particularly in the early summer months if the colony is in good heart and prosperous and becoming over-crowded. In this case queen cells are built, appropriate eggs laid and larvae nourished; then, shortly before a queen is ready to emerge from the oldest queen cell, as much as half the colony or more leaves as a swarm, together with the old queen. The swarm searches for a place to form a new colony by sending out scouts, and then settles down again and builds a new nest in the chosen site. The scouts communicate with the others in the swarm by a tail-wagging dance, like the nectar dance described below. The actual details of swarming and the reasons leading to it are many and variable, and cannot be fully covered here.

The bees remaining in the parent colony will then decide, according partly to the weather and partly to their inheritance, whether to send out another swarm or 'cast'. If they do not so decide, then the first virgin queen to emerge from her cell in the old colony sets about killing all potential rival queens by tearing holes in their cells and stinging them, and by fighting and stinging any that have emerged in the meantime. Whilst fighting the virgin queens emit a loud call on a high note ('piping') which can be heard several yards away, though piping is not confined to virgin queens. In about twelve hours there is only one virgin queen left, who in about ten days' time will have mated and be able to lay fertilized eggs. Mating takes place in the air, after which the newly fertilized queen returns to the nest fully able to head the colony.

The sting, barbed in the workers, is the modified ovipositor or egg-laying tube, which now has a different function and is supplied with poison glands. The poison contains a complex

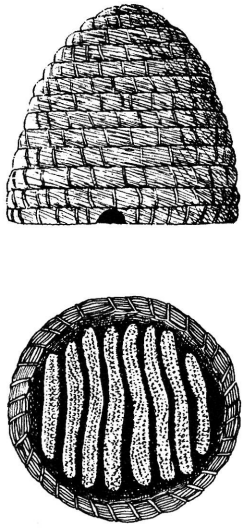


Modern hive (left), partially dismantled (right).

mixture of protein and enzymes, the latter acting on the victim's tissues to release histamine, which is responsible for many of the resulting symptoms. The workers use their stings for defence and usually lose them owing to the barbs; the queens use theirs solely in their fight for supremacy and, lacking barbs, can use them repeatedly.

If the bees in the old colony do decide on a second swarm, then the first virgin queen to emerge is not allowed to attack the other queen cells. She goes off with a swarm unmated and must find mates after selection of a new nest site. The old colony then allows other queens to fight for supremacy or may even send off yet another cast swarm.

Until the last century, beekeepers used simple hives as mentioned above, and to harvest the honey the heaviest and lightest colonies were killed by sulphur fumes; or sometimes the bees were driven off, usually in the late summer. Enough medium weight colonies were left to provide stock for the next season. The honeycombs from the chosen hives, particularly the heavy ones, were cut out and crushed to extract the honey. The lighter colonies were destroyed as they would not be able to overwinter, and at least the wax could be used. Swarming was encouraged because more stocks could be built up in the hope of a larger harvest.

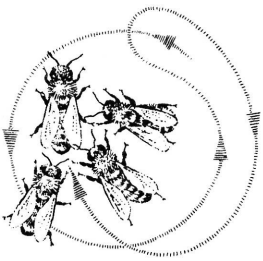


Old fashioned straw skep hive (upper); seen from below to show comb arrangement (lower).

In 1851, L. L. Langstroth in Philadelphia introduced the principle of the movable-frame hive. This enables the hive to be taken apart; only the honeycomb that is needed is removed, and the bee colony can be kept for further seasons. The really important discovery made by Langstroth was that if a gap is left just wide enough for a bee to get through easily (a 'bee space'), then the bees do not build comb across it and thus the frames holding the combs can be removed singly. Since then, various kinds of hives have been developed using his principles, though the older, simple style of hive is still to be found in less sophisticated communities.

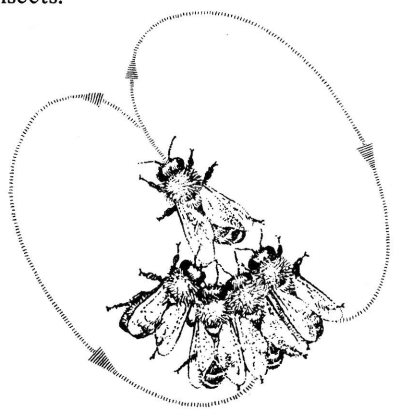
Great developments were made over the next 50 years, an important one being the perfection of the 'queen excluder'. This is a grid with slots just too narrow to allow the queen through, so that she is confined to one part of the nest only. This part is known as the 'brood chamber', and here eggs are laid and brood raised. Other chambers are added above, and these the workers fill with honey stores which may be harvested by the beekeeper at will. A foundation press was invented to emboss sheets of beeswax with a hexagonal pattern, thus enabling the bees to build their combs more quickly, with less effort and with greater uniformity. With this modern type of beekeeping, swarming is a disadvantage because it results in too many small colonies; the aim is to build up populous, efficient colonies in large hives, each producing a big

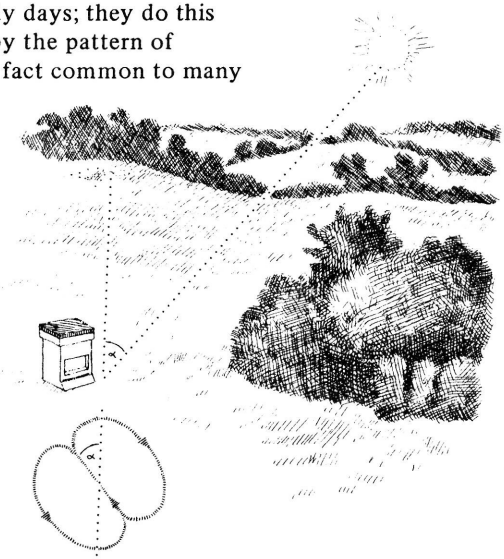
weight of honey which can be harvested without harming the bees.



'Round dance'.

It has long been known that honeybees quickly gather at a source of food, and research, especially by the Austrian entomologist von Frisch, has shown that the bees are able to communicate with each other by means of a special dance. A worker finding a rich source of nectar flies back to the hive and executes an excited dance on the comb which soon attracts other workers. According to von Frisch, the dance tells the others either that there is some source close at hand ('round dance') or else that there is a more distant source (over 100 metres from the hive) in a particular direction – in which case a 'tail-wagging dance' is executed involving flicking of the abdomen. The direction of the nectar is given by the angle between the line of a straight run in the middle of the dance and the vertical. The other bees note this angle which gives them the extent they must bear away from the sun and to which side. Distance is conveyed by the duration of the abdominal flicks ('tail-wagging') during the straight run. The dancing bee also carries the scent of the flowers and this is picked up by the others so that they can recognize the exact source of nectar as they approach it. Another interesting feature of this means of communication is that the bees are able to find their direction according to the sun compass even on cloudy days; they do this because they can detect the sun's position by the pattern of polarized light in the sky – this ability is in fact common to many insects.





'Tail-wagging dance' with schematic diagram showing use of sun compass.

Communication amongst bees and their ability to organize life within the colony are fascinating subjects but more detail is beyond the scope of this short account. Those interested are advised to seek out some of the many books that have been written on the topic: for example *The behaviour and social life of honeybees* by C. R. Ribbands, published 1953 by the Bee Research Association, London, or *The world of the honeybee* by C. G. Butler, published 1954 by Collins.

Printed in Great Britain by Henry Ling Ltd., at the Dorset Press, Dorchester, Dorset