Apis : The Honey Bee

The insect order **Hymenoptera** includes bees, ants, wasps and some other insects. These are characterized by the possession of two pairs of membranous wings, chewing or chewing and lapping type of mouthparts and, in many, a sting in the female.

Honey bees are the most familiar members of the order Hymenoptera. The honey bee usually described in textbooks is *Apis mellifera* (=*A. mellifica*), the common European honey bee. The small-sized honey bee, employed for commercial bee-keeping (apiculture) in India, is *Apis indica.* Other honey bees commonly found in India are *A. dorsata,* the giant honey bee and *A. florae,* the little honey bee. Approximately 20,000 species of honey bees are known to human.

SYSTEMATIC POSITION

Phylum	Arthropoda
Class	Insecta
Subclass	Pterygota
Division	Endopterygota
Order	Hymenoptera
Family	Apidae
Genus	*Apis*

HABITS AND HABITAT

Honey bees are found all over the world and are known for their art of manufacturing honey and bee-wax. They are highly specialized insects, both in structure and habits. Sense organs, mouthparts, wings,

legs and many internal organs are more diversified and specialized than in cockroach or grasshopper. They are social insects living in colonies and exhibiting polymorphism and division of labour. The nests or **beehives** of honey bees, harbouring thousands of individuals, are seen hanging down the tree branches or ceilings of houses and old buildings. These are built by their cooperative efforts and manifest a spectacular engineering feat. Honey bees feed on pollen and nectar of flowers. They communicate with each other through a sign language. Mating occurs in a nuptial flight and development includes metamorphosis.

BEE COLONY (CASTES)

A colony of honey bees consists of three kinds of individuals or **castes** : (i) **workers** which are sterile females, (ii) **drones** which are fertile males, and (iii) **queen** which is a fertile female. Population of an average-sized colony consists of one adult queen, about 100 drones and 60,000 workers. Drones and queen are concerned solely with reproduction. Hence, the workers perform all other duties such as producing royal jelly for feeding the community, producing wax and building the beehives, rearing the larvae, cleaning and ventillating the hive, disposing of the debris and dead bees, etc.

EXTERNAL MORPHOLOGY

[I] Worker Bee

Worker bee is the smallest member of colony and makes up the largest number of colony individuals. It is black or brownish in colour with body densely covered with hairs.

Like all other insects, the body of worker bee is divisible into three regions : **head, thorax** and **abdomen**.

1. Head. It is a wide triangular structure with the apex pointed below. It bears dorso-laterally a pair of large **compound eyes** and three **ocelli** on the middle of its top. A pair of short and 13-jointed **antennae** (12-jointed in male) are borne on the middle of face and probably serve as tactile and gustatory organs. From the bottom of head project the specialized mouthparts.

(a) Mouthparts. Mouthparts of honey bee are of **chewing** and **lapping type**, adapted for sucking nectar from flowers and moulding the wax. A broad and short **labrum** lies below clypeus and a fleshy **epipharynx** projects beneath it. The spoon-shaped and smooth-edged **mandibles** are situated below and one on either side of labrum. They work sideways and are used for moulding wax and manipulating pollen. In each **first maxilla**, lacinia is absent, maxillary palp is reduced and galea forms an elongated blade. Glossae of **second maxillae** or **labium** form a tongue-like process or **ligula** with a spoon-like depression at its tip, called **labellum** or **honey spoon**. It has a mid-ventral groove (food channel) and constitutes a tube or proboscis for sucking up the nectar. **Labial palps** are well developed and elongated. Paraglossae are very much reduced.

(b) Feeding. When the bee sucks nectar, it extends its ligula or tongue into the nectary of flower. The nectar rises up through its ventral groove or food channel by capillary action.

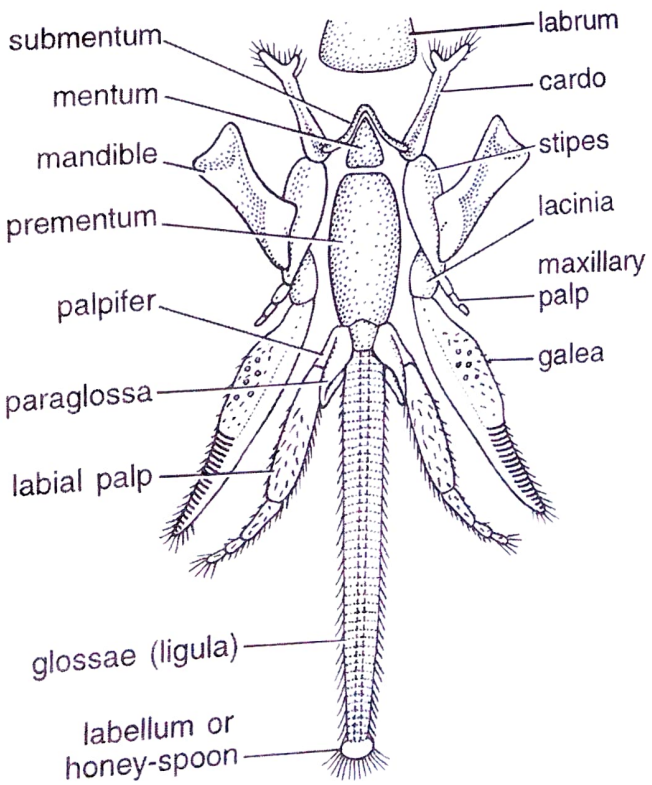

Fig. 2. Honey bee. Mouthparts.

Moreover, the shortening of ligula and the sucking action of pharynx helps in sucking up the nectar.

2. Thorax. Thorax is divided into the usual 3 segments : an anterior **prothorax,** a middle **mesothorax** and a posterior **metathorax**. Each of these segments bears a pair of **legs** and a pair of **wings** is borne by each of the mesothorax as well as metathorax.

(a) Legs. Three pairs of legs are densely covered with hair and are variously adapted. Because of their complexity and differences, each leg will be considered separately.

(i) Prothoracic legs. The segments of a prothoracic or foreleg are : (1) an oblong **coxa**, (2) a short **trochanter,** (3) a long **femur** provided with pollen-carrying hairs, (4) a **tibia** with a fringe of stiff hairs, or **eye brush,** along its medial edge for cleaning the compound eye, and a movable spine-like **velum** and a **pollen brush** on opposite margin at the distal end, and (5) a 5-segmented **tarsus** terminating in a pad-like **pulvillus**, which secretes a sticky substance for adherence, and a pair of **claws**. Its proximal segment or **metatarsus** bears a semicircular notch, called **antennal comb.** This comb, along with tibial velum, forms the **antenna cleaner** that serves to clean the antenna drawn in between them.

(ii) Mesothoracic legs. A mesothoracic or mid-leg has all the segments as seen in the foreleg. It has a spike-like **pollen spur** at the distal end of tibia and a **pollen brush** on the inner surface of metatarsus. Spurs of both the mid-legs are used to remove pollen from **pollen baskets** of hindlegs and to dislodge wax from wax pockets on the ventral surface of abdomen.

(iii) Metathoracic legs. Segments of a metathoracic or hind-leg too are the same. The expanded tibia bears a **pollen basket** on its outer concave surface which is partially covered by rows of long curved bristles along both its margins. Lower end of tibia bears a row of stout bristles forming the **pecten**. Proximal end of metatarsus bears a smooth, concave, lip-like plate, the **auricle**. Pecten and auricle together form a **pollen packer** to convey and pack pollen into the pollen basket. Inner surface of metatarsus bears many transverse rows of stiff bristles, forming the **pollen combs**. These brush off pollen from the body parts and handle wax.

(b) Wings. Two pairs of wings are double-layered, small, narrow, membranous and transparent. They have a much modified and reduced venation. Front margin of each hindwing bears a row of minute hooks, called **hamuli**, that fasten to the grooves along rear margin of forewing forming a single flight blade. Wings may vibrate over 400 times per second during flight. Workers may travel as far as 15 km to gather nectar and pollen.

3. Abdomen. It consists of 6 visible segments and bears the **wax glands** and the **sting**.

(a) Wax glands. The glandular area secreting wax lies on the ventral surface of the last 4 visible segments of abdomen. Wax is secreted through minute pores in the form of flat scales. It is masticated by the mandibles before its use for building the 'cells' of the honeycomb.

(b) Sting. Sting is the modified ovipositor of the insect and is used for injecting poison for protection. It is composed of two straight grooved **stylets** or **lancets**. Their distal free ends are provided with many anteriorly-pointed spines or **barbs** which prevent the removal of sting. The muscles associated with the sting help in the operation of lancets. A set of 3 chitinous plates on either side act as levers to move the barbs. A pair of filiform **poison glands** secrete the acidic

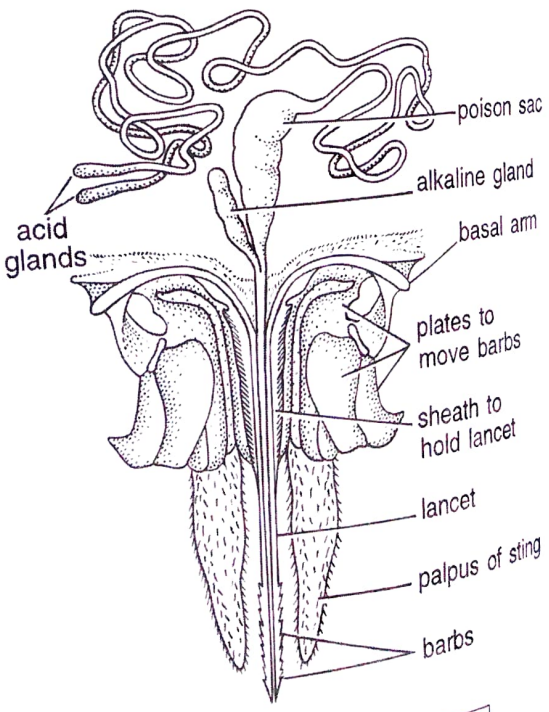

Fig. 3. Honey bee. Sting.

material that is stored in a sac-like storage **poison sac** located at the base of the sting. Associated with it is an elongated **alkaline gland** that secretes an alkaline material. The two materials mix to form the poison or **bee venom** that flows down the sting into the wound of the victim. After stinging, the worker bee leaves the sting apparatus and dies. Sting of queen bee is longer but less barbed and can be withdrawn without injury to her own body. Males do not have a sting because they have a copulatory apparatus instead of an ovipositor.

[II] Queen

Queen is the only fertile female in a beehive, having immensely developed ovaries. She is elongated, 15-20 mm long and is easily distinguished by her long tapering abdomen, short legs and wings. She has pointed mandibles and shorter mouthparts. She can sting repeatedly as there are no barbs on her sting. She is unable to produce wax and honey or gather pollen or nectar. She is a specialized and degenerate individual with a small brain and without salivary glands.

The queen arises from a fertilized egg and larva especially fed on **royal jelly**. She alone lays eggs and is the mother of almost all the members of the hive. She lives for several successive years laying about 2,000 or more eggs a day and up to about 1,500,000 eggs during her lifetime.

[III] Drones

Flying idly near the hive in the sunshine can be seen the male bees or drones. There are usually 100 drones in a typical colony, depending upon the season of the year. They are intermediate in size 15-17 mm long, but considerably stouter and broader. They possess very large eyes, small pointed mandibles and lack wax-producing glands, pollen-collecting apparatus and a sting.

Drones do not work and may be seen begging for honey from workers. If not fed by workers, they will die. They live for about 5 weeks only. They develop parthenogenetically from unfertilized eggs laid by the queen and exist only to mate with the queen of their own or some other colony.

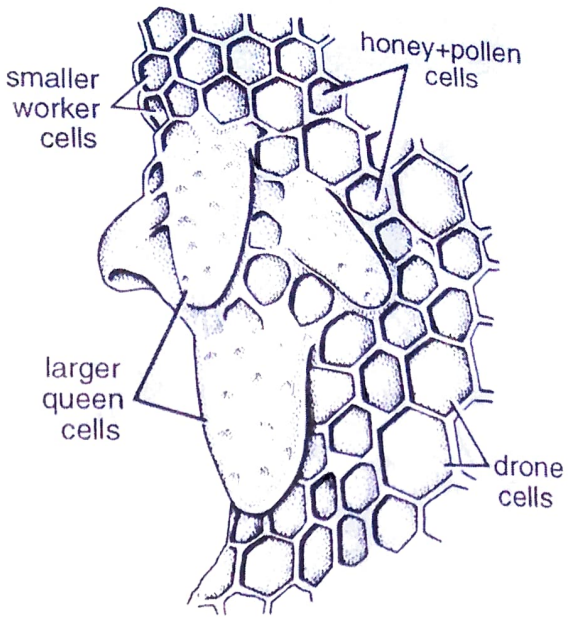

Fig. 4. A portion of the honeycomb showing various types of cells.

BEEHIVE OR HONEYCOMB

The honeycomb or nest is commonly built hanging down vertically from a rock, building or branch of a tree. It consists of two layers of hexagonal chambers of cells made by the beeswax secreted from the abdominal glands of worker bees. Their walls are extremely thin and fragile. **Storage cells,** containing honey and pollen, are usually built near the top and margins of the comb. **Brood cells,** generally occupying the lower and central positions, contain the young stages. In *A. dorsata,* brood cells are similar in shape and size but in other species they may be of three types. **Worker cells**, in which workers are reared, are small like honey cells. **Drone cells** are slightly larger, while **queen cells** are enormous, irregular, cylindrical or vase-shaped structures hanging down from the bottom. Queen cells cannot be used again like other cells.

INTERNAL ANATOMY

1. Body cavity. Body cavity is a haemocoel. True coelom is greatly reduced.

2. Digestive system. Mouth parts of honey bee are fitted for both chewing and sucking pollen and fluids which are sucked through **mouth** into a small **pharynx**. An elongated thin **oesophagus** joins a globular **crop** or **honey sac** in the anterior part of abdomen, where nectar of flowers is chemically changed into honey. Honey sac empties into a large cylindrical **stomach,** followed by a narrow **intestine** and an expanded **rectum**, which opens at the **anus**.

3. Circulatory system. A long, tubular, muscular and 5-chambered **heart** lies mid-dorsally in a **pericardial sinus**, receiving blood through 5 pairs of **ostia**, with valves to prevent backflow. Blood is pumped into head region through an anterior **aorta,** and it diffuses through haemocoel back into pericardial sinus. Blood is colourless, with **white blood corpuscles** in its plasma.

4. Respiratory system. 7 pairs of very small lateral **spiracles** (2 thoracic and 5 abdominal) admit air into a branched system of **tracheae** which convey O_2 to all body parts. Certain tracheae enlarge to become **air sacs** which are larger than those of grasshopper.

5. Excretory system. Numerous hollow, glandular and thread-like **Malpighian tubules** excrete wastes from haemocoel into the anterior end of intestine, much in the same manner as in grasshopper.

6. Nervous system. It is similar but **brain** is proportionately larger than that of grasshopper. **Ventral** nerve cord is double containing 2 **thoracic** and 5 **abdominal ganglia**.

7. Sensory system. Sense organs are more highly developed than in grasshopper. The **antennae** bear end organs of smell **(olfactory),** hearing **(auditory)** and touch **(tactile)**. Bristle-like taste setae **(gustatory)** are located near mouth and on the so-called 'tongue'. There are two large **compound eyes (visual)** and 3 **ocelli** on top of head.

8. Reproductive system. The sterile worker honey bee contains only vestigial reproductive organs. The **female reproductive system** of queen bee includes a pair of large **ovaries** almost filling the long abdomen, a pair of **oviducts** that unite to form the **vagina**, and a large **spermatheca** for storing spermatozoa and arising from the dorsal wall of vagina. The **sting** is a modified **ovipositor** formed by the external genitalia.

The **male reproductive system** of male or drone consists of one pair each of **testes, vasa deferentia, seminal vesicles** and **accessory glands,** and an **ejaculatory duct** that leads to the **copulatory apparatus**.

During **spermatogenesis,** there is no reduction division or **meiosis** because drones develop parthenogenetically from unfertilized eggs so that their cells are haploid containing 16 chromosomes. Whereas in **oogenesis**, meiosis occurs because the cells of female are diploid containing 32 chromosomes.

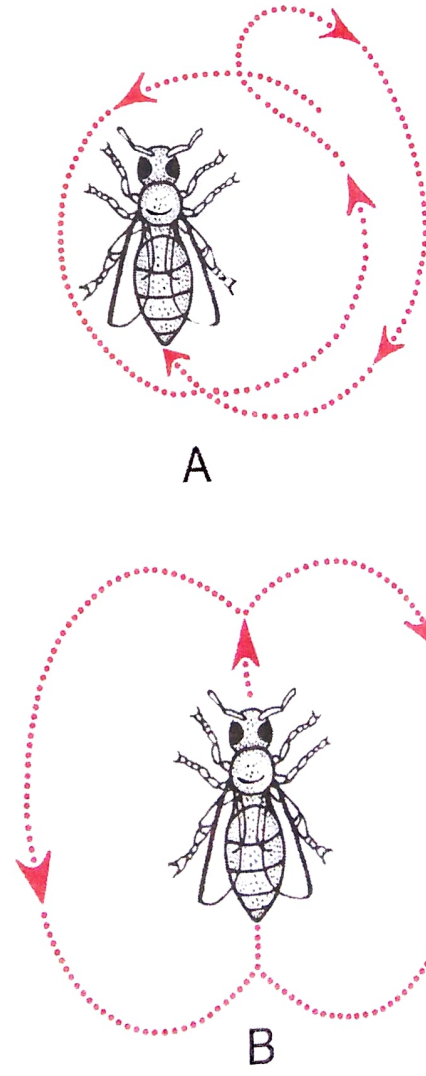

Fig. 6. Bee dances. **A.** Round dance. **B.** Tail-wagging danc

BEE LANGUAGE AND COMMUNICATION

Bees find flowers both by scent and sight. According to the brilliant Austrian Scientist, **Prof. Karl Ernst Von Frisch** (1948), the foraging bees returning to the hive indicate the new source of nectar and pollen by performing certain rhythmic body movements, called **bee dances** or **dance language**, which are readily understood by other bees of the colony. The two extreme kinds of bee dances are as follows :

1. **Round dance.** The bee turns in a circle, once to left and then once to right. The round or circling dance indicates that the source of food is near the hive.

2. **Wag-tail dance.** If the source of food is more than 100 metres away, the informant bee performs a wag-tail dance on the vertical comb. It runs for a short distance in a straight line swiftly wagging or vibrating its tail, and then moves in two semicircles one on either side of this straight line. Direction of food is indicated by the direction of tail-wagging. Running vertically up the comb means the food is in the direction of sun. Running vertically down the comb means that food is present opposite the sun. However, if the straight run is oblique, then source of food is at the corresponding angle. If it is dark, the worker bees touch the runner with their antennae to determine the direction of its run.

LIFE HISTORY

1. Swarming

The behaviour of honey bees to come out of the hive in large numbers is called **swarming**. It takes place during the spring or early summer. It relieves the over crowding and provides a means of colony reproduction, *i.e.*, founding of new colonies. On a fine forenoon, the **old queen** leaves the hive accompanied by a large number of **old workers** and **drones** in a swarm. The swarm soon settles down, often on the branch of a tree, and builds a new nest. Left behind in the old hive are the young workers and several new queens still in their cells but approaching the time of emergence. Only one queen survives by stinging to death the other newly-hatched queens.

2. Nuptial or Marriage Flight

The **prime swarm** is led by the old queen while the **second swarm** is accompanied by the newly-emerged virgin queen. About a week after emergence, the new queen takes her first aerial flight followed by a swarm of drones. The queen flies very high and the drones gradually drop out of the race. The last drone left in the race, mates with her. **Mating** occurs in mid-air, during which the queen receives spermatophores from one of the drones. The queen mates only once in a life time. The sperms stored in her spermatheca fertilize her eggs as long as she lives. The genital parts of male are forced out with such a great pressure that he dies after mating. The pair then

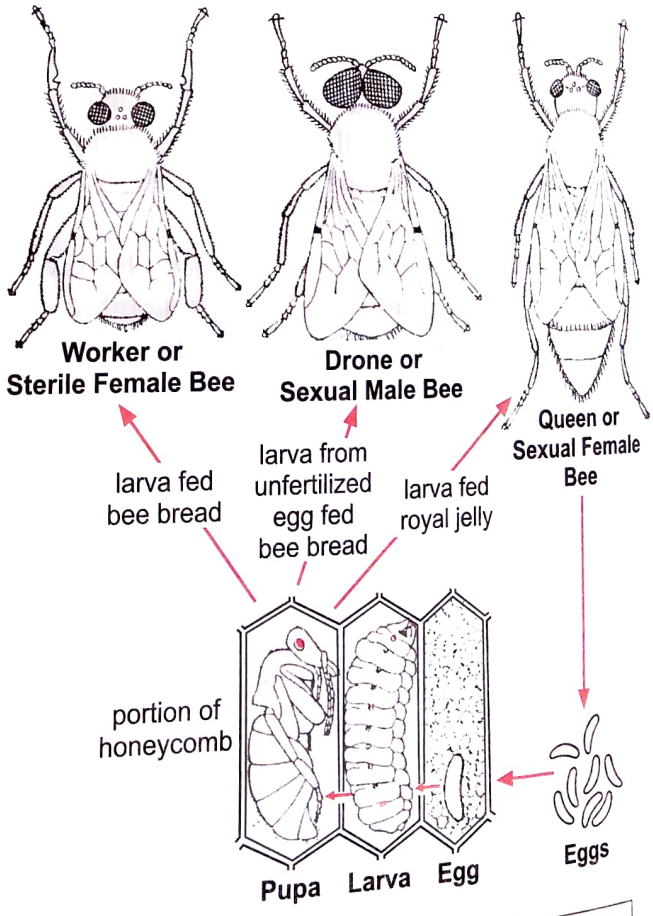

Fig. 7. Honey bee. Stages of Life history and castes.

falls to the ground and the queen after pulling herself away returns to the hive not to leave it again, until she grows old and leads a prime swarm.

3. Development and Caste Determination

Development takes place in the cells of hive and undergoes complete metamorphosis through larval and pupal stages. 3 or 4 days after mating, the young queen begins to oviposit.

1. **Eggs.** As an egg passes down the ovary through oviduct, it receives a **shell** and gets fertilized by a sperm. The queen has a remarkable capacity of controlling the fertilization of its eggs. A fertilized egg is laid in a worker or queen cell of honeycomb, while an unfertilized egg in a drone cell, the latter developing parthenogenetically. Eggs are small, oblong and bluish-white. A queen may lay one million eggs in her life time at the rate of 1500 eggs per day.

2. **Larvae.** After 3 or 4 days, small larvae or **grubs** hatch out from the eggs. They have no legs or eyes. The formation of a queen or worker depends on the diet which the larvae receive. All larvae are fed by the workers for the first few days on **royal jelly**, which is composed of a predigested mixture of honey and pollen. The larvae destined to become queens receive this food throughout their life. While, after 3rd day, the worker and drone larvae are fed upon a mixture of honey and pollen, called **bee bread**. If a worker larva is transferred to a queen cell before 3rd day, it develops into a queen, and vice versa.

3. **Pupae.** The grubs grow and moult several times and after 5 or 6 days develop into pupae. A pupa is enclosed in a silken **cocoon** secreted by the larva. It takes the queen on an average 13 days, the worker 18 days and the drone 21 days to complete metamorphosis and emerge out as adults.

At the approach of winter, drones are driven out of the hive by workers. They are either stung by workers or die of cold or hunger. The queen and the workers bridge over the winter season by feeding upon the stored honey and pollen.

ECONOMIC IMPORTANCE OF HONEY BEE

(1) The **honey** makes an important food for man and other animals. It is the crop or honey-sac where the nectar is changed into honey by losing a certain amount of water and becoming chemically altered. The salivary enzyme converts the complex sugar of nectar into the simple sugar of honey.

(2) **Bee wax** is used for medical purposes.

(3) The honey bee is probably of greatest importance to agriculture in the **pollination** of plants. It is the only pollinating insect which can be controlled by man and, therefore, is extremely valuable to him. Certain orchard trees yield very little without the aid of the bees.

(4) Lastly, to some extent, they can **annoy** man by their stings.

APICULTURE

[I] Apiculture in India

Before man learned to manufacture sugar, he depended for sweets largely upon honey, which formed an important element in his diet. Honey is mentioned in ancient Indian books like Vedas, Purans, Ramayan and Mahabharat, etc. Foreign travellers, like Fahiyan, have described its medicinal use. Honey is produced by honey bees which has been most intimately associated with mankind since very ancient times, and has reached the highest degree of domestication. Bee-keeping therefore, is one of the oldest agricultural pursuits of man. The modern scientific and commercial method of breeding and care of bees for the production of honey and bees wax is known as **apiculture**.

Bee-keeping or apiculture is widely practiced in U.S.A., Canada, Australia and New Zealand. In India also it is a thriving cottage industry widespread in South India as well as in some northern states where it is providing gainful employment to several lakhs of people. The Khadi and Village Industries Commission (KVIC) and the Indian Council of Agricultural Research (ICAR) are making efforts to raise the industrial status of apiculture in India.

[II] Choice of Flora

A place where bees are kept is known as **apiary**. For setting up an apiary, the local flora is an important part of apiculture. Bees can collect nector and pollen from far distant places but it will be better to choose more nector-yielding plants such as neem, jamun, soapnut, etc. Plants like maize, rose and sorghum are rich in pollen whereas others like cherry, apple, sheesham, coconut, guava and musturd serve both for nector and pollen.

[III] Choice of Bees

For starting an apiary, it is important to select a good variety of bees for domestication. (i) They should be gentle in temperament and have a colonial habit. (ii) They should be able to protect from enemies. (iii) Their workers should be smart and energetic and be able to suck juice from a variety of plants. (iv) They should be high honey yielding. (v) They should be such that can form a hive anywhere.

Four species of honey bees (*Apis*) commonly found in India are :

1. ***Apis dorsata.*** Popularly known as Giant Honey Bee, it is the largest in size, about 20 mm in length. It yields maximum honey of all, about 25 kg from each comb. But they could not be domesticated because of their ferocious and irritable nature and migratory habits.

2. ***A. indica.*** The small Indian Bee (about 15 mm long) inhabits forests and plain regions throughout India. It can be easily domesticated because of gentle nature, but the yield of honey is much less, only 3 to 4 kg per comb.

3. ***A. florea.*** The Little Bee is still smaller in size (8 mm) and its honey-yielding capacity is 250 gm per comb. It is docile in nature and stings rarely, so that removal of combs for honey extraction is easier.

4. ***A. mellifera.*** The European Bee, is also docile in nature and easy to domesticate.

Out of the four species of honey bee mentioned above, *A. indica* is the best, used in India for apiculture industries.

[IV] Apiculture Methods

The main aim of apiculture is to obtain more and more honey in pure form. There are two methods of apiculture in practice : (i) **old** or **indigenous** and (ii) **modern**.

1. Old or indigenous method. The primitive old method is very crude and unplanned. The hives used are : (i) natural **fixed combs** prepared by bees on walls or the branches of trees, and (ii) artificial **movable hives** prepared of hollow wooden logs, empty boxes and earthen pots, etc. For collecting honey by this primitive method, the bees are first killed or made to escape by smoking or by bringing fire flames near the bee hives especially during night when the bees are at rest.

The main drawbacks of this old crude method of bee-keeping are :

(i) Honey thus extracted is not pure because the brood cells containing larvae and pupae and pollen cells are also extracted.

(ii) It destroys the old colony affecting future yield of honey and the bees have to spend a lot of energy afresh in the construction of new hives.

(iii) Bees may not construct new hive at the same old place again.

(iv) Natural hives may be attacked by enemies (rats, ants, wasps and monkeys) or damaged by climatic factors.

(v) Chances of improving the race are not possible.

The crude indigenous method of apiculture despite many drawbacks still persists in many parts even today. But it is being gradually replaced by a better and scientific modern method.

2. Modern method. In modern method, honey bees are reared in movable artificial hives invented by **Longstroth** in 1951. This has

converted apiculture into a cottage industry providing employment to lakhs of village and urban people.

A brief description of the various **appliances** used in modern method is as follows :

(a) Artificial hive. Artificial hives are made of wooden boxes which can be shifted easily. A typical movable hive has many parts arranged in 2 or 3 tiers.

(i) Brood chamber. Base of hive is formed by a **bottom board** with two gates for entry and exit of worker bees. The bottom board carries a wooden box made of two chambers. The larger lower chamber is called the **brood chamber**, which contains the queen bee, and the upper smaller one the **super chamber**. The two are separated by a perforated zinc sheet called **queen excluder**. The size of perforations is 3.75 mm so that workers and drones can pass easily through them. But the queen bee with a 4.3 mm to 4.5 mm thorax size can never pass through them. This prevents her from laying eggs in the super chamber which would create problem in obtaining pure honey.

The super chamber is covered by a wooden **inner cover** bearing several holes for proper ventilation. Finally a **top cover** fitted with a plain and slopping zinc sheet, protects the bee hive from rains. The entire behive is mounted on a **stand** which is adjustible for creating the slope needed.

(ii) Comb foundations. The brood chamber contains 5 to 10 vertical **frames** in parallel position with their upper ends touching the queen excluder partition and lower ends in contact with the bottom board. In each frame is kept a bees wax sheet in vertical position, having hexagonal chambers on both sides. These wax sheets are called **comb foundations** as they provide the basis for construction of comb by the worker bees. The queen bee lays eggs in the hexagonal chambers of these comb plates which can be used repeatedly for getting a regular brood of worker bees.

The super chamber also contains additional frames with comb foundations in which the bees collect only honey.

(iii) Models of hives. Various models of artificial beehives have been developed for use in different parts of India. The **Longstroth model** having 10 frames (44.8 cm by 23 cm) is used in Jammu and Kashmir, Punjab and Himachal Pradesh. The **Newton Model** with 7 to 10 frames (21 cm by 14.5 cm) is popular in south, east and central India. The **Jeolikote model** contains 8 frames (30 cm by 18 cm). The Indian Standard Institute (ISI) has even standardized two models, one with smaller frames (21 cm by 14.5 cm) and the other with larger frames (31 cm by 24.4 cm). In India, comb foundations of different sizes are manufactured at the Central Bee Research Station, Poona.

(b) Honey extractor. It is large drum of tin containing revolving rods bearing pockets of netted cloth. Extraction of honey is done on the principle of centrifugal force. Comb foundations full of honey are kept in pockets of netted cloth and the rods rotated manually at a high speed, as in a centrifuge. The pure honey thus extracted is collected through a basal outlet. The comb foundations remain undamaged and can be used again and again.

(c) Uncapping knife. In the beehive, chambers full of honey are sealed with a wax seal by worker bees. Before placing these combs in honey extractor, their wax seals are uncapped or scraped with a knife heated over steam.

(d) Miscellaneous equipment. A few other things needed are : (i) a **smoking apparatus** which is a simple tin box having an outlet at its top for the smoke to come out. (ii) **rubber gloves** to protect hands from the sting of bees, (iii) **bee net** made of synthetic or cotton cloth to protect from the attacks of bees.

[V] Products of Apiculture

Two main products are **honey** and **bee wax.**

1. Honey. This is the most important product of apiculture. It is used as food as well as in medicines.

Honey is believed to be highly nutritious. 200 gm of honey provides the same nourishment as 330 gm meat or 11.5 litre of milk or 1.6 kg cream. It has been estimated that 2.1 gm of honey contains 67 K. calories of energy. Our body systems readily absorb the sugar, mineral, vitamin and other elements of honey. Honey is useful to a healthy as well as sick person of all ages, even

the newly born, and can be taken without the consideration of time. It is also used in the preparation of cakes and biscuits, etc., and also taken with or without milk.

Honey has its great medicinal value. It is generally used in Ayurvedic and Unani systems of medical treatment. It is a mild luxative, antiseptic and sedative, and helps in the formation of haemoglobin in anaemic patients. It prevents cough, cold and fever. It is used as a blood purifier, and to cure the ulcers of tongue and alimentary tract. It is also recommended in severe heart attack and to cure diabeties. It is helpful in indigestion. It is a quick killer of germs of typhoid, dysentry and branchiopneumonia. It also give quick energy.

Besides food and medicinal value, honey is used in distillaries for making alcoholic drinks, and in poultry and fishing industries. It is of great value in laboratories where it is used as growth stimulant of plants, for the bacterial culture, for inoculating the seeds of clove, etc. It forms the diet of many insects and is used in making poison baits to save many fruits from fruitflies.

Honey is a sugar rich compound having the following constituents : (i) Levulose – 38.9%; (ii) Dextrose – 21.28%; (iii) Maltose and other sugars – 8.81%; (iv) Enzymes and pigments – 2.21%; (v) Ash – 1.0%; (vi) Water – 17.20%.

2. Bees wax. It is useful in the manufacture of cosmetics, face creams, paints, polishes, plastic works, ointments, carbon papers and many lubricants. It is of common use in the microtomy work in laboratories to prepare blocks of tissue where it is mixed with common wax. Bees consume 10-20 kg of honey to produce 1 kg of wax.

Chibnall (1934) has reported that all insect waxes are complex mixture of varying proprortion of : (i) Even numbered alcohols ranging from C_{24} to C_{36}. (ii) Even numbered normal fatty acids from C_{24} to C_{34} and (iii) Odd numbered normal paraffins ranging from C_{23} to C_{37}.

The various bees waxes differ only due to change in the proportions of these constituents.

[VI] Bee Enemies

Colony of honey bees is harmed by enemies of bees in different ways. The wax moths (*Galleria melonella* and *Achoria grisella*), the bee eaters (*Merops orientalis*) and Kingcrow (*Dicrurus macrocercus*) are common enemies of bee's comb and honey.

Important Questions