CHAPTER 17

Apiculture

Apiculture is the technique of rearing honey bees and extracting honey and wax from their nests or bee hives. The bee hive may be natural or artificial. In the latter case specially designed boxes are provided to the honey bees for building nests.

Old method

The importance of honey is known to mankind from pre-historic times. All religious books have reference of honey and honey bees. And from ancient time only method of collection was to go to the forests in search of hives built in the wild. After getting a hive, the honey collectors used to drive away the bees by using fire and then used to collect the honey and bees wax. Such age-old practices are still followed in different parts of our country. These methods have following limitations:

1. Extraction of honey is done in a very crude way. As it also contains pollens, body fluid of the larvae of bees, body parts of the bees and dust, it is not considered pure and hygienic.
2. Searching of bee hive inside the dense forest is a time-consuming and risky process. Compared to the labour and risk involved, the reward of the collectors are often poor.

New method

With the introduction of new method, the apiculture has become a profitable cottage industry. The countries like America, Canada, Australia, New Zealand and United Kingdom have increased their production of honey and bees wax through new methods of apiculture (See Table)

In our country, bee-keeping is emphasised in the five-year plans and community development projects. The institutes like Indian Agriculture Research Institute at New Delhi provide research information on different aspects of the problems of bee-keeping and its improvement. All India Khadi and Gramudyog Commission provides assistance and encouragement for bee-keeping. In 1975, under the guidance and encouragement of Khadi and Gramudyog Commission, co-operatives of bee-keepers have been established in five districts of West Bengal. It had a total member strength of 8,870. In 2,458 villages of these five districts a total of 33,500 boxes have been used. Total honey produced out of these boxes are 116,000 kg. A kilo of honey costs Rs. 10/-. It is now clear that bee-keeping can improve village economy to a great extent.

If apiculture is to be done on commercial basis, then the apiculturist must have to be acquainted with the bees, their life history and some equipments.

Honey bee and its life history

The bees belong to the genus *Apis* and come under the class insecta of the Phylum Arthropoda. The common honey bees of our country are *Apis* (*Megapis*) *dorsata*, *Apis* (*Microapis*) *florea* and *Apis indica*. The European honey bee, *Apis mellifera* or *Apis mellifica*, has been introduced to many honey-producing countries of the world. There are many similarities between *Apis indica* and *Apis mellifera* and both are domesticated for apiculture. The features of different Indian honey bees are given below:

Apis (*Megapis*) *dorsata*. These are commonly known as rock-bee or Bombara. These large sized bees are seen all over the

Countries	Honey in kg.	Bees wax in kg	Value in 10 million Rupees	No. of hives	Nos. of people engaged
America	100,874,000	2,724,000	25	4,756,000	500,000
Canada	23,154,000	272,000	12	400,000	32,000
India	4,086,000	90,800	5	?	?

Table showing the countries engaged in apiculture, the yield of honey and bees wax, and their sale price and the number of people engaged.

uninhabited buildings. Each hive varies in size from 1·5 m to 2·1 m from side to side and 0·6 m to 1·2 m from top to bottom.

Each cell of the hive is hexagonal in appearance. These bees are good gatherers of honey but efforts to domesticate them have failed.

Apis (Microapis) florea. These popularly known "little bees" are seen only in the plains all over India. These bees make small hive in the branches of trees, hedges and house chimneys and the size of the hive does not exceed the size of the palm. These bees are poor producers of honey and each hive yields about 0·5 kg of honey. These bees are not good for domestication.

Apis indica. These bees are found all over the country. The strains which are seen in hill areas are darker in comparison to the strains seen in the plains. Their hives are built in the crevices of tree trunk, hollows of rocks and other common closed and covered places. Each hive yields 4 to 4·5 kg of honey. These bees are good for domestication and forms hive in wooden boxes and packing cases. Because of their gentle temperament, these bees are easy to handle.

Life-history

Honey bees live in colonies and have an organised social life, where division of work is well marked. In a hive, honey bees are of three different castes—queen, workers and drones or males (Fig. 17.1). In a hive there live a single queen, twenty to thirty thousand workers and a few hundred males.

The queen bee is larger in size than workers and drones. Her only function is to lay both fertilized and unfertilized eggs.

The males or drones are slightly larger in size than the workers. The drone is responsible for mating with the queen. The worker bees control the population of drone in a hive and if there is scarcity of food all the drones are driven out from the hive.

The worker bees are small in size but maximum in number. They are imperfectly developed females and perform

Pollen grains which are rich in protein are converted into food called *Bee's bread*. Bees also produce a special kind of food called *Royal jelly*.

A pair of *wax glands* is present on the ventral surface of each of the last four abdominal segments. The wax is secreted by the wax glands and the worker bees trim this wax for constructing new cells or repairing the old cells of the hive.

During breeding season, the queen bee together with the drones fly out of the hive. In this nuptial flight, only one drone copulates with the queen and then dies. The queen stores the sperm cells in a special chamber called *spermatheca*. After returning to the hive it starts laying eggs and at that time some eggs are fertilized by the sperm. The future queen is fed by the special food *Royal jelly* and would-be drones are given the *bee's bread*.

Composition of honey

Honey is an aromatic, viscid, sweet material derived from the nectars through the collection of bees and modified and stored by them as a denser liquid. It contains the following:

Water	17%
Simple Sugar (Levulose and Dextrose)	78%
Minerals (Compounds of Si, Fe, Cu, Mn, Cl, Ca, K, Na, P, S, Al, Mg)	5%
Acids (Acetic, Formic, Malic, etc.)	
Plant pigments (Carotene, Xanthophyll)	
Enzymes (Invertase, Diastase, etc.)	
Vitamins (A, B & C)	

Composition of bees wax

The wax secreted by honey bee is a mixture of esters of palmitic acid with myricyl alcohol. It is yellowish or grey-brown in colour. It is insoluble in water but soluble in ether, chloroform and xylol. Its melting point ranges between 60°C and 65°C.

Use of honey and bees wax

The honey is well known for its food value. With milk it provides easily digestible high energy-yielding food specially for infants, invalids and aged people. It plays important role in the formation of haemoglobin and helps in removing fatigue. The nourishing capacity of 200 gm honey is equivalent to 1·135 kg of milk or 340 g of meat or 8 oranges or 10 eggs.

Honey is used in baking breads, cakes and biscuits. It gives flavour and at the same time being hygroscopic prevents them from drying up.

Honey is used as base in Aurvedic and Unani system of medicine. It is considered as laxative, purifier of blood and preventor of cold. It is also used in cases of malnutrition, heart attack, digestive complains, ulcers in the alimentary tract, etc.

Honey is used during religious ceremonies by Hindu, Jews and Catholics. In the Western Country, honey is used for preparing drinks. It is given to race horses for increasing stamina and to cattle for increased production of milk.

Several items are manufactured by bees wax. It is used in the preparation of cosmetics. The candles used by Roman Catholics are strictly made up of bees wax. It is also used for Batique art.

Knowledge about bee pasturage, equipments and diseases

Bee pasturage

Honey bees remain active practically all through the year. In severe winter the bees cease work and do not rear any brood. They sit clustered in the hive and the bees that remain at the surface of the cluster form an insulating layer. Occasionally at this time of the year the bees take honey for the generation of body temperature.

During the period of activity the worker bees collect nectar and pollen from flowers. The plants which yield these two substances are collectively called *Bee pasturage* or *Bee forage* or nectar and pollen plants. 'Honey flow period' is the season of the year when a good number of plants bear nectar to be foraged by the bees. If the nectar production by a good number of plants of a given species is plenty the season is called *major honey flow period*. When the amount of nectar available is too small the period is called *minor honey flow period*. Dearth period is the time when there is no honey flow.

Success at bee-keeping will be possible if the bee-keepers have some knowledge of the bees pasturage and honey flow

periods. Bee-keeping becomes profitable if there remains one or two major and minor honey flow period and where dearth period is of short duration.

Equipments

Movable frame hive. From ancient times attempts have been made to keep bees in a crude manner. The discovery of the principle of movable frame hive in 1851 by Rev. Langstroth gave a momentum to bee-keeping. Many countries started introducing this innovation.

The movable frame hive rests on the principle of bee space (Fig. 17.3). This is

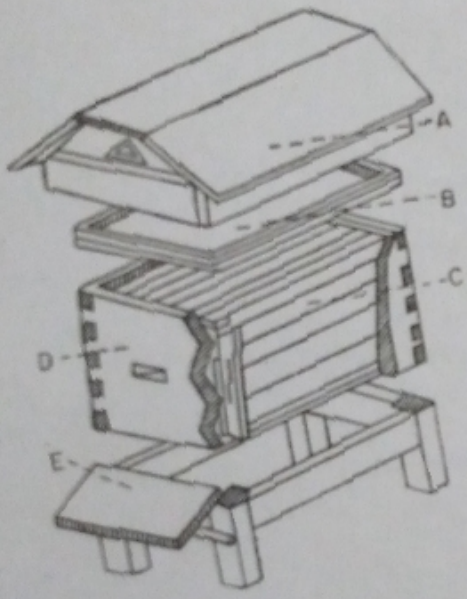

Fig. 17.3. Movable frame hive invented by Langstroth. Sloping top cover (A), Inner cover (B), Frame (C), Brood-chamber (D), Alighting space for bees in the stand (E).

a space large enough to allow free passage for worker bees but too small to encourage bees building a comb.

The components of a standard movable frame hive are:

(*a*) *Stand*—A four-legged stand less than one foot (30 cm) in height is used. It is made heavy. A slanting piece of wood called 'alighting board' remains fixed with it.

(*b*) *Bottom board*—This may be made of a single piece of wood or two pieces of wood nailed together. It is placed over the stand and the fitting is perfect. To it remains nailed six wooden rods. Of these rods the front one is provided with an entrance aperture for the worker bees.

(*c*) *Brood-chamber*—It is a rectangular wooden box without top and bottom. It rests on the bottom board.

(*d*) *Standard Langstroth frame*—It consists of a top bar, two side bars and a bottom bar. The top bar has a groove in the middle of its lower side for fixing the comb foundation sheet. The top bar and the bottom bar remain fixed with side bars. The side bars are provided with holes for wiring.

(*e*) *Super*—Its construction is almost similar to that of the brood-chamber and it lies above the brood-chamber.

(*f*) *Inner cover*—It is a wooden board to cover the brood-chamber or the super as the case may be.

(*g*) *Flat top cover*—It is a wooden board nailed to a rectangular frame. It is provided with a metallic cover on all sides to prevent rain water.

(*h*) *Sloping top cover*—The top of the box is made of sloping top cover.

The movable hive as discovered by Langstroth in modified form is sold by Bee-keeping Co-operatives. Khadi and Gramudyog Commission sells bee-keeping boxes. The cost of a box is less than Rupees one hundred.

Wall hives—Several designs of wall hives with movable frame are now available in India. The village bee-keeper often use these wall hives.

Equipments for handling bees. Since bees have sting and to avoid the stings various instruments are used. They are smoker, hive tool, over all, bee veil (Fig. 17.4), etc.

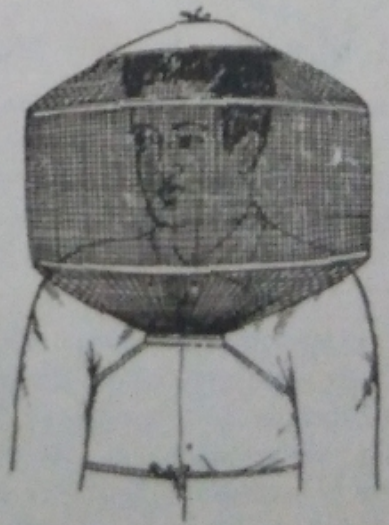

Fig. 17.4. Veil used by honey gatherers. Note the thick nature of clothing.

Equipment for honey extraction. This is an apparatus for extracting honey from the comb in pure form. It consists of a cage encased in an outside container and the

whole structure can be rotated. Honey comes out of the comb under its centrifugal force.

Enemies and Diseases

Some preliminary knowledge about the enemy and diseases of bees will be useful to a bee-keeper. Enemy number one is wax-moth (*Galleria* sp.). The female wax-moths lay eggs in the hives. The larvae emerging out start taking the honey and bees wax of the hive and thereby destroy it. To prevent this the aperture through which the worker bees enter or exit out of the bees box should be made small so that the wax-moths may not enter through it. Other enemies are wax-beetle (*Platybolium* sp.), *Vespa*, Black ants (*Dorylus* sp.) and honey bird (*Merops* sp.).

Both the adults and brood of honey bees are preyed upon by various bacteria, fungi and protozoa which may cause total or partial damage to the colony. In India specially in West Bengal disease of a colony caused by bacteria or fungus are rare. *Nosema apis* causes protozoan disease.

Habit and Habitat

There are several kinds of bees. The one which is described here is scientifically known as *Apis mellifica*. The other important species are *Apis dorsata*, *Apis florea* and *Apis indica*. Honey bees are well-known for their organised social life and great economic importance. The nest of the honey bee is known as the *bee-hive*. It is commonly seen on tall trees and ceilings of houses. The practice of rearing bees in artificial hives for honey and wax is long known to man and is followed throughout the world.

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Polymorphism in honey bee. Thousands of bees (50,000 to 80,000) which live in a hive are of three different forms—(1) workers, (2) drones and the (3) queens (Fig. 16.73). The phenomenon of the existence of several morphological forms in a

species is known as polymorphism. So, the bees are polymorphic species.

WORKER BEE. The size of worker bee is small but they constitute the majority in a hive. Each worker bee in its life time acts in different capacities—cleaner, nurse, builder, technician, soldier and porter.

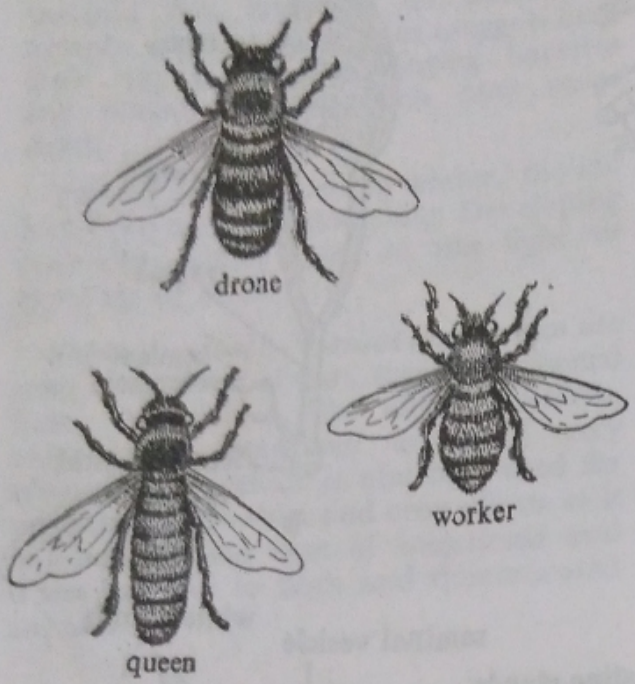

Fig. 16.73. Three different forms in a colony of honey bees.

DRONE BEE. Little larger than the workers, but are idle and noisy. They come out of the hive only at the time of nuptial flight.

QUEEN BEE. Generally a single matured queen is present in each hive. The size is very large specially the abdomen. It is responsible only for laying of eggs.

External structures

Three tagmata of the body, namely, *head*, *thorax* and *abdomen* are provided with certain specialised structures to help it in its peculiar habit.

HEAD. The triangular head (Fig. 16.74) contains (1) three OCELLI in the middle, (2) two well-marked COMPOUND EYES, (3) two short, many-jointed ANTENNAE and several appendages around the mouth which are of *rasping* and *lapping* type. These mouth parts include—(*a*) *Mandible.* These paired spoon-shaped structures are very strongly built in worker bees and are used at the time of making of combs. (*b*) *First maxilla.* Each of the paired maxillae includes a *lamina* or *galea* on a basal piece which is composed of *two elements—stipes* and *cardo*. The *maxillary palps* are poorly developed. (*c*) *Second maxilla.* These paired appendages form the lower lip. It is well developed in the workers. The proximal parts of the two maxillae are united. From the outer side of each second maxilla hangs a long *labial palp*. The inner side may be splitted into two parts—*glossa* and *paraglossa*. Two glossae, one from each second maxilla, are united to form the tongue or *ligula*. The distal spoon-like tip of the tongue is called labellum and it has

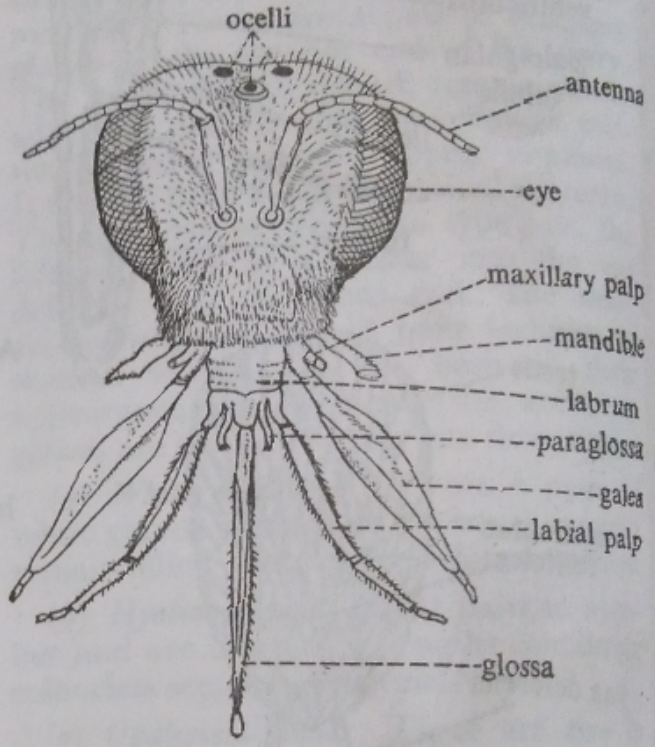

Fig. 16.74. Enlarged view of the head of honey bee (after Thomson).

a ventro-median groove. The paraglossa is firmly united with the base of the ligula. Three parts—labial palps, ligula and paraglossae form an airtight tube for sucking nectar. The elongated mouth parts, while not in use are kept folded.

THORAX. The thorax, as in other insects, consists of three segments—prothorax, mesothorax and metathorax. Each thoracic segment bears a pair of appendages in the form of legs. Two pairs of wings occur as non-appendicular structures. There are two pairs of spiracles—one pair in the mesothorax and the other on the metathorax.

LEGS. The legs have the same pattern as that of cockroach but are largely modified for their particular way of life (Fig. 16.75). (1) *Prothoracic legs.* Here the tibia of each

leg is provided with soft hairs called *eye brushes*, which are used for cleaning the pollens and debris from the eye. The stiff bristles known as *pollen brushes* are present on the first tarsal segment to work as antenna cleaner. (2) *Mesothoracic legs*. In addition to pollen brushes of the first tarsal segment, the tibia bears a *wax spine stick* for removing wax from the wax glands. (3) *Metathoracic legs*. The first tarsal segment bears at its inner part *pollen combs*,

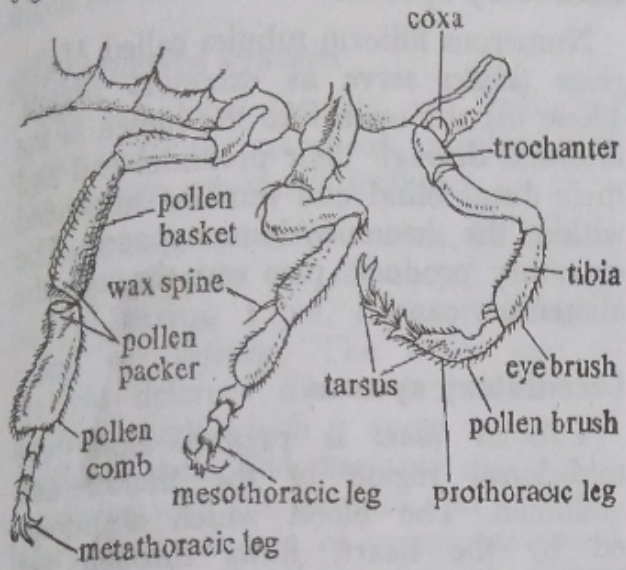

Fig. 16.75. Thoracic legs of a worker honey bee (only one side is shown). Note the difference in structure (after Kimbal).

which are responsible for collecting pollens from the pollen brushes of other legs. A structure called *pollen packers* is present near the junction of tibia and first tarsal segment. This pollen packer is formed by a spiny *pecten* on tibia and a knotched plate called *auricle* on the first tarsal segment. It cleans the pollen combs and deposits the pollens within pollen basket which is placed on the outer side of the tibia.

WINGS. Two pairs of wings are placed on the dorsal side of the thorax. The wings are largest in drones and smallest in queens. The wings are structurally same as that of cockroach, but the mechanism of wing action during flight is peculiar and completely different from most other flying animals. The wings instead of mere flapping, perform a speedy rotatory motion. Such action helps the bee to do various movements during flight, e.g. ascending, descending, remaining fixed and also backward movement. Aerodynamically speaking, the flight of honey bee resembles more with the helicopter than aeroplane.

ABDOMEN. The number of segments in the abdomen are seven in drones but six in workers and queens. In drones, the abdomen is broad but smaller than the wings. In queens the abdomen is elongated and tapering. The abdomen bears several apertures called *stigmata*, which are six pairs in drones and five pairs in queens and workers. The workers bear on the ventral side four pairs of *wax glands* to produce wax. The wax is liberated through minute pores which form scales. In queens and workers the posteriormost end of the abdomen is provided with a *sting* which is connected to the internal *poison gland*. The sting is formed by a dorsal *stylet sheath* and a pair of ventral *lancelets*. These three pieces enclose an inner *poison canal*. At its proximal end the sting has a swollen *bulb* and a pair of *bifid arms*, one on each side of it. The distal tip is beset with spines called *barbs* (Fig. 16.76). Three pairs of plates—

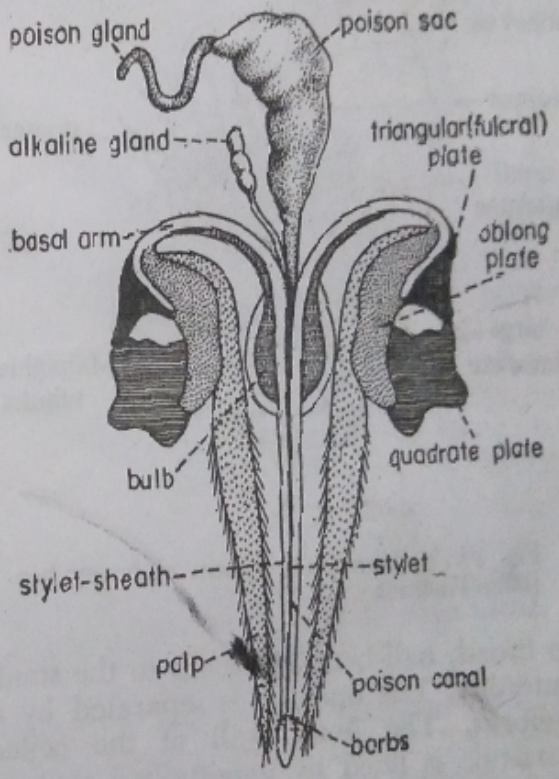

Fig. 16.76. Sting of a honey bee (worker).

oblong, *fulcral* and *quadrate*, remain associated with the sting to act as lever. From each oblong plate arises an elongated palp to enclose the sting. The poison gland is short and slender. Its secretion remains stored in a large poison sac, which opens to the proximal end of the sting near the bulb. In the queen, the sting also acts as an ovipositor.

Digestive system

In addition to the *mouth* and *pharynx*, the ALIMENTARY CANAL consists of

following parts—*oesophagus*, *honey sac*, *chyle stomach*, *small intestine*, *large intestine* and *anus* (Fig. 16.77). Straight and tube-like oesophagus passes through the thoracic region. Within the abdomen the last part of the oesophagus dilates to become a honey sac. The honey sac opens to the chyle stomach. The opening is guarded by a complex stopper. The chyle stomach

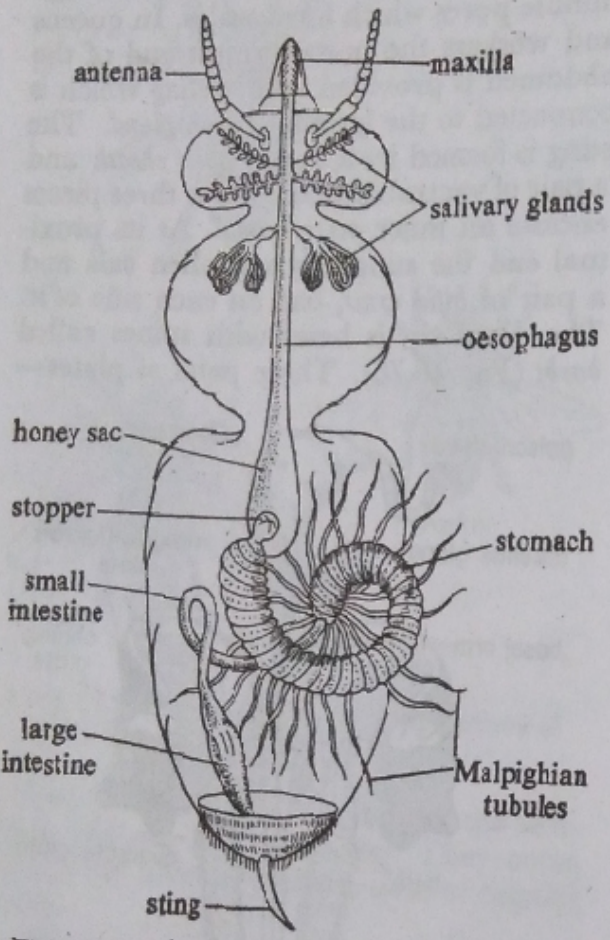

Fig. 16.77. Alimentary system of honey bee (after Thomson).

is broad, half-bent and leads to the small intestine. The opening is separated by a pylorus. The inner wall of the coiled intestine is lined by longitudinal rows of chitinous teeth. The sac-like large intestine is the posterior continuation of the small intestine. The opening between small intestine and large intestine is guarded by valves of six plates. According to some workers the stopper and the chyle stomach are equivalents of proventriculus and ventriculus respectively.

The DIGESTIVE GLANDS are represented by three pairs of *salivary glands*. The saliva from these glands mix with pollens and nectar. The enzymatic action converts the nectar into honey. It is either digested or regurgitated into the comb for future use. Another pair of coiled glands is present in the head of worker bees which produce a nitrogenous food, called 'Royal jelly'.

Respiratory system

The respiratory organs are *tracheae*. The arrangement of tracheae is same as in cockroach and consists of *stigmata*, *longitudinal trunks* and *segmental branches*. In certain regions the tracheae are dilated to become air sacs.

Excretory system

Numerous filiform tubules called *Malpighian tubules* serve as excretory organs. These tubules open into the lumen of the intestine through their proximal end and their distal blind end remains suspended within the haemocoelomic spaces. The excretory products pass out through the alimentary canal.

Circulatory system

Tubular *heart* is present along the mid-dorsal region of the thorax and abdomen. The blood which is pumped by the heart, flows through the haemocoelomic spaces. The blood is known as *haemolymph* and it possesses a few amoeboid cells with prominent nuclei.

Nervous system

The nervous system is well developed in honey bee. These insects possess extremely powerful sense organs and are well known for their power of communication which serves as the basis of their social life. The CENTRAL NERVOUS SYSTEM in honey bee includes (*a*) prominent SUPRA-OESOPHAGEAL GANGLION on the dorsal side of the head which is formed by the fusion of several ganglia, (*b*) SUB-OESOPHAGEAL GANGLION on the ventral side of the oesophagus is formed by the union of three pairs of ganglia and (*c*) a double VENTRAL NERVE CORD, which begins from the sub-oesophageal ganglia and runs along the mid-ventral line up to the posterior end of the abdomen. On each side the supra-oesophageal ganglion is connected with the sub-oesophageal ganglion by a connective. The ventral nerve cord along its path bears three pairs of *thoracic ganglia* and four (in drones and females) or five (in workers) pairs of *abdominal ganglia*. The PERIPHERAL NERVES are given from these different ganglia. From brain, the paired optic nerves arise as broad projections. The important SENSE ORGANS are

antennae and *eyes*. The antennae bear special receptor cells for detecting smell and measuring distances. Both the simple and compound eyes are present. The simple eyes are meant for detecting the intensity of light while the compound eyes are responsible for vision. It has been shown experimentally that honey bees have special power for selection of colours. It can detect a few more colours in the infra-red and ultra-violet zone of the spectrum, which are invisible to the human eye.

Reproductive system

The functional females are known as queens while the males are called drones. The workers are sterile females.

MALE REPRODUCTIVE SYSTEM. In drones, a pair of *testes* is connected with a pair of narrow tubes, each of which is called *vas deferens*. The outer end of the vas deferens dilates into a *seminal vesicle* through which it opens within the *ejaculatory duct*. The *copulatory apparatus* is connected with the terminal end of ejaculatory duct. A pair of prominent *mucous glands* open at the point of union. When matured, the sperms come out of each testis and crowd near the end of the ejaculatory duct. The sperms are transferred to the females in packets, called *spermatophores*.

FEMALE REPRODUCTIVE SYSTEM. In the queen, the paired, tubular *ovaries* are present. In the matured state the ovaries are large and conspicuous. Each ovary contains several tubes and each tube contains eggs at different stages of maturity. Each ovary communicates to an *oviduct* and the two oviducts unite to form a *common oviduct*. The inner end of the common oviduct is connected to a round vesicle called *spermatheca*. The oviduct finally opens to the exterior through a *copulatory pouch*.

MECHANISM OF REPRODUCTION. Each hive contains one matured queen, several drones and innumerable workers. During reproduction, the queen performs a nuptial flight with several drones. The drone which copulates with the female loses its copulatory apparatus and ultimately dies. The sperm cells remain stored in the spermatheca of the female. The queen after returning to the hive starts laying eggs. The fertilization occurs only at this stage. The queen lays both unfertilized and fertilized eggs. The entire process is believed to be either under the voluntary control of the female or by the size of the cell of the hive, where the egg is laid.

Development and Life history

The larvae hatch out of the eggs three days after laying (Fig. 16.78). The unfertilized eggs become drones and the fertilized eggs become either females or workers. The population of male, female and

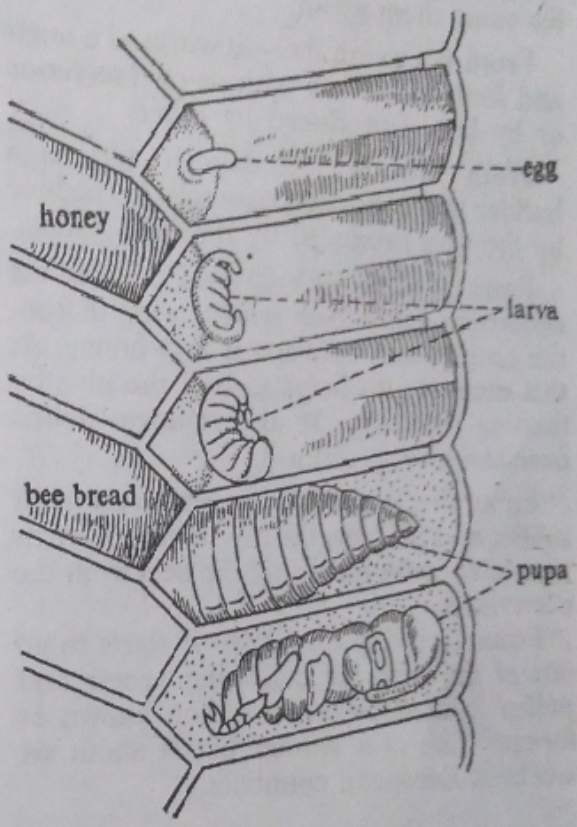

Fig. 16.78. Diagrammatic sectional view of the hive. Note different developmental stages within the cells of the hive.

workers in a hive are controlled by differential feeding of the larvae. The controlling function is done by workers. The future workers are fed with only honey. The would-be drones are given a mixture of honey and pollen grains (called the *bee-bread*) and the future queen is given the special food, 'Royal jelly'. The larva which is selected to become queen, is taken before the third day of development in a special chamber called *queen's chamber*. It is fed continuously for five consecutive days with royal jelly. It results into the enormous increase in size. The larva at this stage produces a cocoon around its body and enters into pupa stage. Inside the cocoon, rapid transformation takes place and finally the adult gets out of the cocoon

by cutting it. If several queens are produced, only one survives and others are eliminated. The queen comes out at the end of fifteenth day, the workers after twenty-one days and the drones after twenty-four days. The worker bees after coming out of the pupal case start working and their duties are changed with the advancement of age. The different works done by a worker bee is given below:

From 1st to 3rd day—it cleans the compartment of the hive where it was born for using them again.

From 4th to 9th day—it works as a nurse and feeds the larvae with its own secretion or by honey produced by others.

From 10th to 11th day—it acts as a builder and constructs new cells in the hive by the wax produced by the wax glands.

From 17th to 19th day—it collects the nectars from the bees which bring it from the outside and converts it into honey. At this time, it also helps to cool the hive by fanning the wing. It also removes debris from the hive to clean it.

From 21st to 25th day—it works as a soldier and protects the hive from the invasion of enemies including the bees from the other hives.

From 25th day onwards—it starts to go out of the hive for collecting nectar and pollen from flowers. It is then known as forager. Life of a worker bee is about six weeks in European countries.

Economic importance

The use of *honey* and *wax* is known to man for a long time. As these two products come from beehive, the honey bees are considered by man as economically important. Bees are very economically important in connection with pollination to agriculturists. The abdominal body hairs and hairs distributed all over the surfaces of their legs are mainly responsible for collecting the pollen grains. The pollen grains are transferred from one flower to other during their honey collection and thus cause pollination. The bees while foraging, collect nectar and pollen from flowers. Within the hive, the worker bees drink the nectar. Inside their honey sac, by the action of special enzyme, the cane sugar part of the nectar is converted into *glucose* (*dextrose*) and *fructose* (*leevulose*). **Constitution of honey:** 454 g of honey contain 165 g fructose (fruit sugar), 142 g glucose, 9 g sucrose, 85 g moisture, 7 g dextrine and gums, 1 g of Fe, Ca, Na and about 4% undetermined substances. The honey thus formed is regurgitated and stored in the hive for future use. The honey is regarded as antiseptic and is believed to have profound medical importance. **Food value of honey:** 454 g of honey is equal to 1·6 kg of potato or 2·0 kg of grapes or 1·4 kg of bananas or 6·0 kg of cauliflower or 2·3 kg of apples. It is also a very powerful tonic and compared to 365 u.g.—Vit. B (Thiamin), 268 u.g.—Vit. C (Riboflavin), 18 mg—Vit. C (Ascorbic acid) or 0·60 mg—Nicotinic acid. The wax is produced by the wax gland of worker bees and is used to construct the hive. Two other products, *propolis* and *balm*, are also collected from various parts of the plants and are used in the construction of hive. The propolis is used as cement to bind broken parts and the balm is taken for polishing inner walls.

Language of honey bee

Bees are known to have some method of communication amongst themselves. As soon as one bee finds a source of nectar, it immediately conveys the source and direction of the source to other bees of the same community. They perform certain rythmic movements and emit odours that are easily received by other bees. When the source is nearer to hive, *reporter bee* performs a *round dance*, turning in a circle, once to left then to right and repeating the same movement for 1½ minute in one place. If the source is further away, the *reporter bee* performs a *tail wagging dance* (Fig. 16.79). It runs towards the direction straight ahead for a short distance, wagging the abdomen, make a 360° turn towards left, run ahead once again and turns right. This is repeated for several times. These dances are closely watched by other bees in the hive and then immediately they come out in search of the source.

Odours play a vital role in their communication. Sudden death of queen bee is relayed to 60,000 or more bees of the hive in less than an hour. Healthy queen secrets an aromatic substance called 'queen substance' which is licked off by her nurse bees, when the queen dies the secretion stops and the absence of the queen substance is

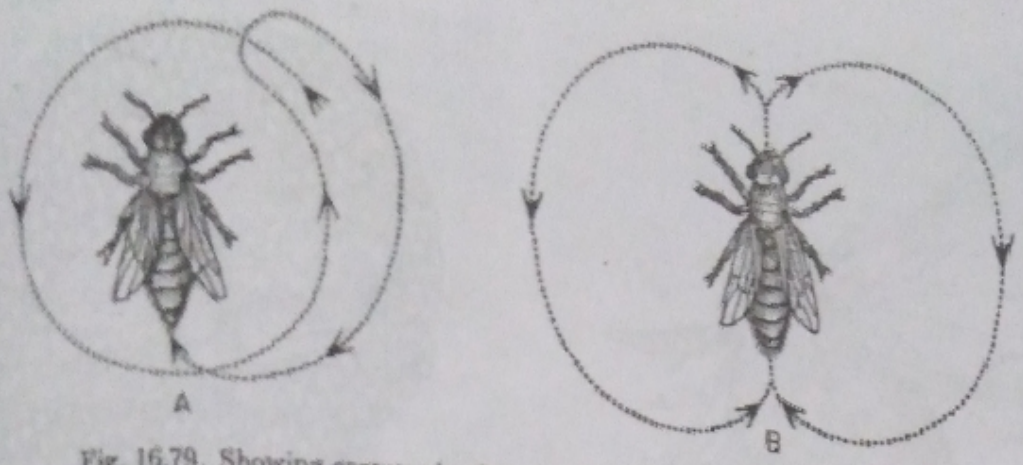

Fig. 16.79. Showing communicating system in honey bee through dancing. A. Round dance. B. Tail wagging dance.

immediately relayed to all the members of the colony. The message being conveyed to all members of the colony they at once set about the vital task of rearing a new queen.

Example of the Phylum Arthropoda—*Silkworm*

The importance of silkworm in silk production was known in China during 3500 B.C. and was later smuggled throughout the world. Silk industry is based on a product released by the silkmoth. The rearing of the silkmoth and production of silk is known as *sericulture*. The silkworm which produces the common silk is scientifically known as *Bombyx mori*. It belongs to the order Lepidoptera under the Class Insecta. Several other forms *Bombyx textor*, *Bombyx fortunatux*, *Bombyx meridionalis* are well known in our country. Certain silks of inferior quality, e.g. Muga, Tussore, etc. are produced from silkworms which are known as *Antheraea assamensis* and *Antheraea mylitta* respectively.

Habit and Habitat

The silk-producing moth *Bombyx mori* is now available in completely domesticated form (Fig. 16.80). The adult moths seldom eat and are primarily concerned with reproduction. Their larvae are voracious eaters. They feed on the leaves of mulberry trees (*Morus indica*, *Morus serrata*, *Morus lenigata*). Some moths are single-brooded or *univoltine* and others are many-brooded or *multivoltine*. There is definite life cycle which involves the appearance of stages completely different from the adult. Such transformation is known as complete metamorphosis. The different stages are—*adult*, *egg*, *caterpillar larva*, *pupa* and *imago*.

Adult moth. The adult moths are 25 mm in length and the span of wings is 40–50 mm. The female silk moths are larger than the males. The univoltines are larger than the multivoltines. Usually whitish in colour and in some forms specially the males have grey marks on their wings. The body is distinctly divisible into three tagmata—*head*, *thorax* and *abdomen*. The head contains distinct *eyes* and feathery *antennae*, the later being larger in males. Three pairs of legs and two pairs of wings are present in the thoracic region. Female moths do not have any mouth. They rarely move. Internally, the body contains well-developed excretory and reproductive systems. The digestive system is poorly developed. The excretory organs are three pairs of *Malpighian tubules*. There are three such tubules on each side. A duct from each side unites together to form a common tube which opens into the stomach at its posterior end. In males, the paired *testes* are lodged within a capsule. From each testis originates a duct called *vas deferens* which inflates immediately after its origin to form a *seminal vesicle*. Posteriorly the two vasa deferentia unite to form a much coiled *ejaculatory duct* which opens to the exterior through the genital opening. In the female, each of the paired *ovary* contains four *egg tubes*. From each ovary arises an *oviduct;* the two oviducts unite to form a *common oviduct*. There are *two* female genital apertures—through one opens the oviduct and through the other communicates a large sac-like *copulatory pouch*. A short tube links the pouch with the oviduct. This tube is called *seminal duct*. A portion of it is dilated to act as *spermatheca*.