Udai Pratap (Autonomous) College, Varanasi

E-learning Material

Module/Lecture	13
Subject	Zoology
Year/Semester	B.Sc. 5th Semester
Unit	VIII
Topic	Applied Zoology
Sub-topic	*Apiculture (Honey bee)*
Key-Words	Life Cycle, Pathogenecity and Control
Name	Dr Sanjay Kumar Srivastava
Department	Department of Zoology
Faculty	Assistant Professor
College	Udai Pratap (Autonomous) College, Varanasi
Mobile No.	9415390652
E-mail	drsanjay70@gmail.com

Apiculture (Honey bee) :

Phylum : Arthropoda

Class : Insecta

Subclass : Pterygota

Order : Hymenoptera

Family : Apidae

Genus : ***Apis***

Species : ***dorsata,***

indica,

cerana

florea,

mellifera

Apis (Honeybee) is a social insect living in colonies of 50,000 or more individuals. Honeybees are mostly vegetable feeders preferably living on pollen and nectar of flowers. The larvae which have no legs are helpless and are fed by the nursing workers of the colony up to their pupation time.

The adults chiefly live upon honey, while the young ones are given pure pollen or pollen mixed with honey and water to form a paste called bees-bread. Although these insects thrive best in gardens and forests, yet they have been noticed lapping the honey dew of some plant bugs and also seeking sugar from places other than flowers.

All honeybees are social insects and live together in nests or hives. The honeybee is remarkable for the dancing movements it performs in the hive to communicate information to its fellow bees about the location, distance, size, and quality of a particular food source in the surrounding area. Keeping of Honey bee is known as Apiculture.

Apiculture is the scientific rearing of honey bee for the commercial production of honey and other bee products like wax, pollen, bee venom and royal jelly. It is also called Bee keeping. Bee keepers are known as apiarist and place were bees are maintained is called an apiary.

Bee keeping has been practiced in India since time immemorial. The earliest references date back to Vedas and Ramayana. But Scientific bee with the help o simple machine and untouched by hand is a comparatively new venture. The western method of frame- hive was first introduced in **Bengal in 1882 and in the Panjab in 1883-84**.

In recent times progress has been rapid, for practical apiculture is an art which has during the last forty years not only undergone a complete revolution due to efforts of Khadi and Village industries has attained national status in India.

In 1962 the commission under its directorate of bee keeping established the Central Bee Research Training Institute at Pune. This institute is gradually progressing and has made its observation posts at Kodaikanal, Mercara, Castle Rock, Mahabaleshwar, Kangra and Kashmir.

Habit and habitat:

Commonly inhabits forests, plains and protected places like mud walls, earthen pots, thick lushes, wells and walls of buildings. The honey hives are made under branches of trees and any protected place in houses.

Distribution:

Cosmopolitan especially found in India, Canada, Australia and New Zealand

The genus Apis includes 4 species of eusocial bees which naturally distributed in Asia, Africa and Europe. Human beings later introduced the bees into other parts of the world mainly for beekeeping. There are four well recognized types of bees in the world are

Apis dorsata (Rock bee) :

Apis dorsata are giant bees they build a single open nest on branches of tall tree, rocks and buildings. It is the largest Indian species of bees, about 20-30 mm in size. It builds large comb (0.90 x 15 metres) on the tree branches, under caves or under roofs of high buildings. Each comb may produce 20-30 Kg of honey.

They are highly aggressive and hence cannot be domesticated for beekeeping. They are migratory species as during June and July

they swarm to the hills, but in Winter come back to the plains. This bee is notorious for its ferocity and tendency to make unprovoked, sometimes fatal, mass attack on persons who approach its hive.

Apis florea (Little bee) :

Apis florea are also called Little bee or Dwarf bees which construct single open hive on twigs and branches of shrubs and woody plants close to the ground. They are the smallest, measuring about 5mm in size and produce only 100-250 mg of honey hence they are not suited for bee keeping.

Apis cerana (Indian bee) :

They construct multiple combs in dark cavities or enclosures. They measure about 7-8mm and produce about 3-5 kg of honey. They are more docile and can be easily maintained by the beekeepers. .

Apis mellifera (European bee):

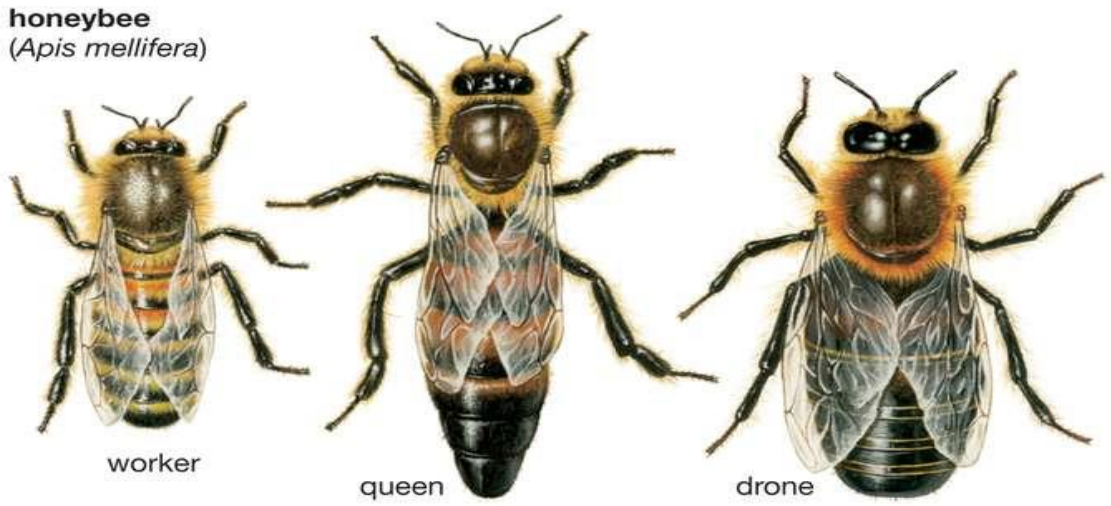
They are also called European bees or domestic honeybee as they are native to Europe. They are about 8-9mm in size and build multiple combs in dark cavities, caves and crevices. They are docile and produce about 10-20 kg of honey per annum. They can also be effectively used for beekeeping.

Note: ***Apis cerana, Apis florea*** **and** ***Apis dorsata*** **are native species mainly found in Asian continent including India. Where as** ***Apis. mellifera*** **is an exotic species.**

Apis indica (Indian bee) is the common honey bee found in plains and forests throughout India. This is slightly longer than ***Apis florea*** and smaller than ***Apis dorsata***. It builds several parallel combs about one foot across in protected places like hollow of trees, thick bushes, within caves of rocks, wells, on walls and other places of safety in buildings.

This is the only Indian honey bee which is capable of domestication in artificial hives although it does not yield much honey, not more than 3 kg annually. It very readily swarms although to some extent migrates also. Various forms are met within the hills and plains.

Some species of honeybee.



Social organisation in Honey bees:

Honey bees are social insects They live in colonies and show division of labour. The nest of honey bee is known as the bee hive. There are three types of individuals in a colony namely the Queen bee, the drones and the worker bees. In a colony there is normally one queen, 10,000 to 30,000 workers and few hundred drones (male bees).

The honeybees live in a highly organised colony wherein a perfect corporate life under strict discipline is exhibited. Excellent division of labour with the common aim of keeping the good of the society in view, make the life very harmonious and extremely busy.

Castes of Apis (The Honeybee):

The colonies of honeybees are perennial. A good colony of Indian bees has 40 to 50 thousands individuals consisting mainly of three castes, viz., queen or fertile female, drones or males and workers or sterile females. The number of workers in one colony exceeds 90

per cent of the total population.

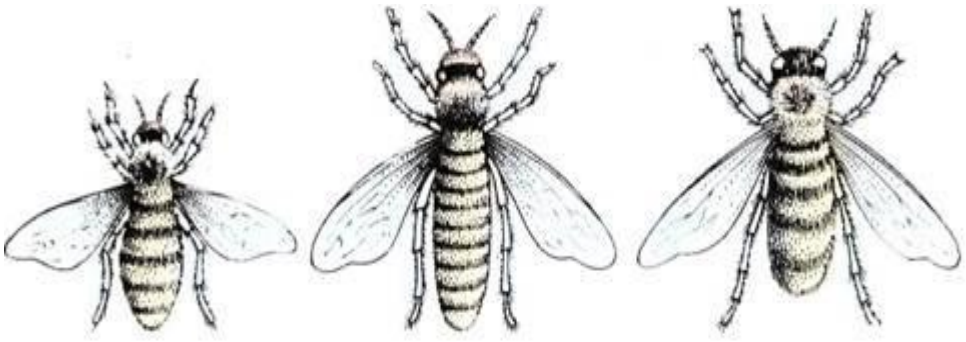


Fig. 77.1. Castes of honeybee.

Queen Bee:

General anatomy is the same as in a worker, but it is larger in size, has a longer abdomen extending behind folded wings, since it takes no part in nest making or pollen gathering. It has no wax glands or modifications on legs for pollen collection.It has notched mandibles, 12-jointed antennae and a sting which is used only to combat a rival queen, the sting can be used more than once.

Queen bee is a fertile female present in each hive and feeds on Royal Jelly. They are formed from fertilized eggs. The queen bee mates only once in her life. A unique flight called “nuptial flight” takes place by the queen bee followed by several drones. The sole function of queen is to lay eggs. In a life span of two to four years, a queen bee lays about 15 lakh eggs. When the queen bee loses its capacity to lay eggs, another worker bee larva is fed with Royal Jelly and thus develops into a new queen.

Nuptial flight.

Drones:

The male or drone is larger and stouter than the worker. It has holoptic eyes which touch each other dorsally, the frontal region is reduced. It has small notched mandibles because they do not mould wax, antennae are 13-jointed, it has no sting, but the 9th sternum has 2 claspers and a membranous aedeagus. Drones are formed from un-fertilised eggs

The drone is the functional male member of the colony which develops from an unfertilized egg. It lives in a chamber called drone cell. Drones totally depend on workers for honey. The sole duty of the drone is to fertilize the virgin queen hence called “King of the colony”.

Worker Bees:

The workers attend to all duties of food collection, bringing nectar, secreting wax, tending the young, building and cleaning the

comb. Consequently their mouth parts are modified for collecting nectar and moulding wax, the epidermis of abdomen for secreting wax, and their legs for collecting pollen. **In queens and drones the mouth parts are shorter because they do not collect nectar, their epidermis has no wax-secreting glands, and modifications of metathoracic legs are absent**.

They are sterile female bees developed from the fertilized eggs. They are the smallest and are present in large members in the colony. Their function is to collect honey, look after the young ones, clean the comb, defend the hive and maintain the temperature of the bee hive. Worker bee lives in a chamber called 'Worker Cell' and it takes about 21 days to develop from the egg to adult and its lifespan is about six weeks. Each worker has to perform different types of work in her life time.

During the first half of her life, she becomes a nurse bee attending to indoor duties such as secretion of royal jelly, prepares bee-bread to feed the larvae, feeds the queen, takes care of the queen and drones, secretes bees wax, builds combs, cleans and fans the bee hive. Then she becomes a soldier and guards the bee hive. In the second half her life lasting for three weeks, she functions like a forager to collect the pollen, nectar, propolis and water.

Life History of Apis (The Honeybee):

When the population gets too large for the hive, then the old queen and a large number of workers swarm out to find a new colony. In the meanwhile a new queen is formed in the original colony. It takes a nuptial flight or mating flight with a number of drones. Copulation occurs in air and the new fertilised queen returns to the old hive.

The spermatozoa she has received must serve for all the eggs as the queen does not copulate again. The queen can control the fertilisation of eggs. Un-fertilised eggs are haploid with 16 chromosomes, they produce drones, fertilised eggs are diploid with 32 chromosomes, they produce the queens and sterile female workers.

The queen generally lays one egg in one brood cell. The egg is pinkish, elongated, cylindrical and generally attached at the bottom of a cell at the junction of any two walls. After three days a tiny larva is developed from each egg. For two days all the larvae are fed on a protein rich royal jelly.

Thereafter, the larvae of drone and workers are fed on honey and pollen, but larvae of queen are continuously fed on royal jelly throughout.

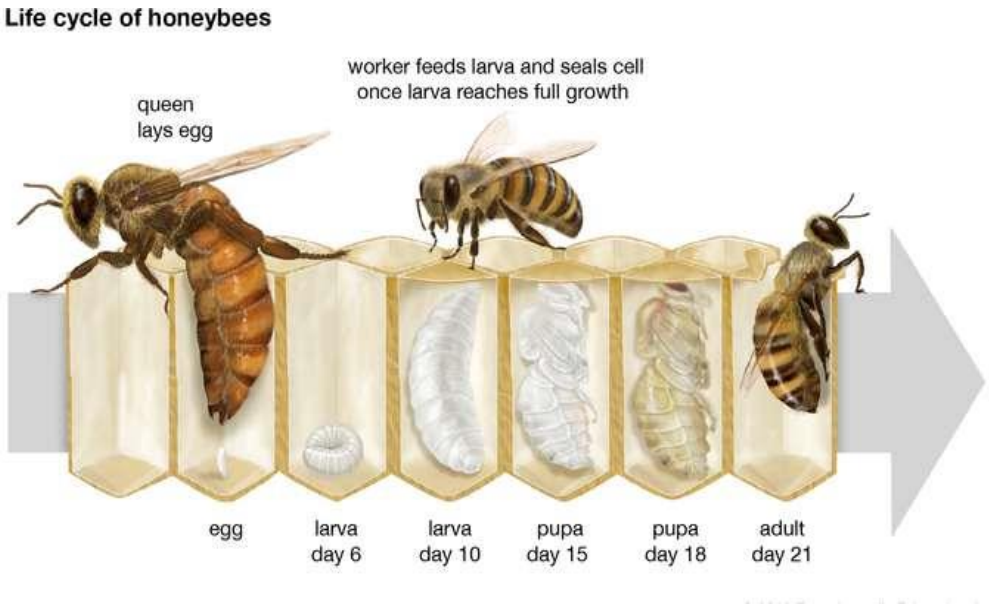
In this way the food supply causes them to develop differently. Each larva has moults and grows; then its cell is sealed with a wax-

cap. It spins a thick silken imperfect cocoon and pupates. There, as a pupa, it undergoes complete metamorphosis and finally cuts the cell-cap with its mandibles to emerge as a young bee.

The time of development for each caste is standardised because of the temperature regulation in the hive:

Queen	:	egg, 3;	larva, $5\frac{1}{2}$;	pupa, $7\frac{1}{2}$ = 16 days.
Worker	:	egg, 3;	larva, 6;	pupa, 12 = 21 days.
Drone	:	egg, 3;	larva, $6\frac{1}{2}$;	pupa, $14\frac{1}{2}$ = 24 days.

The freshly emerged workers are first entrusted with the indoor duties for two to three weeks during which they act as nursing bees, dance attendance on the royalties, look after brood cells, build and repair the comb. Later on, they are put to outdoor duties and they are completely occupied in collection of nectar and pollen, guarding the hive, air conditioning, temperature regulation and ripening honey, etc.



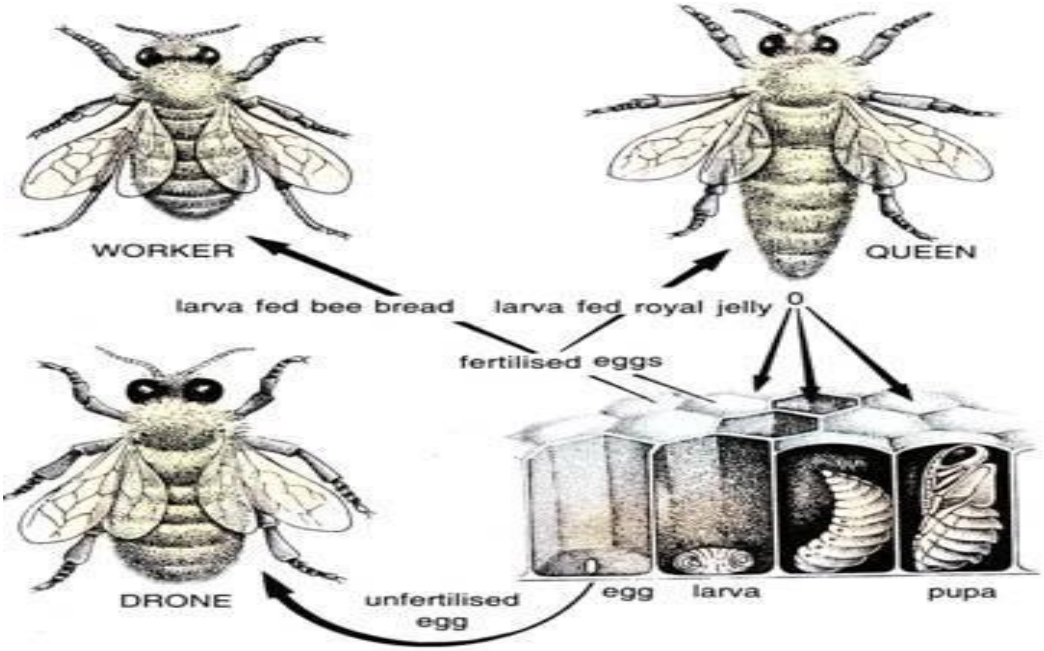


Fig. 77.7. Honeybee. Life cycle.

Structure of Bee Comb or Hive :

The hive is a series of combs composed of two layers of six-sided cells made of wax produced and secreted by the workers. Food in the form of honey, plant nectar, and so-called bee bread, made from pollen, is stored in the cells. The Indian honeybees live in hives, Resin and gum from plants is also used for repairs of the hive. Each hive (Fig.) is made up of a number of combs generally remaining parallel to each other. Each comb has thousands of hexagonal cells arranged in two sets opposite to each other on a common base.

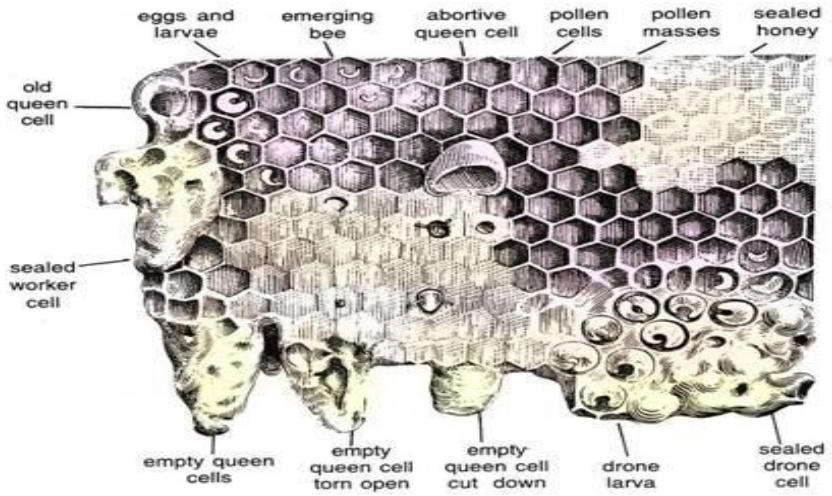
The cells are thin-walled and so arranged that each side-wall serves for two adjacent cells and each cell-base for two opposite cells. The worker cells, where workers are reared and honey is stored, are about 5 mm across, and the drone cells 6 mm across, serve to rear

drones and for storage. Large vertical peanut-like queen cells, open below, are built along the lower comb margins for queen rearing.

The comb of the bees is formed mainly by the secretion of the wax glands present in the abdomen of the worker bee. A comb is a vertical sheet of wax with double layer of hexagonal cells. The cells of the comb are of various types. The storage cells contain honey and pollen. They are built in the margin and at the top of the comb. The brood cells contain the young stages of the honey bees and they are built in the centre and the lower part of the comb. The brood chamber is divided into three types **Worker chamber, Drone chamber and Queen chamber** where the larvae developing into worker, drone and queen are reared.

Acherontia.

Philanthus.



The combs keep a vertical plane, while the cells a horizontal position. There are no special cells for lodging the adults which generally keep clustering or moving about on the surface of the comb. The cells are mainly intended for storage of honey and pollen specially in the upper portion of the comb, while those in the lower part for brood rearing.

Useful products obtained from honey bees are bee pollen, royal jelly, propolis and bee venom.

Honey:

The foraging worker bees suck the nectar from various flowers. The nectar passes to the honey sac. In the honey sac (honey stomach), sucrose present in the nectar mixes with acidic secretion and by enzymatic action it is converted into honey which is stored in the special chambers of the hive.

Honeybees require forty to eighty thousand trips to visit several times the number of flowers for collecting 1 (one) kg of honey. Each trip of the bee is two to three km long. Honey, as derived from the beehive, is not the actual nectar or sugar-bearing secretion of plants, collected by bees from flowers and stored in the minute waxen bottles in the hive.

The insects swallow the nectar and carry it in their honey sac or within their crop until they are at their hive, where it is regurgitated after chemical changes due to its mixing with saliva, i.e., sucrose is hydrolysed to glucose, levulose and fructose, which are more readily assimilable by man.

The water contents of nectar are mostly evaporated away by a strong current of air produced by the rapid wing beats of the workers crawling over the cells. The nectar, thus, ripens and forms honey. The cells, in which it is stored, are capped over with wax plugs to be reopened at the time of need because it is the principal food of adults and larval bees.

Honey is used in many ways by man also as the chief source of natural sweet in preparing candies, cakes and bread, etc.

It forms a very important food for patients of diabetes or for persons undergoing very strenuous physical exertion.

The great food value of honey can be estimated by the fact that 450 gms of honey is equal to 1 kg 600 gms potatoes or 2 kg grapes or 1 kg 350 gms bananas or 5kg 850gms cauliflower or cabbage or 3 kg 400 gms pear or 2 kg 250 gms apples or 3 kg 200 gms peaches.

Honey is also a very powerful tonic as it can be easily compared to 365 UG—vitamin B, (Thiamin) 268 UG—vitamin G (Riboflavin), 18 MG vitamin C (Ascorbic acid); 254 UG—Pantothenic acid or 0.60 MG Nicotinic acid. Half kg of honey contains 6 1/2 oz. Levulose (fruit sugar), 5 1/2 oz. Dextrose (Glucose), 9 gms Sucrose, 3 oz. moisture, 7 gms Dextrines and Gums, 1 gm of Fe, Ca, Na, etc., and about 4% of undetermined substances.

Bee wax:

Bee wax is the natural by-product secreted by the wax glands of worker bee to construct the combs of bee hive. It is widely used in cosmetic and pharmaceutical industries. It is used for making candles, water proofing materials, polishes for floors, furniture, appliances,

leather and taps. The worker bees secrete wax from glands situated in the abdomen. The secretion is exuded between the segments of the underside of the abdomen and scales of wax can be noticed as a result of hardening of this secretion. These scales are detached from the body by the setae of tarsi and passed onwards to the mouth, wherein they are chewed and made plastic to be used in building the comb walls.

This wax is isolated and forms an important base for an important industry concerned with the manufacture of toilet goods and cosmetics. A large quantity is utilised in pressing comb foundations and returned to the bees-hive wherever artificial methods of rearing is carried out.

Several thousand mounds bees-wax is used in preparing candles, shaving creams, cold creams, cosmetics, polishes, castings of models, carbon paper, cryons, electrical and other products.

Bee Venom:

Bee venom is a colourless, acidic liquid. Bees excrete it through their stingers into a target when they sting. It contains both anti Inflammatory and inflammatory compounds, including enzymes, sugars, minerals, and amino acids. Bee venom is used for treating rheumatoid arthritis, nerve pain, multiple sclerosis etc.

Royal jelly:

It is a secretion produced by the hypopharyngeal glands of nurse bees that is used in the nutrition of larvae as well as adult queen.

Royal jelly is used in the treatment of asthma and also as a dietary supplement.

Methods of Bee keeping:

Bee keeping is a scientific method of keeping ***A cerana*** or ***A mellifera*** bees for the production of honey and other useful bee products. The main objective is to get more and more quality honey.

There are two methods used by apiculturists. The traditional method and modern method.

Traditional Method of bee keeping/ Old or indigenous method:

Traditional beehives simply provided an enclosure for the bee colony. Because no internal structures were provided for the bees, the bees create their own honeycomb within the hives, mainly clay hive

or mud hives pot. The comb is often crossattached and cannot be moved without destroying it. This is sometimes called a fixed-frame hive to differentiate it from the modern movable-frame hives.

Movable hive in the pot

Fixed hive:

Fixed hive in which bees themselves build hive in the natural space provided. Movable hive: may be a hollow log, box or even earthen or wooden pots. The bees are collected from the wild and are placed into these hives.

Disadvantages of Indigenous method:

- Selection of species was not possible as swarming bees were used in this method.
- Bees were either killed or smoked to extract honey. This disturbed the natural population of bees.
- Honey from traditional methods was typically extracted by pressing- crushing the wax honeycomb to squeeze out the honey.

Modern method of bee keeping:

To overcome the drawbacks of the indigenous method, the modern method has been developed to improve the texture of hives. It was introduced by **Rev. Lorenz Longstroth in 1851** for which he was awarded Nobel prize. In India, there are two types of beehives in practice namely, **Langstroth and Newton**.

The Langstroth or Newton's movable hive mainly consists of wood with basic six parts.

1. **Stand** is the basal part of the hive on which the hive is constructed. The stands are adjusted to make a slope for rain water to drain
2. **Bottom board** is situated above the stand and forms the proper base for the hive. It has a gate, gate functions as an entrance for the foraging bees to enter and leave the hive
3. **Brood chamber (hive body)** is the most important part of the hive. It is provided with 8-10 frames through which the workers can easily pass. The frame is composed of wax sheet which is held in vertical position. It is the most important part of the hive. This chamber is used for brood rearing. In addition to brood cells bees also maintain pollen cells and honey cells to store pollen and honey for brood rearing.
4. **Super or Honey chambers** are placed above the excluder depending on the honey flow and season. It is provided with many frames containing comb foundation to provide additional space honey storage.
5. **Inner cover** is a wooden piece used for covering the super with many holes for proper ventilation.
6. **Top cover** is meant for protecting the colonies from rains. It is covered with a sheet which is plain and sloping.

Besides the bee box other accessory equipment used in beekeeping are:

- **Bee gloves** are used by bee keepers for protecting their hands while inspecting the hives.
- **Bee veil** is a device made of fine nettings to protect the bee - keeper from bee sting.
- **Smoker** is used to scare the bees during hive maintenance and honey collection by releasing smoke.
- **Hive Tool** is a flat, narrow and long piece of iron which helps in scraping excess propolis or wax from hive parts.
- **Uncapping knife** is a long knife which helps in removing the cap from the combs as a first step in honey extraction.
- **Bee brush** is a large brush often employed to brush off bees from honey combs particularly at the time of extraction.
- **Queen introducing cage** is a pipe made of wire nets used for keeping the queen for about 24 hours for acquaintance with the hive and worker bees.
- **Feeder** is a basin with sugar syrup covered by grass to feed the bees during drought season. The grass prevents the bees from sinking into the syrup.
- **Honey Extractor** is a stainless-steel device which spins the combs rapidly to extract honey

- **Hive Entrance Guard/ Queen gate** is a device similar to queen excluder in front of the hive entrance which prevents the escape of queen during warming season

Selection of suitable site for the hive :

- The site selected should have good bee flora(flowers) which produces large quantity of superior quality nectar and pollen which is the main food for the brood and adults.
- The site should be free from the natural predators and enemies of bees like ants, spiders, wasps, birds and lizards.
- The site should be free from pollution and excessive intrusion by man.

Hygienic extraction of honey :

- In Modern bee keeping practices only honey stored in the super is extracted and thus it does not disturb the brood chamber.
- Honey is extracted when honey super chambers are filled with ripened honey that are covered by a thin layer of wax (capped honey).
- The frames from the super chambers are removed and bees sitting in these frames are removed using mild smoke using the smoker.
- Honey from the honey filled frames are removed first by removing the wax cap using the heated knife.

- Uncapped frames are placed in the metallic slots of extractor machine which is rotated to create a centrifugal force. The centrifugal force removes the honey from the frames and the honey collects at the bottom of the machine.
- The collected honey can be filtered and heated (pasteurised) before filling in the sterile containers.

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Declaration