

BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY

Department of Zoology

**Lecture Outline /Summary Notes**

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**ZL (OE) - 02: ECONOMIC ZOOLOGY UNIT 1: APICULTURE**

**TOPIC- Classification, Biology & Social Organization of Honey Bees**

**SCIENTIFIC CLASSIFICATION**

Kingdom	Animalia	animals
Phylum	Arthropoda	Jointed legs
Class	Insecta	They have jointed legs, compound eyes, antennae, exoskeletons, and three-part bodies-Head, thorax, abdomen
Order	Hymenoptera	“Membrane winged”. This order includes bees, ants, wasps, and sawflies.
Super family	Apoidea	The bees
Family	Apidae	Honey and stingless bees
Sub family	Apinae	Perennial social colonies
Genus	Apis	Hive bee
Species	Mellifera L.	“Honey bearing”

**HONEY BEES SPECIES**

All honey bees are classified into the genus *Apis* and the family *Apidae*. There are four accepted groupings of honeybee species each morphologically distinct. Each of the Asian species groups is subdivided into two or more further species. It is characteristic of all species of honey bees to control their brood nest temperature, to separate their brood from their food by storing their food above their brood and to live exclusively on pollen and honey. Two of the groups are characterized by cavity nesting while the other two groups make a single comb in the open. The greatest diversity of honey bee species is in India and adjacent regions, with all the species of honeybee except *Apis mellifera* present as native species. The Asian hive bee, *Apis cerana*, which is extremely closely related to the Western Honey bee, is only found in Asia where it is widely kept for its honey. The so-called giant honey bee, *Apis dorsata* and the closely related Himalayan honey bee, *Apis laboriosa* are large bees that build a single comb in the open. These species are frequently exploited by honey hunters. The little honey bee, *Apis florea* is probably the closest, living descendant of the earliest honey bees and has spread from Asia into the Middle East.

The following species are now recognised as distinct species of honey bee (Michener 2000):

- Small bees nesting with with single exposed combs: *A. florea* Fabricius *A. andreniformis* Smith

- Large species nesting with single exposed combs *A. dorsata* Fabricius, *A. laboriosa* Smith (*A. beviligula* Maa, *A. binghami* Cockerell)
- Middle sized species nesting with multiple combs in cavities: *A. mellifera* Linnaeus, *A. cerana* Fabricius, *A. koshevnictsi* Buttel-Reepen, *A. nigrocincta* Smith, *A. nuluensis* Tinget, Koeniger and Koeniger

Bees belong to super-family *Apoidea* of the order *Hymenoptera*. Their body is covered with small, branched hairs. Their body secretes a wax which is used to make nests. They also make nests using resins, leaves, sand, and secretions from the sting gland and using silk produced by the adult bees. Superfamily *Apoidea* has about nine families of bees leading either social or solitary lives. Bees leading an advanced social life produce honey and they belong to three families viz. *Apidae*, *Bombidae* and *Meliponidae*.

Honeybees are of two types:

1. True honeybees of genus *Apis*
2. Stingless bees of genus *Trigona*

Genus *Apis* has six species of which four types of honey bees are found in India. They are *Apis florea*, *A. cerana indica*, *A. dorsata* and *A. laboriosa*. The bee species people most use for their own benefit is the common honey bee *Apis mellifera*. This honey bee is native to the continents of Europe and Africa but, since the 1600s CE, has been widely and successfully spread throughout the Americas and Australasia as part of these countries' colonial or trading history. Latterly *Apis mellifera* has spread throughout Asia.

#### **Dwarf Honey Bee (*Apis florea*)**

*Dwarf honey bee* or *Apis florea* are the smallest of honeybees and often mistaken for stingless bees since they do not sting easily. They prefer hot and dry climate so they are found in plains and sub-tropical areas. Their comb shows a distinct honey portion at the top. They usually build their nests in small trees with dense leaves or in closely placed plant stalks like those of jowar or rice.

#### **The Rock Bee (*Apis dorsata*)**

These bees build their nests out in the open and are given a support underneath such as using a tree branch, rock cliff, etc. This is one reason why they are called **rock bees**. They build the largest hives with some measuring up to 200 cm X 150 cm in dimensions. They are semi-circular and hang from above. They even forage during moon-lit nights. Forest honey hunting is commonly carried out with rock bees.

#### **Indian Hive Bee (*Apis indica*)**

They are, as the name suggests, **Indian hive bees** and are considered to a sub-species of the Asian bees *Apis cerana*. There are two varieties here:

1. Gandhiana- They are dark and large.
2. Indica- They are yellow colored and smaller.

*Gandhiana* is considered to be of the plain variety. They make combs in cavities like those in tree crevices, rock cavities etc. They exhibit an absconding tendency yet they are one of the domesticated varieties.

### **European Bee (*Apis mellifera*)**

They are believed to have originated in Italy and introduced into different countries worldwide. It was introduced in India in 1965 with the original stock in Punjab. It was multiplied and the progenies were successfully distributed to other states by the All India Co-Ordinated Project on Honey Bee Research Training, ICAR Central Bee Research and Training Institute, and Khadi and Village Industries Commission. It yields 4-5 times more honey than *Apis indica*.

Globally, it is one of the most preferred bees for honey bee farm because:

1. It has a gentle temper.
2. It is less swarming.
3. There is a prolific queen
4. It is a good honey gatherer.
5. It can protect itself and the hive against its enemies except wasps.
6. It adapts very easily to frame hives.

## **BIOLOGY OF HONEY BEES**

Honey bees are one of the few insects that have a social structure, a caste, which consists of a single reproductive queen (only egg layer in the colony), numerous drones (males) depending on time of year, and a small number to about 60,000 worker bees or non-reproductive female bees. Honey bees undergo complete metamorphosis (holometabolism) and develop through four life stages, egg, larva, pupa, and adult. Several thousand worker bees cooperate in nest building, food collection, and brood rearing. Each honey bee in the worker caste has an age-related task to perform, which begins inside the hive (house bee) and eventually moves to foraging outside the hive. The immature forms of the bee are called the brood, and they are fed and cared for by the worker bee caste.

Some of the major biological features that beekeepers need to understand are: basic bee nest ecology, the bee caste system, bee anatomy, the development of bee brood, worker bee sequence of duties, caste brood rearing/adult population seasonality, communication as a “key” to maintaining the social cohesion of the colony, queen and colony reproduction/replacement, and how to read/understand bee behavior/biology.

**GENERAL MORPHOLOGY** - Like all insects, the honeybee has three main parts: the head, the thorax and the abdomen.

### **(1) THE HEAD**

This is triangular in shape and bears eyes (a pair of compound eyes and 3 small simple eyes (ocelli)), a pair of antennae, jaws, antennae, and mouth.

#### **(a) The eyes**

A bee has a pair of compound eyes and three small simple eyes called **ocelli**. The compound eyes are composed of several thousands of simple light-sensitive cells called

**ommatidia** that enable the bee to distinguish between light and colour and to detect directional information from the sun's ultraviolet rays. The eyes of the drone are larger by far than those of the worker or queen-bee occupying a larger proportion of the total volume of the head. These assist the drone to locate the queen as he pursues her during the mating flight.

(b) **The antennae**

These are a pair of sensitive receptors whose base is situated in a small socket-like membranous area of the head wall. These serve to guide the bee outside and inside the hive as they are sensitive to touch and smell. They also assist the bee to differentiate floral and pheromone odours and to locate hive intruders.

(c) **Mandibles**

These are a pair of jaws suspended from the head and parts of the mouth. They are used to chew wood when re-designing the hive entrance, chew pollen and work wax for comb building.

(d) **Proboscis**

Unlike the proboscis of other sucking insects, that of the honeybee is not a permanent functional organ. It is temporarily improvised by assembling parts of the maxillae and the labium to produce a unique tube for drawing up liquids such as sweet juices, nectar, water and honey. The bee releases it when needed for use, then withdraws and folds it back beneath the head when it is not needed.

(2) **THORAX**

This is an armour-plated mid-section of the insect. It supports two pairs of wings and three pairs of legs. It has muscles that control movement of the head, abdomen and wings.

(a) **Legs-** Each pair of legs differs from the other two pairs and is jointed into six segments with claws at the tip that help the bee to cling to surfaces. Legs help the bee to walk and run but various parts also serve special purposes other than locomotion e.g. sweeping pollen and other particles from the head, eyes and mouth.

i) **Antennae cleaner**

This is located on the inner margin of the tibia of the forelegs. It consists of a deeply cut semi-circular notch, equipped with a comb-like row of small spines. This cleaning device is on all the workers, queen and drones.

ii) **Pollen baskets**

The pollen baskets (corbiculae) are located on the tibia of the hind legs of the worker bee to enable it to carry pollen. Pollen baskets are concave in shape and are surrounded by several long hair which bind the pollen into a solid mass which is easy to carry back to the hive.

(b) **Wings-** Like in other insects' wings, these are thin, flat and two layered. The front pair is much longer than the rear pair. Workers wings are for flight and ventilating the hive while those for the drone and queen are for flight only.

### (3) ABDOMEN

This is also armour-plated and contains vital parts like the heart, honey sac, stomach, intestines and the sting. An adult insect bee abdomen has nine segments while the larva has 10 (ten).

### INTERNAL ORGANS

The internal organs include hypopharyngeal gland, wax gland, scent or pheromone glands, the queen's pheromone glands and the sting.

#### a) Hypopharyngeal gland

This is located in the head of the worker bee in front of the brain. It starts to mature three days after the emergence of the bee, and develops only when the insect secretes royal jelly to feed the young larvae and the queen.

#### b) Wax gland

This is located in the lower part of the young worker's abdomen. It releases wax between a series of overlapping plates called **sterna** below the abdomen. The worker begins to secrete wax 12 days after emerging. Six days later, the gland degenerates and the worker stops comb building.

#### c) Scent glands

A worker bee produces three main scents. The gland beneath the sting produces a special pheromone consisting mainly of **isopental** acetate which it sprays around the spot of the sting. The odour stimulates other workers to pursue and sting the victim.

- Another alarm pheromone is released by glands at the base of the mandibles. It has the same function as the first one.
- The third gland is located near the rear of the abdomen. This produces a pheromone which when released by scout bees, attracts swarms of other bees to move towards them.

#### d) Queen's pheromone glands

These are located in the queen's mandibles, and release pheromones called the queen substances. These enable her:

- To identify members of the colony;
- To inhibit ovary development in worker bees;
- To prevent workers from building queen cells;
- Help a swarm (colony) to move as a cohesive unit;
- To attract drones during mating flights.

**NOTE:** Absence of the queen substance (e.g. when the queen dies) produces opposite responses it enables worker bees to begin developing ovaries and to build queen cells, and a swarm searching for a accommodation will not cluster but will divide into smaller groups which cannot support the normal life of a bee colony.

e) **The sting**

A worker bee's sting is designed to perforate the skin of the enemy and pump poison into the wound. It has about ten (10) barbs so that when it is thrust into flesh, the bee cannot pull it back again. It breaks off with the poison sac always attached to it. This enables more poison to penetrate for as long as it remains in the flesh. The sting is lodged in a special sheath and is only released when the need arises. The sting of the queen is longer than that of the worker. It is used only to fight and kill rival queens in the hive. The drone has no sting and is totally defenseless.

**SOCIAL ORGANIZATION OF BEE COLONY (QUEEN, DRONE, WORKER)**

In an average bee colony there are:

- a) One fertile queen whose main activity is laying eggs.
- b) From 20,000 to 80,000 sterile female worker bees who do everything that needs to be done in the colony.
- c) From 300 to 800 fertile males called drones.

In addition to these, there are about 5,000 eggs and 25,000 – 30,000 immature bees, called the brood, that are in various stages of development. Of these, some 10,000 newly hatched ones are the larvae which have to be fed by the workers. The remainder, after the larval stage, are pupae sealed into their cells by the workers to mature- These are called the **seal brood**.

**The honeybee nest**

The beehive or colony nest consists of a number of vertical combs that hang parallel to each other at a distance of about 10 mm. The combs, which are about 25 mm wide, are composed of hexagonal cells.

- In the worker cells in the lower part of the comb, the bees rear the worker brood.
- Pollen and honey are stored in the upper part of the comb.
- Drones are reared in the drone cells.
- Occasionally, a third type of cell known as the queen cells are built for the rearing of queens.

**BEE COLONY AND CASTE DISTINCTION**

Being social insect honeybees have divided their society into different castes viz. drone bees, queen bees and worker bees.

**Drone Bees**

They are the male bees developed from the unfertilized eggs. Larvae developing from unfertilized eggs are fed on the royal jelly by the worker bees thus giving rise to drones. Drones are stout and larger than the workers, they do not have suitable proboscis for gathering nectar, no sting to defend self or the colony, no baskets for collecting pollen grains, no glands for secreting wax for comb construction and does not work in the hive but is fed and eats large quantities of food and moves about in sunshine. Their main purpose is to mate the queen bees and fertilize the eggs.

The spermatozoa are produced in the drones' testes during the pupal stage. After the drone emerges from the comb cell, the spermatozoa pass into seminal vesicles where they remain until mating. During mating spermatozoa pass into the copulatory apparatus. Mating occurs in the open air in the drones' congregation areas. During mating, the drone inserts his copulatory organ (apparatus) injecting the semen into the queen's oviducts and leaving part of the apparatus in the tipoff in the queen's abdomen. That part visible in the queen remaining from the mating flight is called the **mating sign**. The drone dies during mating.

The male bees are taken care of by the worker bees till the queen in the colony is ready to mate. After mating the drone dies. Similarly, once the mated queen returns to hive, the drones are neglected by the worker bees.

When fresh nectar becomes scarce, the workers prevent drones from feeding. They first push the drones from the broad combs to the side combs and eventually drag them half starved from the hive. During unfavourable conditions (periods), drones are tolerated only in queen-less colonies or those containing unmated queens. Thus the presence of drones in a colony during such periods shows that something is wrong with the queen and so action by the bee keeper is necessary

### **Queen Bees**

Queens are the fertile female of the beehive. Every hive has one queen who stays in the colony for about 10 days till the period of maturity. Once mature they go out on mating flights. Post mating, they return to the hive to play the role of queen mother by laying the eggs. They normally lay up to 15,000 eggs per day. However, it is the availability of food royal jelly that controls the egg laying. Queens can live up to 3 years but their effective fertilized egg laying period lasts upto 2 years. The worker brood cells in the hive receive the fertilized eggs while drone cells receive unfertilized ones that develop into worker and drone larvae respectively.

- There is always one queen in a hive;
- She is larger than the workers and longer than the drone;
- Her wings are much shorter than her body and cannot cover the whole of her abdomen;
- Her long tapering abdomen makes her resemble a wasp;
- She has sparkling gold hairs on her sting body;
- She has a sting but unlike the aggressive workers, she does not use it to fight hive intruders but only rival queens.
- She does not go out to collect pollen, nectar, water or propolis and therefore, unlike the worker bee, she does not have collecting apparatus like pollen baskets, long proboscis for drawing nectar or wax glands to secrete wax to build comb cells. She does not feed herself.

Immediately after the queen emerges, she tours the hive to see if there is any rival queen hiding somewhere. If there is any, the two queens will fight until one is killed. If the colony is not preparing to swarm, then the newly emerged queen seeks out potential queens hiding

in comb cells. The queen pops to make a special noise and the hidden capped queen responds. Immediately the emerged queen locates the cell, tears it to pieces and kills the unemerged queen. Sometimes the workers watching as spectators will help the queen to evacuate the contents of every queen cell.

- Five days after the queen emerges from her cell, she starts to fly out of the hive, making **orientation flights** of about five minutes.
- Next, she makes mating flights which last about 30 minutes.
- She flies to an area 6 – 10m above the ground where drones have congregated because she is not attractive to drones in other places.
- During a successful mating flight, she is mated by about eight drones.
- If the flight is not successful, she makes another one the next day.
- During mating, the drones semen is injected into her oviducts and from there, the spermatozoa enter into a special reservoir called **spermatheca**.
- A well inseminated queen carries about 5,000,000 spermatozoa stored in her spermatheca.
- Each queen produces a queen substance called a **pheromone** which controls many and most of the activities of the bee colony.
- In the absence of a queen or pheromone, the workers transform some worker cells containing young larvae into queen cells and start to rear new queens.
- When there are no larvae younger than three days in the colony, the bees have no way of rearing new queens. In this case ovaries of some workers develop and they start to lay eggs.
- However, as worker bees, they cannot be inseminated and so they lay only unfertilized eggs. Such workers are called laying workers.

### **Worker Bees**

Workers are the smallest and most numerous of the colony's population, constituting over 98%. One colony may have as many as 80,000 workers. Although they never mate, workers possess organs necessary for carrying out many essential duties in the well being of the colony. They have a longer proboscis than the queen and drones and so are well suited for sucking nectar from flowers. Workers have large honey stomachs to carry nectar from the field to the hive. They have pollen baskets on their third pair of legs to transport the pollen to the hive. They have glands in their head which produce royal jelly as food for the larvae, glands in their thorax which secrete enzymes necessary for the ripening of honey and four sets of wax glands inside the last four ventral segments of the abdomen which produce wax for comb construction. They have a well-developed sting which permits them to defend the colony very efficiently.

The workers are infertile females developed from fertilized eggs. It is the number of workers that determine the strength of the hive and success of the honey bee farm. They are smaller than drones and queens and have a strong influence of the pheromones produced by the queens. It has a lifespan of maximum 6 weeks. The first two weeks following birth is spent in doing indoor duties like cleaning the hive, nursing the young, repairing the damage parts of the hive, secreting royal jelly, attending the queen, etc and it

is referred to as **house bee**. The next 3 weeks are spent in outdoor duties like gathering nectar, pollen, water, ripening honey, etc and the worker is referred to as a **field bee**. It has no individual identity but spends its life doing well for the colony. On an average it makes about one- twelfth spoon of honey in its lifetime.



QUEEN



DRONE



WORKER