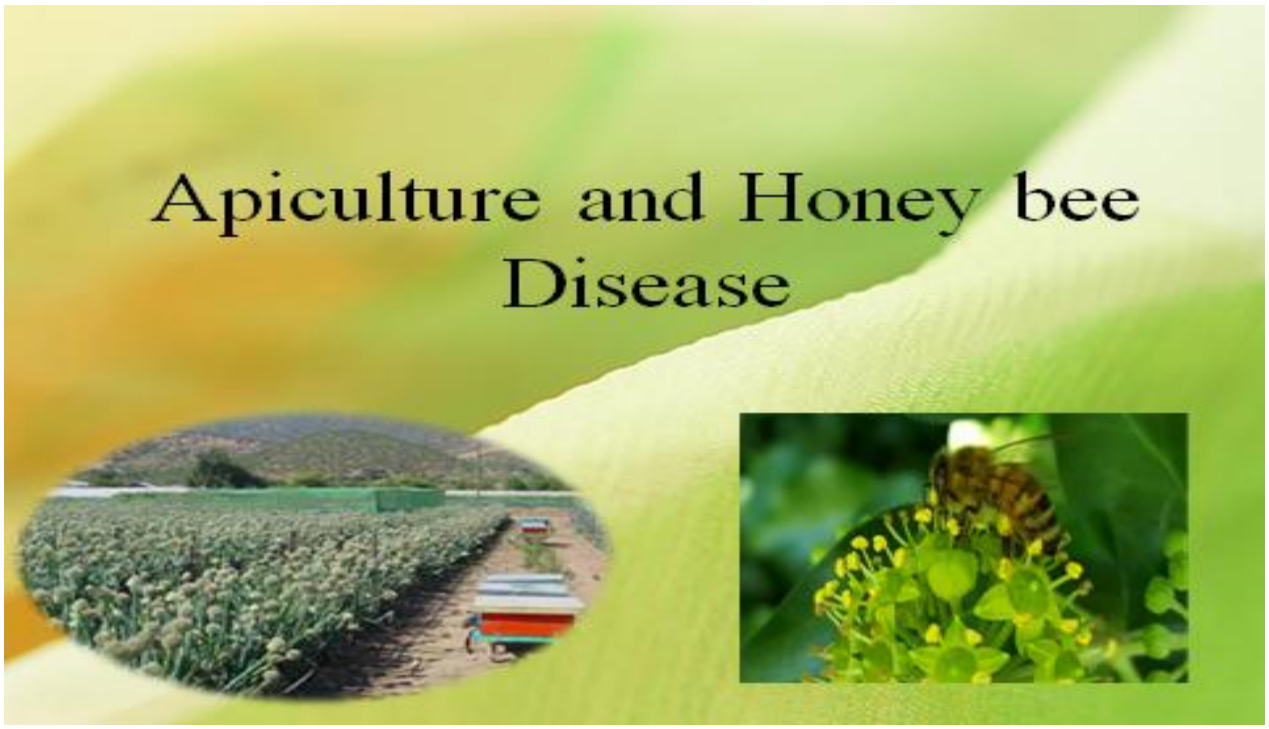
Chapter 1: Beekeeping in Ethiopia



Beekeeping (BK): Definition

BK is a science that deals with about honey bees

BK is an art of keeping honeybees for the economic benefit of the beekeepers.

Appr. definition- It is the maintenance of health colonies of honeybees in a hive designed for easy operation for bee keepers and removal of the products

Advantages of beekeeping

***Beekeeping has** many advantages. These are:*

1. It does not compete with other agricultural activities for resources
2. It requires low investment
3. It can be done by any age and sex
4. It serves as source of supplementary food
5. It requires little land or it is exclusively non- land activity, so land less- farmers can practice beekeeping
6. It requires low technological inputs
7. The products are not perishable if kept properly
8. It is a means of creating job
9. It helps for pollination
10. It is source of income

Beekeeping in Ethiopia

Bee keeping as a component of agriculture has a long history in Ethiopia, most probably prior to all other countries in the World

It is indicated t/t 21,000 tones of honey and 2,100 tones of bees wax is produced yearly, w/c places the country 1st in Africa and 10th in the world in honey production and 4th from the world in wax exporting.

Beekeeping in Ethiopia.....

Bee keeping, now-a-days too is playing a significant role in supplementing the annual income of the beekeepers through the sell of honey and bee colonies and serving as a healthy food for the consumers.

Despite the rich experience of the beekeepers, the production of honey and other hive products is not a such boosting mainly for the dramatic reduction of resources and backward extension service.....

Nevertheless, these days, considering that it is the best alternative low cost means of income for land scarce and highly populated areas in Ethiopia, the attention of both the farmers and the government is raised and efforts are being made to increase the stock, beneficiaries, feed resources and to upgrade the knowledge of the beekeepers in the field.

Systems of beekeeping

In Ethiopia there are 4 recognised systems of honey collection or bee-keeping which are as follows:

1. Honey hunting

The collection of honey from honey bee colonies nested in hollows and crevices.

This is still a common practice in the country

It is a very inefficient system often involves the bees being killed and the swarm destroyed in order to extract the honey. The honey is usually unprocessed and is therefore, of poor quality.

Fire is the main tool used to kill the bees

Systems of beekeeping.

2. Traditional bee-keeping

This activity has been practiced for 5,000 years or longer.

It makes use of hives made from cheap local materials such as gourds, pots, grass, logs, cow dung, mud and straw.

All traditional hives are placed high in trees around dwellings in order to attract the bees which are left alone for some time. After enough time has elapsed to build up honey stores the container is lowered and the bees killed (usually by fire) and the hive products taken (inefficient system)

It is estimated that there are about 3.5 million traditional hives in Ethiopia.

Systems of beekeeping.....

3. Intermediate bee-keeping

This involves low-cost, traditional technology often using the Kenya Top Bar beehive.

Management of these hives is much easier and allows the hive products to be harvested without the bees being killed.

However, attempts are being made to develop mud (chika) top bar hives using mud, dung and straw.

Both types of hive produce a better quality honey and is more efficient without the bees having to be killed.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Systems of beekeeping.....

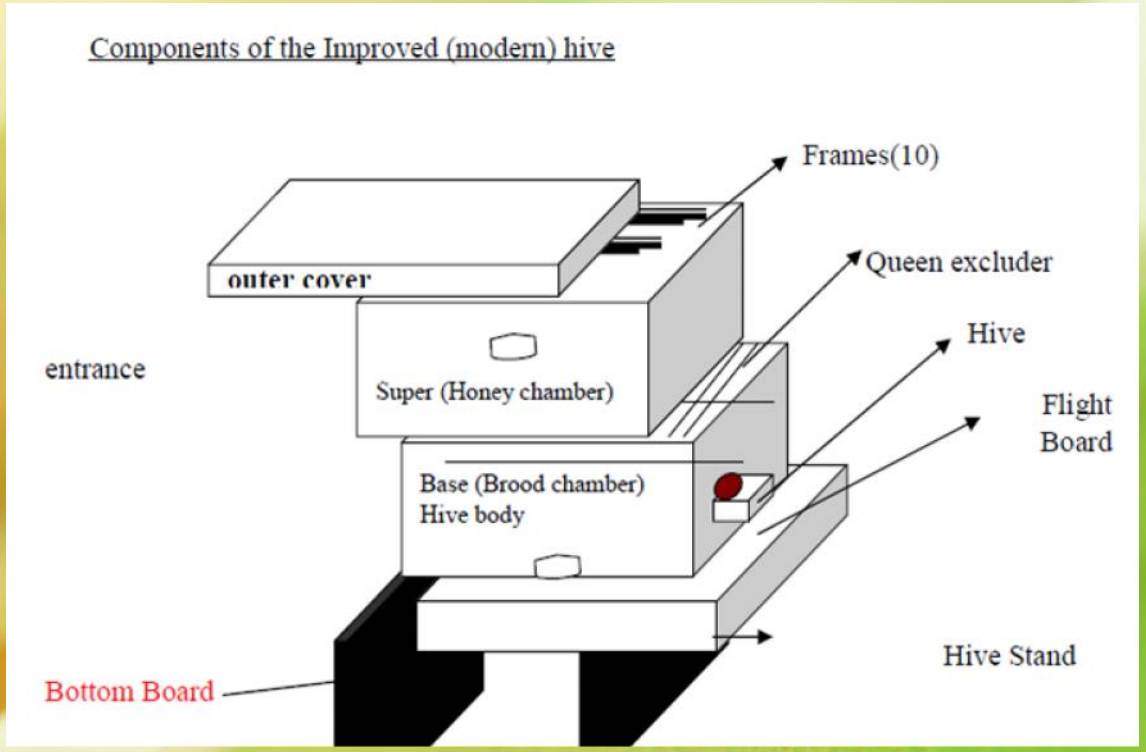
4. Frame hive bee-keeping

This is the most intensive system which needs comparatively expensive inputs and relatively skilled manpower to manage the colonies successfully.

The hives are more complex and difficult to build but they are easily transportable and can generate greater quantities of better quality honey which will command higher prices.

The amount of honey produced per hive is very variable but generally the amount of honey harvested increases as one progresses from honey hunting to traditional hives, to intermediate bee-keeping with frame hives producing the greatest quantities of honey.

Thus, for traditional hives the average amount of honey produced is approximately 6Kg per hive while frame hives yield an average of 17Kg per hive.



Uncapping the honeycombs and extracting honey

Constraints of BK in Ethiopia

1. Honey bee colony related
2. Apicultural Equipment related
3. Bee Product related
4. Bee forage related
5. Bee product storage related
6. Research related
7. Market related

Constraints of BK in Ethiopia…….

- What about TASMA Production Constraints????????
- What about YETINIGN MAR production??????
- What are the opportunities to improve this sector????

Chapter 2: Bee Biology and Classification of Honeybee

Honey Bee Biology ……..

OUTLINE:

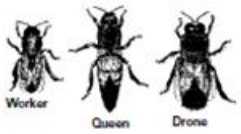
- Hbee Colony????
- Composition (Hbee Casts & …) of the Colony???
- Hbee Nest????????
- Hbee Comb???????
- Comb Cells???????
- Types of Comb Cells???????
- Developmental stages of Honey bees?
- What happens from Q emergency time to egg laying time?????????

Development of Honeybee

- A bee colony has three castes. There are two sexes, the female and the male, but the former is subdivided into two castes. In the average colony, there are -

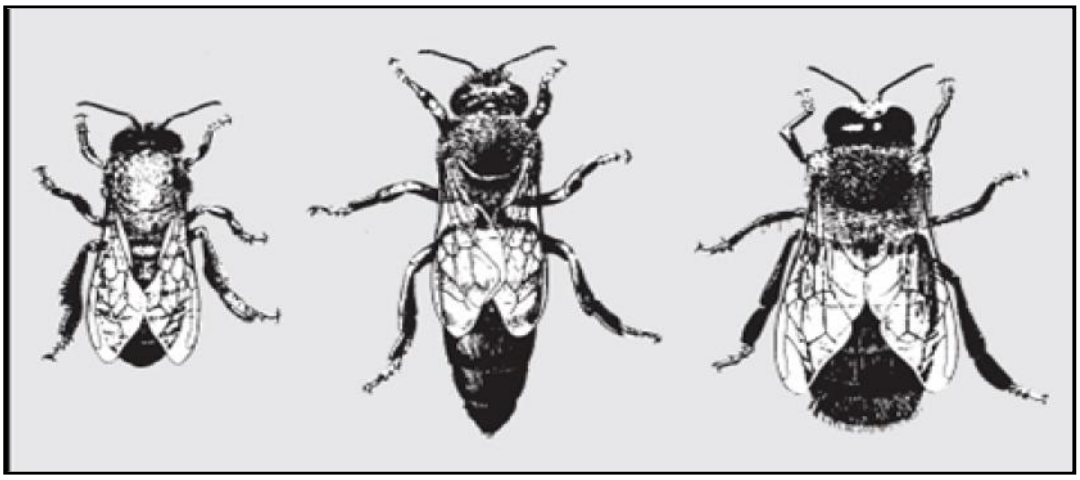
a) one fertile queen, whose main activity is egg- laying,
b) from 20 000 to 80 000 sterile female worker bees, which do almost everything that needs to be done in the colony, and
c) from 300 to 800 fertile males, generally called drones.

- In addition, there are about 5 000 eggs & 25-30 000 immature bees in various stages of their development, c/d the brood. Of these, some 10 000, newly hatched, are the larvae, w/c have to be fed by the workers, while the remainder, after the larval stage, are pupae, sealed into their cells by the workers to mature. They are c/d the sealed brood.



Members of the honey bee colony (worker, queen, drone).

Three Casts



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Developmental stages……

Table 1. Developmental stages of the three castes of bees.

DEVELOPMENTAL STAGE	DURATION OF STAGES		
	QUEEN	WORKER	DRONE
	Days		
Egg	3	3	3
Larval stage	5 ½	6	6 ½
Pupal stage	7 ½	12	14 ½
Total developmental time	16	21	24

Eggs & Larvae

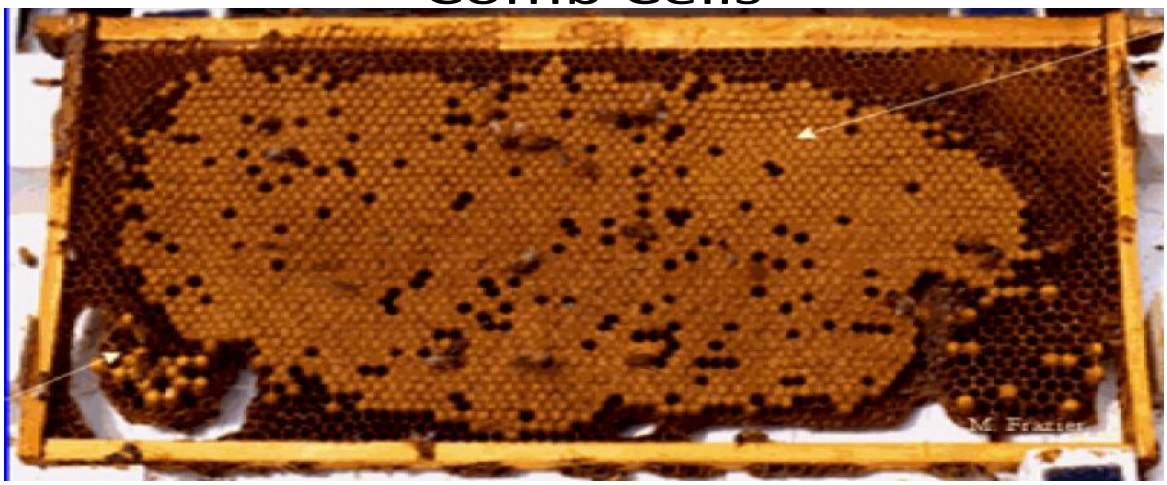
Larvae

About to pupate

About to be capped

Pupae

Comb Cells



Q cells

Worker cells are horizontal while queen cells are vertical. As the queen larva grows, the cell enlarges and becomes peanut-shaped when capped for the pupal stage of development.

Supersedure Cell

Jobs……..Except Ds

- Workers do the work in the bee society. Employment is based on the age of the bee and the needs of the colony. During their life they pass through many job promotions:
- Nurse Bee
  - ✓ 1 – 12 days
  - ✓ Clean own cell and others
  - ✓ Feeding brood (larvae)
- House Bee
  - ✓ 10 – 20 days old
  - ✓ Comb building
  - ✓ House keeping
  - ✓ Undertaker
  - ✓ Ripening honey
  - ✓ Climate control
  - ✓ Secreting/molding wax into cells
  - ✓ Accept and store pollen and nectar from foragers
- House Security
  - ✓ Guard hive and its entrance (some say only about 5% of bees perform this job)
  - ✓ Orientation flights to learn surroundings
- Field Agent
  - ✓ After about three weeks the girls are ready to spend the rest of their lives as **foragers** gathering pollen, nectar, tree resin (that they turn into propolis) and water for the hive. During this time they work themselves to death – literally
  - ✓ Worker bees in the summer only live about six weeks. In the winter they live a leisurely life for several months

Taxonomic classification of honey bees

Honeybee belongs to

Kingdom -Animalia
Phylum –Arthropoda
Class –insecta
Order-Hymenoptera
Super family –Apoidae
Family – Apidae
Genus – Apis
Spp. - > 20,000 spp.

Bees that produce enough honey to make harvesting worthwhile belong to two sub- families honeybees (Apinae) & stingless bees (Meliponinae).

Taxonomic classification of honey bees.....

Apinae has only one genus-Apis, of which five species are economically important.

1. *Apis florea*
2. *Apis dorsata*
3. *Apis cerana/indica*
4. *Apis mellifera*
5. *Apis laboriosa*

Of these five species of honeybees, *A. mellifera* has greatest economic importance and widely distributed all over the world.

Taxonomic classification of honey bees.....

These species of honeybees are categorized into two as primitive or advanced.

Primitive	Advanced
A. florea	*A. cerana*(indica)
A. dorsata	*A. mellifera*
A. laboriosa	

The origin of the Primitive Ones is South East Asia, while the original homeland of the most important honey bees (*Apis mellifera*) is Europe, Africa and the near east.

Some people said that original homeland of *Apis mellifera* is from tropics or sub-tropics of Africa and migrated to Western Asia and colder European climate later came to equator, then to beyond the Arctic Circle.

Honeybee species and their behavior

1. *Apis florea* (the little bee / the dwarf honeybee)

- It is found in lowlands of south Asia (i.e. Pakistan, India, Srilanka, Thailand& Malaysia)
- Is the smallest of all honeybee species, its size is about 7mm in length
- It maintained several ancestral characteristics of genus Apis.
- Probably, it is the closest living descendent of earliest honeybees
- Its colony size is small (about 5,000)
- It tolerate very hot temperature (up to 50^0c)
- It is economically less important (produce 0.5-1kg of honey/colony)

Honeybee species .....

2. *Apis Dorsata* (giant bee)

- These bees are large in size- 17-19 mm
- Have 20,000 or more workers in colony
- Produce honey up to 35kg/year
- The colonies migrate up and down mountains to take advantage of seasonal food source, i.e. has nomadic nature
- The workers are aggressive

Honeybee species .....

3. *Apis laboriosa*

- Is the largest honeybee species
- Is dark in appearance
- Has long hairy coat
- Live in high mountains
- It is very aggressive

Honeybee species .....

4. *Apis cerana/Indica/*

- Apis cerana is more closely resembles *A. mellifera*
- It is body size is quite similar but a smaller than *A. Mellifera*
- Average honey yield is 35kg/year
- It is used for commercial purposes in India and in other parts of Asia
- These bees can be kept in smaller hives
- The honey production is not as that of *A. mellifera*. So now it is replaced by imported strains of Western (*A. mellifera*) bees. But these two species of bees are difficult to keep them together in the same area b/c they cross breed each other without giving offspring.
- It tends to swarm
- It tends to migrate to secure better food source
- It is resistant to Nosema disease

Honeybee species .....

5. *Apis mellifera*

- *Apis mellifera* is the most productive of all honeybee species
- Average honey yield is 45---180kg /year in good honey yield area
- It has high degree of adaptability
- It is fairly aggressive
- The population of worker bees is about 50,000-80,000
- It is less prone to swarm than other species
- The serious disadvantage of this honeybee is its vulnerability to certain diseases especially a parasite like the varroa mite.
- These are originated from Asia, Europe and Africa-the old world, and today they are found in all parts of the world where environmental conditions let them to live.

- There are 24—25 races of *A. mellifera* in the world, most of which are in Africa.
- As it is the *A. mellifera*, which is the most adapted and widely distributed in the world, the following are the *A. mellifera* races.

Honey bee Races

Races of honeybees (*A. mellifera* races)

Hbee Race ????????.....

In the original home land of *A. mellifera* in Europe, Africa and the near East, the bees remained under the effect of natural selection for long time.

Races of honeybees (*A. mellifera* races).....

Some of the important characters used to characterize races of honeybees

A. Morphometric characters

1. Size

Width of thorax
Width of segments
Length of tongue
Length of legs
Size of wings and others
The smaller bees build smaller cells
The larger bees build bigger cells
The differences in the size of body affect the size of the natural cells

Races of honeybees (*A. mellifera* races).....

A. *Morphometric characters.....*

2. Colour

The dorsal abdominal segments vary in color from light yellow to entirely dark from race to race.
But due to the variability of color within the same race, its value for characterizing is less important.

3. Length of tongue

Tongue length is the most important characteristics for identification of races & during selection.
It is also one of the important parts that influence the productivity of the race.

4. Hair coverage

The area covered by the bands of hair on the abdomen
The length & co lour of hair are important character for race identification

5. Veins of wing

In the taxonomy of the honeybee the veins (the blood vessels) of the wing play important role.
The angle of the venation or cubital index is frequently used i.e. the proportion between the two lines say b and a

6. The shape and size of wax glands and others

Races of honeybees (*A. mellifera* races).....

A. ***Morphometric characters.....***

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Races of honeybees (*A. mellifera* races).....

B. Behavioral characters

Winter success ability
Productivity
Inclination to - swarm
- migrate
- abscond

Resistance to diseases
Gentleness (aggressiveness)
Tendency to propolis collection

Races of honeybees (*A. mellifera* races).....

European Honeybee races (*A. mellifera* races).

Some important races of *Apis mellifera*

1. *A. m. Lingustica*
2. *A. m. mellifera*
3. *A. m. carnica*
4. *A. m. Caucasica*

These bees are the most productive & manageable bees in different parts of the world (temperate).

Races of honeybees (*A. mellifera* races).....

A. **European Honeybee races (*A. mellifera* races).....**

1. Apis mellifera lingustica (Italian bees)

The original homeland is Italy

It is smaller than the black bee (*A.m. mellifera*)

Have bright yellow bands on the abdominal segments

Its abdomen is slender

Have relatively long tongue (6.3-6.6mm)

Races of honeybees (*A. mellifera* races).....

A. **European Honeybee races (*A. mellifera* races).....**

2.*Apis mellifera mellifera* (dark bees)

Its original homeland is all of Europe, north and west of Alps, & Central Russia.

It is the first honeybee brought to the new world

At present these bees are found in some parts of Spain, France, Poland and Russia as a pure race.

Races of honeybees (*A. mellifera* races).....

A. **European Honeybee races (*A. mellifera* races).....**

3. *Apis mellifera carnica* (carniolan bee)

Its original homeland is Southern part of the Austrian Alps, North Balkan (Yugoslavia), Hungary, Rumania, and Bulgaria.

Races of honeybees (*A. mellifera* races).....

A. European Honeybee races (*A. mellifera* races).....

4. *Apis mellifer Caucasica (Russian* bee)

Original homeland is the high valleys of central Caucasus in Russia.

Appearances

The color of the chitin is dark with brown spot on the first bands of abdomen

But have no uniform color in their original homeland

Very long tongue (7.2mm)

Races of honeybees (*A. mellifera* races).....

B. African Honeybee races (*A. mellifera* races)

There is high variability between the African bees b/c of extreme d/c in very vast area of the continent & due to adaptation to d/t tropical conditions.

Compared to European honeybees, African races:

Have small body size

Have strong tendency to -swarm
-abscond &
-migrate

Have short developmental time & rapidly reproduce

Are highly aggressive that exhibit great vigor in defense of the nesting sites.

Races of honeybees (*A. mellifera* races).....

Some of the important races of African honeybees are the following

1. A. m. Intermissa

It occupies the countries of North Africa, from Morocco to Libya
It has very long proboscis
It is small in size
Very dark bee
Bad temper
High tendency to swarm
Excellent in honey production in mostly extreme climatic condition of North Africa.
It constructs many queen cells during swarming about 100 queen cells
It has the ability to resist drought

Races of honeybees (*A. mellifera* races).....

Some of the important races of African.....

***2. A. m. saharansis* (Saharan bees)**

Found in fertile parts of Sahara Desert, along south edge of mountain Morocco
It tolerates extreme change of temperature range from 8 ^{o}C -50 ^{o}C
Small in size than intermissa
Have moderate tendency to swarm
Are docile i. e. not aggressive
Not effective at defending its nest

Races of honeybees (*A. mellifera* races).....

Some of the important races of African.....

***3. A. m. lamarckii* (Egyptian bee)**

Medium size with thick hair

Less aggressive

Poor in honey production

It is restricted to the Nile valley North of Nubian

Races of honeybees (*A. mellifera* races).....

Some of the important races of African.....

4. A. m. Jemenitica

Is very small in size

It is called honeybee of hot-arid zone of Eastern Africa & Arabia.

Yellow in color

Have short morphometric characters like hair, legs, wings

Exhibit variable behaviour & morphometric characters

Exist in high temperature range (27- 31^{o}C) and low rain fall range of 30--300mm

Races of honeybees (*A. mellifera* races).....

Some of the important races of African.....

5. *A. m. Scutellata*

It is native to Tanzania, Burundi, Kenya & Ethiopia
Found in central and eastern equatorial Africa South of Sahara
In savannah land of Africa from semi desert to tropical rain forest
Small in size
Very aggressive and their management is difficult
Has short tongue
Slender body
Brood rearing is rapid, the queen is very prolific, the colonies grow much more rapidly than those of European bees
Forage intensively
Very high swarming tendency
Worker bees mature in 19-20 days as compared to 21 days for European bees

Races of honeybees (*A. mellifera* races).....

Some of the important races of African.....

6. *A. m. Litorea*

It is found in the humid coastal regions of East Africa, Like Tanzania
Small body size
But has longer tongue
It is yellow strip bee

Races of honeybees (*A. mellifera* races).....

Some of the important races of African.....

7. *A. m. Monitcola*

It is found in the mountain regions of East Africa, i.e. Tanzania, Ethiopia & Kenya Mountain in altitudes of more than 2400m.

It is large is size

Good honey producer

Relatively gentle

Its hair is longer than those any other African bees

Races of honeybees (*A. mellifera* races).....

Some of the important races of African.....

8. *A. m. Adansonii*

In the earlier description this name was uniformly used for all races of bees of South of Sahara.

A.m. adansanii sometimes called as African bees

Its abdomen is remarkably broad

Its hair is externally short

It has tendency to form migratory swarm.

Races of honeybees (*A. mellifera* races).....

Some of the important races of African.....

9. *A. m. Unicola*

It is native to Madagascar
Has short tongue & legs
Easy to handle & gentle
Is uniformly black honeybee
Found between 1000—2000 m. a.s.l.
Exhibit variability in behavioral characters

Races of honeybees (*A. mellifera* races).....

Some of the important races of African.....

10. *A. m. capensis* (Cape Town bees)

It lives in a very restricted area in South West of South Africa (Region of Cape town)
The bees are darker
With short tongue
The most remarkable feature of these bees is in queen less colony the ability of workers to lay eggs without mating to produce female brood from which queen may be reared.
The laying workers have spermatheca but not filled with sperm.
In the queen less colony the workers soon start laying eggs, in which high percentage of them develop without fertilization into females.
She is attractive by other bees
She also secrets queen substances
It also suppressed the development of ovaries of the other worker bees

Races of honeybees (*A. mellifera* races).....

C. Honeybee races of Ethiopian (*A. mellifera* races).

I. According to Ato Ayalew Kasaye 1990 about 5 geographical races of honeybees were reported to exist in different parts of the country. These are:

- *A. m. adansonii* found to exist in South and Western parts of country (samples from Negelie, Gamugofa, Kaffa, & Wollega.)
- *A.m. jemenitica* found to exist in the low land areas of Eastern Ethiopia Wollo, Afar & Harraraghe.
- *A.m. monticola* found to exist in South East mountain of Bale- Dinsho
- *A.m. litorea* found to exist in Gambella
- *A.m. abyssinica* found to exist in high land area of Central, West & Southern parts of the country.

✓ But this study considered only partial part of the country: -i.e. central, east, South & West.

Races of honeybees (*A. mellifera* races).....

C. Honeybee races of Ethiopian .....

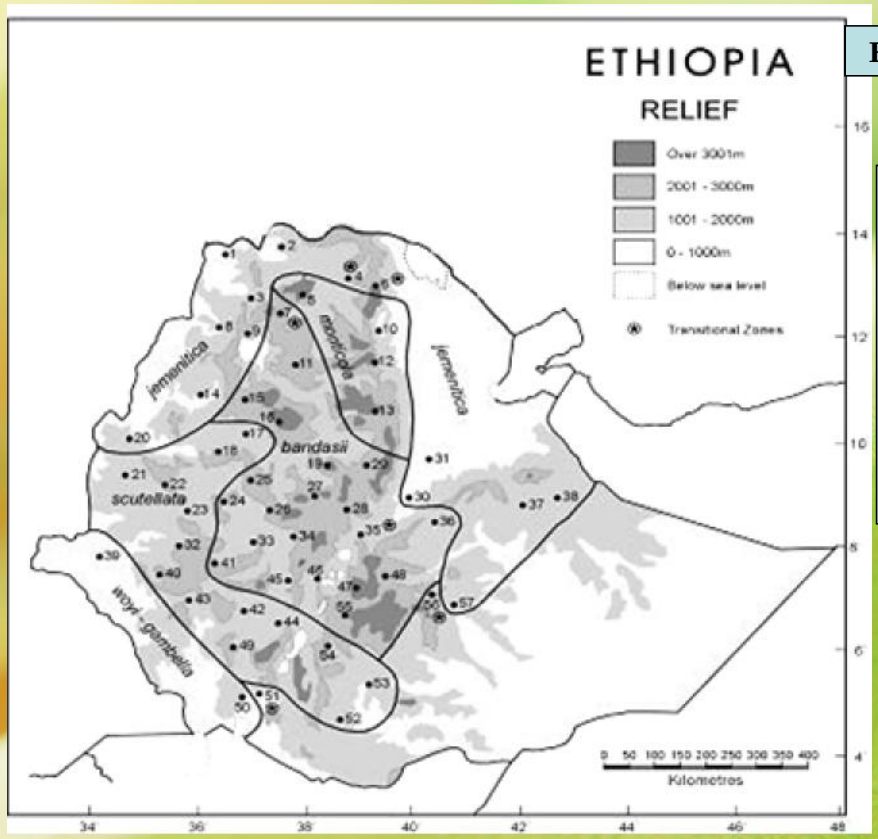
II. According to the study made by S.E. Radloff and H.R.Hupbern University of South Africa in 1996.

1. A.m. jemenitica found to exist in the Northern Ethiopia :(Gonder & Gojjam)
2. A.m. bandasii was reported to be found in the central parts of Ethiopia
3. A.m. scutellata found to exist in the Sothern Ethiopia (Ageremanian)

- But in this study A.m Monticola &, A.m.litorea were not reported to exist in the country. This may be due to the samples were taken along the transect of one route (i.e. from Mega, Ageremariam, Shashemene, Holetta, Debremarkos, Bahirdar, Gonder & Adi Arkay).

C. Honeybee races of Ethiopian .....

III. According to recent study done on morph clusters of geographical races of Ethiopian honeybees by Amssalu B. e.tal. (2002), the following 5 honeybee races have been reported to exist in the country.



Ethiopian honeybees

A. m. bandasii
A. m. jementica
A. m. scutellata
A. m. monticola
A. m. woyi-gambella

Races of honeybees (*A. mellifera* races).....

C. Honeybee races of Ethiopian .....

1. A.m. Monticola

The biggest and darkest of all other races found in the country

Found to exist in the northern high mountainous part of the country

Has low tendency for reproductive swarming and migration

Less aggressive than other races

Has longest body hair than other races

Races of honeybees (*A. mellifera* races).....

C. Honeybee races of Ethiopian .....

III. According to recent study …….

2 .A. m. Bandansii

- The largest honeybees next to monticola
- Found in central highlands of the country
- Dark in colour, but has few yellow members
- Has longest body hair next to monticola
- Has high tendency for reproductive swarming
- Has less migration tendency than *A. m. jemenitica*
- Is less aggressive than *A. m. Jemenitica*
- Give better honey yield than A. *m. jemenitica*

Races of honeybees (*A. mellifera* races).....

C. Honeybee races of Ethiopian .....

III. According to recent study …….

3.A. m. Scutelltata

Occupy the wet tropical forest lands
It is darker than A. m. jemenitica & A.m.woy-gambella
Its population comprises some yellow honeybees
Has higher tendency for migration
It exhibits aggressive to highly aggressive behaviour
Give better yield than *A. m. jemenitica*

Races of honeybees (*A. mellifera* races).....

C. Honeybee races of Ethiopian .....

III. According to recent study …….

4. A. m. Jemenitica

Is the yellowiest honeybee but also consists black members
Smaller than bandansii, monticola & scutellata
Has less tendency for reproductive swarming
Has high migration tendency
Is aggressive than other races

Races of honeybees (*A. mellifera* races).....

C. Honeybee races of Ethiopian .....

III. According to recent study …….

5. A.m. woyi-Gambella

Found in the extreme western and southern semi-arid to sub moist low lands
Found only in Ethiopia
It is the smallest of all honeybee races in the world
It has shortest hair cover
It is predominantly yellow in colour, but also comprise black members
Has less tendency for reproductive swarming
Has intermediate migration behaviour
It is aggressive to highly aggressive in behaviour

Anatomy and physiology Honey Bee

Bee Anatomy & Physiology

- To understand the creature, basic anatomy and physiology is of important as these structures enable honeybee and it alone

- ✓ to perform function as gathering and ripening nectar, collecting pollen and propolis, and producing wax etc., and at the same time fertilizing flowering plants.

Anatomy of a Honey Bee

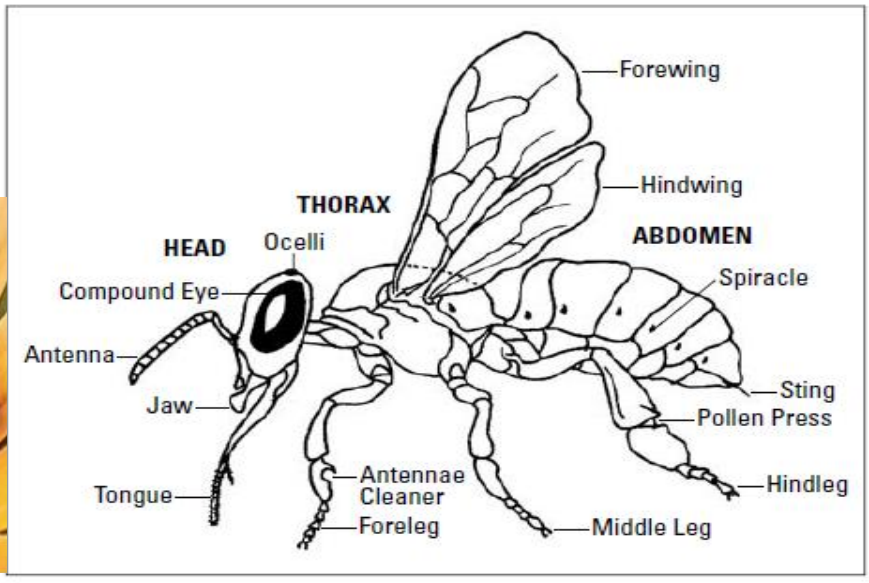
Bee Anatomy

Insects have a hard outer covering called an exoskeleton, rather than an internal skeleton like vertebrates (humans). The exoskeleton, which is made of a material called chitin, helps to protect the internal organs of the insect and helps prevent desiccation (drying out). In order to grow, the insect must shed the exoskeleton.

The three main sections of the Honey Bee's body:

a. Head
b. Thorax
c. Abdomen

Anatomy of a Honey Bee



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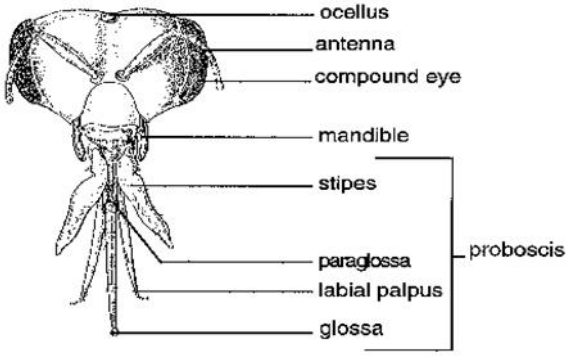
Anatomy of a Honey Bee

a. Head

Honey Bee Head and Mouthparts (Hairs not shown)



A. **Head**: is triangular in shape. Its structure differs among the members of colony

EYE: there are about 5 eyes on honeybees
i.e. three simple eyes &two compound eyes.

❑**Simple eyes**
-are three in number & located on the head
-there is no lens or ocular unit that can form image on the retina
The function of these eyes is to detect the intensity of light

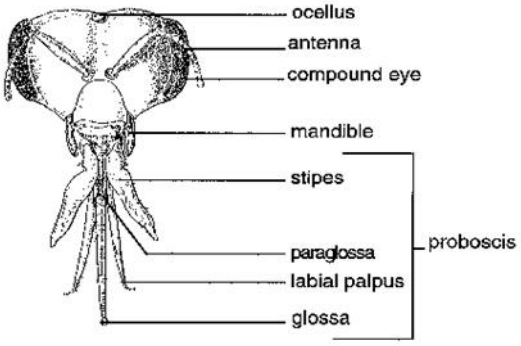
❑**Compound eyes**
- They are two in number & located on the sides of the head of honey bees
-The size varies with the members
-It contains very small &numerous facets called ocular unit also known as ommatidia
-The facets serve as the lenses & can form image

Function of compounds eyes
- To detect movable objects
-To recognize colour and shape of the objects

Anatomy of a Honey Bee

a) Head

Honey Bee Head and Mouthparts (Hairs not shown)



Antennae
– Honeybee has a pair of Antennae, which varies among the castes of a colony

Function of Antennae:
-Serves as tactile organs
-Serves as organ of hearing & smelling

Organ of feeding
-Consists mandible and proboscis
Mandible – spoon shaped jaws which concave and rigid on the inner side
Functions of mandible
-It helps to transfer pollen in to the mouth
-It helps for chewing (kneading) bees wax
-It helps Supporting external proboscis while feeding
-Feeding brood food to the larvae
-Dragging debris & dead bees of the hive

Proboscis –it folds when not used and extended when used
Function of proboscis
-Licking/sucking of liquid materials such as sugar and syrup
-Used for exchanging of food b/n workers & Queen
-Lick pheromone from the queen and exchange them with other workers

Anatomy of a Honey Bee

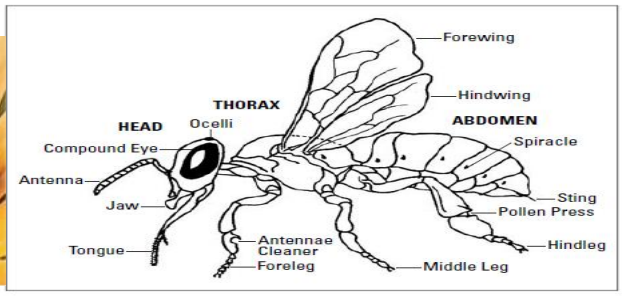
b. **THORAX** -it is the middle portion of honey bees body t/t has four d/t parts

- **prothorax** –base of front leg

-**mesothorax** –contain middle leg & front wing

-**metathorax** - contain hind leg & hind wing

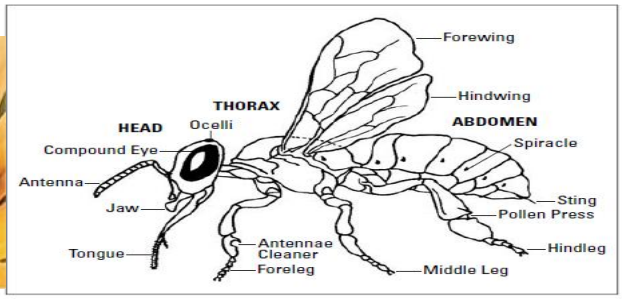
-**propodeum** –not true thoracic segment



Anatomy of a Honey Bee

b. **THORAX** -------

❑supports two pairs of wings and three pairs of legs, and carries the locomotor, or engine, & the muscles that control the movement of the head, the abdomen and the wings.



Anatomy of a Honey Bee

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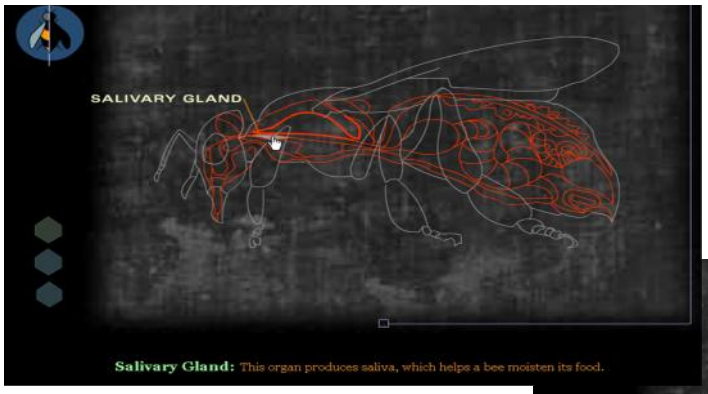
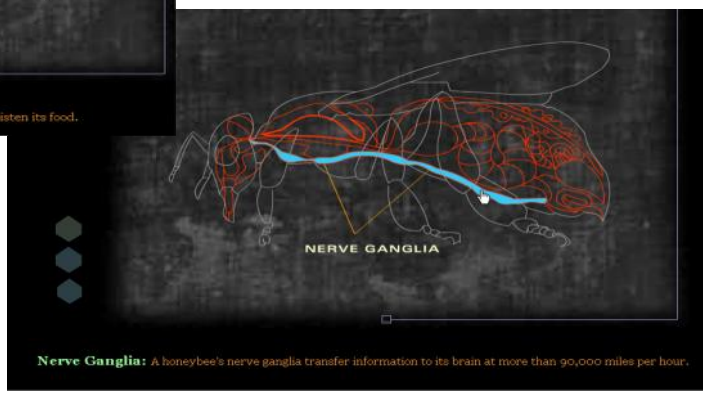


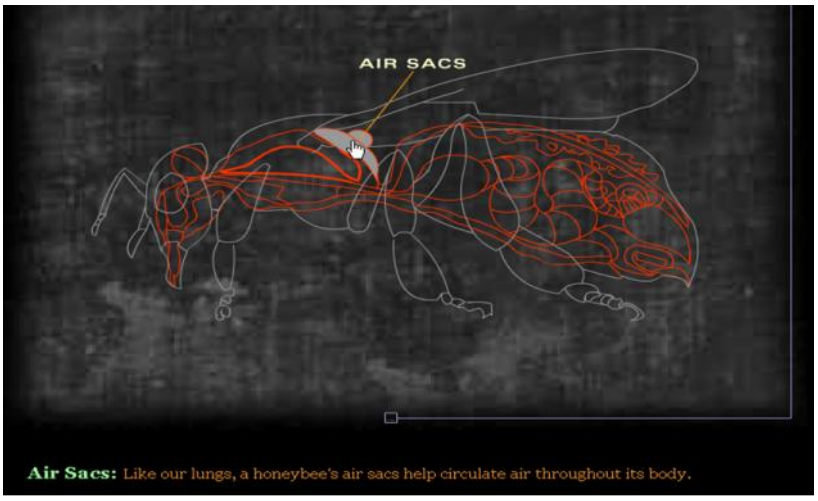
The saliva is mixed with bees wax to make it sticky.

The nervous system comprises a small "brain" and 7 ganglia right down the body. The 7th is near the end of the abdomen. This is why the detached body part of the bee sting continues to pump venom. The ganglia control the wings, haemolymph, legs, etc….



Anatomy of a Honey Bee

b. Thorax (cont.)



The air sacs (think lungs) are connected to the surface by tracheal tubes, emerging near the wings for breathing.

(like having nostrils between your shoulder blades)

NB: There are also breathing pores (spiracles) along the sides of the abdomen.

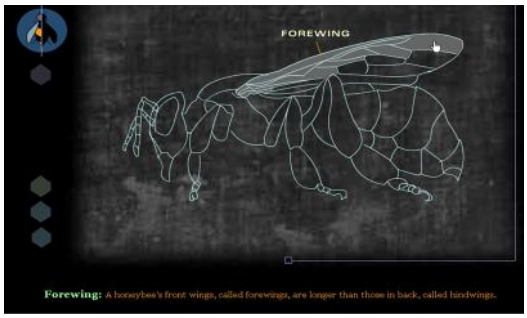
Anatomy of a Honey Bee

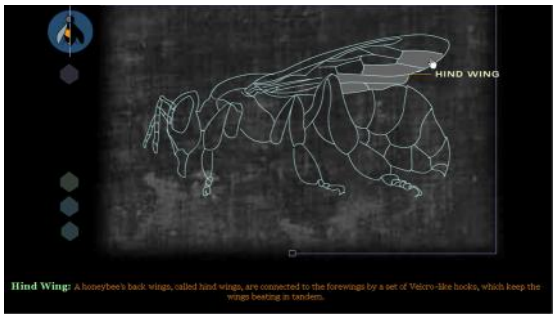
3b) Thorax (cont.)

There is a total of 4 wings, 2 on each side.

The forewing & hind wing on each side are joined during flight by a system of hooks .

It is the rapid flapping of the wings that causes the distinctive “buzz”.





Anatomy of a Honey Bee

b. Thorax (cont.)

Wing –

The front wing is larger and stronger than hind wings. On the rear edge of the front wings there are marginal fold that helps to hook the front and hind wings together.

On the other hand, on the front edge of hind wings there are several hooks (hamuli) that helps to hook the wing while flying

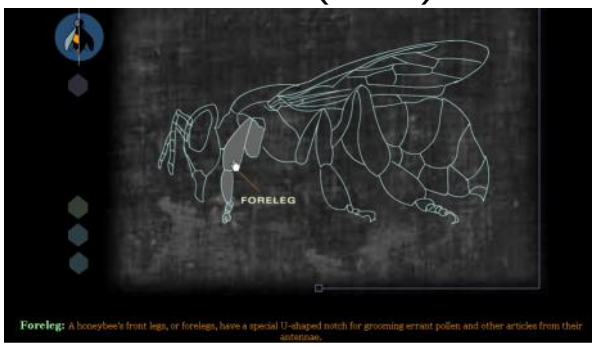
Function of wings

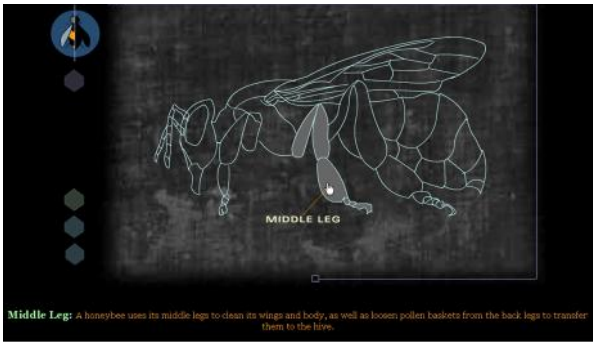
-For flying
-To regulate hive temperature by fanning
-To evaporate the moisture content from unripe honey by fanning the difference of the two are in the first the bees facing in ward and the second the bees facing out ward
-Helps to remove bad odour and CO_2 from the hive

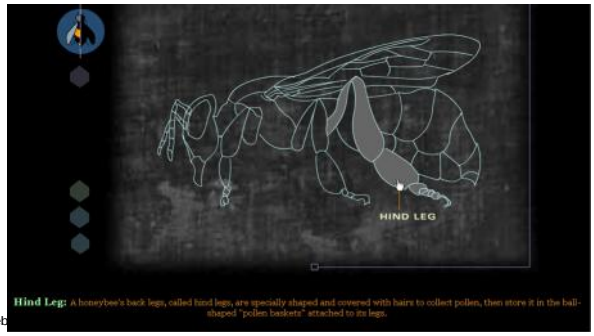
Feb 13, 09

Anatomy of a Honey Bee

b. Thorax (cont.)







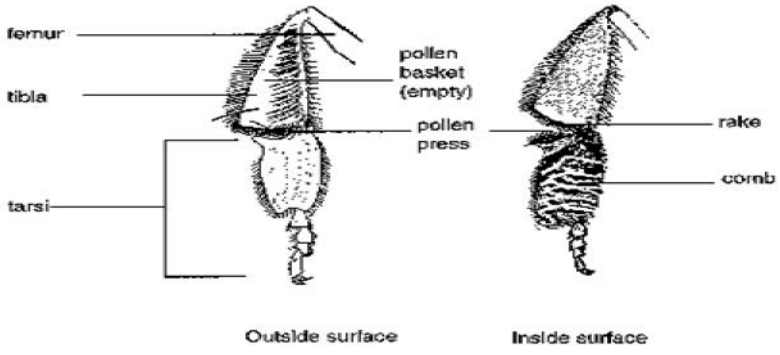
Like all insects, there are 6 legs. The legs of the bee are primarily used for walking.

Feb

Anatomy of a Honey Bee

b. Thorax (cont.)

Parts of the Worker Honey Bee Hind Leg



Each with 5 segments i.e. Coxa, trochanter, femur, tibia & tarsus (has 5 sub segments; the first & the largest being the basitarsus & the final one pretarsus or foot).

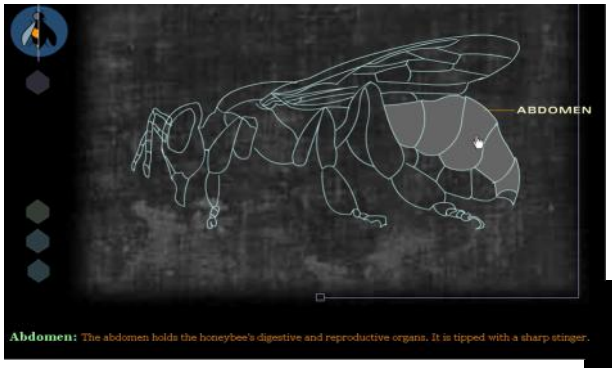
Each pair differs in size and shape

The legs of the bee are primarily used for walking.

However, honey bee legs have specialized areas such as ***the antennae cleaners on the forelegs***, & the pollen baskets on the hind legs.

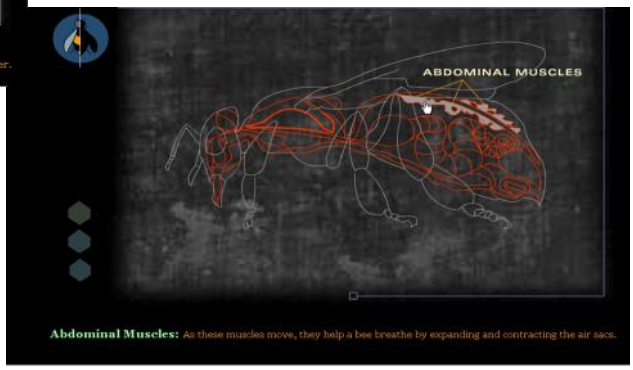
Anatomy of a Honey Bee

c. Abdomen



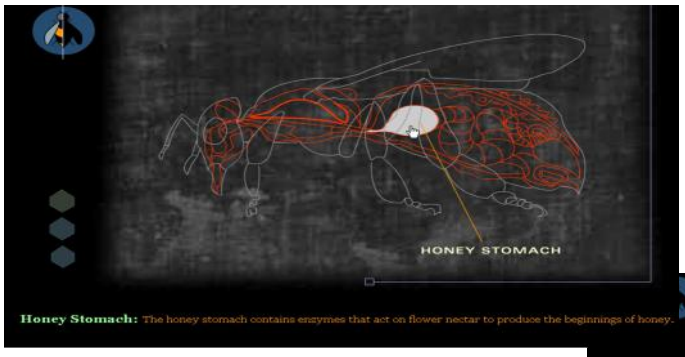
Honey Bees have "six-pack" abs.

Actually, as seen from the outside, only six abdominal segments can be observed, but the adult honeybee has nine, while the larva has ten.



Anatomy of a Honey Bee

c. Abdomen (cont.)



Honey bees have reversible movement of foods from mouthparts to/from a honey stomach.

Fore gut – consists of pharynx, oesophagus, crop & proventriculus.

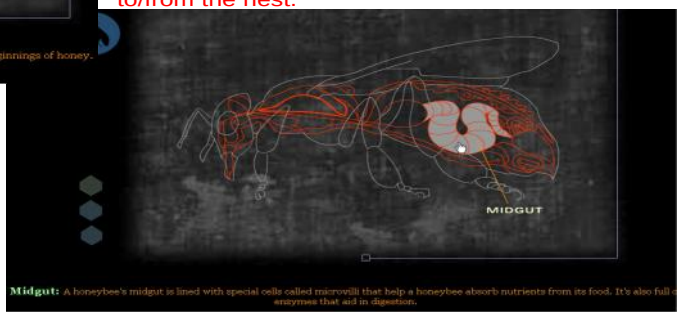
Crop- principal function is to carry nectar from filed to hive

-It is called honey stomach

-Serve as a temporary storage

The honey stomach is a crop or storage area to hold freshly collected nectar or water for transport to/from the nest.

Digestion of foods occurs in the mid-gut. The hind-gut reclaims water and nutrients and passes small amounts of indigestible wastes to the rectum for storage until excretion.



Anatomy of a Honey Bee

c. Abdomen (cont.)

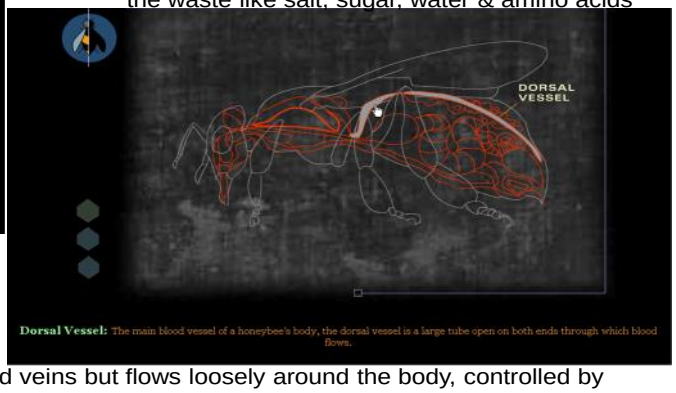
Mid gut / ventriculus/

it is principal stomach of honey bees
it is the largest part of A. canal
secretion & digestion takes place in it

Hindgut

It has two principal parts

1. Anterior (small intestine) - several enzymes are produced
2. Posterior (rectum) –serve as a passage for waste materials---- reabsorb some nutrients from the waste like salt, sugar, water & amino acids



The blood (haemolymph) is not carried by arteries and veins but flows loosely around the body, controlled by the dorsal and ventral diaphragms, sometimes called vessels, bellows or heart. Oxygen enters into the bee via spiracles (including two rows of 6 on the abdomen and by trachea connected by 3 spiracles on the upper thorax) then into the bellows in the abdomen which distribute it into the blood.

Anatomy of a Honey Bee

c. Abdomen (cont.)

The wax is discharged as a liquid, hardens to small flakes or scales, and sits in wax pockets. The wax scale is then transferred to the mandibles where it is chewed into a compact, pliant mass. After the worker bee outgrows the wax forming period, the glands degenerate and become a flat layer of cells.

Wax Gland(s): Four pairs of glands, sometimes called mirrors, are specialized parts of the body wall. During the wax forming period in the life of a worker, the glands greatly thicken and take on their glandular structure.

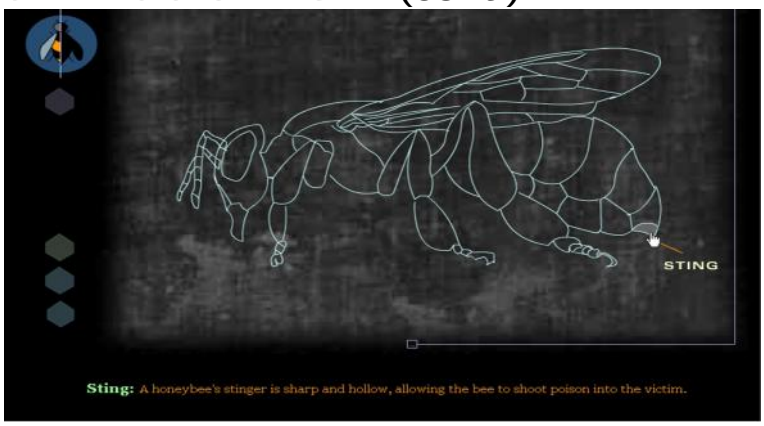
Anatomy of a Honey Bee

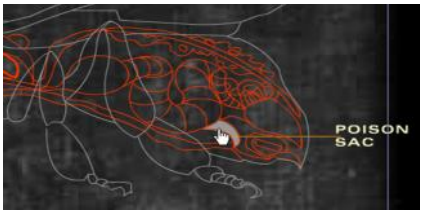
c. Abdomen (cont.)

Workers have a Nasanoff gland at the end of their abdomen. This Nasanoff gland is used by the guard bees at the hive entrance to disseminate a scent that guides young bees back to the entrance during early flights.

Anatomy of a Honey Bee

c. Abdomen (cont.) …… ***ovipositor***





On the end of the female bee's abdomen is the *ovipositor* (stinger). The ovipositor of the worker bee is barbed so that it remains imbedded into whatever the honeybee stings. In its struggle to free itself, a portion of the bee (stinger, venom sac, ganglia) is left behind, which damages her enough to kill her. The venom sac continues to contract by reflex action, continuously pumping venom into the wound for several seconds. The queen's ovipositor is slightly barbed and is "reusable": It's used to kill rival queens.

Detail Reading Assignment on Physiology of Honey bee!!!!!!!

Feb 13, 09

Chapter 4: Development, Organization, Communication & Defense in Hbee

The organization and structure of the honeybee colony

When we compare honeybees to other insects, they have well developed social organization

At all times of the year a honeybee colony contains a fertile female, the queen and 1000's infertile females, the workers and 100's drones

Each of the members of the colony (queen, worker and drone) is specialized for particular functions.

- ✓ Each of the members of the colony differs in morphology, physiology and behaviour.
- ✓ each of the member of the colony is specialized for particular function and differs in morphology, physiology a behaviour

The three (3) castes in a honeybee colony are:

(1). The queen: - is a fully fertile female specialized for producing eggs. The queen affects the colony by producing chemicals called "Pheromones" that regulate the behaviours of other bees.

(2). The worker bees: -are reproductively underdeveloped females that do all the work of the colony. A colony may have 50,000 - 80,000 worker bees. The only difference between workers and queens is the quality of the larvae diet i.e. a special food called "Royal jelly".

(3). The Drones: -are male honeybees, which are bigger than the workers but not as big as the queen. At any time, there may be between 200-300 drones in a colony. But when there is a scarcity of resource there may be no drone in the colony.

Queen

- ➢ The queen in honeybee colony is the only fully competent female present under normal conditions
- ➢ She is the mother of all other individuals in the colony.
- ➢ A queen honeybee is readily distinguished from both worker and drone.
  - Her wings are much shorter in proportion to her body length.
  - Because of her long tapering abdomen she appears wasp
- ➢ Her curved sting used only in battles against the rivals queen (when there is more than one queen in the colony)
- ➢ Her movement is slow under normal condition.
- ➢ The queen's proboscis is shorter than that of the worker bees. She lacks the following glands and structures:
  - Pollen basket (corbiculae)

- Hypopharyngeal gland that is useful in production of royal jelly in worker bees
- Wax gland that is used to secret wax in worker honeybees and
- Nasonov glands, that is useful for production of pheromones that is used in communication in worker honeybees.

But the queen has well-developed glands for queen's substance (pheromones) production particularly the large mandibular glands.

The mandibular glands secret pheromones that have the following functions:

1. Inhibits ovarial development in worker bees,

2. Inhibits queen cell production in the colony,

3. For queen recognition by the members of colony, and

4. For attracting the drones to the mating area (congregation area).

- The queen ovaries contain a numerous ovarioles (egg laying sacs) compared to the worker bees.
- Each of her two ovary consists of 160-180 ovarioles where as worker ovary has only 2-12 ovarioles .
- The ovarioles can produce unlimited number of eggs often as many as million or more during her lifetime.
- Queen has well developed spermatheca, which holds sperm from drone; which has mated with queen early in her lifetime.
- Honeybees rear queen only under three conditions.

1. When they are about to swarm.

2. When a colony is about to replace an old or filing a queen /supersedure/

3. When the colony becomes queen less /through accident or natural causes/

Drone

- Is a male honey bee
- Produced from unfertilized eggs
- Exists only to mate queen
- Performs no works for the colony and is fed by the worker
- Drone has very short proboscis
- Drone has large compound eyes
- Drone has large and broad muscles
- Drone has no wax glands, hypopharyngeal glands and pollen basket
- In contrast, orientation flight muscles and relating structures are highly developed.
- Drone mate only once in his life time and die soon since much of endophallus break off from drone is left in the queen during copulation.

Worker honeybees and their duties

- They are female honeybees and obtained from fertilized eggs.
- As their name implies, the workers perform almost all the tasks in the colony, only reproduction that is beyond their task.
- The activities that worker honeybees perform are related with their age..

1. Nurse Bees / House bees/

- are those workers bees who spent most of their time by performing activities inside the hive
- This starts from the first day of emergency up to 21 days.

2. Forager bees/Field bees/

- Forager bees are those worker honeybees, which perform their activities outside the hive. This high labour worker honeybee has an effect on their age and the age of worker honeybees is shorter than queen and drone.
- The maximum age of worker bees is 42 days. But they can live up to 60-90 days even up to 10 months (these are exceptions).
- The age of worker bees is determined by the activities they perform. Some activities performed by nurse bees are the following: -

A. Body cleaning

The first task of a worker bee immediately after emergency is cleaning of her own body besides to this nurse bee's also clean body of other worker bees, queen and drone. A bee that needs to be cleaned performs a grooming invitation dance during which it rapidly stamps its legs and shake's its body from side to side. This usually results in a nearby bee cleaning it, in the wing bases and in the constriction b/n the thorax and abdomen where a bee is unable to clean itself.

B. **Cleaning nest**

The cleaning of the nest includes: -

- Cleaning the cell from which brood were hatched.
- Removing the remains of cocoons and larval excreta.
- Removing moldy pollen from the cell
- Removing dead larvae, dead bees
- Removing of only foreign materials that are found inside the hive.

For example, if bees found dead spider or ants inside their cell, they remove out of their hive with the help of their mandible. But for a bigger foreign materials such as lizard, snake this material is heavier for the bees to remove, and then they fix with the wall of their hive by the use of propolis. In doing this, they try to avoid bad smell due to this foreign material.

C. **Brood feeding**

The major activity associated with brood feeding is nursing, in which the workers with developed hypo pharyngeal and mandible glands feed brood food to larvae.

Therefore, bees that attain the age (usually between 6 and 16 days old) used to feed

- Larvae of queen
- Larvae of worker
- Larvae of drone
- In addition to this the adult queen is also fed by nurse bees unless and otherwise the queen is caged where the workers are not able to feed her.
- Nurse bees visit individual larvae an average of about 1300 visits per day, other studies have shown higher values of up to7200 visits or a maximum of 1140 feeding visits per larva.
- A Single nurse bee rears the equivalent of two to three larvae during its nursing life.

A. **Queen Tending /Taking attention for queen/**

Workers attend the queen at about the same time they are participating in brood- nursing activities. A circle of six to ten attendant workers is usually formed around the queen, with the individual attendants rotating frequently; a typical visit lasts less than one minute.

The workers are examining the queen with their antennae and fore legs, licking her with their tongues, and feeding her dark mouth- to- mouth food exchange

B. **Comb construction**

Comb is a back-to-back arrangement of series of hexagonal cells made of bees wax to hold brood, pollen or honey.

Beeswax, the material used by the honeybees in construction of the comb is secreted by worker bees (8-17 days old)

Worker bees involved in wax secretion form a cluster in order to increase their body temperature, because wax-secreting worker requires high amount of energy.

In order to gain this high energy, worker bees feed with large quantity of honey or sometime sugar/nectar

C. **Cell capping**

The young workers of 2-3 days old usually engage in cell capping activity.

Older workers are producing wax and place wax secretion on the rims of the cells, which need to be capped.

D. Orientation Flight

The mean age at which orientation flight is performed is usually about one day before the mean foraging age.

This is at the age of 21-24 days old.

The purpose of orientation flight is, as the name implies to orient to the nest location before workers take trips a field to forage.

These flights tend to take place on warm, windless, sunny afternoon

E. Colony Defense

This stage is transitional between nursing activity and field activity. All nurse bees are not involved in the guarding activity, because the number of involved bees is related with the number of enemies in the areas. Worker bees have well developed stinging apparatus.

Those who do guard the nest perform this activity most frequently between the ages of 12 and 25 days, and they usually guard for only a few hours or days before foraging commences.

Each guard patrols limited areas around the entrance, inspecting incoming workers with the antennae and determine their odor and behavior whether they are colony members or not.

More workers assume guarding duties when the colony has been under attack or during periods of forage dearth, when robbing is more likely.

Defensive Mechanisms

The defensive can be done in the following ways

By stinging. E.g. Man, cattle

By biting with their mandibles. E.g. Ants.

By fanning their wings. E.g. ants

By kicking with legs. E.g. Ants

F. Nest Homeostasis/ Thermoregulation

One of the great advantages and challenges of insect social organization is colony homeostasis, or maintenance of hive temperature and other environmental factors at relatively constant levels regardless of external conditions.

The advantages of homeostasis are many, including rearing of brood under stable conditions, survival of populous colonies through cold and hot, early initiation of brood rearing and flight warming of foragers.

Bees require temperature about 34 ^{o}C to 35 ^{o}C inside the brood nest temp.

To maintain the above temperature, bees use different methods for regulating hive temperature.

Minor activities performed by nurse bees

a. Nectar filling
b. Pollen packing
c. Food handling
d.

II. Duties of field bee or Foragers

The final task performed by workers before their death is foraging, although workers occasionally revert to other tasks, as colony needs dictate

Foragers leave the colony to collect four resources.

These are: - 1. Nectar 2. Pollen 3. Propolis 4.Water

The hypopharngeal and the wax glands of foragers degenerate and workers who have been foraging for more than a few days begin to look old and worn out, as they lose their hair and show wing fraying. The life of the foraging bee is short, an average worker forages for only 4 to 5 days before she dies.

Most foragers make about 10 trips a day but Ribbands (1949) observed that one worker collects 29 pollen loads in a day, 150 trips per day to artificial syrup dishes and 110 trips to collect water have also been recorded. The flight distance accumulated by a forager has more of an influence on her life span than chronological age, since workers seem to die after flying a total of 800 km whether the distance was flown in 5 days or 30.

This appears to be caused by a break down in the enzymatic mechanisms that metabolize carbohydrates into glycogen. When the glycogen reserves, which accumulate in the flight muscles of young workers, are exhausted, the older foragers are unable to synthesize additional glycogen and they die (Neuk irch, 1982)

Communication and control of the colony

Living in group or community needs to communicate with one another. They do this in a number of ways, not all of which are understood by science. They may communicate by making various noises perhaps by drumming of feet or flapping of wings. They also communicate by touch and food exchange.

In general communication means divided in to two:

a. Physical and
b. chemical
c.

I) Physical communication

Among all physical communications, dance is the main media or it is the core one that tells

Direction, distance, quality & quantity & time

Dances are divided in to:

1. Round /circle dance
2. Waggle dance
3. Dorso- ventral abdominal vibration are clearly understood dances

1. **Round dance**

Round dance is the simplest dance and does not communicate precise distance or direction information. Rather it simply informs workers that there is a resource within close proximity to the nest less than approximately 100 meters.

In performing this dance, an incoming worker, which has discovered a nearby food source, first exchanges nectar with workers inside the nest. Then she performs round dance being closely followed by attending bees. In this dance the dancer repeatedly makes small circles, reversing and going opposite direction after every 1 or 2 revolutions, and some times more frequently. Up to 20 of these reversals can occur, with dances lasting for only seconds or up to minutes. Often, food is then exchanged again between the dancer & the nest bees, and then the dancing may resume.

The dancer may then leave the nest on another foraging trip, while recruits clean themselves, take some honey for energy on their flight and then exit the colony.

There is no evidence, however; that the round dance transmits information concerning the exact location of the food source, and it seems that exiting recruits must search the immediate vicinity of the nest to find the resource

2. The Waggle dance

The honeybee uses the waggle dance to communicate information about the distance, direction & quality of resource at distances greater than 100 meters. It has also been called the tail wagging or figure eight dance, since workers shake their abdomens during some of its "steps" and its characteristic pattern of movement is in the configuration of a figure eight.

In atypical waggle dance the bee runs straight ahead for short distance, emphasizing its movement by shaking the body vigorously from side to side at a rate of about 13-15 times/second.

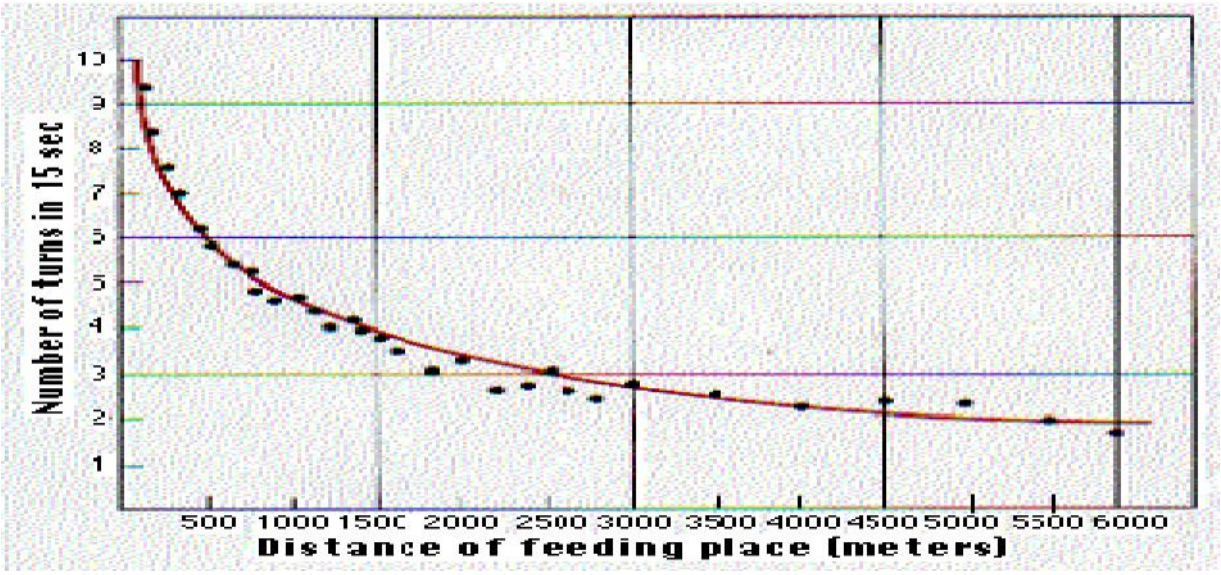
At the end of each straight run the bee turns in one direction and makes semi circular turn back to the straight point, followed by another straight and semi circular turn in the opposite direction. As in round dance, the waggle dance is punctuated by the dancer stopping distributing food from its honey stomach to nearby workers, and the dance itself is closely attended by retinue of workers with extended antennae. The dance followers may produce a squeaking sound of short duration, lasting 0.1 - 0.2 sec. that has been called a "begging signal" and causes dancer to halt and exchange food with the bee that squeaked. Both Nectar and pollen collectors dance in the same manner.

The remarkable aspect of this dance is the way information is translated from abstract dance language into terms, which the attending workers can read, and use to locate resource.

During the waggling movements a series of sound blips are made at low frequency of 250 hertz, and these sounds are inaudible to the human ear. The No. of sound blips was found to highly correlate with distance to known food source and therefore could be a form of distance communication. Another possible means of communication distance is the time that the bees are engaged in portion of the dance.

The number of straight run per 15 seconds was measured for bees foraging at different distances and found to be correlated with those distances. For example, Von Frisch (1967) found the following approximately distances and time:

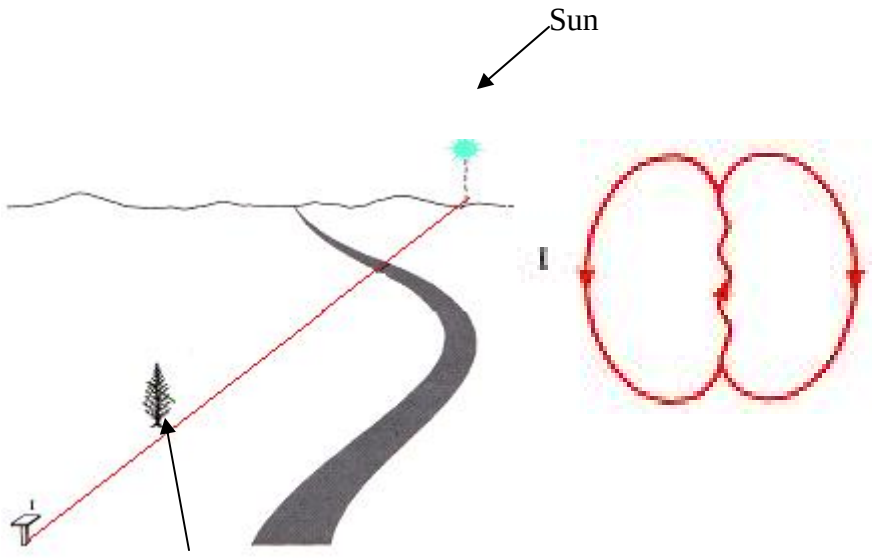
Distance (meters)	Straight runs per/15sec.
100	9-10
600	7
1,000	4
6,000	2



Perhaps the best indicator of distance is the time spent in the straight run portion of the wag-tail dance, as found by von Frisch & Lander (1957).

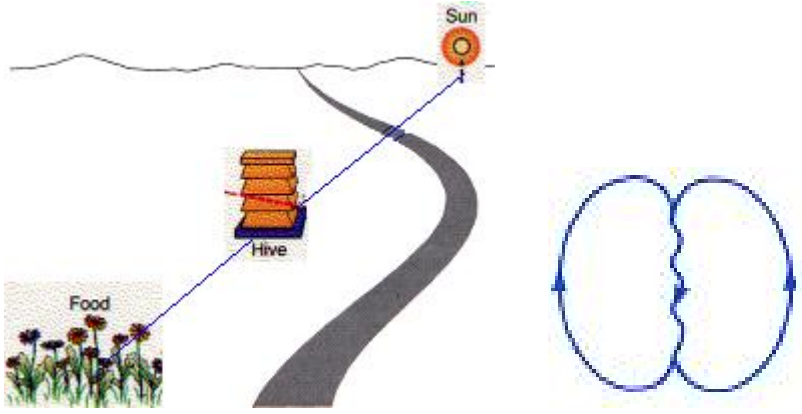
The communication of direction would have been a great advantage to honeybee during their evolution, particularly when food sources were great distances from the nest. The evidence for direction communication is found in the dance configuration, specifically in the direction of straight run portion of the wag-tail dance, in the relation to the line of gravity, and related to the direction (in the horizontal plane) of the sun from the line.

If the food source is directly toward the direction of the sun, the straight run portion of the dance is oriented straight up on the brood comb.

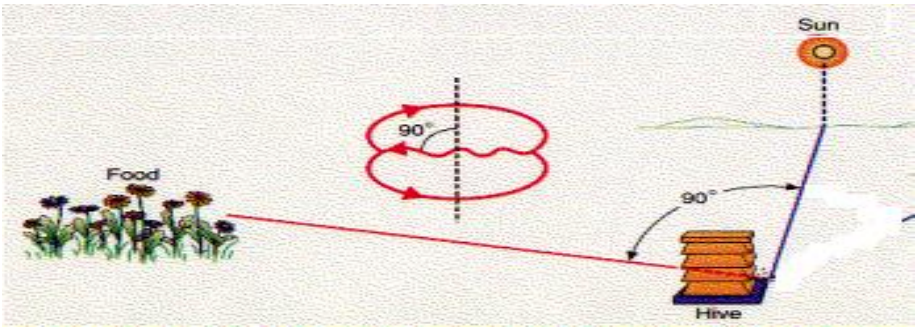


Hive Food

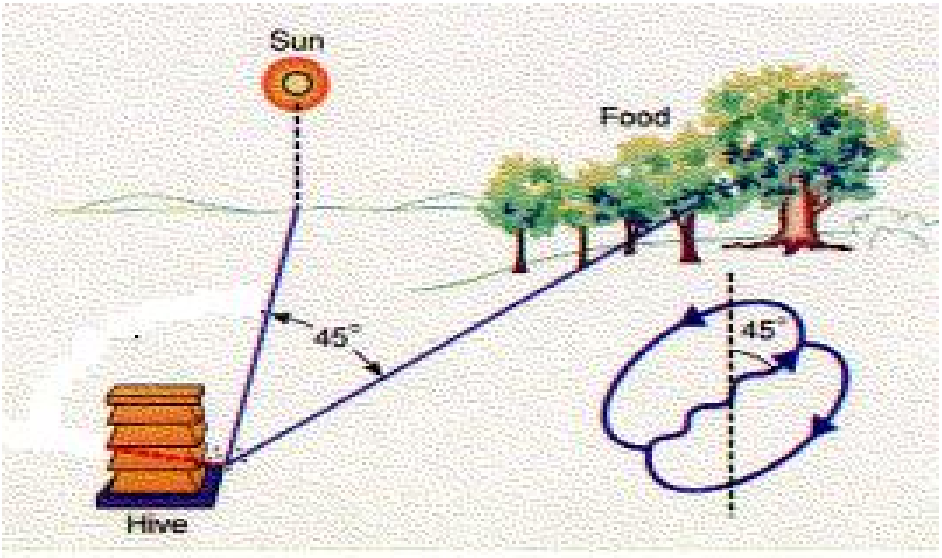
If the food source is opposite direction from the sun, the straight run is dawn ward.



When the source of food is to the left of sun, the bees dance at an angle counter clock wise to the line of gravity.



When the source of food is to the right of the sun the bee dance to the right of the line of gravity.



As the sun moves across the sky, the bee changes the orientation of the straight portion of the dance, consequently always indicating the correct direction to the food source.

Another source of information during communication actively is the fragrance of the flower. There is evidence that these odors cling to waxy cuticle layer covering of the body. During the dance there is ample of opportunity for the potential recruit bees to smell the fragrance, and then respond selectively to this odor later while "searching" in the field. Some scientist think that this means of communication may be as effective, perhaps more so, than communication by dance. The odor that is in nectar may be equally important.

Some information is contained in the flavor of nectar that is passed from the returning forager to receiving bees that are potential forager. This mechanism is probably very significant in alerting bees to rich food sources that containing high sugar concentration in the nectar.

Other information that is communicated is the time of food availability. This is important because many plant species yield nectar and /or pollen at rather precise, and sometimes brief, time periods during the day. The time the bee is dancing indicates, the time when food is present in the field, and bees have ability to remember this time.

The quantity of food probably is communicated by the number of dancing bees in the hive and frequency of dances. If forager are stimulated sufficiently by short " loading" times, as would be expected when the yield per flower are great they would return more frequently to the hive and perform more dances. Dance actively ceases when nectar supplies diminishes, so there is rather constant feedback of current information on the quantity of food available in the field.

Hazards associated with the foraging are communicated indirectly. Foragers are subjected to the hazards of predators, natural toxic materials present in the nectar and pollen of small number of plant species and pesticides in the contemporary environment. These factors can prevent the return of affected foragers to the hive, or upset their normal behavior significantly, thus interfering with further communication that might lead to the exposure of new foragers to

hazardous foraging conditions such protection is enhanced by the time delay mechanism in which experienced foragers normally make several trips to food resources before they stimulated sufficiently to the dance at the hive, thus the effect of slow acting toxic materials or significant predation pressure would be expressed maximally before communication take place.

3. Dorsoventral Abdominal Vibration / DVAV /

The worker vibrates its body dorsoventrally, particularly the abdomen frequently while grasping another worker or queen.

This dance is used to regulate foraging and swarming activities concerning foraging, these dances used to regulate both daily and seasonal foraging patterns according to short and long term fluctuations in food availability. The regulatory actively of vibration dance functions in number of ways.

1st Workers of foraging age, but not younger workers, respond to the dance by increasing their rate of movement in the nest, particularly by moving to the area where waggle dances are performed.

2nd Peaks in the level of vibration dancing are closely related to peaks in foraging activity

3rd There are long term seasonal peaks in vibration dancing associated with periods of food abundance.

In summary, DVAV seem to have an activating effect on foraging in worker- worker interaction and an inhibitory effect on queen activity that may also function to prime queens gradually for swarming or mating flight when vibrating diminishes. There are other dances in the nest for which functions are not were understood. These dances include:

- Jostling run
- Spasmodic dance
- Buzzing run
- Shaking dance

II). Chemical communication (Pheromone)

Pheromones play an important part in control of the colony. These are chemical substances produced by bees to convey precise messages to other bees. Honeybees have a number of pheromones systems controlling their behavior, but the methods by which these chemicals exert control are extremely complex. Queens, drones and worker bees, including brood, all produce pheromones. Queen pheromones attract workers to her, stimulating foraging, brood rearing and comb building, and inhibiting queen rearing. The presence of the queen has a profound effect upon the workers. If the queen is removed from the hive then a change in behavior of the colony can be detected very quickly. This communication is brought about by important behaviors – such as food sharing.

Trembling dance

A). Workers pheromone

1. Nasanov scent – This is the pheromone produced by worker bees which helps them
   - ♠ To attract the queen
   - ♠ For guidance to the site (scout), swarming
   - ♠ For foraging
2. Alarm pheromone
   - ♠ it helps to indicate the position of intruders
   - ♠ it helps to Call other bees for defence

B) Queen pheromone

The queen pheromone is produced from mandibular gland. This pheromone

1. Helps to attracted workers
2. Activates the worker activity
3. Attract drones during mating
4. To fly the group cohesively while warming
5. To prevent reproduction by

❖ Inhibiting ovary development of worker bees
❖ Preventing the development of new queen

C/ Brood: Both larvae & pupae can produce pheromones, which activate foragers /workers/

Chapter 5: Breeding in Honeybee (Queen Rearing)

1.10 Queen rearing

Importance of queen rearing

Generally queen rearing is an integral part of beekeeping and has many advantages like: -

1. To improve the genetic conditions of a stock

The success in beekeeping partly depends on the nature and performance of a queen that is: -

A. The various behaviour of a colony like: - aggressiveness, swarming and migratory tendencies, hording ability and others partly governed by heritable traits that pass from the parent.

B. The productivity of a colony in most cases proportional to the population size of a colony, which is, again depend on the prolific and population build up nature of a queen.

2. To re-queen the old queens

The life expectance of a queen is 3-5 years; however after 2 years, the performance of a queen is gradually become decline and the colony become less productive. As that of replacement of a stock in commercial poultry, in beekeeping also the old queens have to be replaced timely. The commercial life span of a queen is 2 years. When a queen become old, the number of eggs laid becomes less or the queen may run out of stored sperm in spermatica and it may, only lay unfertilized eggs, which become only drones that bring the colony totally unproductive.

3. To replace a sudden lose of a queen.

During hive operation or some other reasons a queen may die as a result very strong colony may become queen less. Having extra queens is very important to rescue such queen less colonies.

4. To multiply colonies

In the country the honeybee colony population is in state of continuous declining from time to time for many reasons

i) Due to indiscriminate application of various agrochemicals,

ii) Due to population pressure and associated ecological changes

1 Clearing of vegetation

2. Over populated livestock that graze all field flowers before blooming

1 Extensive cultivation of cereal crops (barely & wheat)

iii) Recurrent drought and long dry periods in the absence of subsistence feeding practices which lead death of the colony due to starvation

iv) Brutal way of honey harvesting with complete destruction of colonies and their nests that contributed much in declining of colony in the country

As a result of these the honeybee population density becomes very low in many parts of the country particularly in central, eastern and northern parts of the country. In the past during swarming period, it was a mater of days to be occupied baits hives by swarm, but now a day in many parts of the country it become very rare or very unlikely.

During swarming period beekeepers spent watching their colonies without going church and funeral ceremonies not to miss a single swarm which indicate how it serious to get a colony.

4.1) As a source of income

Multiplications of colony through queen rearing can be one of area of income generation or mean of diversification of income. Multiplication and selling colonies can be also area of specialization. In some areas, a colony multiplication is more attractive than honey selling as a price of colony rises up to 300 - 500 birr..

4.2) To increase the existing stock. Many beekeepers want to increase their colony number, but their options are through purchasing or baiting which always may not be simple and possible. In this regard rearing honeybee queens is very important.

Types of queen rearing

There are two types queen rearing

1. Natural
2. Artificial

Natural queen rearing

Under natural conditions colonies rear queens for one of the following reasons.

1. As emergency queen: - when colony lost its queen suddenly, the colony try to rear its queens from the eggs or young larvae that have been laid before dieing of the queen, but colonies may not always become successful. Such types of queen cells are called emergency queen cells and it usually built at the center of the combs and not more than 5-8 queen cells. During inspection such queen pupae have to be aborted by leaving two proper pupae or all can be used for increasing colony number.

. **Superseder queens**

When a queen become old, the queen unable to secret adequate queen pheromone to harmonize the colony. Under such conditions a colony build few queen cells at the periphery of a comb. Such types of queen cells are called supersedure and are not related to high population size as that of reproductive swarming. During inspection such queen pupae have to be aborted while leaving 2 proper queen pupae or have to be harvested to multiply colonies.

3. **During reproductive swarming**

Reproductive swarming is a natural phenomenon by which the perpetuation of the species is maintained. So when a colony prepares for reproductive swarming, it rears quite large number of queens. Reproductive swarming mostly occurs during flowering period in favorable seasons. The reproductive swarming cells are mostly constructed at the periphery of a comb and the queen cells can be 15-20. Reproductive swarming is more frequent in small volume hive/nests. Reproductive swarming mostly accompanied with successive swarming of colony, which result in reduction or total lose of yield for that particular season. If the beekeeper's objective is to get honey reproductive swarming has to be controlled by aborting the queen cells. If the beekeepers priority is to multiply his colonies, reproductive swarming can be well exploited for colony multiplications.

Limitations of natural queen rearing

1 May not be happen always (The swarming tendencies of some strain of bees is very low and may stay up to 10-15 years with out issuing reproductive swarms
2. It is not possible to get the required number of queens
3. It is not exactly predictable when it will takes place.

Artificial queen rearing

Artificial queen rearing is way of raising honeybee queens artificially It has been started long years a go and it is more than century old practices. Through these periods in different parts of the world, many investigators in one way or another had contributed a lot to words the success of artificial queen rearing. As a result to day there are dozens way of queen rearing techniques. However, all techniques of queen rearing may not be equally suitable to all type of races of bees and to all levels of beekeeping. According to studies carried out at Holeta Bee Research Center on assessing the responses of local honeybees to different queen rearing techniques it has been found that splitting, miller and overcrowding are more suitable to local bees & to the level of beekeeping conditions in the country

Generally artificial ways of queen rearing can be categorized into two groups.

1) Simple and 2) commercial methods of queen rearing

Simple methods of queen rearing are methods of raising few queens in small-scale level with less technological inputs.

Simple methods of queen rearing include: Splitting, Miller, over crowding and others methods. A commercial method of queen rearing involves raising of large number of queens for commercial purpose. It requires advanced technologies and it is relatively more intensive and sophisticated.

Preconditions for artificial queen rearing

Even through artificial queen rearing is forcing bees to rear queens artificially, but it has to be carried out at ideal environmental conditions. Other wise the responses of bees towards artificial queen rearing is very low.

Some of the important considerations in artificial queen rearing are as follow: -

1. The area should be with ample flowering of bee plants that can serve as adequate source of pollen & nectar.
2. Artificial queen rearing has to be carried out at peak flowering period of the area.
3. Having of standard or inter changeable hives and hive parts like frames are very important
4. At commencing of queen rearing, we have to be certain the presence of adult drones to mate the reared virgin queens.

5. To get good responses there must be strong colonies with large worker bee population with different stages of brood
6. There should be two sites, which are at least 0.5 - 1 km far apart to move & place the split & nuclei colonies.
7. Strong colonies possibly with better performance history (in yield) are very essentials.
8. Feeding is very important to stimulate the queen to rear more broods and to create population pressure. Feed should be given before, during and after queen rearing.
9. Adequate knowledge about brood development stages
10. Strong follows up with better management practices are vary important.

Simple methods of queen rearing

There are a number of simple methods of queen rearing among these splitting, and overcrowding found to be appropriate.

Splitting

This method involves the splitting of strong colony into two or more parts. Splitting method can be practiced both in box and top-bar hives, but with small modifications. splitting can be done in two ways.

1. Random splitting

In random splitting, one strong colony randomly split into two or more parts. As long as eggs and 24 hrs old larvae are present in whichever parts become queen less can rear their own queens. In random splitting techniques it is not necessary to look for and to be sure in which split the queen is present. But we have to be sure that egg; young larvae, pollen & honey are present in all splits. The limitation of random splitting, since the population and the broods are equally divided in each of split the population pressure in queen less splits may not be strong enough to get maximum responses.

Pre arranged splitting

In such splitting, re arrangements of frames should be carried out 24 hrs before the splitting process. During rearrangement the queen has to be confined in one of the compartment preferably in bottom chamber in box hive and in front part of the hive in top bar hives using queen excluder and large proportion of combs with egg, young larvae, honey and pollen should be kept in the queen less compartment beyond the queen excluder. On the next day, splitting of colonies will be carried out by pushing large proportion of worker bees to words the queen-less compartment, using smoke from the entrance in box hives and from behinds in top-bar hives.

During splitting high care should be taken to be sure that the queen is remaining in the intended compartment. The queen right split should be moved 0.5 -1km away from its original place. Feeds have to be given for both splits. After 2-3 days both colonies should be inspected for their progress, many queen cups can be observed in the queen less split. On the ninth days of splitting the queen pupae should be harvested, caged and incubated in the same colony. Improved or traditional queen cages can be used. Small amount of solidified honey have to be placed in the cage to be used by the newly immerged queens. When the queens are hatched out nuclei colonies have to be formed by taking small amount worker bees from queen less colonies.

Nucleus colonies can be formed before the hatching out of the queen. In this case the nuclei will be provided with the matured queen pupae attached to the brood combs. For one nucleus colony 2 queen pupae should be given to increase the probability of success of the queen. That is if one of the pupae is aborted the probability of hatching the other will be increased.

Providing of mature queen pupae is more accepted than the virgin queen by the nuclei colonies.
Limitation of splitting, since it takes place as sudden lose of original queen; the reared queens may not be properly reared as that of natural reproductive swarming queens.

Over crowding

Overcrowding is one of the simple ways of rearing queens. It is natural, as well as artificial. Natural is in that the bees rear new queens in the presence of the old one by their own time. If the environmental conditions are not suitable the started queen cells can be aborted by the colonies. It is also artificial in that man can induce it, by reducing the super or by not providing adequate volumes when it is supposed to be given. Due to congestions created, all bees in a colony may unable to receive adequate queen pheromone and initiates them to produce queens.
The suspected or deliberately induced colonies have to be regularly inspected. When a queen pupa is observed it can be harvested, caged and given to the newly formed nucleus colony. Overcrowding can be practiced even in traditional hives by keeping bees in small volume of basket hives but there is no chance to inspect them.

Advantages of overcrowding

Queens reared under overcrowding are better than other artificial queens because bees gradually prepare to raise queens on their own time with proper feeding.

The limitations of overcrowding: -

1. Time of queen emerging is not predictable,
2. It requires to inspect the colony frequently,
3. It may not take place always as needed by beekeepers,
4. The queens may escape with out the knowledge of the beekeepers.

Miller method

- This method was developed by medical physician doctor C.C. Miller
- This method involves providing of trimmed comb (a comb which bottom part is cut in a zig- Zag fashion) to a queen less colony. Here the comb, which is going to be trimmed, should be wire less and have young worker larvae or eggs in worker cells.
- The first step is to print foundation sheet, the foundation sheet is fixed to standard frames without frame wires.
- The frame is placed between the two broad combs in best colony. After about a week the comb is taken from the colony. The comb will contain egg and larvae and the lower edge of the comb is trimmed so that several eggs (about to hatch) and many larvae towards the bottom edge of the comb will be exposed. This given to strong queen less colony.
- About ten day after the comb is introduced into the queen less colony the ripe pupae will be removed and caged. Or before hatching the pupae can be given to the nuclei colony.
- Miller method can be practiced using the Kenya top bar hives also.

Precautions during mature queen pupae harvesting, caging and incubating

In simple methods of queen rearing the queen less colony may rear queens using different ages of larvae and eggs. So the queen pupae may not be of the same age as that of grafting one. Some of the pupae could be very immature and are very delicate which requires carefil

handlings. Some times the queen cells can be constructed very irregularly in difficult ways to harvest them. Some times two queen pupae can be reared together sharing cell cups partly which requires careful operation during harvesting at least to save one of the queen pupae. Some of the necessary precautions are

- Carefully move the pupae during harvesting
- During harvesting use very sharp knife, scissors or blade.
- Carefully hang the pupae either in the cage or on the brood comb until it hatched out.
- keep small amount of crystallized honey in the cage to be used by the newly emerged queens
- Never use liquid honey that kills the queen due to sticking.
- If cage is used the cage should not allow workers bees to get into it, they may kill the queen as a result of congestion.
- release the queen with out delay
-

Commercial method of queen rearing

Commercial queen rearing is a method used to rear queens in large scale. This method involves the transferring of young larva from a brood cell comb into artificial queen rearing cups. Unlike simple methods of queen rearing, grafting method requires to use of some equipments like: -

Materials required for commercial queen rearing

1. Grafting needle to transfer larvae from brood comb into queen rearing cups
2. Queen rearing cups to hold grafted larvae and it could be plastic or a wooden base with beeswax cup
3. Dipping sticks to make cell cups by dipping the sticks into molten beeswax, then put in the cold water
4. Cell bar frames used to hold cell cups
5. Nuclei box this is a five frames box used to keep newly reared queen with a few number of worker honeybees until it will be transferred to the normal hive.
6. Magnifying glass used to see the larvae to be transferred clearly
7. Table lamp as light source during grafting process.
8. Grafting room: - grafting room should be suitable and conducive; it should have a temperature of 75°F and humidity of 50%

Selection of colonies for grafting

1. Select the colony with the following selection criteria.
- High bee population with adequate pollen and nectar and brood.
- Having good history of honey production
-Good brood patterns (i.e. the queen lays eggs in uniform pattern);
Gentle bees with minimum nervousness behavior on the combs.
-Disease resistant
- fast population build up
- adequate young larvae for grafting preferably in new combs

Procedures of grafting method

- Remove the queen from selected colony 24 hrs before grafting
- On the next day remove 2-3 combs with young larvae,

- Carefully remove the young larvae (24hrs old) and graft to the artificial queen cells using grafting needle against strong light.
- care should be taken for the larvae not be chilled and dried.
- keep the grafted larvae between brood combs in brood chamber
- remove all their own eggs and young larvae combs not to start to rear queens from their own combs.
- Provide adequate honey with pollen or crud honey to stimulate royal jelly production.
- After three days inspect the status of a colony, if the colony accepts the grafting it is possible to see queen cups.
- If the bees did not accept provide with re grafted larvae.
- After nine days of grafting remove the queen pupae and caged them until it hatch out.
- Depending on the number of hatched virgin queen prepare nuclei colonies and introduce the virgin queen along with queen cages.
- 24 hrs after introduction release the queen.

Chapter 6: Beekeeping Equipments and Accessories

BEEKEEPING EQUIUPMENT AND ACCESSORIES

Some beekeeping equipments and materials with their uses.

1. Bee hives

- traditional/Local/hives
- transitional/top bar/hives
- improved/modern/hives

2. Frame wire-

✓ is thin galvanized wire which is stretched through the holes in the end bars of the frames, pulled tight and fastened.

✓ It is used to support honey combs in the frame i.e. prevent the curving down of combs due to weight and permits rapid handling and transporting long distance with little or no damage of combs.

BEEKEEPING EQUIUPMENT AND.....

3. Casting mould (22x42cm)-it is a metal coated with zinc and manually operated equipment used to make artificial comb foundation sheet.

4. Transformer – is an electrical device used to fix comb foundation sheet o the frame wire

5. Embedder (knife) – it can be hot iron or sharp knife used as an alternative as of transformer)

6. Honey extractor- is a device used to extract honey from framed combs by centrifugal method(manually or electrically)

7. Uncapping fork- is a device used to decap the cells of ripened honey before the framed honey combs are place in the honey extracting device.

8. Honey presser- is a material used to extract honey from combs which are not framed by a method of hand pressing

BEEKEEPING EQUIUPMENT AND.....

9. **Queen excluder (separating screen):-** is a device used to form an appropriate partition between the brood box and honey super.

10. **Wax extractor: -** are materials used to separate wax from old combs, broken combs and other impurities.

11. **Honey jars(glass or plastic)** – are materials important (used) in handling extracted honey until reaching the consumer(contain 500gm)

12. Chisel (beekeepers tool)- is material made up of iron metal which is sharp on one end. It is used to open the hive clean propolis, wax and unnecessary materials from the frame, hive, and seen in the hive.

BEEKEEPING EQUIUPMENT AND.....

13. **Bee brush-** is a material made up of soft sisal fibre mounted on wood and used to remove the bees from honey combs and draw the bees to the hive while transferring or honey harvesting

14. **Smoker-** is manually operated material used to smoke the hive.
15. **Protective cloth.**

. **Bee veil** - is the material used to protect head region, face and neck from bee's sting.

. **Overall (suit)** – made up of cloth used to protect the overall body except the above mentioned.

- **Glove**- is a material used to protect the hand from bees sting

. **Boots-** material used to protect the foot from bees sting

BEEKEEPING EQUIUPMENT AND.....

16. Water sprayer- it is a material used to spray water on the bees (especially in low land areas) This is to reduce aggressiveness and immediate evacuation from their nest.

17. Honey strainer- is a double course screen cloth used to remove sediments and wax capping from honey immediately after extracting honey.

18. Honey weighing scale- device used for weighing honey harvested and keep record of honey.

Types of Hive

1. Traditional hives

- Traditional hive is one of the oldest and primitive hive in the history of beekeeping. It is not clearly known when and where it was started.
- There are about more than ten visually assessed local hives in our country based on the way of construction, locally available materials used to construct it and the way in which the beekeeper put.
- These are log hive, bark hive, Bamboo hive, woven straw hive, climber hive, clay hive, false banana hive and Animal dung hives.

Types of Hive….

1. **Traditional hives……**

- **Advantages of traditional hives**
  . Very cheap
  . Easily constructed
  . Does not require skilled manpower
  . High production of wax

- **Disadvantages of traditional hives**
  . Low quality and quantity of honey is produced
  . Less durable and small in size
  . Not water proof
  . Inconveniency to inspect

Types of Hive….

2. Transitional hives

- Transitional Beekeeping is one method of keeping bees using the top bar hives .

- It is an intermediate between traditional and modern beekeeping.

Types of Hive….

2. Transitional hives…..

Types transitional hives.

- Kenyan top bar hives(KTBH)- trapezium in shape
- Tanzanian top bar hives (TTBH)- Rectangular in shape
- Mud hives.

- Generally top bar hives are any size or design in which the bees build their comb from top bar instead of attaching comb to the ceiling of the hive.

- Each hive accommodates specially designed 27-30 pieces of bars where honey bees attach their combs after smearing with bees wax on its centre. The bars are 3.2cm wide and 48.3 cm long and are arranged across the hive.

Types of Hive….

2. Transitional hives…..

-Advantages of transitional hives

.Easily and quickly opened
.The bees are guided in building parallel combs which does not break usually
.The top –bars are easier to construct than frames
.Less expensive than modern (frame) hives
.Combs can be lifted out from the hive and replaced
.Honey combs can be removed for harvesting without disturbing brood combs in the hive.

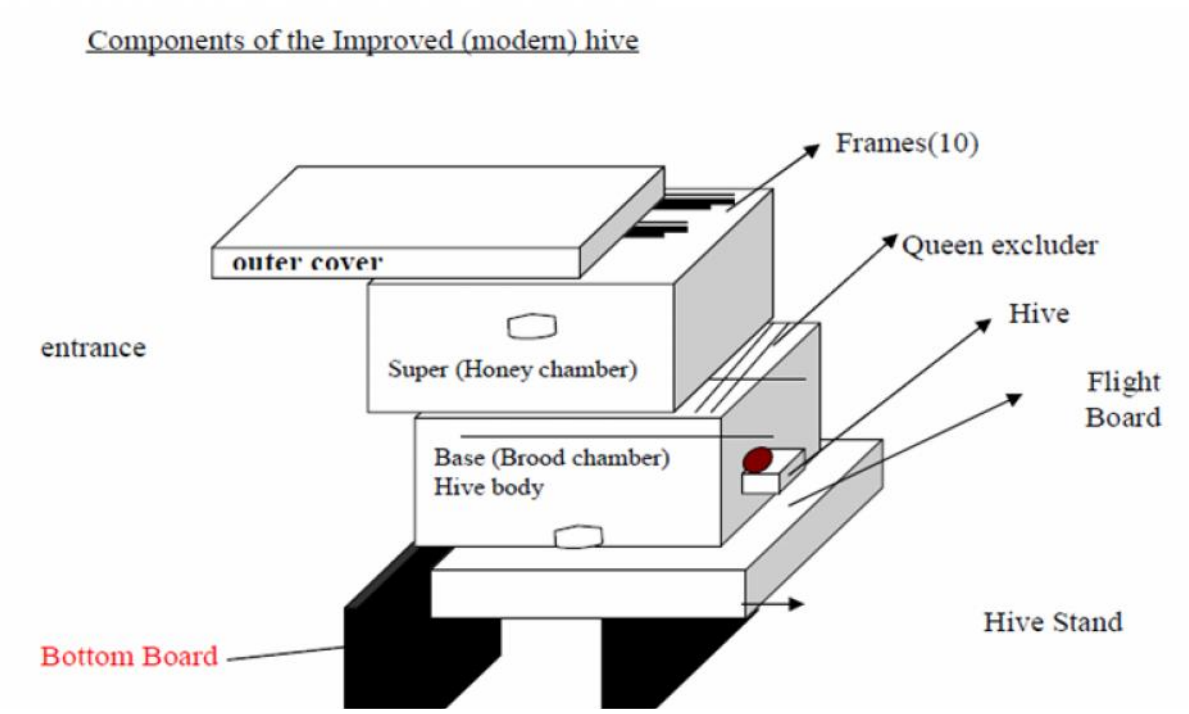
-Disadvantages of transitional hive

.More expensive than traditional hives
.Combs suspended from top bars are more apt to break off than framed combs, thus transportation is difficult especially on bad roads.
.Less quality honey than frame hives

Types of Hive….

3. Modern hives.

- Are the most developed and productive type of hives in history of beekeeping.
- They are frame hives also being used in our country
- The hives differ in the number and size of frames that are used and thus the overall dimension are different.



Types of Hive….

3. Modern hives…….

-Advantages of modern hives (modern beekeeping)

.high amount of honey is produced (15-20kg per hive on a average but ranges from 0-60kg per hive)

. High quality honey is produced than others- This is due to

- . Queen excluder
- . Honey extractor
- . Honey strainer used.

. Possible to control (reduce swarming) by:

.Supering the hives

.Seasonal colony inspection & management activities.

.It is possible to undertake migratory beekeeping i.e. to search available flowering plants for the bees and for pollination.

Types of Hive….

3. Modern hives…….

-Disadvantages of modern hives

.The equipments used are relatively very expensive

.It requires skilled man power

.It needs specific precaution.

- There are different models of Local hive in different parts of the country. Mention the reasons for their difference?.

Hive products

1. Honey

Commodity definition

- Honey is unfermented sweet substance produced by honey bees from the nectar of blossoms or from secretion of living parts of plants or excretions of plant sucking insects on the plant which they collect, transform and combine with specific substance and store in a honey comb.

Uses of Honey

Honey is used :- - as food & medicine
- for cosmetic industry
-for home and factory beverage production

Hive products.....

Honey management

A. **Honey harvesting** – the time of honey harvesting depends on flowering period of honey plants and the extent of honey flow.

- It is removed from the hive when it is ripe. i.e. when 3/4 of the honey comb is capped/sealed/ with fresh bees wax .
- make sure that you have all the necessary materials like chisel, bee brush, smoker and others.

B. **Extracting of honey**

-The first stage in extracting honey from the comb is to uncap them

- Put the uncapped comb in honey extractor / the frames should be in balance/

-During extraction, the extractor should be closed.

Hive products.....

C .**Straining and clarifying Honey**

- strain immediately after extraction which helps to remove small particles
- Strain the honey first by a coarse sieve and then through a fine cloth or a nylon stocking fastened a cross the underside of the sieve .
- After straining let the honey to stand for few hours so the unfiltered particles float on the surface,

Hive products.....

D. Warming Honey

- warming is important:-
  - to destroy yeast/ to prevent fermentation
  - to dissolve particles
  - to re back granulated / crystallized honey/

- During warming care should be taken not to destroy the enzymes

Hive products.....

E. Storing honey

- After processing the honey should be stored in odourless ,moisture proof, easy to remove honey from it & have its own lid.

- The recommended containers are plastic jar, glass jar or stainless steel.

- This is because honey can absorb& loss moisture which has pronounced effect on the quality of honey.

Hive products.....

F. **Honey marketing and packing**

- In honey marketing and packing the honey should be either completely liquid or Finely , uniformly crystallized.
- The honey shall not have any of objectionable flavour, aroma absorbed from foreign matter during processing & storage and shall not contain natural plant toxins.
- To keep honey for long period of time
  - keep at a temperature of less than 10^{o}c
  - should be free from air bubbles, pollen, crystals & dusts
  - The moisture content has to be 18.5 %

Hive products.....

2. Bees wax

- **Bees wax is hive product which is secreted by the worker bees.**

Uses of bees wax

- **Bees wax is used for:**

✓ comb foundation, candles, making cosmetics, models, lubricants, electrical applications, protective preparations, veterinary uses & others.

Sources of bees wax are:

-Old combs, Broken combs, capping, tej residue

Bees wax processing.

✓ The process by which wax from comb is converted in to blocks of clean bees wax by melting is called Rendering.

Hive products.....

Methods of rendering / Bees wax processing/

A/ Solar extraction

✓ Radiant energy from the sun melts pieces of wax placed on he metal base of shallow box.

B/ Simple straining method

✓ Combs, capping boiled in water thank and the sludge is strained through the screen.

C/ Heated wax press.

-combs or residues soaked in water for 24 hours. this loosen pollen and other west materials.

-Then boiled with water and the melted /boiled wax put between two wooden or metal separators then pressure is applied.

Hive products.....

Clarification of Beeswax

Settling : to remove the solid and water soluble impurities . The wax is melted in a thank with half filled water, then the wax floats because of its specific gravity.

Centrifuging. some fine particles which do not settle easily can be settled by the use of centrifuge.

Filtration

✓ The impure can be filtered out by using fine cloth or fine paper.

Hive products.....

Precautions

- In processing bees wax the following should be strictly considered

  - ✓ Never save infected combs
  - ✓ Never heat bees wax over an open flame
  - ✓ Do not boil bees wax vigorously or for too long time.
  - ✓ Do not mix waxes obtained from different sources
  - ✓ The melted wax should be poured in to tapered and smooth molds for easy removal.
  - ✓ Never store bees wax together with pesticides because wax highly absorbs volatile chemicals.

Mention the use of bees wax in the area of beekeeping?

Hive products.....

3. Pollen Grain

Uses of pollen grain

- pollen grain is used for:
  - nutritional and medicinal purposes.
  - Honey detection and labelling
  - for taxonomy and others.

Harvesting and Management of pollen

-It can be easily harvested by putting pollen traps at hive entrance

-It must be stored after complete air dry or frozen

Requirements for pollen purchase

- clean, free from moth eggs, larvae and insect fragments
- Moisture content 8-11% and must be dried in temperature less than 40^{o}c
- Stored properly in tins

Hive products.....

4.Propolis./ plant glue/

Definition:- propolis is a sticky, gummy resinous material gathered by bees from trees and other vegetation either from bud or from bark.

Uses of propolis:

For bees –To fill cracks

-To reduce opening

-To smooth over interior of the hive

-To varnish the brood cells & strengthen the comb

-To cover enemies & other objectionable objects

For other purposes

-as varnish and

-for veterinary services

Production

- During regular hive inspection any propolis found in the hive can be Scraped & collected
- Bees can deliberately exposed to cold to produce more propolis

Hive products.....

5. Bee Venom

Definition:-It is a clean liquid produced in worker bees gland called venom gland & stored in the venom sac

Uses of bee venom

-Bee venom consists several Biochemical and pharmacological active substances.

-use of bee venom against disease called Api-therapy.

Harvesting and Handling

- From a hive entrance pick up a worker Bees and pressed the bees so that she sting in to a fabric tissue

-Then dried by freezing

-To get 1gm of venom 20 bee colonies required

Hive products.....

6. Royal jelly / Bee milk

Definition – Royal jelly is creamy, milky, white , strongly acidic, highly nitrogenous substance with slightly pungent odder & some what bitter taste secreted by worker bees.

Uses of Royal jelly

- preventive measures against illness & diseases .
- for making medicinal pills
-for cosmetics
-for longevity in honey bees & others

Production

- On small scale it is possible to produce Royal jelly by simple de-queering and harvest the R-jelly from emergency queen cells the bees construct.

Hive products.....

7.Bee Brood

Definition – Is the collective name used by beekeepers for the eggs, larvae and pupae in honey bee colony.

Uses of Bee Brood:

Used as – feed for small animals & caged brides
-protein source for human being.

Harvesting

-Brood cells free from adult bees are uncapped with a thin knife and the brood is then removed from each frame by impacts, so that it falls in to a tray below.
-After harvesting it is stored in refrigerator.

Chapter 7: Honey bee forage

The bees obtain their food and raw materials for the hive products of interest to man from plants. Honeybees collect everything they need (except water) from plants. Nectar and pollen from flowers can provide all their nutritional requirements. Other sweet material s are also collected from plants when available; extra floral nectar (from parts other than plants), honeydew produced by insects from plant sap, and exposed sap as from cut sugar cane.

A colony needs water to counteract overheating. If the bees cannot collect water, and it is not provided by the beekeeper, they will suffer heat suffer; under extreme conditions, all adult bees and brood will die.

Pollen consists of a minute pollen grains which are the male fertilizing elements in a flower. Pollen provides the proteins, vitamins and other nutrients needed by the larvae and by the immature adult bees that feed the larvae. Without pollen, or an adequate substitute supplied by the beekeeper, a colony will not starve immediately, but will slowly die, because it cannot rear new bees to replace those that die. Honeybees also collect sticky plant materials known as propolis which is used for building hive or/and nests.

In the world today there are about 250 000 species of flowering plants. Many produce nectar and pollen accessible to honeybees, and honeybees pollinate a large number of them, but some plants in the tropics have nectar lying too deep in the flower for honey bees to reach it. About some 40 000 plant species have some importance to honeybees as source food and 4000 are the source of most of the world's honey.

In the tropics there is much greater variety of flowering plant than in the temperate zones, and flowers are available through much of the year.

In general, the bees must be adapted to local conditions of climate and plant growth, and bees taken outside their native habitat may fail to exploit rich plant resources economically. For instance, the daily rhythm of plants in the new area may be out of phase with the bees' flying rhythm.

7.1. Energy foods

The carbohydrate foods collected by bees from plants are derived from the sap of the phloem, the living food-conductive cell system of plants known as vascular plants. The energy the plant needs to make and transport the nutrients is obtained by photosynthesis. The carbohydrates most commonly formed are sugars, for instance

$6co_2 + 12\ H_2o \Rightarrow c6h12O_6 + 6O_2 + 6H_2O$

7.1.1. Nectar composition

The composition of nectars from different plants is similar in that the main constituents are sugars and water. The total concentration of sugars varies from species to species, and within species, according to any factors. There are three main pattern of sugar composition of the nectar, Namely: with sucrose dominant, with fructose+glucose dominant, and balanced, i.e. with the three sugars present in similar amount. In addition to sugars, nectar contains small amounts of chemical compounds that include the aromatic substances, minerals, organic acids and amino acids. Some of the compounds are important indicators of the botanical origin of the honey.

Factors affecting nectar secretion and composition

Secretion of nectar may be determined by, in a complex way, by heritable factors within the plant. Nectar secretion also follows daily cycle, usually with a peak time during day light for plants pollinated by day fliers, or during the night for flowers pollinated by night flying moths or bats. Some of the external factors affecting nectar secretion are of great importance to beekeepers. These factors include; the amount of radiation or solar energy the plant received, Temperature Minerals in the soil, or added in fertilizers, Evaporation of water etc.

Toxic nectars

Toxicants in piousness honey are derived from the nectar, with the exception of honeydew source. Whose toxicant is introduced from the insect concerned.

Very few nectars are toxic to bees. It was reported in the dry years in the north temperate zone, bees may be found dead, under certain lime trees (Tilia); the main cause is the presence of mannose in the nectar, which disturbs the carbohydrate metabolism of the bees so that they cannot digest fructose and gluctose (Crane, 1977, 1978d).

Application of insecticide to the plant may make the nectar toxic.

7.1.2. Honey dew

Honeydew, like nectar, is mainly carbohydrate material which bees collect and convert into honey. Its production involves both plants and the plant sucking insects of the order Homoptera. Such insects pierce plant surfaces, the sap inside the plant being forced out by the plant's internal pressure and by the insect's own pumping. Excess fluid secreted by the insects is deposited on leaves, twigs, etc. in small droplets, Known as Honey dew. It is collected by other insects, including bees and ants. Honeydew is produced high up in the trees canopy, and one is more likely to hear bees working a honey dew flow than to see them.

Honeydew differs in composition from nectar, and honeydew honey has different characteristics from the obtained from nectar. The most apparent differences are, usually, a more pronounced flavor and a darker color. Honeydew honey receives premium price in areas where it has traditionally been produced, and where it therefore enjoys consumer preference.

Almost nothing is known about the production of honey dew or honeydew honey in the tropics and sub-tropics. It may be of only tribal importance, or in certain areas, possibly at higher altitudes, it may be a rich resource that should be systematically exploited.

7.2. Pollen

Pollen is the male element in plant's reproductive process, is produced by the anthers of a flower. Identification of pollen grain in honey, using a microscope and a reference collection of known pollen grains of local plants, can help to determine the plant source of the honey.

Pollen is the source of protein and lipid. It enables the colony rear brood, and hence new generations of adult bees. Without it, a colony dies. Flowers of a few plants produce nectar but no pollen, and the pollen of some others are nutritionally deficient for bees. Almost nothing is known about topical plants in this respect.

Some important sources of honey dew honey

Conifers, Honey Dew only	Deciduous trees	
	Honey dew only	Nectar+honeydew
Abies alba, silver fir	*Fagus sylvatica*, beech	*Acer platanoides*, Norway maple
Abies borisii-regis; A. cephalonica, Greek fir	*Nothofagus solandri v.* cliffortioides, mountain beech	*Acer pseudoplatanus*, sycamore
Calocedurs decurrens, incense cedar	*Populus spp.*, popular	*Castanea sativa*, sweet chestnut
Llarix decidua, norway spruce	*Quercus robur*, English oak	*Robinia pseudoacacia*, false acacia

In general, unlike the necatr, pollen contains a wide variety of nutrients that support growth and development in living organisms. Many of the nutrients, and especially certain amino acids, are essential for the development of honeybees from the egg to the mature adult, and pollen is the bees' only source of them. The larvae obtain them in brood food produced by young worker nurse bees, which themselves eat pollen. A beekeeper who wants to harvest pollen must use 'a pollen trap' to remove pollen carried by the bees before they enter the hive; the colony continues to need pollen, and foragers therefore continue to collect.

Water need in relation to food supply

Like nectar and pollen, water is essential to the colony, for several reasons, and a little can be stored in the honey sac of reservoir bees. Sources of water are many and include edges of streams, lakes and other ways which afford the bees a foothold, also damp patches of ground, vegetation wet with rain or dew, and open drains. Requirements for natural water supply are

Permanence

- Nearness to the hives
- Clean water acceptable to the bees
- Safe access to water
- No contamination from surfactants

4.HONEYBEE PROTECTION

4.1 Bee diseases

Honeybee diseases caused by:

- Bacteria- American foul brood (AFB) & European foul brood (EFB)
- Fungi- Chalk brood & stone brood
- Protozoa Nosema & Amoeba
- Virus- paralysis, sac brood, etc
- Parasitic mites varroatosis Acarin disease

Types of honeybee diseases

Honeybee diseases are of two types:

1) Those affecting adult honeybees are called adult honeybee diseases. This includes Nosema, Amoeba, paralysis, varroatosis & Acarin disease

2) Those affecting the immature stages of honeybees are called brood honeybee diseases. This includes AFB, EFB, Chalk brood, stone brood & sac brood

Means of transmit ion

Honeybee diseases are transmitted through:

- Feeding
- Swarming
- Robbing
- Drifting
- Infecting equipments interchanging brood combs or frames between health and diseased colonies

Brood honeybee diseases

American foul brood (AFB)

- It is caused by rod-shaped bacteria called *Bacillus larvae*
- Its spore is resistant to heat, chemicals, dehydration, disinfectant & remains infective for at least 35 yrs.
- AFB attacks all the larvae of three casts (larvae of workers drones and queen).

Effect up on the colony (Economic importance)

- The diseases are the most destructive brood disease and very infectious.
- It is very contagious and if unchecked can kill all the colonies or spread to other colonies in the apiary or another near by apiaries.
- It causes large loses in bees, honey & equipment's.
- The spore remains infective for at least 35 yrs.
- The chemotherapy has no effect on spores that contaminate combs & equipments.
- AFB cannot be treated successfully except by burning.
- The practice of burning diseased colonies and equipment is uneconomical or it is costive especially taking in to account the current cost of bee keeping equipment.

- In Europe in some counties, the beekeepers that destroy their AFB infected colonies receive compensation directly from government or beekeeper association organizations.

Symptom

- Irregular brood arrangement
- Sunken and dark capping
- Cells with punctured capping
- Sticky or ropy dead brood
- Slight to pronounced odor

European foulbrood (EFB)

- EFB is a brood disease caused by bacterium known as *melissoccocus pluton*.
- Affects the larvae of all the casts
- The larvae die within one or two days before they are sealed in their cells and some shortly after words.
- The disease occurs mostly during the early summer when colonies are growing quickly.

Symptom

- Scattered brood pattern
- Discolored, punctured &/ or sunken capping
- Diseased larvae become white to yellow, then finally dark
- Form slight odor to penetrating odor
- The larvae show unnatural position in the cell & melted down appearance (loose of surface)

Chalk brood

- Caused by Fungus known as *Ascosphoraera apis* and is found in Ethiopia
- The best suitable ecological zones for CBD in Ethiopia are:
    - Moist weina dega and
    - Moist dega
    - Wet weina dega
- Commonly it is disease of workers and drones
- It infest the larvae of 3-4 days after hatching
- The infection occur naturally either through ingestion of spores with food or via body surface from (combs and flowers)
- Chalk brood spores could be picked up at source of nectar, pollen or water
- Attack young brood in condition of extreme cold and humidity

Chalk brood greatly aggravated by

- Practice that cause the loss of heat from colonies
- Excessive hive moisture
- Nutritional stress
- Colony weakening from other diseases and poisoning
- Rapid colonies expanding in early spring (Brood: Adult bees = high)
- Old comb and damp weather
- Low temperature

Symptom

- Dead larvae are left uncapped

- Initially the larvae covered by fully white mould and swollen to fill the cell
- Then, dry & shrink and become gray or black
- Mummies found on floor or in front of the hive iterance

Prevention

Chalk brood spores are very long-lived, resistant to heat ultra-violet light and many chemicals. Thus manage mental treatment is vita to prevent chalk brood diseases

Prevention measures employed are:

√ Prevent the factors causing stress condition

- suppress or control the disease
- Feed weak or infected colonies

√ Prevent chilling:

- Remove damp combs
- Avoid spreading broods (transfer to nuclei box)
- Avoid moisture accumulation on the bottom boards
- Move hives to dry location
- Enlarge the hive entrance

√ Clean and remove the infected combs from the hive

√ Keep apiary clean and dry

√ Isolate the infected colony from the healthy ones

Sac brood

- It is virus caused brood disease
- It interferes the molting process and the larvae fail to pupate

Symptom

- The infected larvae remain stretched on their back with their heads toward the cell capping
- Fluid accumulate between the body of a diseased larvae and its tough unshed skin
- The infected larvae color change from white to pale yellow, after drying becomes dark brown
- The head and thoracic regions darken first (typical sign for sac brood)

Treatment & prevention

- Sanitary management
- Brood nest renewal
- Strengthening the colony
- No chemotherapeutic treatment

Stone brood

- It is caused by fungus called *Aspergillus flavus* or less often by *Aspergillus fumigatus*
- Both fungi are common and occur in soil and cereal products.
- They infect other insects and some times cause respiratory disease in animals particularly man and birds

Symptom

- The infected larvae may be sealed or unsealed
- At first they are white and later turn pale brownish or greenish-yellow

- Become very hard

Adult honeybee diseases

Nosema Disease

- It is caused by Protozoa known as *Nosema apis*
- It is found in Ethiopia
- Honeybees is infected by ingesting the spores
- Shorten the life of honeybees with out showing out word symptoms
- The infected bees do not fully develop their hypophrygeal gland, which might account for the failure of 15% eggs to produce mature larvae
- Young honeybee ceases to rear brood & to attend queen and turn guard bees and forager earlier than under normal condition
- The infected queen is also cease to lay eggs and die with in few weeks
- Other honeybee become infected by Nosema while cleaning the hive
- The disease seems to be severing during cold and damp weather when honeybee can not fly out. But the disease is not serious in Ethiopia
- The primary means of transmission is comb, which has been spoiled by excreta

Symptoms

- Crawling bees on the landing board
- Honeybees with distended abdomen

Laboratory Diagnosis

- Take 20-30 honeybees from suspected colony
- Cut the abdomen and grind them in 2 ml of distilled water
- Examine the solution for the presence of Nosema spore with magnification of 40X

Control or treatments

- Transferring of colonies to uncontaminated combs
- Fumigate empty combs to kill the dormant spors with Formalin or Acetic acid
- Feed a colony with 200 mg of Fumagillin in 4.5-9 lit of syrup

Amoeba

- This disease also caused by Protozoa commonly known as *Malpighamoeba mellificae*
- The protozoa is found in the malpighian tubules of honey bees
- Its combined effect with Nosema can kill the honeybees
- It also found in the country

Symptoms

- No gross symptoms characterizes Amoeba disease
- Microscopic examination of malpighian tubules can give a clue

Lab. Diagnosis

- The same as Nosema

Treatments

- Do not require chemical treatments
- Can be corrected by management (feeding, hygiene, strengthening)

Acarine Disease

- Caused by microscopic mite known as *Acarapis woodii*
- It is suspected to be found in Ethiopia
- The mite enters the tracheae through spiracles and interferes with breathing
- Numerous mites in the tracheae partially suffocate the bee and impair its ability to fly

Symptoms

- No out gross symptoms
- Crawl ring bee usually seen in front of the hive

Lab diagnosis

- Can only be diagnosed adequately by microscope

Procedures

- Obtain 20 or 30 bees from the entrance
- Kill bees either by boiling water or Ether
- Held the abdomen between thumb & forefinger & push off the head with forelegs
- Cut parallel a small disc of the breast
- Put all the discs in small bottle containing 10% Potassium and boil in water bath for 4-8 minutes
- Put the discs on wire gauze and rinse in tape water to clean all muscles dissolved
- Put these discs in watching glass with few drops of water
- Examine through microscope using magnification of 20 - 40X

Results: If positive, dark spot on tracheae and/or the mite observed

Varroatosis

- Caused by mite known as *Varroa destractor*
- Is a serious ectoparasitic mite pest of honey pest
- Affects both adult and larvae of all casts
- Can be seen by naked eyes and has eight legs (four pairs) and reddish in color
- The mite feed on the heamolymph of larvae and adult honeybees
- The mite is usually found between the thorax and abdomen of the adult honeybees
- It is also found on the sealed brood especially on drone brood
- The mites also found on bottom board
- It is rapidly expanding its territory
- Has no effective control so far

- Various chemicals have been used to control the mite, but unfortunately chemicals can potentially harm bees and also contaminate honey if not used carefully.

Paralysis

- Caused by virus
- In sever cases it suddenly collapse the colony and weaken colonies

Symptoms

- Bees fail to fly
- Crawl on the ground and up on grass stem, sometimes in masses of thousands of individuals
- They often have bloated abdomen and dislocated wings

- In some cases honeybees appear black and become hairless
- Only diagnosed with electron microscope

Precautionary Measures Against honey bee disease

1. Keep the apiary clean and tidy. Never throw propolis or brace comb on the ground, where it may be robbed: place it in a suitable container and remove it from the apiary.
2. Never buy old combs
3. Never buy colonies of bees unless it is known that they come from disease free apiaries, and never accept stray swarms of unknown origin.
4. Always disinfect secondhand hives before use, by the method described above.
5. Never feed honey from doubtful sources, or allow bees to gain access to it.
6. If a colony dies during the winter and the trouble is not due to starvation, close the hive, pending the examination of a sample comp, to prevent the remaining stores being robbed out.
7. Never exchange brood or super combs between one colony and another unless it is known that all colonies in the apiary are free from disease. Where possible, supers should be marked and always used on the same colonies.
8. Care should be taken to prevent robbing at all times.
9. The hives should be arranged in such a way that drifting is reduced to the minimum.
10. Always keep a careful watch on the brood for signs of disease. If there is the least suspicion that all is not well, send a comb of brood to Holeta Bee Research Center

Sample collection protocols

Brood samples:

- Cut 2x2inchs of combs containing suspected brood (dead or discolored)
- Warp the sample in paper towel or newsprint
- Pack loosely in heavy cardboard box
- Do not send samples with nectar or honey
- Label the sample (code, name of collectors, address and description)

Adult honeybee sample

- Collect 100-150 bees from the comb or crawling in front of the hive
- Place the bees in leak-proof plastic bottle with screw-cap lid
- Add enough 70% isopropanol (rubbing alcohol), ethanol or methanol and completely cover the bees
- Seal the bottle tightly and tape around the cap/ bottle junction
- Place the bottle in plastic bag with ziper and pack in cardboard box with enough absorbent materials to soak alcohol in events of leaking
- Do not forget to include all necessary information.
-

4.2 Honeybee Enemies [Pests and Predators of Honeybees]

1. Ants

- Order Hymenoptera.
- Common in many parts of the country, especially in moist or humid high land parts of the country
- Attacks honey, brood, pollen & bees themselves.
- Cause of aggressiveness & absconding of colonies.

Control of Ants

- keeping apiaries clean,
  - i. e. free of debris
- Controlling overgrowths of grasses
- Keeping the ground dry under hive stands.
- Destroying ant nests.

- However for sustainable & reliable ant control,
  - i. Plastering an inner tube in cone shape form on the hive stand leg(s).
  - ii. Plastering the hive stand with cone shape smooth iron sheets.
  - iii. Placing the legs of hive stands in open tins filled with used engine oil

2. **WAX MOTH**

- Order lepidoptera
- Eat & destroy the bees' wax
- Habituate in the hive of honeybees.
- It produces a great damage on combs.
- The larvae of this wax moth form a silken feeding funnel & create a mass of webbing on comb cells

Two species Wax moths

a. Greater wax-moth (Galleria mellonella)
b. Lesser wax moth (Achoria grisella)

- Both are very troublesome to beekeepers
- The infection stage is not adult stage, but the larval stage.
- Cause damage to combs, the hive body & on frames

Signs

- Pile of debris that falls to the hive floor.
- Formation of silken webs (funnels) along the midrib of the combs.

Control measures

1. Strengthening the colony.
2. Proper seasonal management
3. Biological control
4. Chemical
5. Non-chemical treatment
   a) Heat treatment- exposing combs to high temperature 72^0c
   b) Cold treatment (freezing)
   c) Exposing combs to very low temperature (17^0c).

- For rural beekeepers, withdrawing & melting the infested comb & making new foundation sheet is the best solution

Death's Head Hawks Moth

- Enters the hives at night & drinks honey.
- It protects itself from bees' sting by vibrating its wing & producing a whistling & irritating sound.
- Found at Bahirdar, Yabelo, Debrezeit, & even in highland like Gedo & Holeta.

Control

- By understanding its time of attack
- Putting a piece of queen excluder can keep the pest out side the bees' hive.

Beetles

Pollen competent beetle

- It interacts with bees computing for pollen
- Also produces mechanical damage on their hives

Control

- Producing regular irritation through its hole so that it leaves for another abode
-

Large hive Beetle-Oplostomus fuliginous

- Large & black beetle
- Do much damage to combs & comb contents
- Feeds honey

Control

- Reducing the hive entrance to 9mm,
- Or placing a metal screen over the hive entrance.
-

Wax/Small hive beetle (Aethina tumida)

- Is only 7mm long
- Larvae pupate in the soil
- Females lay eggs in any combs
- Pollen combs are reduced to dust

Symptoms

- Grubs found in debris on the bottom board

Predators

BIRDS

- Prey upon many insects [honeybees]
- Serious when they attack apiary in flocks

HONEY BADGER['Hama, or hamagota, or Hamakosi, or Shelemmetmat]

- Catch adult bees outside the bees' hive.
- It is nocturnal in nature.
- Have strong claws & jaws.
- Puts its tail into the beehive & swirl it all round.

➤Scoop out the combs & eat the honey or the brood.

Control methods

➤Different types of controlling means are practiced.

➤Making strong fence (made of stone, barbed wire … etc)

➤Tame doges to chase and kill the animal

Wasps

➤ They are social insects like bees are of different types.

-Yellow banded brown wasp (Vespa Orientals)

-Golden wasp (Vesp auraria)

-Large Black wasp (Vesp magnifica)

➤They are all predaceous by nature

➤ Catch bees from blossoms or at the entrance of a hive

➤Wasps macerate bees & feed their young ones on a paste like material

Control

➤As the pest itself & organisms on which it prey is not well studied. An effective control measure of this pest is unknown.

Lizards

- These are Amphibians (Reptiles), which predate & eat on honeybees
- They live in cracks of buildings & houses
- Catch the bees, weaken the colony.

Toads

- Toads are considered as honeybee pests
- Different species exist & interact with bees in the country
- They cause more damage in hotter areas of the country
- Live in the cracks & premises of buildings, stones houses

Control

- Place the colony on hive stands about nee height
- Regular supervision & killing the toads

Prey-mantis

- Pray mantis preys upon bees.
- It catch & squeeze the bees in between its claws & tibias of its forelegs
- It detaches the bees' body using its forelegs & hind-legs & finally sucks the haemolymph (blood) of the bees.
- It produces little damage on bees' colony

Control

- Because of its feeds outside the hive, no control methods were developed

Spiders (Arachnidae)

- They prey exclusively on insects.
- Usually construct webs on hive body, landing boards & on flowering plants & catch many bees

- When the bees are in their webs they kill it by on & off attack coming closer to bees.
- Once the bee dies they suck the haemolymph of the bees.
- The black & the toughest spider usually produce major nuisance on apiary

Control
- Continuous supervision of apiaries & regularly cleaning the places where the spiders' web are constructed.
- Killing & destroying the whole rests of the spiders

Bee Lice (Braula Coeca) [Yenib mesuger]

Description
- Wingless
- Reddish brown in color
- About 1.5mm long
- Its body is covered by sift, spine like hairs
- Its last tarsal joint of each leg is covered by small spine hairs (for attachment)
- This insect, sometimes called blind louse
- Found only on honeybees
- Its larvae feed on honey & pollen
- The abdomen is large round & the legs have claws that enable it to cling to the hairy body of the bee.
- It attaches itself to a bee, usually on the upper side of the thorax & lives by sucking honey from the tongue of its host.
- It is common in most parts of the country.
- Also, distributed all over the world

Control
- Identifying bee colonies suffering from bee lice, blowing tobacco smoke briefly through the hive entrance.
- By the gentle smoke of tobacco, the lice will fall down from the bees

Parasites

Pseudo scorpions (Chelifer Species.)
- Are often noticed in beehives,
- They get themselves carried from the flowers to the bees hive by clinging to the legs of worker bees
- They cause little damage to bees.
- However, by attaching to the bees' legs they cause a considerable nuisance on bees
- There is an assumption that they keep them free from wax months & mites by eating these hive pests.

4.3 Honeybee poisoning

- To supply food for increasing number of people of the world. Controlling of pests of agriculture is as important as
    - Good seeds

- Sufficient rain or water
- Intelligent use of fertilizer
- Proper cultivation

- Practically every species of plants has
  - Disease
  - Insect or weed pests, which influence its growth
- Agricultural chemicals or pesticides for specific purpose is utilized to alleviate the problem of pests
- Individual problems are controlled with chemicals for specific use

such as

Acaricides

- Antibiotics
- Fungicides
- Herbicides
- Insecticides
- Nematocides etc.

- Un fortunately the honeybee is susceptible to many of pesticides this intensive continuous hazard of chemicals overshadow the honeybee disease problems
- As the result beekeeping industry is having an increasingly difficult time in maintaining an adequate honeybee colonies in intensive cultivated areas and affects the pollination of cultivated crops

Pesticides could poison honeybees either through

Contact
OR Direct spray
Fumigation
Feeding the contaminated forage

Effect of pesticides

- The forager stop bringing in pollen
- The queen ceases to lay eggs (being not fed royal jelly)
- The colony dwindles to sure death
- The brood is killed by desiccation and/or starvation
- Reduces the hive products and pollination services
- Reduce the number of honeybee colony population

Symptoms of Pesticide Poisoning

- The build up of dead & dying worker bees at the hive entrance
- Many of the workers will die with their tongues extended and wet and sticky with nectar (Organophospherous cmpound)
- Honeybees become agitated, aggressive
- Became paralyzed, Show abnormal jerky, spinning movement
- Crawling around in front of the hive
- Poorhouse cleaning
- Unusual number of dead colonies at one time particularly while containing honey
- Depleted population when colony should be strong
- Sudden cessation of food storage
- Dead and deserted brood, with honey in the hive

- Sever break in brood rearing
- Dead bees in the hive
- Absence of the usual hum of workers in the air

Factors Aggravating Poisoning of Honeybee

1 Spray during blooming

- Honeybees can be poisoned while foraging
- 27 fold of honeybee killed in the presence of attractive blooms

2 Temperature

Temperature has modifying effect on residual action of pesticides

- Low temperature greatly increased the residual toxicity ie.
- Unusual cold nights following hot days cause condensation of copious dew on foliage, & the residual action of pesticides is then increased

- Spray during high temperature is also exposes honeybee to the pesticides (conducive for foraging)

3 Time of spray

Spraying when honeybees are active expose honeybees to the pesticide action

4 Formulation of pesticides

A) Dust formulation of pesticides are usually hazardous to honeybee than spray
B) Wettable powders often has longer residual effect than emulsifiable concentrates

This typical sequence probably is due to differential pick up of toxic residues by honeybees

5 Mode of spray

A) Spray by airplane is more dangerous than by moter
B) Spray by auto is more dangerous than manual spray

6 Strength of colony

- The strength of colony has a definite effect on toxicity ie.
- Populous colony colonies always suffer grater loss than small colonies (more foragers are exposed)

7 Distance from treated field

- Honeybee mortality is inversely proportional to the distance of colonies from the treated field (9-fold reduction of kill as little as 1 km further away from the treated area)

8 Lack of bee forage plants

- The presence of in adequate store exposes honeybees to toxicity (provision of pollen cake in the hive prevent bee mortality)

9 Age of honeybees

- Age of honeybees affects their tolerance to insecticides (young honeybees are more susceptible to insecticides than the older ones)

10 Selectivity of the chemicals

- Use of highly toxic insecticides increase the mortality of honeybees

Prevention

It is difficult to completely prevent the effect of pesticides, but reduce the effect

1 Use less hazard materials (insecticides toxic to bees should not be applied to crops in bloom)

2 Use less hazard method of application

- Ground application is generally less hazardous than aerial application (there is less drift of pesticides and smaller areas are treated at one time)

3 Use less hazard formulation

- Dust and wet table powders are hazardous than emulsifiable concentrates or solutions (granular formulations are low hazard to honeybees

4 Use low hazard timing of applications

- Chemicals which breakdown within few hours can be applied during late evening, night or early morning with relative safety to honeybees (early morning application is more hazardous than late evening or night applications)

5 Do not apply during blooming time

- Chemical application during blooming exposes foragers to poison (remove flowers of weeds)

6 Modify programme in relation to temperature

- Insecticides should not be applied when unusual low temperatures are expected after words (residues would remain toxic to honeybees for much longer time)
- High temperature causes honeybees to start foraging earlier in the morning or to continue foraging later in the evening

7 Use less hazard apiary location

- Select sites at least 6 km from crops being intensively treated with toxic materials

8 Use selected insecticides and integrated pest management programme

- Integrating programme which rely upon biological and cultural methods as part of the pest management minimize use of chemicals
- Selective insecticides are often less hazardous to bees

9 Use educational programme

- Teach growers, pesticide applicators and beekeepers how to reduce poisoning

Review Questions

Multiple Choice Type Questions. Circle the Letter of the Correct Choice.

_____1. Which one is true?
A. Ethiopia stands 1st in Africa in bee wax production
B. Ethiopia stands 9th in the world in honey production
C. Ethiopia stands 4th in the world in wax export
D. Ethiopia stands 5th in Africa in wax export

_____2. Which one is the right sequence in line with SIZE of honeybees?
A. Worker ⟹ Queen ⟹ Drone
B. Drone ⟹ Worker ⟹ Queen
C. Worker ⟹ Drone ⟹ Queen
D. Queen ⟹ Drone ⟹ Workers

_____3. What does it mean by saying "Beekeeping is self- reliant"?
A. It improves ecology B. It doesn't need fertile land
C. It doesn't depend on importation of foreign inputs D. It gives multiple products

_____4. Which one is true about the stages of development of honeybees?
A. Pupae ⟹ Eggs ⟹ Larvae B. Eggs ⟹ Pupae ⟹ Larvae
C. Eggs ⟹ Larvae ⟹ Pupae D. Pupae ⟹ Larvae ⟹ Eggs

_____5. Which one is inclusive?
A. Nest of a bee colony B. Worker cells D. Drone cells D. Honeybee combs

_____6. Which one of the following is different from the rest? (in line with the use of apicultural equipments)
A. Traditional Beekeeping B. Intermediate Beekeeping
C. Honey Hunting C. Modern Beekeeping

_____7. Which one is not true?
A. Worker comb cells are the smaller cells
B. Drone comb cells are the largest cells from which bees constructs Queen Cells
C. Drone comb cells are the larger cells where in bees rear Worker and Queen broods
D. None

_____8. Which of the following can be honeybee character?
A. Low absconding rate of honeybee
B. Strong colony strength of honeybee
C. High reproductive rate of honeybee
D. Honey yield of honeybee

_____9. Which one of the following can be the correct nomenclature of honey bee race?
A. *A. m. Florea* B. *a. m .florea* C. *A. M. Florea* *D. A. m. florea*

_____10. Which one of the following is not true?
A. Honey yield is independent of outer beehive color
B. Honey yield is independent of the height of the tree on which hives have been hanged
C. Honey yield is dependent on the population of Drones in the colony
D. The population of Drones doesn't have an impact on the honey yield as far as the virgin Queen has been mated

_____11. Which one is different from the rest?
A. Circle Dance
B. Waggle Dance
C. DAVD
D. Spasmodic Dance
E. Round Dance

_____12. Which one is true about Pollen and Nectar?
A. Pollen is responsible for the color honey produced
B. Nectar is responsible for the color wax produced
C. Nectar exhibit endless varation
D. Nectar is used to determine the plant source of honey
E. None

_____13. Which one of the following is the main cause of honey bee colony population reduction in Ethiopia?
A. Chemical Poisoning B. Recurrent draught & long dry periods
C. Brutal way of honey harvesting D. Ecological changes i.e. Deforestation
E. All except C

_____14. Which one of the following is not the main reason/ aim/ for Queen Rearing?
A. Genetic improvement of a stock B. Re-queening of an age-old Queen
C. Replacement of a sudden loss of a Queen D. Expansion of the existing stock
E. None

_____15. Which one is not true?
A. Emergency Q--------is a new Q produced when a colony lost its Q
B. Superseder Q--------is a new Q produced when the existing Q becomes old
C. Emergency Q--------is a new Q produced when the existing Q unable to secret adequate Q Pheromone
D. Superseder Q-------- is a new Q produced when the existing Q unable to secret adequate Q Pheromone
E. All, Emergency Q, Superseder Q & Reproductively swarm Q, are the same in everything
F. C & E

_____16. Which one is true about honey bee disease?
A. If pathogen "X" affects a 2-3 days old larva after hatching; we can say it is bacterial disease
B. If pathogen "X" affects a 2-3 days old larva after hatching; we can definitely say it is EFB
C. If pathogen "X" affects a 2-3 days old larva after hatching; we can say it is fungal disease
D. All
E. A & B

_____17. Which one is inclusive?
A. CCD B. Acute Bee Paralysis Virus/ ABPV/
C. Chronic Bee Paralysis Virus/ CBPV/ D. All
E. None

_____18. Which one is not true about Nectar?
A. It mainly constitutes sugar B. It is responsible for the color of honey
C. It mainly contains sugar and protein D. It mainly contains both sugar and water
E. C & D

_____19. Among the following honey bee disease transmissions, which one do you think is the main/ best/ means of honey bee disease transmission?
A. Robbing
B. Feeding
C. Interchanging of brood comb & infected equipments b/n diseased & Health colony
D. Swarming
E. None

_____20. Which one is not true about Nuc-colony?
A. It is a colony found in Top Bar Hive
B. It is a colony found in an ordinary Frame Hive
C. It is a prepared colony for Queen Rearing purpose
D. Mostly, it is a queen less colony
E. A & B

_____21. Which one of the following honey bee products satisfies a modern man slogan: *Make your food your medicine; make your medicine your food*?
A. Honey bee Brood B. Pollen C. Honey D. Royal Jelly D. None

_____22. Which one is true about pollen?
A. It mainly provide protein
B. It is used to determine the plant source of the honey produced
C. It is used to know the botanical origin of the honey produced
D. It is responsible for the color of honey
D. It is responsible for the color of bee wax
E. Its color is mainly yellow or creamy

_____23. Which one of the following is the best physical properties of honey i.e. which one is the best physical quality parameter of honey?
A. Aroma B. Flavor C. Color D. Water content E. All

_____24. Which one of the following affects the sugar concentration of Nectar?
A. Plant species & variety B. The soil type C. The Temperature of the day
D. The Relative Humidity of the day E. All

_____25. Of the following honey bee problems, which one is the most economically important honey bee problem in Ethiopia?
A. Ant B. Honey Badger C. AFB D. All E. A & B

_____26. Which one could be the way in which pesticides could poison honey bees?
A. Direct spray B. Direct contact C. Fumigation
D. Feeding the contaminated forage E. All

_____27. Which one of the following is not true about improvement of genetic qualities of honeybees?
A. Productivity of a colony directly related to the population size of the colony
B. Productivity of a colony depend on the prolific and population build up nature of a Queen
C. Productivity of a colony partially depends on the nature and performance of a Queen
D. Productivity of a colony doesn't depends on the genetic makeup of a Drone as it is developed from unfertilized egg.
E. None

_____28. Which one of the following factors doesn't bring a honeybee colony to a totally unproductive state?
A. Age of Queen B. State of stored sperm in Spermatica
C. Fertility status of laid eggs D. Population size of Drones
E. None

_____29. Which one of the following Queen Rearing Methods enable one to produce very healthy/ much better Queen?
A. Random Splitting Method B. Overcrowding Method
C. Miller Method D. Natural Queen Rearing Method
E. All

_____30. Which one of the following is different from the rest?
A. Hexagonal facet B. Ocular unit C. Ommatidia D. Simple eye
E. Mini-eye F. Simple light sensitive cell
G. None

_____31. Which one is not true about hair of honeybee?
A. It serves as protection B. It serves as thermal insulation
C. It is important in certain sense organs D. It plays no role in gathering pollen
E. None

_____32. Which one of the following Queen Rearing Methods serve BOTH to multiply colony and to improve the genetic qualities of honey bees?
A. Miller Method B. Grafting Method
C. Splitting Method D. Overcrowding Method
E. A & B

_____33. Which one is not true?
A. If "X" pathogen affects a 3-4 days larvae after egg deposition, it affects all casts i.e. Q, D, & W.
B. If "X" pathogen affects a 2-4 days larvae after hatching, it affects all casts i.e. Q, D, & W.
C. If "X" pathogen affects a 3-4 days larvae after hatching, it affects all casts i.e. Q, D, & W.
D. All
E. None

_____34. Which one is not true about physical communication i.e. dance of honeybee?
A. They communicate distance of food source within about 100meters by circle dance
B. They communicate distance of food source more than about 100 meters by Figure "8" dance
C. Jostling run and Buzzing run are dances whose functions are not well understood by sciences
D. Using round dance honeybees communicate well about distance, quality, quantity, & direction of food sources.
E. None

_____35. Which one is not true about Queen Phermone?
A. It is produced by mandibular gland
B. It inhibit ovary development of Worker bees
C. It prevents the development of new Queen
D. Its production more depends on Queen's age i.e. its production increases as the age advances
E. None

_____36. Which one is not true about food sources of honey bees?
A. They can satisfy all their nutritional requirement from intra floral structures of flowering plants
B. They can satisfy all their nutritional requirement from extra floral structures of flowering Plants
C. They can satisfy all their nutritional requirement from nectar and pollen
D. If honeybee colony fails to collect pollen, they will starve immediately
E. B & D

_____37. Which one is true about bacterial diseases of honeybee?
A. They are the most destructive B. They are very infectious

C. They are very contagious D. Chemotherapy has no effect on their spores
D. All

_____38. Which one is not true about honeybee diseases?
A. Sac brood interferes with methamorphosis
B. Acarine disease interferes with breathing
C. Amoeba interferes with the function of small intestine
D. Nosema disease interferes with the function of age-old honeybees and Queens's function
E. None

_____39. Which one of the following affects more specifically Nurse Bees?
A. Amoeba B. Acarine Diseases
C. Varroatosis D. Nosema Diseases
E. Paralysis

_____40. Which one of the following honeybee disease cannot be caused by pathogen?
A. Bacterial Disease B. Protozoal Disease
C. Viral Disease D. CCD
E. None

_____41. Which one of the following attracts honeybees first while foraging in the field?
A. High sugar concentration of nectar
B. Pattern of sugar concentration in the nectar i.e. the pattern with equal amounts of sucrose, fructose and glucose
C. High aromatic substances concentration of nectar
D. A & B
E. All

_____42. Which one is correct in line with Queen Rearing Procedure?
A. Harvesting ⇒ Caging ⇒ Transplanting ⇒ Incubation of Queen pupae
B. Harvesting ⇒ Incubation ⇒ Transplanting ⇒ Caging of Queen pupae
C. Harvesting ⇒ Incubation ⇒ Caging ⇒ Transplanting
D. Harvesting ⇒ Caging ⇒ Incubation ⇒ Transplanting
E. All

Match :. Match Group A with Group B

Group A	***Group B***
_____1. Tactile Organ	A. Interfere with Breathing
_____2. Bee venom use against Disease	B. Burning
_____3. CCD	C. Affect Malpighian Tube
_____4. The small direct flight muscle	D. Api-therapy
_____5. Pollen Basket	E. Insect produced sap
_____6. Honey Sac	F. Honey bee Predator
_____7. Piercing Instrument	G. Ovipositor
_____8. The best solution for AFB	H. Antennae
_____9. Honey dew	I. Honey bee pest
_____10. Involve cutting of comb in a zig-zag fashion	J. Furl Wings
_____11. Egg Laying Sac	K. Bacterial Disease
_____12. Disease transmission means	L. Ovarioles
_____13. Antenae Cleaner	M. Robbing
_____14. Grafting Method	N. Plant Glue
_____15. Propolis	O. Laboratory Method
_____16. Acarine Disease	P. Front leg
_____17. Amoeba	Q. Corbiculae
_____18. Honey Badger	R. Miller Method
_____19. AFB	S. Gut
_____20. Ant	T. Caused by GM_{crops}

True or False Type Questions. Write True or False in Full, not the First Letters 'T' or 'F'!!!!!!!!!!!!!!!!!!!!!!

_____1.A honey bee colony contains three casts i.e. Worker, Drone, and Queen. Queen is the largest cast and it is she that lays eggs in the colony but under rare cases Worker also lays eggs that eventually develops into Drones and Queens.

_____2. A honey bee colony that has high swarming rate produces low honey yield as they more tend to collect low pollen and high nectar while foraging.

_____3. All the larvae, hatched after three days' developmental time, are fed during their first three days of life with *Bee Milk* produced by old aged worker bees. After that time, Queen larvae are fed on the *Bee Milk* during their whole larval life.

_____4. The sole function of Drone and Queen in honeybee colony is mating of old aged Queen, and egg laying. However, almost all activities in the colony are done by Worker bee.

_____5. We can't necessarily say that it is the Queen that lays eggs in honey bee colony.

Match 2: Match Group A with Group B

Group A	***Group B***
_____1. Construct about 100 Queen Cells	A. Sealed Brood
_____2. Immature honybees	B. Hexagonal cell
_____3. The smallest honeybee species	C. Royal jelly
_____4. Honey bee race whose Workers lays eggs in Queenless colony	D. Storage apparatus of sperm
_____5. Basic unit of honeybee comb	E. *Apis mellifera*
_____6. The most productive honeybee species	F. Honeybee colony
_____7. Indigenous to Ethiopia	G. *A.m. intermissa*
_____8. Bee Milk	H. *A. m. capensis*
_____9. Social Community of honey bee	I. *A. m. woyi-gambella*
_____10. Spermatica	J. *Apis florea*

Write Clear Answer for the Following Questions.

1. Write the difference between Honey Hunting and the rest systems in Ethiopia?

2. Write about the mating systems in Honey bees?

3. List apicultural equipments and accessories?

4. List honey bee products?

5. Write in detail about Brood Developmental Stages? Why is it very important to have sufficient knowledge about Brood Developmental Stages in order to multiply Honey bee Colony/ Queen Rearing?

6. Write the different methods of Queen Rearing?

7. Write the different food and raw materials Honey bees collect from the field?

8. List the main Anatomical Organs of honey bees found in the Head, Thorax and Abdomen parts of honey bee body?

9. What is Royal Jelly? What makes it similar to and different from Colostrum?

10. How honey bees communicate information about Distance, Direction, and Quality of food sources even Hazard related to foraging and Food Availability Time?

11. What makes Air Sac of honey bee from Gas Bladder of fish in fishery?

12. Write in detail constraints of Beekeeping in Ethiopia?

13. Write the main difference between Transitional and Modern Beekeeping?

14. Write the advantages of Beekeeping as compared to other Agricultural Activities?

15. Why Beekeepers Rear Queen?

16. What is the difference between Emmergency Queen and Superseder Queen?

17. List at least three reasons to the fact: Prevention Disease is more and better than Curing especially in Beekeeping than others?

18. List the Basic steps involved in Queen Rearing?

19. List the pre-conditions for queen rearing?

20. Under what condition a colony of honey bee perish?

21. What are the main causes of honey bee colony population reduction in Ethiopia?

22. List honey bee enemies i.e. pests and predators?

23. Write the taxonomical classifications of honey bees?

24. Define 'Race of Honey bee? And write the main traits involved in the characterization of honey bee races?

25. What makes African *A. mellifera* honey bee races different from European *A. mellifera* honey *bee races?*

26. Write the physical and chemical properties of honey, which are directly influenced by the composition of nectar collected?

27. List the main patterns of sugar concentrations of nectar?

28. List the main functions of honey bee wings?

29. List the different locally available materials that are used to construct traditional hives?

30. List the different functions of Q, Ws, and Ds in the colony?

31. List the different roles of Qs, Ws, Ds and Broods PHERMONES?

32. What are pesticides? How they poison honey bees?

33. Write the main causative agents of Honey Bee Diseases?

34. Write the main transmition means of Honey Bee Diseases?

35. What is the tragedy of importing honey bee germ plasm and secondhand apicultural equipments from America/ Europe to Ethiopia?

36. Write the main aggravating factors of FUNGAL Diseases of Honey bees in Ethiopia?

37. List precisely the precautionary measures against Honey Bee Diseases?