

BEEKEEPING (650)

NSQF Level 4

(Job Role: Beekeeper)



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NATIONAL INSTITUTE OF OPEN SCHOOLING

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A Word With You

Dear Learner,

Welcome to the National Institute of Open Schooling (NIOS)!

By enrolling with this Institution, you have become part of the family of the world's largest Open Schooling System. As a learner of the NIOS Vocational Programme, I am confident that you will enjoy studying and will benefit from this very unique system of learning.

The course "Beekeeping" (NSQF compliant level 4), comprising of theory and practical components and is intended to provide you self-confidence and a new avenue to the future. This programme is designated for the youths of rural and semi urban areas like you, who are willing to make their career in the beekeeping sector. After completing this course you will acquire all the competencies to carry out beekeeping operations right from understanding bee biology and behaviour to harvesting and processing of products. After completing this course you may either work independently or may work in a beekeeping farm.

We are confident that this course will prove to be beneficial to you. We look forward to any comments and suggestions from you for further improvement. Sincere efforts have been made to present the matter in a very simple manner for your easy understanding. Since this is a practical oriented subject you will have to depend on the Study Centres also for getting empowered in the Beekeeping Techniques.

We wish you all the best in your future career.

Course Team

National Institute of Open Schooling (NIOS)

How to use the Study Material

Congratulation! You have accepted the challenge to be a self-learner. NIOS is with you at every step and has developed the material in *Beekeeping* with the help of a team of experts, keeping you in mind. A format supporting independent learning has been followed. If you follow the instructions given, then you will be able to get the best out of this material. The relevant icons used in the material will guide you. These icons have been explained below for your convenience.

Title: will give a clear indication of the contents within. Do read it.

Introduction: This will introduce you to the lesson linking it to the previous one.



Objectives: These are statements that explain what you are expected to learn from the lesson. The objectives will also help you to check what you have learnt after you have gone through the lesson. Do read them.



Notes: Each page carries empty space in the side margins, for you to write important points or make notes.



Intext Questions: Very short answer self check questions are asked after every section, the answers to which are given at the end of the lesson. These will help you to check your progress. Do solve them. Successful completion will allow you to decide whether to proceed further or go back and learn again.



What You Have Learnt: This is the summary of the main points of the lesson. It will help in recapitulation and revision. You are welcome to add your own points to it also.



Terminal Exercise: These are long and short questions that provide an opportunity to practice for a clear understanding of the whole topic.



Answers: These will help you to know how correctly you have answered the questions.

www

Web site: These websites provide extended learning. Necessary information has been included in the content and you may refer to these for more information.

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TERMS TO KNOW

Absconding swarm – Absconding swarm is an entire colony of bees that abandons the hive because of disease, wax moth, excessive heat or water, lack of resources, or other reasons.

After swarm/ Secondary swarm – After swarm is a small swarm which may leave hive after the first or primary swarm has departed. These after swarms usually have fewer bees associated with them than the primary swarm.

Apiary – The location and total number of hives at one place.

Bacteria – Bacteria are individual distinct cells which possess cell walls. They lack the true nucleus.

Bee Bread – Bee Bread is the food made from honey and pollen that worker bees make and feed to the uncapped worker and drone larvae.

Bee Brush – Bee Brush is a brush or whisk broom used to gently remove bees from combs.

Bee Veil – Bee Veil is a cloth or form of hat usually made of wire netting to protect the beekeeper's head and neck from stings.

Bee venom – Bee venom is the poisonous liquid secreted by bees when it stings.

Beehive – Beehive is a box with movable frames, used for housing a colony of bees.

Beekeeper – Beekeeper is a person who keeps and takes care of bees commercial (e.g., honey and wax production) or agricultural purpose (e.g. pollination of flowers)

Beekeeping of Apiculture – Beekeeping of Apiculture is an art and science of rearing and managing bees in a box called 'bee hive' for production of honey and other products like bee wax, propolis, and bee venom.

Beeswax – Beeswax is a wax produced by honey bees by special glands on the underside of the abdomen. It is used to build comb, where honey and pollen are stored.

Bee Space – Bee space was discovered by L. L. Langstroth as the optimum distance to be left in between two adjacent comb surfaces in a bee hive which is essential for normal movement and functioning of bees. It varies with honeybee species eg. for Indian bees: 7-8 mm and Italian bees: 8-9 mm.

Brood – Immature stages of bees not yet emerged from their cells; the stages are egg, larvae, pupae.

Bureau of India Standards (BIS) – Bureau of India Standards (BIS) is a statutory body set up under the Bureau of Indian Standards Act, 1986. It is responsible for formulating standards and product certification for industrial development, technological needs, export promotion, consumer welfare, health, safety, etc.

Business plan – Business plan is a necessary document for summarizing the entrepreneur's business aspirations, securing legal authorization and mobilizing the resources to launch the business.

Cantharophily – Pollination by beetles.

Capital – Capital is the money available to invest or the total of accumulated assets available for production. Capital is the contribution to productive activity made by investment is physical capital (machinery, factories, tools and equipments) and human capital (e.g. general education, health).

Centrifugal force – Centrifugal force is the apparent force, equal and opposite to the centripetal force, drawing a rotating body away from the center of rotation, caused by the inertia of the body. The centripetal force is the external force required to make a body follow a curved path.

Chilled brood – Chilled brood is immature bees that have died from exposure to cold.

Clarifying – Clarifying is the process of removing visible foreign material from honey or wax to increase its purity.

Clarifying Tank – Clarifying Tank is a tank or holding vessel that is used to temporarily store honey while the wax and other material separate from the honey.

Colony – Colony (in beekeeping) refers to a group of honeybees with one queen bee who is the female parent of the colony, a few hundred drone bees and thousands of worker bees.

Comb Foundation (Sheet) – Comb foundation is a commercially available structure consisting of thin sheets of beeswax with the cell bases of worker cells embossed on both sides in the same manner as they are produced naturally by honey bees.

Consumer – Consumer is the customer who buys the goods and services for consumption.

Cost – Cost is the total money, time and resources associated with the purchase of goods or services.

Cost of production – Cost of production includes all the resources used in producing goods and services, for which the owner receives the payment.

Costing – Costing is the way business calculates the total costs of making and selling a product or providing a service.

Cross pollination – Movement of pollen between blossoms of one variety of plant species and a second, compatible and variety to produce hybrid seed.

Dearth period – Dearth period refers to a period when there are not enough sources of nectar and pollen in the surroundings due to low availability of bee-flora and extreme climatic conditions.

Decoy hive – Decoy hive is a hive placed to attract stray swarms.

Diapause – A hibernation like state in insects.

Direct cost – Direct cost includes all those costs that are directly related to the products or services that businesses makes or sell. Some of the items that are classified as direct cost includes (i) materials, and (ii) salary and wages of labour deployed.

Disease – Disease is any malfunctioning of host cells and tissues that result from continuous irritation by a pathogen or environmental factor and leads to development of symptoms.

Division of labour – Division of labour refers to workers performing a narrow range of tasks (or just one task) in a production process.

Drawn comb – It is simply comb that is ready for either honey/pollen storage or ready for brood.

Ectoparasite – A parasite, such as a flea, that lives on the outside of its host.

Endoparasite – A parasite, such as a tapeworm, that lives inside its host.

Enterprise – Enterprise is a venture characterized by innovation, creativity, dynamism, and risk. Entrepreneur is a person who organizes productive resources to produce goods and services.

Entomophily – Pollination by insects.

Entrepreneurship – Entrepreneurship is the practice or starting new business or organizations or revitalizing mature business or organization in response to identified opportunities.

Feeder – Feeder is device for giving food in the form of sugar syrup to honey bees.

Fermentation – Fermentation is the process of yeast (a fungus) utilizing sugar as a food and produce alcohol as a byproduct.

Field bee (forager/ forage bee) – Worker bee that travels outside the hive to collect nectar, pollen, water and propolis, a waxy substance that bees use in the hive as cement.

Floral fidelity – Consistent visitation of flowers from a single plant species by an individual

Food Grade Plastic – Food Grade Plastic does not contain dyes or recycled plastic which could be harmful to humans.

Frame – Frame is a piece of equipment made of either wood or plastic designed to hold the comb foundation.

Fungi – Fungi belong to a separate group of organisms whose somatic (body) structure is usually filamentous and branched. They are heterotrophic i.e., they have to live on processed substance that are already assimilated by other organisms. They are often seen on stale bread.

Grafting technique – Removing a worker larva (one day old) from its cell and placing it in an artificial queen cup in order to have it reared into a queen.

Granulation or Crystallization – Granulation or Crystallization is the process of formation of glucose crystals in honey. Crystallization is most rapid at 14°C and can be reversed by heating. Honey appears lighter in colour after crystallization.

Gross profit – Gross profit is the difference between the selling price and the cost of an item.

Haemolymph – Haemolymph is similar to blood used by all insects that have an open circulatory system.

Hive Tool – Hive Tool is a metal device used to open hives, pry frames apart, and scrape wax and propolis from the hive parts.

Honey – Honey is the nectar or plant sap ingested by bees, concentrated by them and stored in combs.

Honey bees – Honey bees are species of bees, which belongs to the genus Apis. They are social bees which store significant quantities of honey.

Honey Extractor – Honey extractor is a machine in which honey is spun out of cells into a container.

Honey flow – Period when bees are collecting nectar in plentiful amounts from plants.

Honey supers – Refers to hive bodies used for honey production.

Hygiene – Hygiene refers to the set of practices associated with the prevention of illness and preservation of health and healthy living through cleanliness.

Hygroscope – Hygroscope is the ability of a substance to attract water molecules from the surrounding environment through either absorption or adsorption. Hygroscopic substances include sugar, honey, common salt, glycerol, ethanol, methanol, sulfuric acid, iodine and a variety of other substances.

Indirect cost – Indirect cost is a fixed or overhead cost that cannot be attributed directly to the production of a particular item and is incurred even when there is no output. The items that are classified in direct cost include (i) rent, (ii) interest paid on loan, and (iii) electricity.

Melittophily – Pollination by bees.

Myophily – Pollination by flies.

Myrmecophily – Pollination by ants.

Nectar flow – Nectar flow refers to both the quantity and the quality (amount of dissolved sugars) of the nectar secreted by the plant. The nectar flow in an area at a given time is depended upon the species of plants present and the weather factors affecting those plants.

Nectar flow period – Nectar flow period is the time when nectar is plentiful and bees produce and store surplus honey.

Nectar – A liquid rich in sugars, secreted by nectaries in or near flowers, the raw material for honey obtained from plants.

Net profit – Net profit is the gross profit minus taxes on profit (net Profit = Gross Profit - taxes on profit).

Non-recurring/Fixed cost – Non-recurring/Fixed cost are those expenses which involve starting a business and which are to be paid only one and will not occur again, e.g., Land and Building. It includes those expenses which do not vary from one period to the next.

Nucleus – Nucleus is a hive of bees which consists of two to five frames of comb and used primarily for starting new colonies or rearing or storing queens.

Occupational Hygiene – Occupational Hygiene is the discipline of anticipating, recognizing, evaluating and controlling health hazards in the working environment, with the objective of protecting workers health and well-being and safeguarding the community at large.

Overhead – Overhead is an expense that cannot be attributed to any one single part of the enterprise activities.

Package – Package means a box, bottle, gasket, tin, barrel, case, bag, wrapper or other items used to protect, contain or transport a commodity or product.

Package bees – Package bees are the certain quantity of adult bees or without a queen, contained in a screened shipping case with a new colony.

Packing – Packing is the process of placing product or products in protective packaging.

Pathogen – Pathogen is a biological agent that causes disease or disorder to its host.

Pesticides – A chemical designed to kill a pest.

Pests – Pests are harmful animals or organisms including fungi and viruses.

Phalaenophily – Pollination by moths

Planning – Planning is the process of setting objectives, or goal, and formulating policies, strategies, and procedures to meet them.

Pollen basket – An anatomical structure on hind legs of the bees where pollen is carried

Pollen substitute – Pollen substitute is any material such as soybean flour, powdered skim milk, brewer's yeast, or a mixture of these used in place of pollen as a source of protein to stimulate brood rearing.

Pollen supplement – Pollen supplement is a mixture of pollen and pollen substituted used to stimulate brood rearing typically in early spring to encourage colony expansion.

Pollen Trap – Pollen Trap is device for removing pollen loads from the pollen baskets of bees.

Pollen – Male reproductive cells of flowers collected and used by bees as food for rearing their young. It is the protein part of the diet. It is also called as bee bread when stored in cells in the colony.

Pollinator – An agent that transfers pollen from one flower to another

Profit – Profit is the positive gain from an investment or business operation after deducting all the expenses incurred on producing the good or service.

Profit margin – Profit margin is the difference between your selling price and all of your costs.

Propolis – Propolis is a sap or resinous materials collected from trees or bud of plants by bees and used to strengthen the comb and to seal cracks; also called as bee glue.

Protozoa – Protozoa are unicellular organisms, they have a well – defined cellular structure with a clear nucleus and other organelles.

Psychophily – Pollination by butterflies

Quality – Quality is the totality of features and characteristics of product or service that bear on its ability to satisfy stated or implied needs.

Queen cage – Queen cage is a small cage in which a queen and three to five worker bees are confined for shipping and introduction into a colony.

Queen cell – A special elongated cell resembling a peanut shell in which the queen is reared; usually over an inch in length, it hangs vertically from the bottom of the comb.

Queen excluder sheet – A device made of wire or zinc having perforations, which permits workers to pass but excludes queens and drones; used to confine the queen to a specific part of the hive, usually the brood chamber.

Queen right – Queen right refers to the conditions when a hive has a queen that is laying eggs.

Queen – A fully developed mated female bee responsible for all the egg laying in a colony.

Queenless hive – Queenless hive is referred to a beehive that does not have a queen.

Recurring/Operating costs – Recurring/Operating costs are those expenditures arising out of current business activities, e.g., rent on building, rent on machinery, salaries, electricity, etc.

Refractometer – Refractometer is an instrument that measures the refraction of light as it passes through a glass prism on which a few drops honey have been smeared. It is used to measure water content.

Requeening – Requeening is the process of taking out an old queen from a beehive and putting in a new queen.

Royal jelly – Royal jelly is a glandular secretion of worker honeybees, which is mixed with some regurgitated (repeatedly taken in and out) carbohydrates and fed to the young bees.

Sifting – Sifting means to put through a sieve.

Smoker – Smoker is a device in which materials are slowly burned to produce smoke which is used to subdue bees, but not harm them.

Start-up capital – Start-up capital is the money needed to start a new business or enterprise. It is used for payments in the business before money from sales can cover the payments.

Subsidy – Subsidy is a payment by the government to producers or distributors in an industry to prevent the decline of that industry (e.g., as a result of continuous unprofitable operations) or an increase in the prices of its products or simply to encourage it to hire more labour.

Sugar syrup – Feed for bees, containing sugar and water in ratio of 1:1.

Supersedure – Supersedure is the natural replacement of an established queen in the same hive.

Swarm – Swarm is a large number of worker bees, drones, and usually the old queen that leaves the parent colony to establish a new colony.

Swarm Cells – Swarm Cells are queen cells usually found on the bottom of the combs before swarming.

Swarming – Swarming is the natural replacement of an established queen by a newly reared queen in the same hive.

Tax – Tax is a financial charge levied by the government on goods and services produced by individuals, groups and institutions.

Tax subsidy – Tax subsidy is a tax reduction that a government gives a business for particular purpose, usually to create jobs.

Total cost – Total cost is the sum of all the direct and indirect costs on making and selling a product or service (Total cost = Direct cost + Indirect cost).

Uncapping Knife – Uncapping knife is a knife used to shave or remove the cappings from combs of sealed honey prior to extraction.

Uniting – Combining two or more colonies to form a larger colony

Value added tax – Value added tax is a form of indirect sales tax paid on products and services at each stage of production or distribution, based on the value added at the stage and included in the cost to the ultimate customer.

Viruses – Viruses are simple form of life known to us. They are not cellular and lack certain components needed to live and grow on their own, therefore, they depend on the cell that they infect to provide those missing components. They multiply very fast.

LEARNING RESOURCES/REFERENCES

Books

S. No.	Title of the Book	Author/Publisher
1.	Essentials of Beekeeping	Avatar Singh Atwal
2.	Honeybee and their Management in India	R.C. Misra
3.	Honeybee diseases and their Management	D.P. Abrol
4.	Beekeeping	E.F. Phillips
5.	Introduction to Beekeeping	Stephen Rere
6.	A Handbook of Beekeeping	Dharam Singh, Pratap Singh
7.	Beekeeping	National Council of Educational Research and Training, New Delhi
8.	Beekeeping in India	G.K. Ghosh

Websites

S. No.	About the Website	Website Address
1.	Beekeeping Times – News and Views on Beekeeping in India	http://www.beekeeping times.com
2.	Indian Apiary Industry	http://www.indianapiaryindustry.com
3.	Himachal Pradesh Government scheme on Beekeeping	http://hhorticulture.nic.in
4.	Beekeeping Guide	http://beeeducation.com
5.	APIMONDIA – International Federation of Beekeepers' Association	http://www.easternapiculture.org
6.	Bees-online –An educational website about honey bees and beekeeping	http://www.bees-online.com/BeeBooks.htm
7.	Information on honeybees, their products, biology and disease	http://www.bee-info.com
8.	International Beekeeping Research Association	http://www.ibra.org.uk
9.	Bees for Development	http://www.planbee.org.uk
10.	A Guide to beekeeping	http://www.beekeep.com
11.	TNAU Agritech portal	http://agritech.tnau.ac.in/farm_enterprisesfe_api_harvestingandprocessing.html
12.	Food and Agriculture Organisation	http://www.fao.org/docrep/006/y5110ey5110e06.htm
13.	Khadi and Village Industries Commission	http://www.kVIC.org.in/newwebsitebeekeeping.html
14.	Beekeeping Wikipedia	https://en.wikipedia.org/wiki/Beekeeping



Notes

1

INTRODUCTION TO BEEKEEPING

Honey bees are the social insects and live in a community. They work together in a well organized colony with well demarcated ‘division of labour’. They are engaged in a variety of activities and share the resources they collect from nature. **Beekeeping or Apiculture** (derived from Latin word, ‘Apis’ meaning ‘bees’) is an art and science of rearing and managing honey bees in a box called “beehive” for production of honey and other products like beeswax, propolis, bee venom etc. Beekeeping/ Apiculture is an industry, which provides valuable honey, beeswax and pollination services of honey bees.



OBJECTIVES

After reading this lesson you will be able to:

- enlist the importance of honey bee;
- explain the benefits of beekeeping;
- identify bee hive products and enlist their uses;
- develop a career plan for career progression in beekeeping occupation.

1.1 IMPORTANCE OF HONEY BEES

Honey bees visit flowers of plants and collect nectar and pollen from them. Nectar is collected by bees from the nectaries, which are the glands, located within the flower or on other portions of the plant (extra- floral nectarines). Bees sometimes collect ‘honey dew’, a sugary secretion of certain insects which feed on plant sap. Honey produced from honey dew is dark, strong tasting and of inferior quality.

Pollen, which is the male reproductive cell bodies produced by anthers of flowers, is collected and used by honey bees as their source of protein. In this process bees serve as agents, who bring the male (pollen) and female (stigma) parts of flower together, thus

**Notes**

promoting the fertilization in plants, which is known as pollination. Bees place the nectar and pollen in the cells (small hexagonal divisions) of the honeycomb made of wax, ripen it to turn it into honey and seal it for storage and future use as food. Bees use honey as the main source of energy food.

Honey bees are the primary source of pollination for approximately one-fourth of all crops produced all over the world. Examples of fruit crops that rely on honey bees are almonds, apples, apricots, avocados, blackberries, blueberries, cantaloupes, cherries, cranberries, pears, raspberries, strawberries and watermelons. The seeds of many vegetables are also produced with honeybee pollination; examples include alfalfa, asparagus, broccoli, brussels sprouts, cabbage, carrot, clover, cotton, cucumber, onion, radish, squash, sweet clover and turnip.

1.2 BEEKEEPING IN INDIA

Traditional beekeeping in India was mainly forest based as mostly the tribal farmers were involved in it. The farmers have been keeping Indian bee, as it is a good pollinator and accustomed to the Indian climatic conditions. The Sunderban forests in West Bengal are rich in Rock bee and the organic honey from these forests is in great demand. The exotic bee, popularly known as Western bee, was successfully introduced from Europe during 1960's in foothills of Himachal Pradesh and agricultural plains of Punjab. It has become popular among commercial beekeeper because of its higher honey yield. It spreads gradually to Himachal Pradesh, Bihar, Uttar Pradesh, West Bengal, Kerala, Karnataka and Maharashtra.

In 1980s, Khadi and Village Industries Commission (KVIC) was established for promotion of modern beekeeping through various schemes. Beekeeping is now being practiced on a large scale in several States of India, which include Haryana, Punjab, Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh, Bihar, West Bengal, Tamil Nadu, Kerala and Karnataka. What is your state? Is beekeeping popular in your region?

1.3 WHO CAN DO BEEKEEPING?

Anyone who has undergone education and training in rearing and management of beekeeping can do beekeeping. Beekeeping can be a good source of income for anyone, including farmers, house-makers, retired persons, unemployed persons, girls, women, differently-abled persons and even students. There are three types of beekeeper:

1. Commercial beekeepers: People who are doing beekeeping for production and sale of honey on a commercial scale,
2. Sideliner: People who are doing beekeeping as a side business,
3. Hobbyists: People who have taken up beekeeping as a hobby.

Think a while, which group you belong to? Whatever be, be sincere and committed to your training to learn and earn both.



1.4 BENEFITS OF BEEKEEPING

Beekeeping is the secondary source of income. Because of the following reasons you may adopt it:

- (i) **Production of bee hive products:** Honey bees are the sole source of honey and beeswax. The bee hive products namely honey, pollen or bee bread, royal jelly, bee propolis, bee venom and beeswax can be produced by bee keeper after adoption of beekeeping for generation of income and self employment among rural masses of the country.
- (ii) **Utilization and harvesting of nectar and pollen of highly nectariferous plants:** About 30 – 50 kg honey can be produced and harvested by one hectare highly nectariferous crop plants occupied area such as lahi (*Brassica campestris* var. *toria*), mustard, litchi, pigeon pea, sunflower, eucalyptus, anola, ber, jamun, drumstick, karanj, junglejalibi, mahua, shisam, siris, semal, palas, cucurbits, coriander etc. The natural floral reward i.e. nectar and pollen may be utilized for production of bee hive products as food source otherwise these produce may be wasted in nature.
- (iii) **Enhancement of yield through bee pollination:** If you are associated with growing crops in your field, beekeeping may give you dual benefit by enhancing crop production. The transference of pollen during floral visit is performed by worker bees and consequently stigma of flowers is pollinated by highly suitable highly feasible and acceptable pollen grains. Services of bees resulted in enhancement of yield and improvement of seed quality. About 20-25% yield is increased by bee pollination as compared to the natural pollination of the various crops.
- (iv) **Apitherapy for cure of diseases:** Bee hive products are used as medicinal agent. These materials such as honey, royal jelly, propolis and bee venom can cure more than 50 human diseases. Few are mentioned below -
 - (a) **Honey :** The honey consists of antimicrobial substances. It is useful for respiratory infection and is beneficial against heart diseases. It is also a rapid source of energy.
 - (b) **Royal Jelly :** This bee hive product is anti- tumourous, antimicrobial and most nutritious substance, secreted by the young worker bees for feeding of queen and queen larva. It is used for the treatment of high blood pressure, arthritis and joint pain.
 - (c) **Propolis :** It is beneficial for the treatment of skin diseases as antimicrobial agent, skin burns, joint pain, throat and dental diseases.
 - (d) **Bee venom :** This is the poison that makes bee stings painful. Bee venom is used to make medicine for curing muscular diseases, arthritis and gout.
- (v) **Generation of income and self employment as natural agro-based cottage industry:** The potential of generation of income per colony per year is about Rs. 3000 – 4000 annually through honey production and multiplication of bee colony. Only two trained man power is required for management of apiary of hundred bee colonies.



- (vi) Beekeeping does not require farm land. Farmers with small land holding or even landless can adopt this and become self reliant.
- (vii) It does not require heavy physical work. Even women and children can adopt it.
- (viii) It encourages rural artisans to undertake the job of manufacturing equipments required for beekeeping.
- (ix) It does not require heavy investment. Inputs are very low as raw material for production of honey is obtained free from nature so output to input ratio is very high.
- (x) It provides proportionately more and immediate return than any other agro based profession.
- (xi) Beekeeping is a clean and hygienic profession, as it does not require daily feeding or cleaning of litter.
- (xii) Beekeeping business contributes significantly to national economy.



INTEXT QUESTIONS 1.1

State True or False

- (a) Honey is the plant origin product and modified form of nectar.
- (b) Royal jelly is the most nutritious substance, which is secreted by the young worker bees for feeding of queen and queen larva.
- (c) About 50-55% yield is increased by bee pollination as compared to the natural pollination of the various crops.
- (d) Bee venom is the poison that makes bee stings painful.
- (e) Beekeeping is a clean and hygienic profession.

1.5 HONEYBEE PRODUCTS

Certainly you might have tasted delicious honey many times. But, do you know there are other bee products also which has many health benefits? Let us know about them:

- (i) **Honey:** Honey is the natural sweet substance produced by honey bees from the nectar of blossoms, which honey bees collect, transform and combine with specific substances of their own, store and leave in the honey comb to ripen and mature. Bees normally take about 3-4 weeks for storing, ripening and sealing of honey in comb cells. The colour of honey varies from nearly colourless to dark brown. It also indicates quality, because honey becomes darker during storage or if it is heated.

Honey contains a good amount of digestible sugar, minerals, vitamins, enzymes, water, etc. The aroma, taste and colour of honey are determined by the plants from which the bees have gathered nectar. For example, nectar collected from sunflowers

Introduction to Beekeeping



Notes

give a golden yellow honey. Honey absorbs moisture very quickly and should be kept in air tight containers.



Fig. 1.1: Honey

- (ii) **Pollen:** When bees visit flowers, pollen sticks to the fine feather-like hair which covers the body. Bees remove the pollen from the hairs using the pollen comb; a structure on the hind legs. Then she forms the pollen into small pellets with the pollen press, and sticks it into the pollen basket to carry it back to the hive. Pollen is stored in cells immediately surrounding the brood nest where it is readily available for feeding brood and for consumption by the nurse bees.
- (iii) **Beeswax:** It is a complex mixture of organic compounds secreted by four pairs of special glands on the worker bee's abdomen. It is used for building wax comb. Beeswax can be secreted only at relatively high temperatures and after a large intake of honey or nectar. It is produced by 12 to 18 days old honey bees. A bee converts 15kg of honey into 1 kg of wax. It is used in medicine, confectionery items cosmetics and polish.



Fig. 1.2: Beeswax cake

- (iv) **Royal Jelly:** Royal jelly is the food produced by the young worker bees through glandular secretion. It is given to freshly hatched larvae. Royal jelly has many different components including proteins, sugars, fats minerals and vitamins. It contains many insect growth hormones and is valued as a medicine or tonic in



various parts of the world. It reduces the aging process in human beings. The beekeepers remove the larvae and harvest the royal jelly for marketing. Royal jelly deteriorates quickly after harvest and must be kept frozen or freeze-dried during handling, storage, transport and marketing.

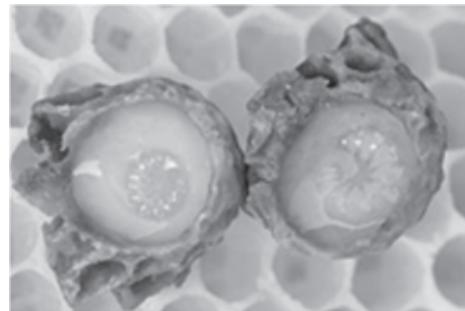


Fig. 1.3: Developing queen larvae surrounded by royal jelly

- (v) **Propolis:** It is a gummy reddish brown substance gathered by the bees from resinous substance found on trees and buds of plants. It is also called ‘bee glue’ and is used to close small crevices in the hive. It is very sticky in warm weather and brittle in cold weather. Bees use propolis as building materials to decrease the size of nest entrances and to make the surface smooth for passing bee traffic and to varnish inside brood cells before a queen lays eggs in them, providing a strong, waterproof and hygienic unit for developing larvae. It is used as an antibiotic and helps in curing the crack feet in human beings. It is used as an ingredient in toothpaste, soaps and ointments.
- (vi) **Bee Venom:** It is present in the sting of honeybee and having medicinal value. Bee venom is clear, odourless, watery liquid having somewhat sharp and bitter taste and hydrolytic blend of proteins with basic pH. It is produced by venom glands associated with the sting apparatus of worker bees and used as a defensive agent against enemies specially predators. The worker bee injects the venom into the victim while stinging. A single worker has about 0.5 mg venom.



INTEXT QUESTIONS 1.2

Fill in the blanks:

- (a) Bees normally take about for storing, ripening and sealing of honey in comb cells.
- (b) Beeswax is a complex mixture of secreted by four pairs of special glands on the worker bee’s abdomen.
- (c) Pollen comb is present at of worker bees.
- (d) Beeswax is produced by old honey bees.
- (e) is used to close small crevices in the hive.



1.6 POTENTIAL MARKET OF HONEY

Before initiating beekeeping it is important to understand the potential market of honey. The natural honey is in demand throughout the year, as it is extensively used in making Ayurvedic medicines, candies, wax candles, cosmetic products, etc. Direct or indirect marketing of honey can be done to (i) Individuals (ii) Local Vegetable Market (iii) Local Grocery Stores (iv) Cooperatives/Associations (v) Food markets/Supermarkets and (iv) Wholesale Dealers.

Indian honey has a good export market. India has exported 29,578.52 MT of natural honey to the world for the worth of Rs. 535.07 crores during the year of 2014-15. The major export destinations are United States, Saudi Arabia, United Arab Emirates, Libya and Morocco.

With the use of modern collection, storage, beekeeping equipment, honey processing plants and bottling technologies the potential export market can be tapped.

1.7 NATURE OF WORK

Beekeeping is a labour intensive process and therefore, generates lot of employment opportunities for people. Most of the work in beekeeping including processing of honey is manual hence emphasis is given on hands-on training.

As a beekeeper, you have to perform the following major activities:

- Decide on the bee species to be kept.
- Prepare a business plan for beekeeping.
- Arrange all the resources required for setting up an apiary and order supplies such as equipment, raw materials, etc.
- Plan the activities to be undertaken and estimate operating costs.
- Supervise various activities for beekeeping and make sure that the temperature, ventilation and other conditions are proper for honey bees.
- Build and maintain equipment and facilities to ensure health standards and high quality of bee products.
- Seek advice of experts.
- Observe and record the amount of produce, expenditure, sale, etc.
- Adjust practices to increase production and decrease expenditure.
- Manage the business.

As a beekeeper, you may earn Rs 20,000 to Rs 60,000 per month depending upon the size of the apiary. Therefore, proper training on all these and other aspects of beekeeping is necessary before you start beekeeping.



Notes



WHAT YOU HAVE LEARNT

Let us recapitulate and enlist salient points we have learnt through this lesson:

- Honey bees are the primary source of pollination and may enhance crop production by 20-25%.
- Honeybees are the sole source of honey and beeswax which has high income potential for agro- based cottage industry.
- Other bee hive products are pollen, royal jelly, bee propolis and bee venom.
- Beekeeping is a labour intensive process and therefore, generates lot of employment opportunities for people.
- As most of the work in beekeeping including processing of honey is manual hence hands-on training is essential.



TERMINAL EXERCISE

1. What is apiculture? Why beekeeping is essential for mankind?
2. Explain the benefits of beekeeping.
3. Write short note on the following topics:
 - (i) Honey
 - (ii) Enhancement of crop yield through pollination
 - (iii) Royal jelly
 - (iv) Medical value of honey bee products
4. Where can you sell your honey bee products?
5. Write a short note on honey bee products.
6. What are the major activities of a beekeeper?



ANSWERS TO INTEXT QUESTIONS

1.1

- (a) True (b) True (c) False (d) True (e) True

1.2

- (a) 3-4 weeks (b) organic compounds (c) hind legs
 (d) 12 to 18 days (e) Propolis/ bee glue



Notes

2

THE WORLD OF HONEY BEES

After going through previous lesson you learnt about the importance of honey bee, benefits of beekeeping, bee hive products and their uses. Now, you are clear about your career plan in beekeeping occupation.

Have you ever seen a honey bee? How a honey bee looks like? What's its colour? How many legs, eyes, etc. does a bee have? So, let us understand the world of honeybees. *Apis dorsata* (Giant / Rock honey bee), *Apis florea* (Little/ Dwarf honey bee), *Apis cerana indica* (Indian/Asian / Eastern honey bee), *Apis mellifera* (Italian/ European honey bee) and *Trigona iridipennis* (Stingless bee/ Dammer bees) bee species are of economic importance. In this lesson we will discuss about the commercially used honeybees, their castes, biology, life cycle, nature of work etc.



OBJECTIVES

After reading this lesson, you will be able to:

- identify different bee species of economic importance;
- identify castes of bees;
- identify parts of honey bees;
- distinguish between different developmental stages of bees;
- enlist bee flora;
- explain bee species;
- describe the communication in bees.

2.1 HONEY BEE SPECIES OF ECONOMIC IMPORTANCE

Honey bees belong to Phylum-Arthropod, Class- Hexapoda/Insecta, Order- Hymenoptera and Family- Apidae. There are five species of honey bees which are of great economic importance (Fig. 2.1).



Notes

- (i) *Apis dorsata* (Giant / Rock honey bee)
- (ii) *A. florea* (Little/ Dwarf honey bee)
- (iii) *A. cerana* (Indian/Asian / Eastern honey bee)
- (iv) *A. mellifera* (Italian/ European honey bee)
- (v) *Trigona iridipennis* (Stingless bee/ Dammer bee)

The first three species are indigenous, while the fourth species *A. mellifera* was introduced in India in 1962 from European country. *A. dorsata* and *A. florea* are wild bees as they construct nest in open and cannot be domesticated in wooden hives. *Trigona* sp. is wild but is rare in peculiar bee hive. Whereas *A. cerana* and *A. mellifera* are hive/domesticated bees as they can be hived inside the wooden hives. We will discuss these species in detail in section 2.6.

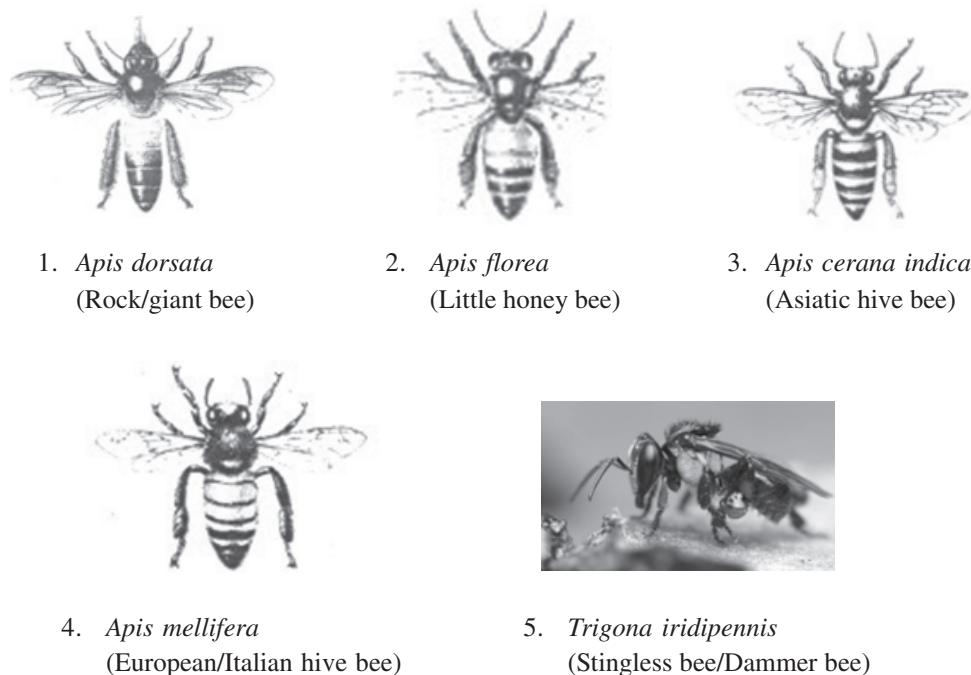


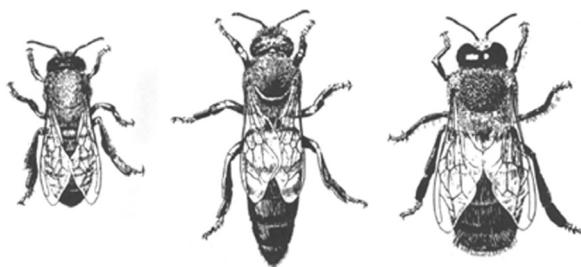
Fig. 2.1: Different species of honey bees

2.2 CASTES OF BEES

We all are social beings. We live in society and work for society. Similar are the bees, a social insect. Like us, each individual in the bee colony has to work for the welfare of others and the colony which we termed as ‘division of labour’. A bee colony consists of different types or ‘castes’ of individuals, who cooperate in collecting food, taking care of young ones and production of honey. A normal bee colony has (i) a Queen bee, (ii) 2000-70000 Workers, (iii) 0-500 Drones. You may recognize them by their morphological differences (Fig. 2.2)



Notes



Worker honey bee Queen honey bee Drone honey bee

Fig. 2.2: Different castes of honey bees

Lets us know the work of individual caste in the colony:

Worker bees

- The workers are sterile females which developed from fertilized eggs.
- Workers are smaller than the drones and have yellowish and dark brown abdominal stripes.
- The workers are the main group in a colony, with 60,000 – 70,000 in an *Apis mellifera* colony and 25,000 – 30,000 in an *Apis cerana* colony.
- They have specialized structures, such as hypopharyngeal glands, scent glands, wax glands, and pollen baskets, which allow them to perform all the labors of the hive.
- All the work in a honeybee colony is performed by the worker bees, including honey and pollen collection, brood rearing, building combs, feeding the drones and queen, cleaning the hive, and defending the colony.
- The specific activities are defined by the age of the bee, with tasks inside the hive for the first 3 weeks after emergence (comb building, brood care, hive cleaning, thermoregulation, queen care, honey ripening) and then outside (foragers and scouts). Under special circumstances, workers can perform any kind of task irrespective of age as per the need of the colony.
- When the colony is active in spring and summer, worker bee may live as long as 5-6 weeks. During inactive period in winter a worker bee lives five months or more.

Queen bee

- Each colony has a single queen bee irrespective of the colony size.
- The queen bee is larger than the worker and drone bees, has a black and shiny cylindrical and longer body, and a round and comparatively small head.
- She is the only perfectly developed female and is the mother of the colony.
- Her primary function is reproduction. She produces both fertilized and unfertilized eggs. During peak production, queens may lay up to 2000-2500 eggs per day. One queen may produce up to 250,000 eggs per year and possibly more than a 10,00000 in her lifetime.



Notes

- The second major function of a queen is secreting pheromone known as queen substance, required for the stability of the colony including inhibition of ovaries of worker bees.
- The average productive life span of queen is 2 to 3 years.

Drone

- Drones (male bees) are the largest bees in the colony and are blackish and hairy.
- A colony will usually have a few hundred drones.
- They develop from unfertilized eggs and complete their life cycle in 24 days.
- They lead a life of leisure, doing no work while being fed by the workers.
- Their sole purpose is to mate with a new queen and also useful to reduce the temperature of the colony by wing beating. They die after mating, or are expelled from the hive as winter approaches.



INTEXT QUESTIONS 2.1

Fill in the blanks:

- and are hive bees and can be domesticated.
- A colony of honey bees usually contains queen, thousands of worker bees and drones.
- is the only perfectly developed female and is the mother of the colony.
- A is the non working male bee.
- bees performs almost all the labours of the hive.

2.3 BEE BIOLOGY

Do you know honey bees are insects? Hence, like other insects their body parts are divided into three regions: head, thorax and abdomen (Fig.2.3).

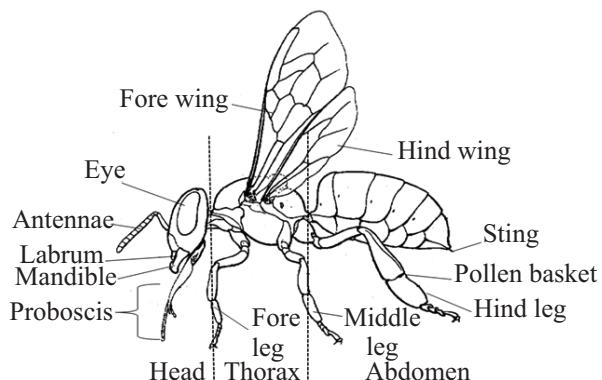


Fig. 2.3: Morphology of a honeybee



Notes

2.3.1 Head

The head of worker bee is triangular, queen bee is triangular but a little roundish and that of drone is almost round (Fig.2.4). The head contains the antennae, eyes and mouth parts.

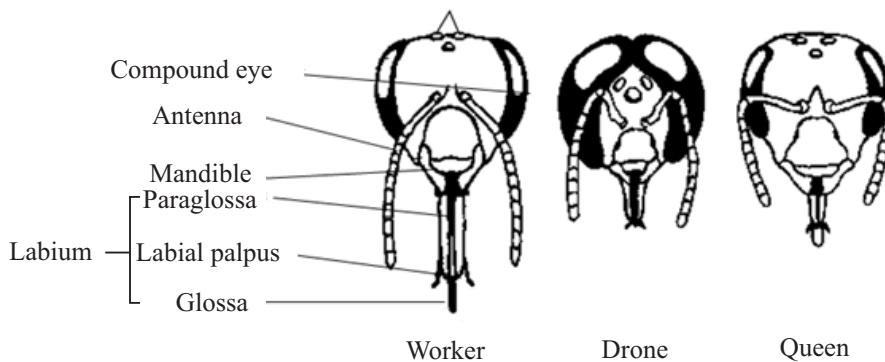


Fig. 2.4. Head capsules of castes of honeybee

Antenna: The head contains a pair of antennae which serve as nose of the bee. The antennae's functions are to feel or touch, detect smell and to help balance the body during walking and fighting.

Eyes: The visual apparatus of the bee consists of a pair of compound eyes and three small simple eyes called the ocelli. The compound eyes can detect the shape and colour of objects, but not light intensity, and are used for distant sight. The simple eyes detect light intensity and are used for near sight. The compound eyes of drone bee are large, black, kidney shaped and unite with each other at the vertex, whereas in workers and queen bees, compound eyes are comparatively much smaller and do not meet at the vertex.

Mouth parts: The mouth parts of honeybees (Fig.2.5) are classified as the chewing and lapping type, meaning that they can manipulate solid material as well as lap up liquids. The mouth is composed of the proboscis, mandibles, labrum, and labium. The proboscis is a flexible tube used to suck up liquids (nectar, water, honey) into the mouth. The sickle-shaped mandibles are like paired 'teeth' one on each side of the mouth. They are used to collect pollen and propolis, to soften and manipulate wax by chewing, to clean other bees, and to bite workers from other colonies or pests. The labium assists in chewing. The labrum is equivalent to the upper lip and supports the sucking process.

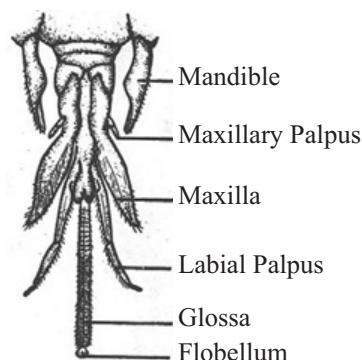


Fig. 2.5. Mouth parts of honeybee



Notes

2.3.2 Thorax

The thorax is the centre for locomotion and is composed of three segments namely prothorax, mesothorax and metathorax. Each segment bears one pair of legs. Both mesothorax and metathorax bears one pair of wings.

Legs: The three pairs of legs are structurally and functionally modified to perform various functions. Each leg of honey bee comprises of usual six segments, *viz.* coxa, trochanter, femur, tibia, tarsus and pretarsus. Prothoracic or fore legs are used for antenna cleaning (Fig 2.6). Mesothoracic or middle legs (Fig. 2.7) are used mainly for removing wax scales and constructing comb. In worker bees, Metathoracic or hind legs (Fig. 2.8) are largest in size and concave outer surface of hind tibia is fringed with long curved hairs to form pollen basket or corbicula. They are used for collecting pollen grains.

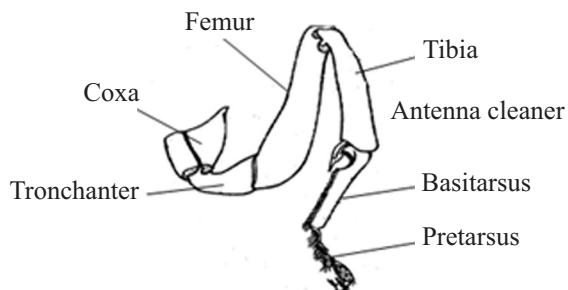


Fig. 2.6. Prothoracic/ Fore leg of honey bee (worker)

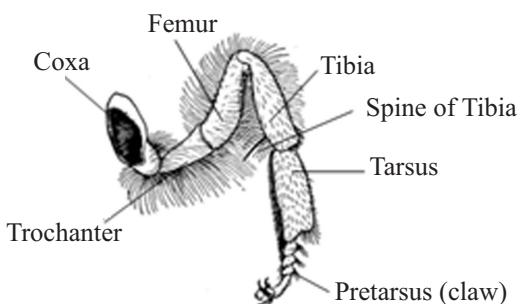


Fig.2.7. Mesothoracic/ Middle leg of honey bee (worker)

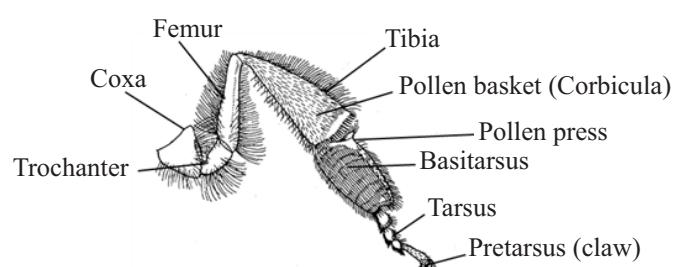


Fig.2.8. Metathoracic/Hind leg of honey bee (worker)



Notes

Wings: Two pair of wings is present on mesothoracic and metathoracic segments. During flight, two wings of each side get coupled with each other by means of hooks (hamuli) (Fig. 2.9). Forewings are larger than the hind wings. The wings of honey bee are generally transparent, except in case of the Giant/ rock bee (*Apis dorsata*) which has smoky wings.

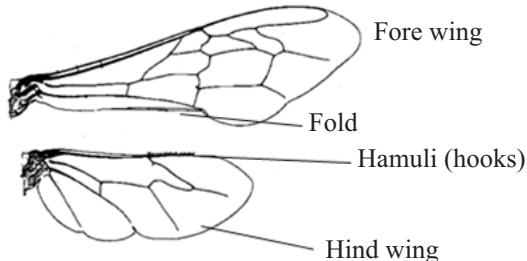


Fig.2.9. Wings of a worker honey bee

2.3.3 Abdomen

The abdomen of adult worker and queen appears to be six segmented. Segment 8-10 are reduced in size whereas first abdominal segment is united with the metathorax. The abdomen bears sting, wax, scent glands and genitalia. The underside of 4th to 7th abdominal segments have one pair of wax glands each which secrete beeswax for comb construction. The bee sting is modified ovipositor and serves as an instrument of defence for worker bees and for killing rival queen bees by a queen bee.

2.4 STAGES OF DEVELOPMENT IN HONEY BEES

The way human beings undergo different life stages comprising of infant, child, adolescent & adult, each bee caste goes through four developmental stages viz. egg, larva, pupa and adult. But the time needed to complete each stage differs.

Let us learn The Life Cycle Stages of honey bees:

(i) Egg

- Queen lays pearly white, slightly curved eggs in the cells singly and vertically with the thin end attached to the bottom of the cell.
- Queen bee lays both fertilized (giving rise to females i.e. worker or queen bee) and unfertilized eggs (giving rise to males i.e. drone bees).
- The egg stage lasts for 3 days. At the start, the egg stands vertically on the base of the cell, then slants, and finally lies flat on the base before hatching.

(ii) Larva

- Small, shiny white larvae hatch from the egg after 3 days.
- Initially the larvae are loop shaped lying on the bottom of the cell but towards cell capping, they get stretched on their back in the cell with head facing distal end of the cell.
- Larvae of all the castes moult four times.



- The average larval period is 5 days for a queen, 6 for a worker, and 7 for a drone.
- After the cell is sealed (at the end of 8th day) and the cocoon has been spun (at the end of 9th day) the larva passes gradually and without moulting into pre-pupa.

(iii) Pupa

- The pupal stage is the dormant stage. Worker bees seal the cells with a porous beeswax cap and the larva spins a cocoon around itself.
- The developing bee remains inside the cocoon without eating or moving.
- The pupal stage lasts for 7–8 days for a queen, 11–12 days for a worker, and 14 days for a drone.
- Worker cells are a little smaller than drone cells. The comparative sizes are five worker cells per linear 25.4 mm of comb and four drone cells per linear 25.4 mm of comb in case of Italian bee.
- During this stage, the internal organs and body appendages develop. Finally the adult bees emerge.

(iv) Adult

- The adults emerge from the cocoon and bite a hole in the top of the sealed cell to come out. Immediately after emergence, the adult workers are a light colour, and then become darker.
- The total time taken to develop from egg to adult is 15–16 days for a queen, 20–21 days for a worker, and 24 days for a drone.

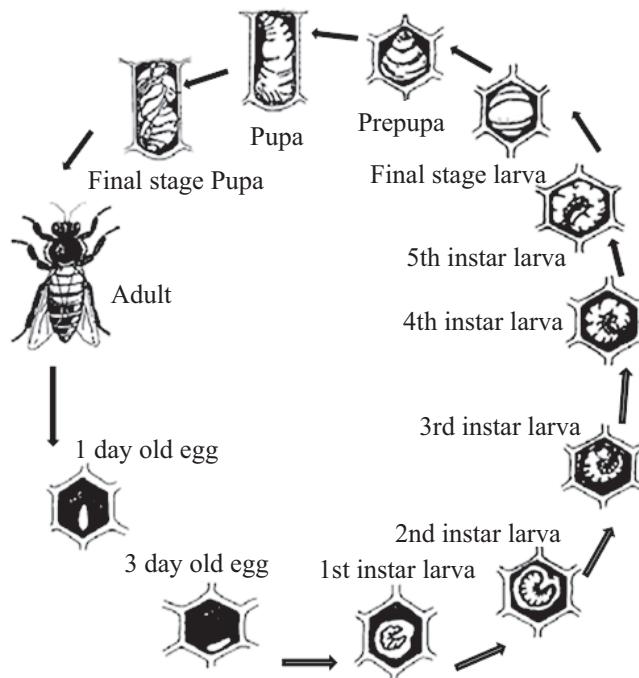


Fig. 2.10: The honeybee life cycle – egg to adult



Notes

Sex Differentiation

The queen lays two types of eggs: (i) Fertilized, and (ii) Unfertilized. The queen and workers comes out from the fertilized eggs, while the unfertilized eggs produce drones (Fig. 2.11).

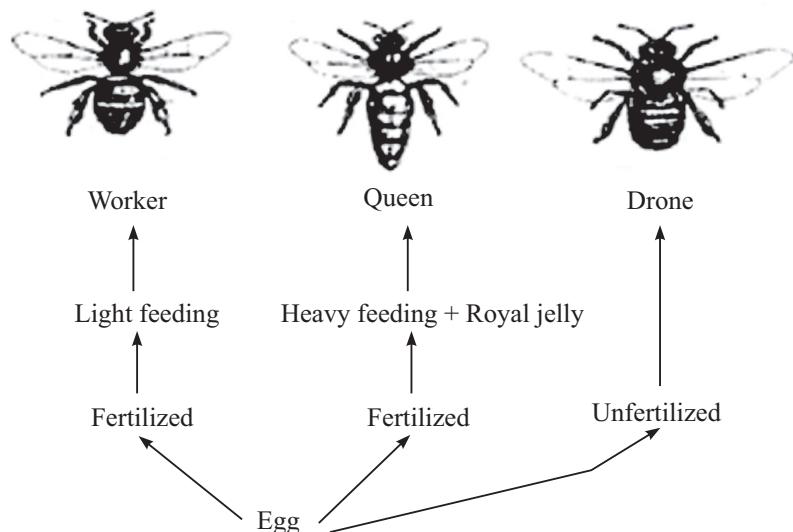


Fig: 2.11: Sex differential in honey bees

Royal jelly is prepared and fed to the larvae by the nurse bees. The queen larvae are fed only royal jelly. The queen gets the royal jelly throughout her life. Upto 3 days, all young stages of bees get protein rich food known as ‘royal jelly’. Royal jelly is fed to the worker and drone larvae only for the first 3 days and then they are fed “bee bread”. Thus, the worker do not get the royal jelly after three days of development and so develop into sterile (cannot reproduce) female.



INTEXT QUESTIONS 2.2

Fill in the blanks:

- is the centre of locomotion in bees.
- Bee body parts are divided into, and
- The head of bees contain, , and
- serve as nose of the bees.
- Honey bees are having type mouth parts.
- Bee queen & workers comes out from eggs while drone from one.
- Royal jelly is fed to the larvae of queen, worker and drone upto days.



2.5 BEE FOOD PLANTS

The food of the bees comes from ‘forage’ or ‘bee flora’ i.e. the flowering plants which provide nectar and/ or pollen for bees. The worker bees that collect pollen, nector, water and propolis for the colony are also called as ‘forager’. Thus, foragers collect following substances for the colony:

- (i) Nector
- (ii) Pollen
- (iii) Propolis
- (iv) Water

Bees get carbohydrate from honey and proteins from pollen. Water is mixed with honey and pollen before bees eat it or feed it to the brood (egg, larvae & pupa). Bees visit flowers and extra- floral nectarines of about 500 flowering plants and trees to collect pollen and nector for food. Some of the commonly visited by bees in India for collecting nector from the flowers are as follows:

1. Vegetables: Okra, Cucumber, brinjal, tomato, bottle gourd, spinach, cauliflower, turnip, sweet gourd, onion, radish
2. Field crops: Mustard or toria, sunflower, cotton, jute, pulse, wheat, gram
3. Fruit plants: Litchi, apple, guava, jamun, imli, papaya, karonda, ber, jackfruit, anar, lemon, bel, mango, banana, papaya, drum stick, citrus, pear, apricot, malta, mausami, orange
4. Ornamental plants: Marigold, rose, cosmos
5. Trees: Eucalyptus, acacia, albizia, calliandra, gemelina, prosopis, babool, neem, arjun, palm, sandal wood, dhak, bottle brush, amaltas
6. Herbs and spices: Tulsi, coriander
7. Plantation crops: Rubber, coconut, cashewnut, coffee

2.6 BEE SPECIES

Let us learn more about the commercially used bee species and their life cycle.

Giant / Rock Honey Bee (*Apis dorsata*)

Rock bee has ferocious temperament and it is provoked by slight disturbance. They are sensitive to smoke. This species is found all over the Hind kush Himalayan region, in the plains as well as in the hills up to height of 2000 meters above the sea mean level. It builds a single comb nest in an open cave under a roof or rock cliff. The size of single open air comb of *Apis dorsata*, depending upon the season and development of the colony, measureing about 1.5 to 2 m from side to side and 0.6 to 1.20 m from top to bottom. The upper portions of the comb contain honey and pollen and are generally 10 to 25 cm thick.



Below this storage area is the brood nest. The average thickness of brood nest is 3.2 cm. The worker bee is light brown in colour. Queen is darker in colour than the worker and about 1/5 as longer than worker and about 2 mm broader than worker bee. The drone is black in colour and is as big as a worker. The giant or rock bee build their comb in such localities where flower with abundant nectar supply are available. As soon as the nectar supply in a particular locality depletes, they migrate to other place. The production capability of *A. dorsata* is about 50 - 80 kg per colony per year. *Apis dorsata* prefers construction of nests on building and rocks as compared to open trees due to the availability of more protection against rain or wind.



Fig. 2.12: Beehives of *Apis dorsata*

Life Cycle of *Apis dorsata*

The development period of *Apis dorsata* (in days) castes is given below:

	Eggs stage	Larva	Pupa	Young/ Immature Adult
Queen	2-3 days	4-5 days	6.5 – 7 days	13 – 14.5 days
Worker	2-3 days	4-5 days	9.5 – 12 days	20 days
Drone	2-3 days	4-5 days	13.5-15.5 days	23.5 days

The Little Bee, *Apis florea*

The little bee, *A. florea* is found in the plains and rarely in place higher than 1500 m above sea level. This small bee also builds a single comb nest which is often suspended from branches of bushes, hedges, trees, caves of buildings, house chimneys, empty caves and piles of dried sticks.

The comb measures about 35 cm in length. 18 cm in height and about 2 cm in thickness. Honey is stored in the upper part of the comb which is about 5.7 cm thick. Nests of *A. florea* are protected by a three to six layer curtain of bees over the comb.

The average honey yield from a colony varies from 0.5-1.0 kg. It is believed that the honey produced by *A. florea* has higher dextrin content and has less tendency to granulate than the honey of other species. During active season, the brood area ranged from 10 - 627.74



Notes

sq. cm and the queen lays about 365 eggs per day. Body colour of queen of *A. florea* is amber yellow. The head and thorax are dark in colour up to tibia but leg is amber yellow. The worker bees of *A. florea* with deep black and white stripes on the posterior half of their bright orange abdomen are comparatively much smaller than the golden brown queen and black drones with smoky grey hair. They are very prone to swarming. A swarm of *A. florea* bee colony consists of about 600 worker bees, a queen and some drones. In this species absconding is very common and dancing behavior occurred in horizontal position.



Fig. 2.13: A nest of *Apis florea* built on a wooden twig

Life Cycle of *Apis florea*

The development period of *Apis florea* (in days) castes is as follows:

	Eggs stage	Larva	Pupa	Young/ Immature Adult
Queen	3- 4 days	5.8 days	7 – 8 days	16.5 days
Worker	3- 4 days	6.4 days	8 – 9 days	20-21 days
Drone	3- 4 days	6.7 days	11 – 12 days	22-23 days

Indian Honey Bee (*Apis cerana indica* Fabr.)

This bee species can be kept in beehive. They construct their combs in the cavities of tree trunks, hollows of rocks, holes and other covered places such as cracks and crevices of walls etc. It can be domesticated in all kinds of hollows and recesses. Hollowed out logs, wooden boxes, packing cases, kerosene tins mud receptacles, wall recesses and unused almirah are the common abodes. Indian honey bee construct series of parallel combs to the direction of entrance. The number of combs vary from 7-8. The length and breadth of the combs are about 300 mm and 175 mm respectively. The upper part of the comb is filled with honey and lower part of the comb is used for brood rearing and in middle part generally pollen is stored. The comb consists of three types of cells i.e. queen, worker and drone cells. The worker comb cell is 4.3-5.0 mm in diameter and drone cells are 1.2 times larger than the worker cells. The honey production capability of *Apis cerana indica* is 10 - 15 kg per colony per year.



The egg laying capacity of the queen of *Apis cerana indica* is about 700-1600 eggs per day. The worker bees are smaller in size as compared to the worker of *Apis mellifera*. The space between two combs, known as bee space, is about 7-8 mm.

Notes

Bee Space – Bee space was discovered by L. L. Langstroth as the optimum distance to be left in between two adjacent comb surfaces in a bee hive which is essential for normal movement and functioning of bees. It varies with honeybee species eg. for Indian bees: 7-8 mm and Italian bees: 8-9 mm.

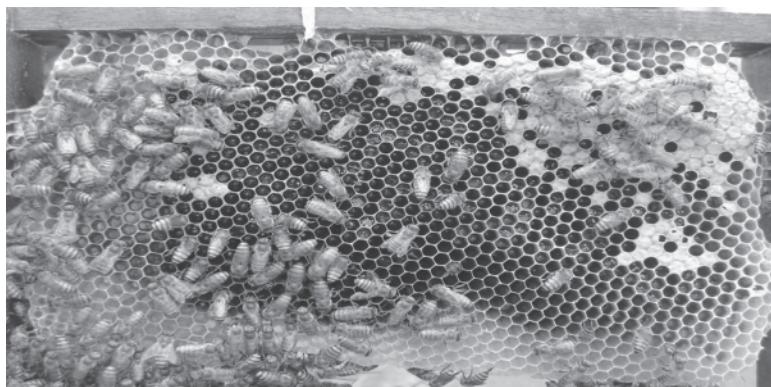


Fig. 2.14: A movable comb of Indian honeybee, *Apis cerana indica* surrounded by bees

Life Cycle of *Apis cerana indica*

Embryonic development and developmental stage of queen, worker and drone of *Apis cerana indica* (in days) is as follows:

	Eggs stage	Larva	Pupa	Young/ Immature Adult
Queen	3 days	5.5-5 days	7-8 days	15-16 days
Worker	3 days	5.5-6 days	11-12 days	20 -21 days
Drone	3 days	6.5-7 days	14-14.5 days	23-24 days

This bee species is susceptible to Thai sac brood virus. The loss of 90% colonies of Indian honey bee is caused by epidemic of Thai sac brood virus during late seventies and eighties in eastern and northern Indian and during nineties in southern states of the country.

Italian/ European Honey Bee (*Apis mellifera*)

This species of honey bee constructs their combs in dark, closed and covered places. The number of combs in *A. mellifera* hive are 10. The combs are parallel to each other and to the entrance of beehive. The space between two combs i.e. bee space is about 8-9 mm. The average length and breadth of the combs are about 440mm and 228mm respectively. The egg laying efficiency of the queen is 2500 – 3000 eggs per day. Consequently, more brood



Notes

is reared by *A. mellifera* as compared to the *A. cerana indica*. The foraging range of the worker bee is about 2-3 km and flight ability is about 5 km. The wing length of *A. mellifera* is about 70% of its body length while the wing length of the Indian honey bee *A. cerana indica* is about 78% of its body length. The average speed of flight of *A. mellifera* is about 50m per 2.95 seconds. The temperature of bee colony is regulated by fanning i.e. about 32.5 – 37°C. The worker bees are larger in size as compared to the worker bees of *A. cerana indica* but smaller than that of *A. dorsata*. The *A. mellifera* maintains a prolific queens, swarms less, has gentle temperament and is good honey gatherer. The honey production capability is about 30-40 kg per colony per year.



Fig. 2.15: A colony of *Apis mellifera* with a comb exposed

Life cycle of *Apis mellifera*

Development period of *Apis mellifera* (in days) castes is given below:

	Egg stage	Larva	Pupa	Young/ Immature Adult
Queen	3 days	5 days	8 days	16 days
Worker	3 days	5 days	12-13 days	21 days
Drone	3 days	6 days	14 days	24 days

Dammer Bee

Two species of stingless or dammer bees, viz. *Melipona* and *Trigona* occur in our country in abundance. The honey is reported to be of high medicinal valuable compared to *Apis* honey. The stingless bees have the importance in the pollination of various food crops. They bite their enemies or intruders and can be domesticated. But the honey yield per hive per year is only 100 gms. Queen is distinguished from the worker by her larger size, mean body length of workers and queen measuring 4.07 and 10.07 mm respectively. Queen is golden brown in colour and has a pointed abdomen. The workers are black pigmented and with pale yellow. Mandibles in workers are smaller than that of the queen. The queen does not have pollen gathering baskets in her legs.



Notes

Habit and Habitat: Dammer bees gather plant resins (propolis) and use it together with wax, to construct their nest. The nests are built in trunks of trees, logs, wall crevices or under the roofs of dwellings. In the nest, there is a group of separate cells for brood rearing and another group of larger “sacs” for storage of pollen and honey. The dark and bitter honey is valued for its medicinal properties.



Fig. 2.16: *Trigona iridepennis*

2.7 COMMUNICATION IN BEES

You know that honey bees live in a colony. They communicate with each other and pass their information using various pheromones. However, worker bees communicate information through their peculiar ‘dance’.

The following types of dances are noticed:

- (a) **Round dance:** It is used to indicate a short distance of food source. The bee runs in circles, first in one direction and then in opposite direction (clockwise and anticlockwise). For example. If the source of the food is less than 100m away, then the bees perform ‘round dance’ making small circles. The number of circles formed by them indicates the distance of beehive from the food source. Workers dance vigorously, if the quantity of food is more and of superior quality. If the food is inferior and the quality is less, then the dance is slow and shorter.
- (b) **Tail wagging dance or Wag-tail dance:** This is used to indicate long distance of food source (more than 100m). Here the bee makes two half circles in opposite directions with a straight run in between. During the straight run, the bee shakes (wags) its abdomen from side to side, the number of wags per unit time inversely proportional to the distance of the food (more the wags, less the distance).

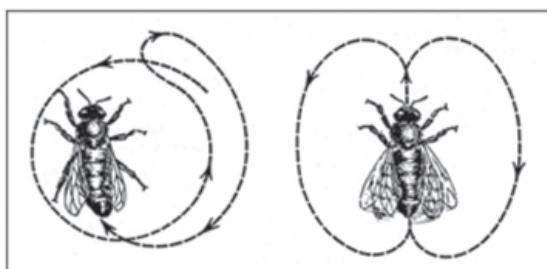


Fig. 2.17: Communication in bees



Notes

The World of Honey Bees

A bee can fly @35km/hr. They go as far as 5km from the hives for collecting nectar.

Honeybees also make a buzzing sound ‘ZZZZZ’ during the dance, which possibly alert the other bees that then attempt to ‘read’ dancer’s message.



INTEXT QUESTIONS 2.3

Fill in the blanks:

- (a) is the term used for flowering plants which provides nector and / or pollen for bees.
- (b) is the worker bee that collects pollen, nector, water or propolis for the colony.
- (c) is the space between adjacent combs in a bee hive.
- (d) The drone of is black in colour & is as big as a worker bee.
- (e) The honey produced by has higher dextrin content & has less tendency to than the honey of other species.
- (f) is susceptible to Tai Sac brood virus.
- (g) and construct series of parallel combs to the direction of entrance.
- (h) is stingless bee species.
- (i) is chemical substances secreted from glands and used as a means of communication in bees.
- (j) is done to indicate short distance of food source.



WHAT YOU HAVE LEARNT

Let us recapitulate and enlist salient points we have learnt through this lesson:

- *Apis dorsata, A. florea, A. cerana indica, A. mellifera* and *Trigona* sp. are different species of honey bees of great economic importance.
- A bee colony consists of a Queen, few Drones and many worker bees.
- Bee body is divided into three regions: head, thorax and abdomen.
- Honey bees undergo four developmental stages viz. egg, larva, pupa and adult. But, the time needed to complete each stage differs.
- The queen lays two types of eggs: (i) Fertilized, and (ii) Unfertilized. The queen and workers comes out from the fertilized eggs, while the unfertilized eggs produce drones.



- The food of the bees comes from the flowering plants which provide nectar and/ or pollen for bees. The worker bees that collect pollen, nectar, water or propolis for the colony are also called as ‘forager’.
- *A. dorsata* are the largest among the bees described. They are found all over India in sub-mountainous regions up to an altitude of 2700 m. They build single vertical comb on thick limbs of a tree or rock cliffs or caves of a building.
- *A. florea* is the smallest species of honeybees, in terms of body size of its workers and in the size of its nest.
- *Apis cerana indica* are smaller than *A. dorsata* but larger than *A. florea*. *They build several parallel combs with uniform distance between them.*
- *Apis mellifera* are bigger than all other honeybees except, *Apis dorsata*. These bees build 8-10 parallel combs side by side in sheltered and closed spaces.
- The dammer bee is very tiny with a vestigial sting and is different from the former three species in appearance and habits. It inhabits crevices in walls and hollow trunks of trees.
- Bees communicate using various pheromones. However, worker bees communicate information through ‘round’ or ‘tail wagging’ dance.



TERMINAL EXERCISE

1. Name economically important honey bees.
2. What are the different castes of honey bees? Explain.
3. Describe the bee parts with labelled diagrams.
4. What do you understand by bee life cycle? Describe pictorially.
5. Write the short notes on the following topics
 - (a) Head capsule of a bee
 - (b) Bee wing
 - (c) Bee flora
 - (d) Indian bee
 - (e) Italian bee
6. Explain the communication in bees.



ANSWERS TO INTEXT QUESTIONS

2.1

- (a) *Apis cerana indica* and *Apis mellifera*
- (b) one, thousands & few
- (c) Queen bee
- (d) drone
- (e) Worker

2.2

- (a) Thorax
- (b) head, thorax & abdomen
- (c) antennae, eyes & mouth parts
- (d) A pair of antennae
- (e) chewing & lapping
- (f) fertilized & non fertilized
- (g) 3 days

2.3

- (a) Forage / Bee flora
- (b) Forager
- (c) Bee space
- (d) *Apis dorsata*
- (e) *Apis florea*, granulate
- (f) *Apis cerana indica*
- (g) *Apis cerana indica* & *Apis mellifera*
- (h) *Melipona* & *Trigona*
- (i) Queen substance
- (j) Round dance



Notes

3

BEEKEEPING EQUIPMENTS

To start beekeeping, you would need the basic components of beehive, a source of bees, protective clothing, hive tools and other equipments for handling the bees and honey. An early procurement of equipments should be done so that they are ready to use when the bees arrive. Always purchase bee equipments from reliable source. Use of standardised equipment will make it easier to interchange hive parts, frames etc. between hives as needed. After gaining experience, you can save money by making your own beehives or renovating used ones. However, it is important that the equipment used should be of standardised size, otherwise you may face problems in using them. As a beekeeper you should get the latest equipment free from any defects and diseases to make sure that honey produced is the best in every way. You should also maintain your equipments well to reduce the overload cost on repair and replacements.



OBJECTIVES

After reading this lesson, you will be able to:

- identify and describe the use of various beekeeping tools and equipments;
- identify and describe the purpose of different components of a beehive;
- use the tools and equipments safely for specific purpose in beekeeping;
- demonstrate knowledge of assembling the frame and a movable frame hive;
- demonstrate application of hygiene and safety practices in beekeeping;
- develop skills for maintaining and handling beekeeping equipments.

3.1 BEEHIVE

Do you know where honey bees live? Natural habitat or artificial structure? Actually both! A man-made or artificial structure created for domesticated honeybees is known as



Notes

a beehive. A beehive is a rectangular wooden box filled with moveable wood or plastic frames, each of which holds a sheet of wax or plastic foundation. The bees build cells upon the sheets of foundation to create a complete honeycomb. Foundation comes in two cell sizes: (i) worker foundation, which enables the bees to create small, hexagonal worker cells and (ii) drone foundation, which allows the bees to build much larger cells for drones. The bottom box, known as brood chamber contains the queen and most of the bees and the upper boxes or supers contain just honey. The young nurse bees produce wax flakes to build honeycomb using the artificial wax foundation as a starting point, after which they may raise brood or deposit honey and pollen in the cells of the comb. You may choose a beehive depending upon the bee species, cost, ease of production and expected returns. Different types of bee hives were in use in various parts of our country. They are pot hive, nucleous hive, single walled and double walled Dadant hives, British standard hive, Langstroth hive, Indian Standard Industries (ISI) hive, Jeolikote hive and Newton hive. Of all these types, Langstroth hives for rearing Italian bee and Newton's hives for rearing Indian bees are most popular. Beehives may be divided into three types:

- **Fixed comb hives:** These are traditional hives, which include structure made of cylindrical bark and log hives and various other hives of many different forms and materials.
- **Movable-comb hives:** These are the top-bar hives, where bees build their comb attached to a top bar that can be lifted out of the hive. They have no frames.
- **Movable-frame hives:** A modern beehive is known as the movable frame hive. These hives have movable frames which hold the wax sheets that serve as a starting point for the bees to build honeycomb. The top wooden box consists of honey while the bottom box consists of queen bee and the other worker bees. A beehive is selected keeping in view the race of bee to be reared. A standard movable frame hive (Fig 3.1) has the following major parts:
 1. **Bottom/floor board:** It forms the floor of the hive made up of a single piece of wood or two pieces of wood joined together. There is a removable entrance rod in the front side with two entrance slits to alter the size of the hive entrance based on need. A two inch wide extended part of the bottom board beyond and in front of the hive entrance is known as 'alighting board' for returning bees to alight on it before passing into the hive through entrance. Bees also take off flight from this board. Most of their movement and observation without opening the hive can be observed at the alighting board.
 2. **Brood Chamber:** It is rectangular box with 8 to 10 hanging wooden frames. Frames inside the brood chamber are called brood frames. The comb cells are used for food storage, clustering, raising baby bees, and air conditioning. The queen or egg laying workers lay eggs inside this chamber. Thus, a brood chamber is like a 'nursery' where the queen lays her eggs and where the colony stores its food. It contains young stages of honeybee (young larva and pupa) and food for them. The daily requirement of honey and pollen is stored in this chamber.

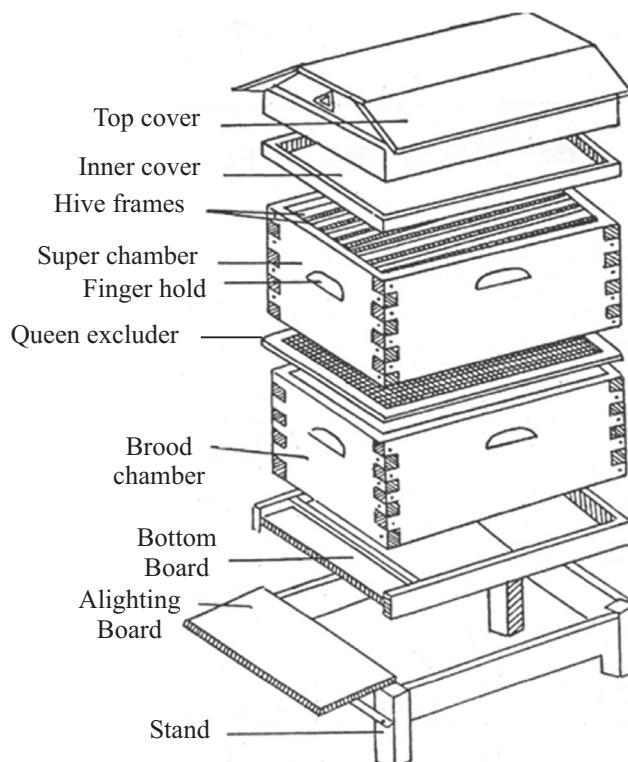


Fig. 3.1: A beehive

3. **Super Chamber:** It is kept over the brood chamber and its construction is similar to that of brood chamber. The frames inside this chamber are called super chambers. The length and width of this chamber is similar to that of brood chamber. The height may be also similar if it is full depth super as in Langstroth hive. But the height will be only half if it in a Newton's hive. Surplus honey is stored in super chamber.
4. **Queen excluder:** Brood chamber and super chamber may be separated by a perforated sheet 'queen excluder' to restrict the movement of egg laying queen bee going into the honey super. This is a metal sheet with regular openings of the specified size, framed with wooden border. The size of opening is such that the worker can move through easily but the queen does not pass through it. The queen bee is, thus, restricted into the lower 'brood chamber' so that the honey is not contaminated.
5. **Hive Cover:** It insulates the interior of the hive. In Newton's hive it has sloping planks on either side. On the inner ceiling plank there is a square ventilation hole fitted with a wire gauze. Two holes present in the front and rear also help in air circulation. In Langstroth hive, the hive cover consists of a crown board or inner cover and an outer cover (top cover). The inner cover is provided with a central ventilation hole covered with wire gauze. The outer cover is covered over with a metallic sheet to make it impervious to rain water. Circular ventilation holes covered by wire gauze help in air circulation. It protects the hive against rain and sun.



6. **Frames:** The frames are so constructed that a series of them may be placed in a vertical position in the brood chamber or the super chamber so as to leave space in between them for bees to move. Each frame consists of a top bar, two side bars and a bottom bar nailed together. Both the ends of the top-bar protrude so that the frame can rest on the rabbet. The depth of the super frame is less than that of the brood frame in Newton's hive and India Standard Industries (ISI) hive. But in Langstroth hive it is same as that of brood frame.

Hive bodies painted externally will last longer. The colour of the paint should be white, blue, yellow or green. White is generally preferred for hive construction. It offers durability, flexibility, easy handling and improves the colony efficiency in regulating hive interior temperature and humidity.

Bee hives are constructed mainly with seasonal timber such as teak, kail or toon. The timber should be free from insect holes, dead knots, shakes, splits and cracks. The thickness of the wooden walls should be 20 mm.

Advantages of Rearing Bees in Modern Beehives

The advantages of rearing bees in modern beehives are as follows:

1. Provides sufficient space for free movement of bees.
2. Provide ample space for increasing number of workers through addition of supers.
3. Facilitates in regular and easy inspection of colonies.
4. Facilitates the bees to construct standard sized combs.
5. Pure honey can be extracted without damaging the combs.
6. Facilitates easy transportation of colonies from place to place whenever and wherever required.
7. It helps in increasing the productivity of honey and other bee products.

3.2 SPECIFICATIONS OF BEEHIVES

Langstroth hives for rearing Italian bee and Newton's hives for rearing Indian bees are most popular. The specifications of both the hives are given below:

Langstroth ten-frame hive

1. **Bottom board (floor board):** Bottom part of the hive length 22" long 16.25" broad and 7/8" thick. Another wooden rod 14.5" be nailed at the back and the front be provided with similar rod (entrance rod but having an entrance in the middle) after leaving 2" space so that these nailed rods make a rectangle of 2" x 16.5".
2. **Alighting board:** The 2" space in front of the entrance rod meant for the bees to take off flight or land on it.



3. **Entrance:** In the middle of the entrance rod is given a cut 3" long and 3/8" deep as a passage for bees to enter or leave the hive.
4. **Brood Chamber:** Is a box, made of wooden planks, without bottom and is placed over the bottom board. It is 20" in length 16.25" in width and 9.5" in height and 0.875" thick. A robbat 0.625"of deep and 0.5" wide is cut along the upper inner length of its width planks. The internal dimensions of the chamber are 18.25" x 14.25".
5. **Frames:** Each chamber contains 10 frames and a dummy board. A frame has four wooden pieces – Top bar, bottom bar and two side bars.
 - (i) **Top bar:** 19" length x 1" width x 7/8" thickness. A groove is present on lower side of top bar to insert comb foundation sheet.
 - (ii) **Side bar:** 9.125" length x 1.125" (upper half) and 1" (lower half) width 3/8" thickness. There are four holes in each of the side bar for wiring the frame.
 - (iii) **Bottom bar:** 17.625" length x 0.75" width x 0.375" thickness.
6. **Dummy board:** Just a wooden plank of the frame size Length 19" at the top and 17.625" at the bottom x 9.125" width 0.375"and thickness.
7. **Super Chamber/honey chamber with bee frames:** Same as the brood chamber.
8. **Inner cover:** Wooden plank 20" long x 16.25" wide and 0.375". Inner cover is nailed 0.375" thick, 0.875" wide wooden rod on its four sides. In the centre of the plank a suitable cut (about 2 x 3") is given which is provided with a wire screen for ventilation.
9. **Top/Upper cover:** It is the top most cover 21" long, 17" wide and 0.375" thick. This plank is provided with a frame, 2" wide 0.875" thick, its top side is covered by GI/Aluminum sheet. Inner side of the outer cover is provided with four small wooden pieces to the inner cover so that the ventilation is not blocked.

Newton's bee hive

1. **Floor board:** 14" x 9.5" in size with an extension in front which serves as an alighting board.
2. **Brood chamber:** 9.75" x 8.25" x 6.75" in size with an entrance slit of 3.5" x 3/8" at the base; it is mounted over the floor board.
3. **Wooden frames:** Eight separate wooden frames 8.75" x 5.75" x 6" in size and 7/8" broad: they are hung inside the brood chamber
4. **Super chamber:** 9.75" x 8.25" x 3.125" in size: it is kept over the brood chamber.
5. **Top cover:** It is board having same dimensions of brood or super chamber. In the centre there is an opening covered with wire gauge. It is kept on super or brood chamber.



INTEXT QUESTIONS 3.1

Fill in the blanks

- (a) Honey bees can be raised in at the farm or home.
- (b) insulates the interior of the hive.
- (c) colour paint is generally preferred for hive construction.
- (d) Four sided rectangular wooden box of cross section without a top and bottom is called
- (e) The depth of the super frame is than that of the brood frame in Newton's hive and ISI hive.

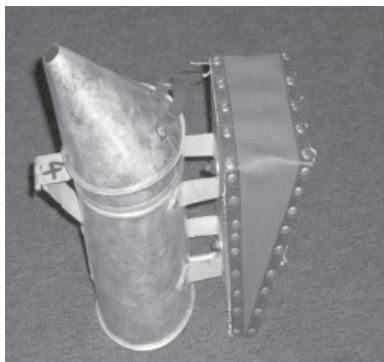
3.3 OTHER BEEKEEPING EQUIPMENTS

Besides the hives, you will need other equipment and tools like the hive stand, nucleus box and smoker to run your business smoothly. You will also need various equipments and machinery for handling and processing of honey, beeswax, for manufacture of comb foundation sheets, and for other operations. Few are described as below:

1. **Hive stand:** A four legged wooden, metal pipe or angle iron, rectangular support to the hive. It helps to protect the bottom board from rot and cold transfer.
2. **Smoker:** The smoker is used to protect beekeepers from bee stings and to control the bees. Smoke is the beekeeper's third line of defence. You may use "smoker"— a device designed to generate smoke from the incomplete combustion of various fuels to calm down the bees. Smoke initiates a feeding response in anticipation of possible hive abandonment due to fire. Smoke also masks alarm pheromones released by guard bees or when bees are squashed in an inspection. The ensuing confusion creates an opportunity for the beekeeper to open the hive and work without triggering a defensive reaction.

You may use hessian, twine, burlap, pine needles, corrugated card board, and mostly rotten or punky wood as a fuel to make a smoker. However, Indian beekeepers, often use coconut fibres as fuel for smoker as they are readily available, safe, and of negligible expense. Some beekeeping supplying sources also sell commercial fuels like pulped paper and compressed cotton, or even aerosol cans of smoke. Other beekeepers use sumac as fuel because it ejects lots of smoke and doesn't have an odour.

Some beekeepers are using "liquid smoke" as a safer, more convenient alternative. It is a water-based solution that is sprayed onto the bees from a plastic spray bottle.

**Fig. 3.2:** Smoker

3. **Protective Clothing:** To protect beekeepers eyes and nose from stings at the time of work near the apiary, proper cloths are required. As novice beekeepers you should always wear gloves and a hooded suit or hat and veil. The face and neck are the most important areas to protect, hence you should wear atleast a veil.

Defensive bees are attracted to the breath, and a sting on the face can lead to much more pain and swelling than a sting elsewhere, while a sting on a bare hand can usually be quickly removed by fingernail scrape to reduce the amount of venom injected. The protective clothing is generally light coloured and of a smooth material. This provides the maximum differentiation from the colony's natural predators. 'Stings' retained in clothing fabric continue to pump out an alarm pheromone that attracts aggressive action and further stinging attacks. Washing suits regularly and rinsing gloved hands in vinegar minimizes attraction. The important clothing and accessories are as follows:

- (i) **Bee veil:** It is a cap made of cloth and wire or fabric net. It is worn over face for protection against stings. It should be made up of black nylon netting screen (12-mesh). Veils should be made to fit snugly around the hat and to fit tightly to the shoulder leaving enough space between veil and face.

**Fig. 3.3:** Beeveil

- (ii) **Overalls:** Also known a bee suit, is a protecting garment worn loosely over the clothes so that the bees cannot get under the clothes. Light coloured cotton



Notes

materials are preferable since they are cooler and create less risk for antagonizing bees. It should be worn bee-tight so that the bees are not able to enter from the sleeves.



Fig: 3.4: Overall

- (iii) **Gloves:** Bee gloves are made of tightly-knit cloth (or) soft leather. They cover the fore arms. The gloves are useful for the beginners to develop confidence in handling bees. But handlings of frames will be cumbersome if gloves are worn.
- (iv) **High boots:** A pair of gum boots will protect the ankles and prevent bees from climbing up under trousers.

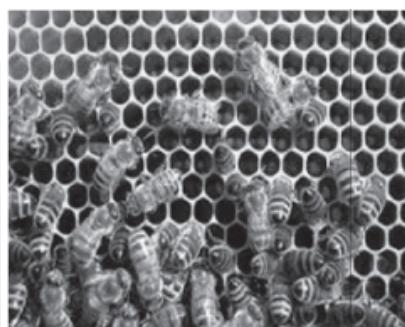


Fig. 3.5: High boots

4. **Comb foundation sheet** – is made up of wax. It is artificially provided for the colonies during honey flow season by cutting them to a proper conical size and attaching them to super frames by means of thread or fibre. It is a thin sheet of beewax embossed with a pattern of hexagons of size equal to the base of natural brood cells on both sides. The size of the hexagon varies with bee species. The sheet is fixed to the frames on fine wires threaded through holes in the side bars and stretched tight. A spur or an electrical heating device is used to embed wires into the comb foundation sheets which are prepared in a comb foundation mill. The bees construct superstructure of comb cells over the sheet.



Notes

**Fig. 3.6:** Comb foundation sheet**Fig. 3.7:** Comb cells

5. **Dummy division board/Movable wall:** It is a wooden board slightly larger than the brood frame. It is placed inside the brood chamber. It prevents the bees from going beyond it. It can be used as a movable wall thereby limiting the volume of brood chamber which will help the bees to maintain the hive temperature and to protect them from enemies. It is useful in managing small colonies.
6. **Porter bee escape board or super clearer:** It is a device which allows the bees to go through a self closing exit. A board having one way passage in the centre can also be used. It is kept in between honey super chamber and brood chamber. It is used for clearing the bees from super chamber for extracting honey.
7. **Drone excluder or drone trap:** It is a rectangular box with one side open. The other side is fitted with queen excluder sheet. At the bottom of the box there is a space for movement of worker bees. There are two hollow cones at the bottom wall of the box. Drones entering through the cones into the box get trapped. The narrow end of the cone is wide enough to let the bees pass out but not large enough to attract their attention or re-entry. This device is used at the entrance to reduce the drone population inside the hive.
8. **Swarm trap:** It is a rectangular box used to trap and carry the swarm. It is fixed near the hive entrance with one (or) two combs inside during the swarming period. This box traps and retains the queen only. But the swarm coming out from the hive re-enter the hive and settles on the comb, since the queen is trapped. Thus the swarm is induced to settle in the frame, which can now be transferred to a hive at a desired place.
9. **Pollen trap:** Pollen trapping screen inside this trap scrapes pellets from the legs of the returning foragers. It is set at the hive entrance. The collected pollen pellets fall into a drawer type of receiving tray.

**Fig. 3.8:** A pollen trap



Notes

10. **Division Board / Sugar Feeder:** It can be hung along with the frames. A wooden strip or cut bits of leaves kept inside serve as float which prevents the drowning of bees in the sugar syrup.
11. **Hive tool:** It is a piece of flattened iron with flattened down edge at one end. It is useful to separate hive parts and frames glued together with propolis. It is also useful in scrapping excess propolis or wax and superfluous combs or wax from various parts of the hive.

**Fig. 3.9:** Hive tool

12. **Queen excluder:** It is made up of perforated zinc sheet. The slots are large enough to allow the workers to pass through but too narrow for the queen. A wire grid/dividing grid with parallel wire mounts can also be used as a queen excluder. It is inserted in between the brood frames in single storey hive. It is useful to confine the queen to brood chamber. But it allows the workers to have access to super. It prevents the queen from laying eggs in honey combs. It is also used in producing royal jelly in queen rearing and in forming multi-queen colonies.

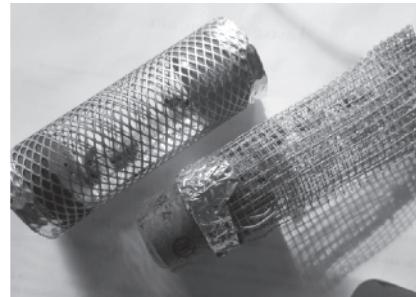
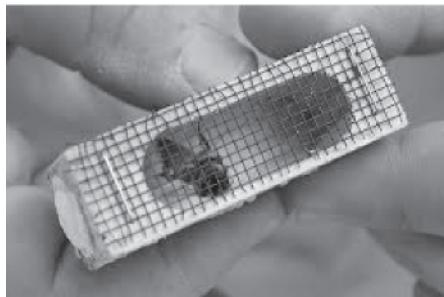
**Fig. 3.10:** Queen excluder

13. **Queen Gate:** It is a piece of queen excluder sheet. It is fitted on the slot of entrance gate. It confines the queen inside the hive. It is useful to prevent swarming and absconding. It also prevents the entry of bee enemies like wasps into the hive.

**Fig. 3.11:** Queen gate

Beekeeping Equipments

14. **Queen Cage:** It is a cage made up of wire gauze. It is useful for queen introduction.



Notes

Fig. 3.12: Queen cage

15. **Queen Cell Protector:** It is a cone shaped structure made of a piece of wire wound spirally. It fits around a queen cell. It is used to protect the queen cell, given from a queen right to a queenless colony until its acceptance by bees.



Fig. 3.13: Queen cell protector

16. **Bee brush:** A soft-camel-hair brush is used to brush the bees off the honeycomb before it is taken for extraction.
17. **Decapping knife:** Single (or) double edged steel knife is used for removing wax cappings from the honey comb.

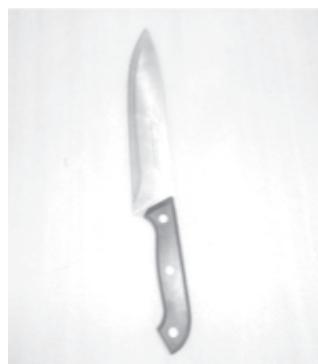


Fig. 3.14: Decapping knife



Notes

Beekeeping Equipments

18. **Honey extractor:** This equipment consists of cylindrical drum containing a rack or box inside to hold the super frames. The box is fixed to a rod at the centre and it can be rotated by a set of two gear wheels. The frames with honey cells are decapped by a sharp knife after dipping it in hot water and fixed to the slots provided in the box which is rotated by the handle. The rotation should be very gentle and slow at first and the speed of revolution increased gradually. With some experience the correct speed can be learnt. The honey in the cells is forced out in droplets by the action of the centrifugal force and can be collected in vessels through an exit in the drum. As cells are constructed on both sides of the comb, by changing the sides of the frames and again rotating, the honey contained in the cells on the other side can also be drained off. Particular care should be taken while handling heavy combs or those which are flimsily attached to the frames.
19. **Embedder:** It is a device just like screw-driver to embed the frame wires in the comb foundation sheets.
20. **Drip Tray:** It is a tray made up of stainless steel or zinc coated iron used to collect the droppings of honey and wax cappings while uncapping the sealed combs of honey.
21. **Feeders:** Used to feed sugar syrup to honeybees during dearth period.



INTEXT QUESTIONS 3.2

Fill in the blanks

- (a) is the beekeeper's third line of defence.
- (b) The smoker is used to bees and drive away bees from super chamber.
- (c) The protective clothing should be generally coloured and of a smooth material.
- (d) is a tool to embed the frame wires in the comb foundation sheets
- (e) is useful to confine queen to the brood chamber.



WHAT YOU HAVE LEARNT

Let us recapitulate and enlist salient points we have learnt through this lesson:

- Different types of bee keeping equipments are required for bee rearing.
- A beehive is an artificial structure for domesticating honeybees.
- Beehives can be divided into fixed comb hives, movable comb hives and movable frame hives.

Beekeeping Equipments

- A modern beehive consists of movable frames which hold the wax sheets that serve as a starting point for the bees to build honeycomb.
- Langstroth hives for rearing Italian bee and Newton's hives for rearing Indian bees are most popular.
- The smoker is used to protect beekeepers from bee stings and to control the bees. Smoke is the beekeeper's third line of defence.
- To protect beekeepers eyes and nose from stings at the time of work near the apiary, proper cloths are required. While knowledge of the bees is the first line of defence, most beekeepers also wear some protective clothing. The protective clothing is generally light colored (but not colorful) and of a smooth material.
- Bee veil is worn over face for protection against stings, Overall, high boots and gloves are other protective clothing.
- Comb foundation sheet, dummy division board, porter bee escape board, drone excluder, swarm trap, pollen trap, hive tool, queen excluder, queen gate, queen cage, queen cell protector, bee brush, decapping knife, honey extractor, embedder, drip tray, feeders etc are important beekeeping equipments.
- Use of recommended beekeeping equipment ensures quality production of honey and other hive products.

Notes



TERMINAL EXERCISE

1. Describe different types of bee hives.
2. Which type of hive is popular for rearing Indian Bees? Describe its dimension.
3. What kind of safety clothing should be used by a bee keeper? Write down the use of following:
 - (i) Bee veil
 - (ii) Overall
 - (iii) Gloves
 - (iv) High boots
4. What is the use of smoke in beekeeping?
5. Describe the uses of the following parts of a beehive:
 - (i) Hive stand
 - (ii) Bottom board
 - (iii) Brood chamber



Notes

Beekeeping Equipments

- (iv) Super chamber
 - (v) Queen excluder
 - (vi) Frame
 - (vii) Top cover
6. Explain the following equipments used in beekeeping:
- (i) Comb foundation sheet
 - (ii) Queen cell protector
 - (iii) Honey extractor
 - (iv) Drone trap



ANSWERS TO INTEXT QUESTIONS

3.1

- (a) beehive
- (b) Hive cover
- (c) White
- (d) brood chamber
- (e) lesser

3.2

- (a) smokes
- (b) calm
- (c) light
- (d) embedder
- (e) queen excluder



Notes

4

APIARY SITE SELECTION

We live in our house located in a village or town. Similarly, bee lives in beehive which is located in an apiary. Thus, an apiary is a place where beehives are placed and managed to allow maximum food gathering by bees. It is also termed as “bee yard”. The nectar flow in an area at a particular time is dependent on the plant species of the locality and weather conditions. Hence, the selection of site is very important to ensure regular flow of nectar by bee colony. While as a beekeeper you can do few efforts to enhance the nectar flow. A good management of bee colony may be one of the important efforts. It is recommended to maintain strong colonies at the time of maximum nectar flow to maximise honey production.



OBJECTIVES

After reading this lesson, you will be able to:

- demonstrate the knowledge of various criteria for selecting a site for an apiary;
- receive and install packaged bees;
- catch a swarm for installation of bees in a hive;
- introduce the nucleus into beehive;
- open and close beehive and inspect the bees for their conditions;
- distinguish between a strong and weak colony;
- demonstrate safe working practices in an apiary.

4.1 LOCATING AN APIARY

You must carefully select the area where you can locate your hives. The selected site should be close to your house for easy and regular supervision. There are several factors you should consider while selecting a site to place beehives. Few are as follows:



Notes

Apiary Site Selection

- Apiary should be located in areas of sufficient sources of nectar and pollen yielding plants. Bees usually forage within a 2-3 km radius of their hives, so make sure there are food sources within that radius.
- The site should be dry without dampness. High relative humidity will affect bee flight and ripening of nectar.
- Easy access to an apiary site throughout the year, with a hard path down to the apiary.
- Apiary should be established away from roads and other busy places.
- A flat site is easier to place hives.
- Apiary should not be located in animal grazing areas because beehives may be toppled.
- The site should receive sun rays in morning and evenings and shade during hottest part of the day.
- The site should be sheltered from wind, so that foragers don't struggle to land at the hive entrance and the roof stays on. A hedge provides good cover against the wind.
- Clean fresh running water should be available in the apiary or nearby apiaries.
- Dense foliage cover can make hives too wet and cold; however some shade in the afternoon helps the bees to work less to cool the hive or even dying from heat exhaustion or collapsing honey combs. Hence, avoid placing hives under dense foliage.
- Enclose the apiary with a barrier of some sort, such as a hedge or fence to force the bees to fly in above head height.
- Avoid establishment of apiaries in poor drainage areas and heavy pesticide use areas.
- Keep the area around the hives clear of tall weeds or grass. Cut grass and weeds – don't use spray of any kind.
- The distance between two hives should be atleast 3 meters.
- An apiary should not have more than 25-40 hives. If too many hives are placed into an apiary the bee colonies compete with each other.
- Facing the hive entrance to the East is the best way to get the most work out of bees as they usually fly from morning until early afternoon. If the bees see the sun early, they will start work earlier.



Fig. 4.1: Bee colonies in apiary

**INTEXT QUESTIONS 4.1**

Notes

State True or False

- Apiary should be established near the roads.
- Apiary site should receive sun rays in the morning and evenings and shade during hottest part of the day.
- Bees usually forage within a range of 2-3 km radius of their hives.
- Dense foliage is required for shading the hives.
- The distance between two hives in an apiary should be atleast 5km.

4.2 STARTING A COLONY

As a beginner, you may start beekeeping by purchasing established colonies from a local beekeeper or the State Department of Agriculture/ State Agricultural University/ Research Institution/ Khadi & Village Industries Board. Normally a bee colony with 5 frames full of bees having sealed brood and immature brood, especially with eggs and young queen should be used to start hiving. Following tips may be useful to you:

- Make preparations:** Before setting up an apiary, you should be ready after undergoing proper training, buying new equipments, assembling new hives with the help of an expert, ordering new colonies well in advance, etc.
- Start small:** Two or four colonies are ideal number for a beginner to keep for one or two year. Expand the colonies as you gain experience.
- Execute work:** When the package of bees arrives, your hives should be on the site. Prepare a work schedule and follow strictly.

Suitable season for starting beekeeping coincides with mild climatic conditions and availability of bee flora in plenty. Normally, spring (February-April) and post-monsoon (September -November) seasons are the best periods to start beekeeping.

4.3 ESTABLISHMENT OF A BEEHIVE

A new beehive may be established by following ways:

- Capturing a swarm of bees
- Purchase a packaged bee colony
- Using of nucelus

4.3.1 Capturing a Swarm of Bees

To establish a bee colony, bees can be obtained by transferring a wild nesting colony to a hive or attract a passing swarm of bees to occupy it. Collecting honey bee swarms in the



Notes

Apiary Site Selection

spring is an excellent way to replace winter losses, strengthen weak colonies, or start new ones. Swarms normally cluster on a tree limb shrub, fence post, or on the side of a building. Swarms near the ground are relatively easy to capture. When possible, remove the swarm gently, disturbing the cluster as little as possible, and put it directly into a hive or enclosed container to transport it to a new hive or location. Before putting a swarm or even a colony in a prepared hive, it would be beneficial to make the hive smell familiar by rubbing old brown comb pieces or some bee wax. If possible, the Queen bee can be captured from a natural swarm and placed under a hive to attract the other bees. Feed the hived swarm for a few weeks with sugar syrup for its easy establishment.

4.3.2 Purchase a Packaged Bee Colony

The easiest and the best way to start beekeeping is by purchasing a packaged bee colony from an established beekeeper or a reputed supplier. A package consists of about 3000-4000 bees. It has a cage with a young mated queen and two or three worker bees to care for her. The cage contains sugar candy as a food source. A cage containing sugar syrup is positioned in the middle of the package for feeding the bees during transportation. The package bees may not produce a honey crop in the first year. The bees will have to be fed until the start of the nectar flow.

4.3.3 Using Nucleus

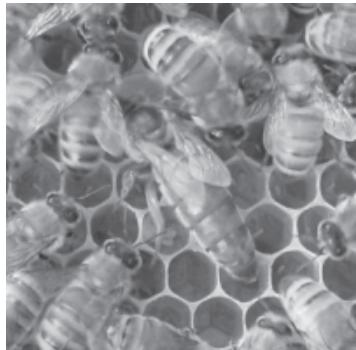
A nucleus, popularly known as “nuc”, is a hive of bees comprising two to five frames of comb instead of the standard 10 frame in a standard hive and smaller in size. A nucleus usually consists of brood, honey and pollen, a laying queen, and each frame has adult bees. Get them inspected for any disease or pest by an expert. If the nucleus colony is strong then there is a possibility of getting a honey crop in the first year itself.

4.4 DIVISION OF COLONY

A colony can be divided when it has a large population of bees, brood and appears overcrowded. The main reasons for dividing colonies are:

1. To increase the number of productive hives.
2. To reduce the size of colonies to discourage swarming.
3. To control mites.
4. To gain income from sale of nucleus colonies.

In the spring, a large colony preparing to swarm is an excellent time to divide. Prior to swarming, a colony produces many queen cells on the bottom portion of frames in the brood area. Once the queen cells are capped, swarming is imminent. Dividing the colony is one method to reduce overcrowding in the brood area and to discourage swarming. To split the colony, you have to move bees and frames of comb physically to another hive in a different location. Add a new queen to form the second colony in the new location. This will result in two smaller colonies, each with its own queen.

**Fig. 4.3:** Queen cells**Fig. 4.2:** Queen with worker bees

INTEXT QUESTIONS 4.2

Fill in the blanks

- The best time to start beekeeping are and
- Swarms nearly cluster on a , or
- is the easiest way to start beekeeping.
- A packaged bee colony consists of about bees.
- is the excellent time to divide a large colony.

4.5 INSPECTING THE BEE COLONY

Before selecting a bee colony, it is necessary to inspect it. When you inspect the brood frames, you should look for a healthy brood pattern. Signs of a healthy and weak colony are given Table 4.1:

Table 4.1: Characteristics of a strong and a weak colony

Strong colony	Weak colony
Healthy larvae or young brood are pearly white	Grey, yellow, brown or black larvae are disease, chilled or injured
Eggs laid by the queen is 1 per cell and stands at the bottom of the cell	Two or more eggs up on the sides of the cell are from a laying worker
Cell caps of healthy brood are convex	Cell caps of unhealthy brood are often concave and perforated with small holes
A prolific queen will have a laying pattern of brood with very few skipped cells over most of the frame	A poor laying queen have a laying pattern with large number of skipped cells over most of the frame
Honey stores in a colony would be at least six super frames or three deep brood chamber frames completely filled with capped honey.	-



Notes

Apiary Site Selection

Checklist for inspecting the hive:

1. Is the queen there and laying eggs, also called “queen right”? We can tell that a hive is queen right if we see eggs in the hive. If we see only the queen, but no egg then the hive is not queen right.
2. Are the bees healthy i.e. look for any signs of damage or attack by the pests and diseases?
3. Do they need feeding?
4. Do they have plenty of space to expand and store honey in the combs?

4.6 SAFETY MEASURES

It is good to remember that ‘prevention is better than cure’. If you follow this rule you will be able to avoid most of the hazards that may threaten your valuable life and of others too.

- (i) **Protect yourself from Sting of Bee:** As a beginner, you should always wear the overall, bee gloves and rubber boots to protect yourself from the stings of the bees. You should always use a smoker before opening a beehive. Smoke has a calming effect on bees and a light puff of smoke at the entrance hole calms the bees and makes inspecting easier.

A bee stings when you visit a hive during the warm period of the day and disturb them without smoke. Don’t make any noise when bees are busy. Standing in the flight path and wearing dark clothes attract bees.

Do not crush a bee near a hive as the juice from the bee’s body will attract other bees and you may be attacked by them. The sting of bees could be fatal. Avoid using after shave lotion and perfumes when working with bees. Wash your clothes regularly to eliminate the smell. Consult your doctor before you start beekeeping for allergy to bee stings, if any. In case you are stung by a bee, remove the sting immediately by scraping or plucking the sting, as any delay will increase the quantity of venom injected.

- (ii) **Avoid burns:** You should be careful while using smoke as any negligence in handling may cause burn injury to you. Extinguish the smoker carefully after you finish the work. Always keep a handy first aid kit while working with smoker.
- (iii) **Use tools carefully:** Learn to use the tools as per instructions, as it will help you in avoiding cuts and bruises while using them.
- (iv) **Avoid too much exposure to heat:** Take necessary precautions while working on hotter part of the day to avoid heat stroke. Do not expose yourself continuously to the direct sunlight for long hours. Take breaks to avoid heat cramps, heat exhaustion or heat stroke.
- (v) **Avoid stress:** Beehives are heavy, therefore you should be careful while lifting them. Do not stress yourself too much while doing lifting and bending work. Use correct postures such as bending your knees when lifting.



INTEXT QUESTIONS 4.3

Fill in the blanks

- Healthy larvae or young brood in a bee colony are
- Cell caps of brood are often concave and perforated with small holes.
- Always wear the to protect yourself from the stings of the bees.
- Any negligence in handling may cause burn injury.
- Use correct such as bending your knees when lifting a beehive.



WHAT YOU HAVE LEARNT

Let us recapitulate and enlist salient points we have learnt through this lesson:

- Due care should be taken while selecting a site to place a beehive.
- A bee colony with 5 frames full of bees having sealed brood and immature brood, especially with eggs and young queen should be used to start hiving.
- Spring (February-April) and post-monsoon (September -November) seasons are the best periods to start beekeeping.
- A beehive may be established by capturing a swarm of bees, purchasing a packaged bee colony or using nucleus.
- To establish a bee colony, bees can be obtained by transferring a wild nesting colony to a hive or attract a passing swarm of bees to occupy it.
- The easiest and the best way for you to start beekeeping is by purchasing a packaged bee colony from an established beekeeper or a reputed supplier.
- A colony can be divided when it has a large population of bees, brood and appears overcrowded.
- Colony is divided to increase the number of producing hives, to reduce the size of colonies, to discourage swarming, to control mites and to gain income from sale of nucleus colonies.
- Inspection of the brood frames is required to select a healthy bee colony.



TERMINAL EXERCISE

- Write down the major factors responsible for selecting a site for apiary.
- How should you place hive in the apiary?
- When should you hive your new package of honey bees?



Notes

Apiary Site Selection

4. How many hives should have in one place for a reasonably good profitable business?
5. What are the reasons for dividing a bee colony?
6. Differentiate between a healthy and weak colony.
7. What should you observe while inspecting a beehive?
8. Write down the ways one can avoid stings of bee.



ANSWERS TO INTEXT QUESTIONS

4.1

- (a) False (b) True (c) True (d) False (e) False

4.2

- (a) Spring and post-monsoon
(b) tree limb shrub, fence post, on the side of a building
(c) Packaged bee colony
(d) 3000-4000
(e) spring

4.3

- (a) pearly white
(b) unhealthy
(c) overall, bee gloves and rubber boots
(d) smoker
(e) postures



Notes

5

APIARY MANAGEMENT

In the previous lesson we have learnt various criteria for selecting a site to establish an apiary. We also learnt about installing packaged bees, catching a swarm, introducing the nucleus into beehive, opening and closing beehive and inspecting the bees for their conditions. Now, you can also distinguish between a strong and weak colony and work safely in an apiary.

The first management step in beekeeping is obtaining bees in a manageable hive. Once you have established the hive, inspect it regularly and manage according to its need.

The goal of apiary management is to aid the colony to build up to its maximum during the main nectar flow and to survive the dearth. Well-managed colonies assure the greatest possible return for the beekeeper.



OBJECTIVES

After reading this lesson, you will be able to:

- explain the basics of apiary management;
- manage bees in different seasons;
- learn bee swarming and its management;
- unite two colonies;
- manage beekeeping records;
- manage bee colonies for pollination.

5.1 MANAGEMENT OF COLONIES

Let us learn the general apiary management practices you should follow in an apiary.



Notes

5.1.1 Colony Inspection

Inspect the beehives at least once in a week during the honey-flow seasons preferably during the morning hours to observe the presence of healthy queen, brood development, storage of honey and pollen, presence of queen cells, bee strength, growth of drones and presence of bee enemies like wax moth, mites and diseases.

5.1.2 Cleaning in Beehive

Clean hive in the following sequence: roof, super chamber, brood chambers and bottom board. Use thin knife to scrape and destroy eggs of wax moth laid in slits or cracks of beehive.

5.1.3 Feeding Bees with Sugar Syrup

Provide sugar syrup (1 part sugar and 1 part water) to feed bees during dearth period. Feed all the colonies in the apiary at the same time to avoid robbing particularly in dearth period.



Fig. 5.1: Sugar syrup feeding to honeybees

5.1.4 Addition of Artificial Comb Foundation Sheets

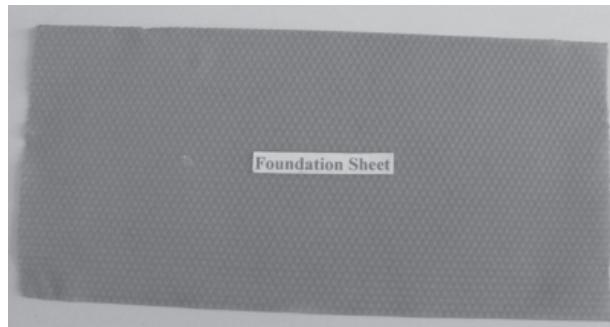
Comb foundation sheets (Figure 5.2) are thin sheet of beeswax with the cell bases of worker cells embossed on both sides in the same manner as they are produced naturally by honey bees. The comb foundation sheets are fixed in the empty wooden frames (one in each) so that bees raise them as worker combs for laying eggs or storing honey, which increases the honey yield. Comb foundation for *Apis mellifera* is designed to fit the Langstroth hive brood frames and can be cut to fit the super frame. Comb foundation for *Apis cerana indica* is designed to fit the Newton hives; it is smaller and has a smaller cell size.

Using comb foundation sheets has a number of advantages-

- Comb foundation sheet saves the bee's time and energy in building new combs.



Notes

**Fig. 5.2:** Comb foundation sheet

- It helps in production of straight regular combs which are easy to handle and fits well in honey extractor.
- Combs are stronger and will not be damaged during migration.
- Drone production in a hive can be minimized as the foundation sheets does not have the larger cells needed for drone rearing. When the bees want to rear drones, they adapt the foundation and make larger cells.

Providing artificial comb foundation sheet in empty frame during honey flow period reduces strain on honeybees for construction of combs.

5.1.5 Bee Swarming and its Management

Swarming is the natural process of multiplication of honey bee colonies. In this process the old queen bee accompanies the swarming bees, leaving behind a cross-section of the old population, having a few queen cells from which the new queen bee emerges. In case the swarming colony is not managed properly and timely, it may issue secondary and tertiary swarms and causes great loss to the beekeeper. Sometimes, when bees swarm in the end of the breeding season the new queen in the mother colony remains unmated and ultimately bee strength dwindles. Even if the queen mates after some days, the colony is unable to build up to a desirable strength for the full exploitation of ensuing main honey flow.

The appearance of drones, queen cells and over-crowded condition in the brood nest are essential pre-requisites of a swarming colony. The presence of larger cells with coarse surface on the periphery of the comb also indicates that the colony is going to issue a swarm.

A. Control of Swarming

- (a) **Preventive measures:** Prevention of swarming in a colony is concerned with the steps that need to be taken to prevent over-crowding and queen cell construction in the honey bee colony.
 - (i) **Removal of congestion:** To avoid congestion in a colony, the timely and adequate provision of space is the most important and vital operation to be



carried out. As a good beekeeper you should always remain ahead of bees in providing the space. The drawn combs if available should be inserted, otherwise frames with comb foundation sheets be added. Foundation sheets should be properly fixed in the frames and embedded on wires so that bees may accept them easily. These new frames should be put in between the middle bee frames having honey or brood so that these are immediately accepted. After inserting new frames, push all the frames towards one side to ensure proper bee space. The colony which is already full with 10 bee frames may be provided with a super if division of the colony is not desired. While providing super, to make the bees accept new chamber easily, baiting in the form of one or two bee frames with some food reserves or brood should be provided in between empty drawn combs/frames with foundations in the super.

- (ii) **Reversing:** When the colonies are at super, reversing the chambers (brood chamber with super and vice versa) is the simplest and easiest method of swarm prevention. It should be done at fortnightly interval. The queen bee has a tendency to restrict her activities in one chamber only. Consequently, that chamber usually becomes over- crowded with the brood and sometimes with food. By reversing the chambers, more space becomes available for laying. The queen bee in the due course of time will shift to the lower chamber, thus relieving the immediate congestion and deterring the construction of queen cells.

(b) Remedial Measures

- (i) Measures such as clipping of queen which involves cutting the wings of the queen by half especially one wing; caging the queen by putting wire entrance guard or by placing queen excluder in between bottom board and brood chamber and destruction of queen cells can delay the swarming but cannot completely prevent the colony from issuing a swarm.
- (ii) The urge of swarming gets subsided by dividing the colonies. You can make more colonies either for own apiary or to sell them out to beginners. However, if your aim is not the multiplication, then the divided colonies can be re-united just before the start of honey flow. By that time the swarming urge gets subsided. During uniting, the older queen should be killed and new one which would then lead the colony would show less swarming urge.

B. Collecting Swarms

Collecting honey bee swarms in the spring is an excellent way to replace winter losses, strengthen weak colonies, or start new ones. Primary swarms are valuable; they may contain as many as 25,000 bees plus the queen. You should consider three points in mind before attempting to collect a swarm:

1. How long the swarm has been there?
2. Where the swarm is located, and
3. Its size.



Notes

There are various methods to capture a swarm. When the swarm first settles down and forms a cluster it is relatively easy to capture the swarm in a suitable box. Swarms normally cluster on a tree limb, shrub, fence post, or on the side of a building. When possible, remove the swarm gently, disturbing the cluster as little as possible, and put it directly into a hive or enclosed container (a cardboard box with a tight-fitting lid works well) to transport it to a new hive or location. If the swarm cannot be cut down, either shake or scrape the bees into a lightweight box (Fig. 5.3). When a swarm settles in a very high tree or on any other inaccessible structure, it is best to leave it there. Such swarms may be an after-swarm with one or more virgin queens and their successful capture can be very difficult. Sometimes you can knock these high swarms into a bucket at the end of a long pole and then lower it to a collecting box. The success rate, however, is very low.



Fig. 5.3: Swarms collected in light-weight box with a tight-fitting lid are easy to transport back to the apiary

Once you have successfully captured a swarm, introduce the swarm into your own equipment by either shaking or dumping the bees into an open hive with several frames removed or simply by shaking it in front of the hive. If you are successful in getting the queen with the rest of the swarm, the bees will adopt the hive. Using drawn combs is better than foundation when introducing swarms to an empty hive, but one or two drawn combs, preferably with pollen, brood, and/or honey (from a disease-free colony), combined with foundation also works. Instead of waiting for swarms to simply appear, you can try baiting swarms. Pheromone lures (available from beekeeping supply companies) placed in special light-weight bait hives or empty hive bodies (with or without drawn comb) can be used to lure swarms. Place trap boxes in exposed locations 8–15 feet off the ground (with entrance reduced to keep birds and squirrels out) and check weekly during the swarm season (April–June, depending on your location). This way you can transfer any swarms into a standard hive in a timely fashion.

Precautions: You should follow following precautions while swarming:

- Release the swarm in the beehive during evening hours.
- Smoke is not recommended to calm a clustered swarm. Smoke will have the opposite effect on a clustered swarm as many bees will become agitated and fly about instead of settling down.



Notes

Apiary Management

- The colonies should be kept in shade as shade makes the bees to tolerate lesser ventilation and overcrowding to some extent.
- Bee colonies headed by older queen are more prone to swarming. Efforts to change the queen in early spring are remunerative in reducing swarming.

5.1.6 Uniting Bee Colonies (Newspaper Method)

Remove the outer and inner covers of colonies to be united and put a single sheet of newspaper on the top bars of strong colony. Make small holes in the newspaper with a small pin. This helps hive odours pass back and forth between the strong colony and the weak one that you're about to place on top. Take the hive body from the weak colony without queen and place it directly on top of the stronger colony's hive. Only the perforated sheet of newspaper separates the two colonies. After two days both the colonies join into one strong colony.



Fig. 5.4: Uniting bee colonies through newspaper method

5.1.7 Avoid Spraying of Pesticides when Crop is in Blooming

Many pesticides are extremely toxic to honey bees and other beneficial insects. Honey bees are attracted to blooming flowers of all plant species. If at all possible do not spray blooms directly with pesticides for pest management. If the pesticide needs to be sprayed, apply it in the evening hours.

5.1.8 Extraction of Honey

The combs, which are completely sealed or two-third capped may be taken out for extraction of honey and returned to supers after honey extraction. There are four steps involved in honey extraction.

Step 1: Open the Hive



Step 2: Remove bees from the frames which are selected for extraction

Step 3: Uncap the cells of honey comb

Step 4: Extract the Honey by using honey extractor

Step 5: Strain and bottle the honey



Fig. 5.5: Uncapping the cells of honey comb



INTEXT QUESTIONS 5.1

1. Fill in the blanks
 - (a) The ratio of sugar and water is for preparation of sugar syrup.
 - (b) For uniting two colonies of bees method is used.
 - (c) Spraying of pesticides is avoided when crop is in stage.
2. Indicate True or False
 - (a) Fifty per cent capped honey combs are ready for honey extraction.
 - (b) Clipping of wings of queen is done to prevent swarming.
 - (c) Provide artificial comb foundation sheet in dearth period.

5.2 SEASONAL MANAGEMENT

The climate and vegetation in different areas is different from season to season. Hence, follow specific management tactics as follows:

5.2.1 Honey Flow Season Management

- Provide more space for honey storage by giving artificial comb foundation sheets.
- Place queen excluder sheets in between brood and super chamber to confine the queen to brood chamber to prevent egg laying in super chamber as it is meant for honey production.
- Prevent swarming.
- Prior to honey flow, use sugar syrup to stimulate the queen to start laying in the spring.



Notes

Apiary Management

- Divide strong colonies into 2-3 new colonies, if colony multiplication is required.
- Artificial queen grafting technique may be followed to produce new queens for new colonies. By following this technique, queens can be produced throughout the year. In normal case queen cells are constructed only in honey flow season.

5.2.2 Summer Management

- To reduce the effect of high temp in summer the colonies are kept under shade of trees or shade provided with sheds.
- Place gunny bags on all sides of beehive except entrance and sprinkle water twice a day.
- Increase ventilation by introducing a splinter between brood and super chamber.
- Provide sugar syrup and pollen supplement.
- A source of fresh water within a short distance of an apiary is essential. Water is required to blend with the food and to lower the temperature of the hives during hot weather.

5.2.3 Winter Management

- Strong colonies perform well in winter as more bees produce heat.
- All cracks crevices and holes should be closed.
- The direction of hives should be in such a way to avoid winds entering.
- Artificial diet should be given to maintain strong and disease free colonies.
- Provide new queen to the hives.
- Winter packing in cooler areas.

5.2.4 Rainy Season/Monsoon Management

- A regular examination of the colony immediately after rains.
- Clean the hive to reduce undue water contents inside the hive.
- While raining when bees are confined to the hive, feed them with sugar syrup.



INTEXT QUESTIONS 5.2

1. Fill in the blanks
 - (a) The queen excluder sheet is placed in between and during honey flow season management.
 - (b) Artificial comb foundation sheet is provided to beehive for
 - (c) Provision of fresh water is compulsory near beehive in season.

**2. State True or False**

- (a) Sugar syrup feeding before honey flow period is to stimulate bees to lay eggs.
- (b) Swarming should be prevented during winter season.
- (c) Inspection of colonies is usually done frequently after rains.

5.3 PRECAUTIONS WHILE HANDLING THE BEES

Follow following precautions while handling bees during various activities of apiary management:

- Handle bee colonies very gently with little disturbance.
- Use bee veils, gloves, overall etc to prevent sting to any part of the body.
- Don't keep mouth open to avoid sting to tongue which may lead to dangerous or even fatal.
- Colonies should be inspected from sides and not from the front of the hive.
- Combs with honey quickly attract robber bees under conditions other than nectar flow. If robbing starts, stop examinations for the rest of the day.
- If a colony becomes noisy or very flighty it is best to close the hive.
- Consult physician after stings by bees.

5.4 BEEKEEPING RECORDS

The maintenance of records is helpful to indicate the state of the colony each time it is inspected. By proper recording you may identify the location of hives in apiaries and plan the management programme for the next season. The record book comprises of three parts:

Apiary layout

This can be a pictorial record to show the location of each colony in the apiary and its identifying mark. Hives on apiaries should be marked to reduce the possibility of theft and identification.

Plan of work in the season

It is particularly useful to record the activities and timing to use for queen rearing and swarm control. It can also be used as a reminder for repairing hives or buying new equipment. Information may also include the dates when specific operations must be carried out e.g. for queen rearing or preparation of an observation hive for a particular occasion.



Notes

Records of the season

This will inform you about the quantity of honey collected during the season and the quality of the queens. Records will also include the state of the hives and the work needed for the next season (Table 5.1):

Table 5.1

Date	Presence/ Absence Queen	Queen cells	Brood	Stores	Egg laying space	Healthy/Diseased	Temperament	Feed (Sugar syrup)	Supers	Weather	Remarks

5.5 MANAGEMENT OF BEE COLONIES FOR POLLINATION

Pollination is the transfer of pollen grains (the male sex cells of a flower) from the anther where they are produced to the receptive surface, or stigma, of the female organ of a flower. Recall your knowledge that plants generally exhibits two modes of pollination: self pollination and cross pollination. Self pollination is the transfer of pollen grains from the anther to the stigma of the same flower. Cross pollination is the transfer of pollen grains from the anther of a flower to the stigma of a flower of a different plant of the same or different species. There are many crops that cannot produce seed if pollinated by their own, hence cross pollination is required. Bees, wasps, moths, butterflies, flies, beetles, mammals, and other vertebrates cross pollinate plants. You may find it interesting that pollination by insects is called entomophily but among the different insects it varies, such as by beetles (cantharophily), flies (myophily), bees (melittophily), butterflies (psychophily), ants (myrmecophily) and moths (phalaenophily). Honey bees are one of the most important pollinators of agricultural crops as they are most efficient carriers of pollen from the anther to the stigma.

5.5.1 Qualities of honeybees that make them very effective pollinators

- Bees are social, live in colonies, young ones (grubs) fed with mixture of honey and pollen by adults throughout year.
- Bees are extremely hairy. Each hair has a branched structure that makes it highly effective at catching pollen. While flying to the next flower, the honeybee will brush



herself and move many of the pollen grains, to arrange them in the pollen baskets made of stiff hairs on her hind legs.

- Honey bees have good sense of vision and smell.
- Body size and proboscis length of bees are suitable for many crops.
- Honey bees have long potential hours, they start in the morning and stop in the evening
- Bees do not injure the plants.
- No diapause (resting period) is observed.
- They are adapted for different climates.
- Honeybees are mass reared for commercial purpose.
- Floral fidelity makes honey bees as good pollinators (collect pollen of just one species).
- Honey bee colonies are mobile. Hives are easily moved to locations where there are not enough pollinators to adequately pollinate a specific crop.
- Pollinate wide variety of crops.

**INTEXT QUESTIONS 5.3**

1. Fill in the blanks
 - (a) Insects aid in pollination of plants is known as
 - (b) Honey bees carry pollen balls on legs.
 - (c) Honey bee stores and in combs for future use.
2. State True or False
 - (a) Honey bees visit flowers for collection of pollen, nectar and propolis.
 - (b) Honey bees cause damage to the crops.
 - (c) Honey bees undergoes diapauses period in its life cycle.

5.5.2 Source of bee colonies for pollination

You can get the bee colonies from local beekeeper or from Government agencies. It is important that the selected bee colonies should be large, strong with unsealed brood for better pollination because larger colonies have more forage bees. Colonies should be well settled, disease free and with strong laying queen. Weak colonies are of little value for crop pollination.



Notes

5.5.3 Transport of bee colonies for pollination

- Before shifting of colonies close the entrance and see proper ventilation. Close the hive during night because all bees return to hive in the night. Beehives are always moved at night when they don't fly and temperature are cooler.
- Remove honey supers from the hive to reduce the weight. Leave only the brood chamber and one empty super on the hive.
- Secure the entrances to the hive by stapling window screen or fine-mesh hardware cloth over the hive entrance. Staple screen over top of the colony. This will keep bees inside the hive while allowing ventilation.
- Attach the hive bottom board to the bottom of the brood chamber with special hive staples. While similar in shape to regular staples, hive staples have points that are 2 inches apart to hold hive components together.
- Attach the other frames to each other in the same manner. Leave enough room so the staples can be removed later.
- Run two nylon straps vertically around the sides of the hive. Tighten the straps to secure the hive bodies. The straps serve as backup protection for the hive staples.
- Place the hive inside the transport vehicle.

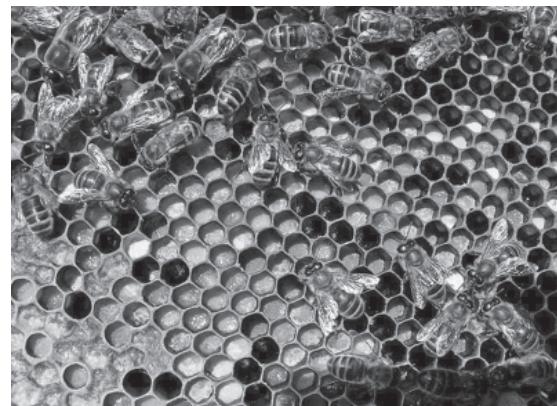


Fig. 5.6: Honey bee comb with pollen

- Double-check that all hive components are securely attached, so that nothing will fly off in transport and become a safety hazard to others.
- Place the hive in its new location and allow it to sit overnight. Remove entrance screen from the hive in one movement.

5.5.4 Management of honeybees for pollination of crops

European honeybee, *Apis mellifera* and Indian honeybee, *Apis cerana indica*, both are hive bees and are used for crop pollination. Honeybee colonies should be managed properly before and at the time of flowering to produce qualitative and quantitative yield of crops.



Notes

5.5.4.1 Foraging Strength of Colonies

Large and stronger colonies are better pollinators than smaller and weaker ones as it has greater foraging bee population at all the times. Bee colonies to be used for pollination should have 8-9 frames in each colony. They must be free from brood (egg, grub, and pupa) and adult diseases. Bee colonies should be removed from the field after blooming is over.

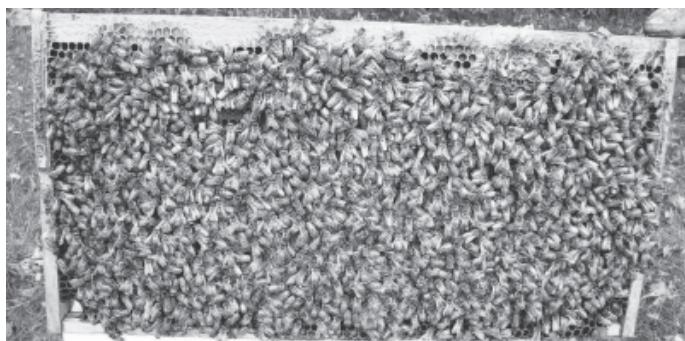


Fig. 5.7: A standard comb with brood and adult bees

5.5.4.2 Number of Colonies

The number of honeybee colonies required for optimum pollination in one unit area of crop varies from crop to crop and season to season. However, three beehives of *Apis mellifera* per hectare and five beehives of *Apis cerana indica* are sufficient to pollinate many crops.

5.5.4.3 Time and Placement of Hives

Place colonies of bees in a field when 5-10 per cent crop is in bloom. If colonies are placed early, bees will forage on crop plants like weeds, and other wild plants that are present in the vicinity of bees. If placed late the bees ignore the blooming. Place hives in ample sunlight and do not place them in low areas which accumulate cool, damp air. Chilly, shaded bees are poor pollinators. As much as possible, keep hives away from farm workers, pedestrians and livestock.

5.5.4.4 Distribution of Colonies in Fields

Usually bees visits sources of pollen and nectar confined to a radius of 1-2 km area. For effective pollination, hives should be placed singly instead of in groups. Bees forage in the area closest to their hives.

5.5.4.5 Increase the Attractiveness of Crops

Spray sugar or honey solution on unattractive crops to attract more forage bees. Feed the bees with sugar syrup in early morning hours to increase bee visits to crop. Directing bees to crops is difficult if the crop has low pollen or nectar sources when compared to nearby forage. Forage on target crops can be increased when odour of target crop is incorporated into colonies food sources.



Notes

5.5.4.6 Increase the Number of Pollen Collectors

Pollen collecting bees are good pollinators than nectar gatherers. To increase pollen collectors, remove pollen stores from the hive at regular intervals.

5.5.4.7 Water Sources near the Hive

Water is essential for survival of the hive. If there is no source of natural water like a spring or a pond, water should be provided near the hive.

5.5.4.8 Colony Replacement or Rotation

Colony replacement or rotations are management options used to increase foraging on crops. Bees that are just moved into an area tend to forage closer plants but rapidly moves outwards. Pollination of crops may be increased by replacing old colonies with new colonies.

5.5.4.9 Avoid Division of Colonies just before the Pollination

Beekeepers should avoid making splits just before the pollination period, as new colonies will not be able to pollinate the target crop as efficiently as established ones.

5.5.4.10 Bees and Pesticides

Do not spray pesticides while crop is in blooming and bees are visiting to it. If it is essential apply granular and solutions which are safer formulations than wettable powders and dusts. Many insecticides are deadly to bees when they are first applied but degrade within hours to a safer level. Since bees only forage in daylight, apply bee-hazardous pesticides in early evening. By morning the insecticide has controlled the target pests, but the residue gets reduced and risk to bees minimizes.

5.6 ADVANTAGES OF BEE POLLINATION

Following are the advantages of bee pollination:

- Improved seed viability.
- More nutritive and aromatic fruits are formed.
- Increased vegetative growth and faster plant growth.
- Increased nectar production.
- Increased fruit set and reduced fruit drop.
- Enhanced resistance to diseases and other adverse climatic conditions.
- Enhanced oil content in oilseed crops.
- Improved crop yield.

**INTEXT QUESTIONS 5.4**

Notes

1. Fill in the blanks
 - (a) Avoid spraying of pesticides while crops in stage against pests.
 - (b) Honey bees which collect nectar and pollen from plants are known as
 - (c) Place colonies of bees in a field when per cent crop is in flowering for pollination.

2. State True or False
 - (a) All castes of honey bees collect nectar and pollen from plants.
 - (b) Pollen collecting bees are good pollinators than nectar gatherers.
 - (c) Honey bees improve oil content of oilseed crops like sunflower.

**WHAT YOU HAVE LEARNT**

Let us recapitulate and enlist salient points we have learnt through this lesson:

- Inspection of beehives is done at least once in a week during the honey-flow seasons preferably during the morning hours.
- Clean hive in the following sequence using a thin knife: roof, super chamber, brood chambers and bottom board. Feeding bees with sugar syrup.
- The comb foundation sheets are fixed in the empty wooden frames (one in each) so that bees raise them as worker combs for laying eggs or storing honey, which increases the honey yield.
- Comb foundation for *Apis mellifera* is designed to fit the Langstroth hive brood frames and can be cut to fit the super frame. Comb foundation for *Apis cerana indica* is designed to fit the Newton hives; it is smaller and has a smaller cell size.
- Swarming is the natural process of multiplication of honey bee colonies.
- In swarming the old queen bee accompanies the swarming bees, leaving behind a cross-section of the old population, having a few queen cells from which the new queen bee emerges.
- Two bee colonies may be united by newspaper method.
- Avoid spraying of pesticides when crop is in blooming.
- Extraction of honey is done when completely sealed or two-third capped.
- Management of bees as per season is essential.
- Maintaining records may help in identifying the location of hives in apiaries and plan the management programme for the next season.
- Management of bee colonies is required to make bees effective pollinators.



Notes



TERMINAL EXERCISE

1. Describe the following in brief
 - (a) Honey flow season management
 - (b) Uniting bee colonies
2. Give the steps in honey extraction.
3. Write short notes on
 - (a) Capturing of bee swarm
 - (b) Division of bee colony
4. Mention qualities of honeybees which make them very effective pollinators.
5. What are the benefits of bee pollination?
6. Why it is important to keep records in beekeeping?
7. Which qualities of honeybees make them very effective pollinators?
8. How the honeybee colonies can be managed for crop pollination.



ANSWERS TO INTEXT QUESTIONS

5.1

1. (a) 1:1 (b) newspaper method (c) blooming
2. (a) False (b) True (c) False

5.2

1. (a) Brood and Super chambers (b) more honey storage
(c) Summer
2. (a) True (b) False (c) True

5.3

1. (a) entomophily (b) hind legs (c) pollen and nectar
2. (a) True (b) False (c) False

5.4

1. (a) blooming or flowering stage (b) forage bees
(c) 5-10%
2. (a) False (b) True (c) True



Notes

6

PESTS AND DISEASES IN BEEHIVE

Honeybee colonies are vulnerable to various pests and diseases for bee brood, adult bees and hive products. Honeybee colonies are affected by a variety of parasitic mites. Wax moths are the major pests of honeybees in tropical and sub-tropical regions and cause greater damage especially during dearth season. Similarly, several species of ants and wasps are known to predate on the brood and adult honeybees. Many species of birds and mammals including monkeys have an impact on beekeeping industry in many parts of the world.

Among bee diseases, only a few viral, bacterial, fungal and protozoan diseases are catastrophic to beekeeping industry. However, a successful, least expensive and ecofriendly management of pests and diseases is indispensable for overall development of beekeeping for honey production and effective crop pollination.

Let us identify some of the major enemies of honey bees and understand the control measures that you should adopt to control them. For more details, you must discuss with an expert, read books, and browse websites on internet.



OBJECTIVES

After reading this lesson, you will be able to:

- identify the pests of honeybee colonies;
- detect the diseases of honeybee colonies;
- manage pests and diseases of honeybee colonies.

6.1 PARASITIC MITES ATTACKING HONEYBEES AND THEIR MANAGEMENT

Parasitic mites are economically important as they cause significant loss to honeybee colonies. These are categorized into endoparasitic and ectoparasitic mites. *Acarapis woodi*, *Varroa destructor*, *Varroa jacobsoni* and *Tropilaelaps clareae* are found to be destructive parasites on honeybee colonies.



Notes

6.1.1 *Acarapis woodi* (Tracheal mite)

Acarapis woodi is an endoparasite mite which inhabits the tracheae and air sacs of adult bees. It infests tracheae that would lead from the first pair of thoracic spiracles of adult bees. The damage caused by this mite is commonly called as Acarine or Isle of Wight disease.

(i) Symptoms

- The infested bees have distended shining abdomen. They generally crawl on the ground with disjointed K-shaped hind wings.
- Presence of dark brown spotting on the tracheal wall which become blackened, brittle and also damages the flight muscle fibres.
- A secondary coating on the interior part of the trachea of infested bees leads to insufficient supply of oxygen.

(ii) Diagnosis

- About 10 suspected bees with K-shaped wings are anesthetized and pinned on their back to a piece of cork through the thorax.
- The head and a chitinous ring like structure around the opening to the thorax are removed with a pair of forceps under microscope.
- On exposing the trachea by teasing, various developmental stages of mites can be seen.
- Serological technique such as Enzyme Linked Immunosorbent Assay (ELISA) is also effective in detecting the acarine mite.
- Acarine infestation spreads through emerging mites, robber bees, drifting bees and beekeepers.



Fig. 6. 1: Infestation of *Acarapis woodi* in the trachea of honeybee



(iii) Management

- Treatment with 85% formic acid (5ml/day) regularly for three weeks.
- Six weeks of continuous exposure of bee colonies to the vapours of menthol and thymol controls the mite infestation.

Notes

6.1.2 *Varroa destructor* and *Varroa jacobsoni*

Varroa destructor is widely distributed on the colonies of *A.mellifera*. Adult female *Varroa* mites are 1.4 to 1.9 mm long and 1.6 to 1.7 mm wide. They are dorsoventrally flattened pilose, reddish brown, crab shaped and could be seen with the naked eye. Males are ovoid much smaller than females and pale in colour. Several morphological features of them have made *Varroa* as a successful ectoparasite.

Varroa has long been referred to as *V.jacobsoni* which parasitizes different populations of *A.cerana indica* throughout Asia is a complex of atleast two species. The haplotypes concealed with the complex of mites infesting *A.cerana indica*, which have become pests of *A.mellifera* worldwide. The Korean haplotype being a parasite of *A.cerana indica* in Korea became pests of *A.mellifera* in Europe, New Zealand, the Middle East, Africa, Asia, Canada, North and South America. The Japan and Thailand haplotype, being a parasite of *A.cerana indica*, became a pest of *A.mellifera* in Japan, Thailand and North America. The Korean haplotype of *V.destructor* appears to be more parasitic on *A.mellifera* than Japan and Thailand type. *Varroa* spp. that infests and reproduces on the drone brood of *A.cerana indica* other than mainland in Asia is *V.jacobsoni* and *Varroa* which infests and reproduces on *A.mellifera* worldwide is *V.destructor*.

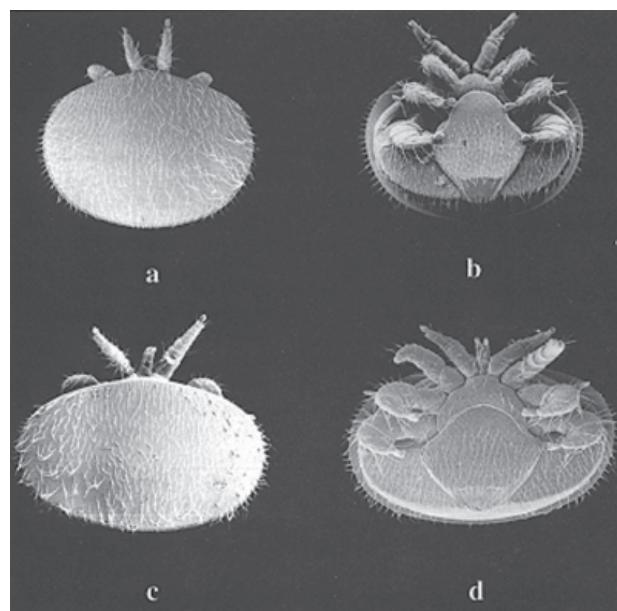


Fig. 6. 2: Dorsal and ventral views of female *Varroa jacobsoni*
(a, b) and *Varroa destructor* (c,d)



Notes

(i) Symptoms

- *Varroa* infested bee colonies become weak and show a spotty brood pattern with punctured capping.
- The mites pierce the soft intersegmental tissues of the abdomen and feed on the haemolymph.
- The bees become stunted with deformed legs and wings.
- The bees infested with many mites usually become crippled or die.
- Parasitized pupae would appear to have small pale or reddish brown spots on their normal white bodies.

(ii) Diagnosis

- Presence of sealed brood cells with perforations.
- Mites are detected by pulling up capped brood cells using a scratcher.
- Mites can be observed on a plastic sheet smeared with sticky material such as petroleum jelly placed on the bottom board.
- Guanine, the faecal material of *Varroa* could be seen as white spots on the walls of brood frames in highly infested colonies.
- *Varroa* mites can be detected by shaking bees in liquids like absolute alcohol, ether etc. in a rotatory shaker.

(iii) Management

- Hand removal of sealed drone brood from freshly infested colonies.
- Creating the colonies broodless by caging queen for three weeks.
- Dusting of wheat flour/sugar powder on bee combs at an interval of 10 days.
- Allowing of mites to move on the culture isolates of the entomopathogenic fungi such as *Hirsutella thompsonii* and *Metarhizium anisopliae* is found effective in control of population.
- Thymol based fumigants, Api life var® and apiguard® are also effective.

6.1.3 *Tropilaelaps clareae*

Tropilaelaps clareae is a native parasite of the giant honeybee, *A.dorsata* and recently it switched over to the colonies of western honeybee, *Apis mellifera* on its introduction in to the Asian continent. It is an ectoparasitic mite that exploits the brood of *Apis dorsata* and *Apis mellifera*. The adult females are 1.0 mm long and 0.55 mm wide, elongated and light reddish brown in colour.

(i) Symptoms

Bee colonies infested with *T.clareae* show following symptoms

- A scattered brood pattern.

Pests and Diseases in Beehive

- The brood cells have sunken capping
- The adult mites can be seen often running on the combs.
- Partly eaten pupae with deformed and mutilated wings and stunted abdomen of the worker bees.

Notes

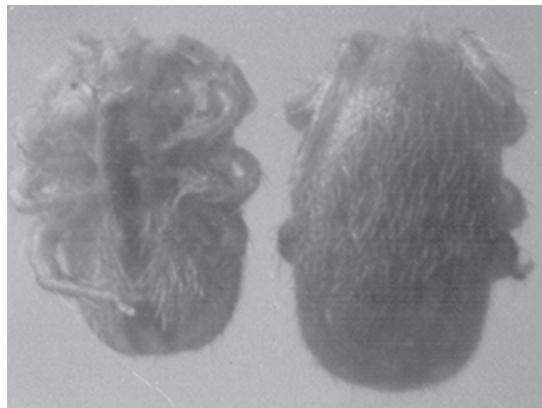


Fig. 6.3: Ventral (a) and dorsal (b) views of adult *Tropilaelaps clareae*

(ii) Diagnosis

- The most reliable method of diagnosis is to open large number of sealed brood cells and examine the nymphs and adult mites.
- Presence of dead mites on a thick sheet of paper inserted on the bottom board.
- The debris collected from infested colonies are placed in a jar filled with alcohol and mites may float on the jars surface on shaking.

(iii) Management

- Creating broodless conditions in bee colonies for 2 to 3 weeks by caging the queen.
- Application of effective doses (200 mg/frame) of sulphur for four weeks.
- Fumigation of 85% formic acid for three weeks during infestation.

6.2 INSECT PESTS

Honeybee colonies are prone to different insect pests which cause serious losses to beekeeping. The wax moths, ants and wasps are the major insect pests in Indian conditions.

6.2.1 Greater Wax Moth

The greater wax moth, *Galleria mellonella* is a serious pest of honeybee colonies in India. The dearth season results in the food scarcity to bees. Under such conditions, bee colonies



Notes

become weak and are attacked by wax moth. It infests combs of all honeybee species throughout the world.

(i) Nature of damage

- The wax moth larvae burrow into the comb by producing silken tunnels along with their excreta.
- They feed on the propolis, pollen and beeswax in the combs.
- During severe infestation, the combs are seen covered with silken web with numerous black faecal particles by destroying the combs.
- The grownup larva spins a dense silken cocoon, which are usually attached firmly to the hive parts.

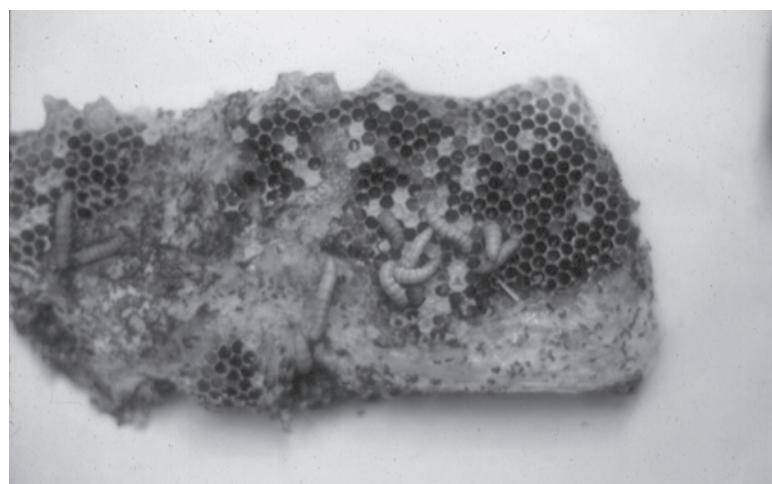


Fig. 6.4: *Apis cerana indica* comb damaged by the larvae of greater wax moth

(ii) Management

- Keep bee colonies strong, hygiene and healthy with adequate food storage.
- Minimize cracks and crevices in the hive, providing artificial feeding during dearth season and removal of unoccupied old combs.
- Keep the bottom board clean. Collect and burn the debris periodically.
- Control diseases and other pests that make the colony weak.
- Avoid pesticidal poisoning which otherwise weaken the colonies.
- Remove extra combs from the hive, especially during dearth period.
- Destroy the silken tunnels to kill wax moth larvae in initial stages.
- Destroy severely attacked combs and melt them in water to render bees wax.
- Spray multiple embedded nuclear polyhedrosis viruses (NPVs) in a suspension on empty infested combs.



- The lethal concentrations of many commercial products of *B.thuringiensis* and *M.anisopliae* are found to be effective.
- The braconid wasp, *Apanteles galleriae* and the parasitic wasps, *Trichogramma* spp parasitize on the egg and larval stages of wax moth.
- Ethylene dibromide (EDB), paradichlorobenzene (PDB) and carbon dioxide (CO₂) are effective fumigants against wax moths in stored comb. Do not apply these in live colonies.
- Fumigation with following chemicals is very much effective in killing the larvae in stored combs in air tight rooms/containers/ chambers:
 - Smouldering sulphur @ 250-300 g/m³ space
 - Aluminium phosphide @ 0.75g/ m³space
- Chlorosol, a mixture of methyl bromide and carbontetrachloride kills all the stages of wax moths including eggs.

6.2.2 Ants

Ants are destructive predators of honeybees and cause heavy loss to beekeeping in tropical and sub-tropical regions. The weaver ant, *Oecophylla smaragdina*, black ants, *Camponotus compressus* and *Camponotus rufoglaucus*, small brown ant, *Monomorium* spp. are the major predators of bee colonies. Ants attack bee colonies and eat or carry away the comb contents such as honey, pollen, brood and adult bees. The ants are initially got attracted towards dead bees near the hive and intern develop tendency to catch live bees and kill the bee colonies. These are responsible for mortality of thousands of bee colonies every year.

(i) Management

- As weak colonies are more vulnerable for ants' attack, keep only strong colony in the apiary.
- Search ants nest in the vicinity of the apiaries and disturb or drive away the ants by using repellents such as ethanol, sodium fluoride, sulphur, borax, kerosene oil etc. is effective in reducing their attack.
- Keep the apiary clean by removing the dead logs, rotten woods, stones and cut the grass regularly.
- Place the hive stand post in bowls of tin or plastic or earthen pots filled with water. Add few drops of wastie oil or kerosene oil or formic acid in water. Clean the bowls regularly to avoid the formation of bridges of vegetation or earth that can be crossed by ants and replenish the liquid frequently.
- Colonies capable of defending by fanning should be selected and used as breeder colonies for mass rearing of queen bees.



Notes



Fig. 6.5: Predation of ants on the pupa of honeybee

6.2.3 Wasps

Wasps are widely distributed highly destructive predators of honeybees. They attack on bees at hive entrance and also on the flowers. The giant hornet, *Vespa mandarina*, yellow banded wasp, *Vespa tropica*, the oriental hornet, *Vespa orientalis*, the brown wasp, *Vespa velutina* are the major wasp predators of honeybee colonies. They take over both brood and adult bees to feed their young ones in their nests.

(i) Management

- Collect and kill adult wasps during active predation.
- Locate and destruct wasp nests by fumigation with calcium cyanide or aluminum phosphide and spray carbaryl on their nests.
- The poisoned jaggery packed in gelatin capsules are glued to the thorax of the trapped foragers. On reach to the nests, the poisoned jaggery would be shared by the nest mates by killing the entire wasp colony.



Fig. 6.6: An Adult yellow banded wasp, *Vespa tropica*



6.3 VERTEBRATE PESTS

Honeybee colonies are affected by variety of vertebrate pests such as amphibians, reptiles, birds and mammals. Among these pests birds cause severe damage to bee colonies.

6.3.1 Frogs and Lizards

The frogs and toads prey upon varieties of insects and occasionally feed on bees at the hive entrance. These are proficient in capturing bees and are less affected by bee stings and bee venom. Lizards are occasional predators of honeybee colonies and eat both brood and adult bees.

(i) Management

- Place bee colonies on hive stands smeared with grease to prevent the entry of toads and lizards into the hive.
- Use of beehives free from cracks and crevices and also maintaining colonies with hygienic conditions and would prevent the lizard problem.

6.3.2 Birds

Birds are the major predators of honeybees. The beaks of the birds are well adapted to catch bees easily during flight. They are able to manipulate the prey, dislodge the sting and remove the poison sac of the bees. The green bee-eater, *Merops orientalis*, blue bearded bee-eater, *Nyctyornis athertoni* and the drango, *Dicrurus leucophaeus* are the most common bird predators of bee colonies. They catch up bees and are snapped up in the bill, returns to their perch and beat the prey against the perch until they die. Similarly, the oriental honey buzzard, *Pernis ptilorhynchus*, swifts, wood peckers also act as predators of honeybees. Woodpeckers have a strong, sharp pointed bill for excavating insect brood holes in trees and a very long sticky tongue for extracting the bee prey.

(i) Management

- The methods such as scaring, producing distress voice at a high volume, restricting the flight using reflective tapes, compact discs etc. have been successful to prevent the bird menace in and around apiaries.
- Covering apiaries with strong mesh would prevent the entry and attack of birds.

6.3.3 Mammals

Mice are known to invade bee colonies for shelter and destroy the combs. They feed on bees and hive products such as honey and pollen. Bears usually dismantle the hives to feed on the honey, pollen, brood and adult bees. They tear the hives into pieces and carry off combs with honey to escape from mass stinging of bees.

The monkeys remove the adult bees from the combs and feed on the honey and brood. Monkeys generally in troops jump on to the beehives and carry away both super and brood combs by shaking the bees to fly away.

**(i) Management**

- Prevent the entry of mice into the hives with use of mouse guards.
- Locate of the live burrows around the apiaries and subsequently fumigate with hydrogen cyanide or aluminum phosphide.
- Construction of strong fence/solar fence around the apiary prevents the entry of bears.
- Scaring monkeys away from the apiaries using loud noise and tying bee boxes with strong wire would reduce the monkeys menace.

**INTEXT QUESTIONS 6.1**

(✓) Tick the correct answer

1. *Varroa destructor* and *Varroa jacobsoni* are:

(a) Endoparasitic mites	(b) Ectoparasitic mites
(c) Both endo and ectoparasitic mites	(d) Phoretic mites
2. The greater wax moth, *Galleria mellonella* infests the combs of:

(a) Wild honeybees	(b) Western honeybees
(c) Asian honeybees	(d) All of these
3. Honeybee colonies are most frequently predated by :

(a) Weaver ants	(b) Black ants
(c) Brown ants	(d) All of these
4. Bears dismantle the hive and feed on:

(a) Honey combs	(b) Brood combs
(c) Both honey and brood combs	(d) None of these
5. The birds can be managed in apiaries by:

(a) Scaring	(b)
(b) Covering apiaries with mesh	
(c) Producing distress voice at high volume	
(d) All of these	
6. The brood mite, *Tropilaelaps clareae* infests the brood of:

(a) <i>Apis dorsata</i>	(b) <i>Apis mellifera</i>
(c) Both (a) and (b)	(d) <i>Apis cerana</i>



7. The endoparasitic mite infesting the tracheae of adult honeybees is:
 - (a) *Acarapis woodi*
 - (b) *Tropilaelaps clareae*
 - (c) *Varroa destructor*
 - (d) *Varroa jacobsoni*

8. The greater wax moth can be controlled by:
 - (a) Maintaining bee colonies strong, hygienic and healthy
 - (b) Minimising cracks and crevices in the hive
 - (c) Providing artificial feeding during dearth period
 - (d) All of these

9. Nuclear Polyhedrosis Viruses (NPVs) are used in management of:
 - (a) Ants
 - (b) Wax moths
 - (c) Wasps
 - (d) None of these

10. The major wasp predators of honeybee colonies are:
 - (a) *Vespa tropica*
 - (b) *Vespa mandarina*
 - (c) *Vespa orientalis*
 - (d) All of these

6.4 DISEASES OF HONEYBEES AND THEIR MANAGEMENT

6.4.1 Viral Diseases

Viruses are microscopic entities causing diseases in honeybees. About 18 viruses have been identified in honeybees and most of them cause sub-lethal infections. Only a few have been reported in *A.cerana indica* in contrast to many viruses from *A.mellifera*. Though a few viruses infect brood, most of the viruses infect both brood as well as adult bees. The major viral diseases of honeybees are Thai sac brood, Sac brood, Kashmir bee virus, paralysis and *Apis* iridescent virus. Filamentous virus, black queen cell virus, Arkansas virus, Egypt bee virus, viruses X and Y, cloudy wing virus, deformed wing virus are other viruses infecting honeybee colonies.

Table.6.1: Major viral diseases of honeybees

Disease	Causal organism	Susceptible Honeybee Species
Thai sac brood	Thai sac brood virus	<i>Apis cerana indica</i>
Sac brood	Sac brood virus	<i>Apis mellifera</i>
Paralysis	Paralysis viruses	<i>Apis mellifera</i>
Kashmir bee virus	Kashmir bee virus	<i>Apis cerana indica</i> <i>Apis mellifera</i>



Notes

Pests and Diseases in Beehive

American Foul Brood	<i>Paenibacillus larvae</i> <i>larvae</i>	<i>Apis mellifera</i> <i>Apis cerana indica</i>
European Foul Brood	<i>Melissococcus</i> <i>plutonius</i>	<i>Apis mellifera</i> <i>Apis cerana indica</i> <i>Apis laboriosa</i>
Chalk brood	<i>Ascospaera apis</i>	<i>Apis mellifera</i> <i>Apis cerana indica</i>
Stone brood	<i>Aspergillus flavus</i>	<i>Apis mellifera</i>
Nosemosis	<i>Nosema apis</i>	<i>Apis mellifera</i> <i>Apis cerana indica</i>
Amoeba disease	<i>Malpighamoeba</i> <i>mellifcae</i>	<i>Apis mellifera</i>

A. Thai Sac Brood Disease

Thai sac brood disease is one of the deadly diseases of *Apis cerana indica* colonies. It was originated for first time in Thailand during 1976 and caused greater losses to beekeeping industry by killing over 80 to 90% bee colonies during 1980s. Thai sac brood virus is confined to the brood and quite evidently the larvae exhibit disease symptoms. Its prevalence is quite evident in brood rearing seasons in honeybee colonies.

(i) Symptoms

- The symptoms are seen in early larval stages and death occurs either in late larval or in the pre-pupal stage.
- The dead larvae usually lie at the bottom of the cell with the head typically turned up.
- Such larvae become scale like and adhere to one side of the cell at the bottom.
- Infected pupae are irregularly scattered on combs with perforations on the capping.
- Adult bees become sluggish with extremely low foraging activity.

(ii) Diagnosis

- The disease can be diagnosed by lifting infected larva with a pointed needle which shows a sac like appearance.
- Examination of ultra thin sections of midgut of infected adult bees reveals bundles of virions accumulated next to the peritrophic membranes in the gut lumen.

B. Sac Brood

Sac brood virus (SBV) is one of the foremost viruses reported from *A. mellifera* colonies. It infects and multiplies in the tissues of young larvae. Such larvae generally fail to pupate

**Notes**

but remain stretched on their back by extruding their head towards cell capping. The larval cuticle looks like a transparent sac accumulated with a fluid between the epidermal layers. The infected larvae changes from pearly white to pale yellow followed by dark brown in colour.

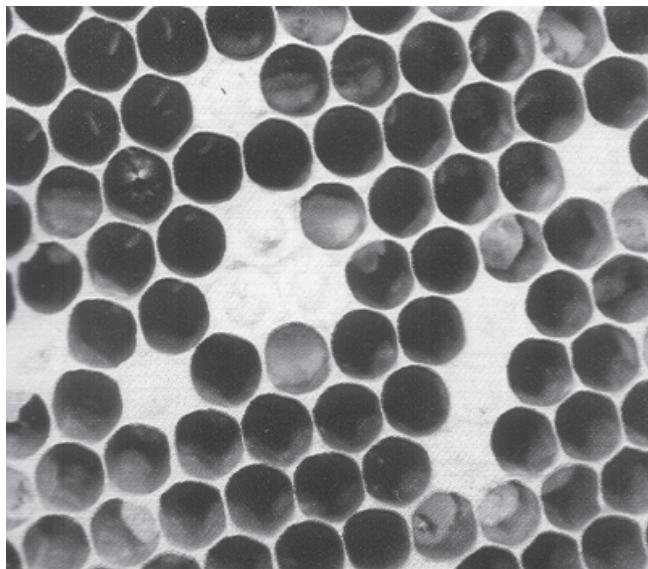


Fig. 6.7: Sac like dead larvae in Thai sac brood virus infected bee comb

C. Kashmir Bee Virus

Kashmir bee virus is a pathogen of *A. cerana* that killed thousands of colonies in Kashmir. The major symptoms of its infection are gradual weakening of bee colonies with large numbers of dead and dying bees near the hive. The infected bees are partly or completely hairless with dark upper thoracic surface and exhibit trembling uncoordinated movements.

D. Paralysis Viruses

Four types of viruses' viz. chronic paralysis, chronic paralysis associate, acute paralysis and slow paralysis are known to cause paralyses in adults of *A. mellifera*. The infected bees become hairless, shiny and have bloated abdomen with partially spread dislocated wings. They show an abnormal trembling motion of the wings and body. They fail to fly out often crawling on the ground and cluster on top of the hive.

E. *Apis* Iridescent Virus

Apis iridescent virus multiplies in the tissues of fat body, alimentary canal, hypopharyngeal glands and ovaries of adult honeybees. The tissues of the diseased bees become blue-violet to green on illumination with bright white light. It is known to reduce the egg-laying capacity of the queen and the worker bees become sluggish and form clusters at the hive entrance.



Management of Viral Diseases

- The adult population of diseased colonies may be transferred to a new or disinfected hive provided with comb foundation. They are fed most frequently with sugar syrup and pollen supplements.
- During severe infection, the combs containing diseased larvae may be burnt to prevent further contamination.
- A break in brood rearing either by de-queening or by caging the queen encourage bees to remove infected dead brood efficiently and thereby keeping the infection under control.
- Avoid exchange of infected combs and use only sterilized beekeeping equipment in the bee colonies.
- The control measures followed to prevent the transmission of viruses through bee mites, protozoan parasites and other vectors would reduce the problem of viral diseases.

6.4.2 Bacterial Diseases

Bacteria cause many diseases in honeybee colonies. They are classified into two broad categories such as non spore-forming bacteria and spore-forming bacteria. American foul brood and European foul brood are highly destructive and widely distributed bacterial diseases of honeybees.

A. American Foul Brood

American foul brood (AFB) is one of the most destructive infectious brood diseases killing millions of *A.mellifera* colonies throughout the world. It is highly contagious and occurs in all seasons on bee brood. *Paenibacillus* (formerly *Bacillus*) *larae* subsp. *lara* causes the disease.

(i) Symptoms

- The diseased brood is irregularly intermingled with healthy brood with uncapped, punctured or sunken capping in the form of ‘pepper box’.
- The diseased brood is initially dull white in colour and gradually changes to light brown or dark brown.
- Death of an infected larva usually takes place after the cell is sealed and the cocoon has been spun.
- The segmentation of the larva is well marked and gives off fish-glue like foul odour.

(ii) Diagnosis

- The spores of the pathogen exhibit Brownian movement in the regions of the smear where pockets of water are formed in the oil. This movement is an extremely valuable



diagnostic tool as the spores of other pathogens of honeybees are usually remained fixed.

- Stretch test is followed where the dead larval contents are easily adhering to the tip of the pointed stick on dipped into the larval extract by stretching in an elastic way when lifted.
- Microscopic examination of infected larval scales stained with nigrosin show a mass of bacterial spores.
- Holst test essentially consists of placing the suspected material such as dried scales into dilute warm milk. The spores turn the milk curdled and cleared within few minutes.
- The immuno fluorescence and immuno diffusion and use of monoclonal antibody in enzyme linked immuno sorbent assay (ELISA) are the other diagnostic techniques followed in detection of AFB.

(iii) Management

- Honeybee colonies could be placed in the areas rich with plenty of nectar and pollen flow during active season.
- Artificial swarming or shook swarm technique is followed in AFB infected colonies during post honey flow seasons. This technique involves transferring of adult bees to a disease free hive followed by destroying diseased brood combs.
- Depleting adult bees supplied with comb foundation leads to break in survival of the pathogen in absence of the brood.
- The combs and equipment may be sterilized by fumigation with formaldehyde.
- Sodium sulphathiazole (1.5g/15l) and oxytetracyclin hydrochloride (0.4g in 5 l) suppress the disease when fed with strong sugar syrup.

B. European Foul Brood

European foul brood is caused by *Melissococcus plutonius*, a non-spore forming bacterium. It is an infectious and contagious disease primarily infecting 2-3 days old young larvae. The virulence of the pathogen is common in high brood rearing season.

(i) Symptoms

- A slight yellow or grey discolouration of the larvae.
- Most of the bee larvae die at coiled stage on the bottom of the cells. The dead larvae appear like collapsed mass giving melted appearance.
- The larvae undergo decaying often giving off a foul odour and are sour in taste.
- An infected larva may spins cocoon with poorly developed silk glands but become flaccid and the tracheal system becomes quite visible.
- The diseased larva dries up into rubbery scales in the cell.

**(ii) Diagnosis**

- Exposing the smears of diseased larvae stained with carbol fuschin under a microscope before appearance of secondary bacteria shows bacteria.
- The Enzyme Linked Immuno Sorbent Assay (ELISA) Polymerase Chain Reactions (PCR) are efficient in detection of the pathogen in the larvae and beehive products.

(iii) Management

- The severely infected colonies may be destroyed.
- Sodium sulphathiazole (1.5g/15 l) suppress the disease on feeding in strong sugar syrup.
- Oxytetracycline hydrochloride (Terramycin®) may be fed or sprinkled with sugar syrup over the bees cluster in the hive in warm weather.

C. Para Foul Brood

The bacterium, *Bacillus paraalvei* causes Para foul brood disease in honeybees. The worker, queen and drone larvae and sometimes pupae are affected by Para foul brood disease.

(i) Symptoms and Management

- The larvae infected are slightly less plumpy and change in colour from glistening white to a dull white.
- The cell capping are dark, sunken and greasy in nature.
- The infected brood produces a sour odour.
- A large number of larvae are coiled or irregularly twisted in the cells, although many larvae die in an extended position.
- The larvae in later stages turn reddish brown and form dark coloured scales.
- Since the epidemiology of Para foul brood is almost similar to that of EFB, similar control measures would also be effective.

Septicemia

Septicemia is a disease associated with adult honeybees and is caused by a bacterium, *Pseudomonas apiseptica*. It is most prevalent in the bee colonies placed near moist soil.

(i) Symptoms and Management

- A change in the colour of the haemolymph of infected bees from apple brown to chalky white followed by rapid regeneration of muscles.
- Severe infection causes the haemolymph to become turbid and milky.

**Notes**

- Dead or dying bees emit a putrid odour.
- Placing bee colonies in well-drained apiary sites and exposing them to the sunlight for at least a part of the day would minimize the disease.

6.4.3 Fungal Diseases

Fungi infect brood, adult bees and combs containing stored products in honeybee colonies. The most common fungal diseases of honeybees are chalk brood and stone brood.

A. Chalk Brood

The fungus, *Ascospaera apis* causes chalk brood disease. It infects larval and pre-pupal stages of the bee brood. The chalk brood causes severe damage to bee colonies most frequently in spring and early summer seasons.

(i) Symptoms

- The fungus infects younger larvae and pre-pupae usually located in outer fringes.
- The infected larvae die after cell capping and turn white followed by grey and black colour on formation of fruiting bodies.

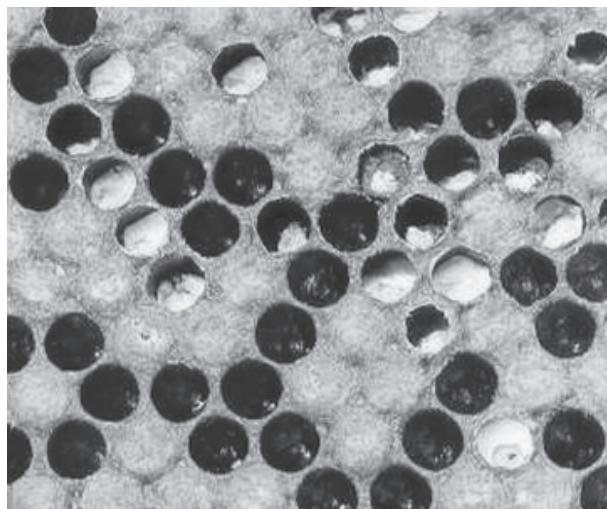


Fig. 6.8: Hard chalk like mummified larvae of honeybee, *Apis mellifera*

- Larva is over grown by fluffy like mycelia and swells.
- The infected larva dries into hard, shrunken white chalk mummies.

(ii) Diagnosis

- Presence of stained mummies containing spore cysts under the microscope.
- Identification of the pathogen by a polymerase chain reaction technique.



(iii) Management

- Strengthening of weak colonies by uniting adult bees and brood combs.
- Periodic renewal of old combs with new ones.
- Fumigation of hive equipment and combs with Ethylene oxide and methyl bromide.
- Trichloro isocyanouric acid (TCA) dissolved water is effective in control of chalk brood.

B. Stone Brood

Stone brood disease is generally caused by the fungus, *Aspergillus flavus* and occasionally by *Aspergillus fumigatus*. It is more prevalent in beehives under damp conditions with poor ventilation.

(i) Symptoms and Management

- The spores are found abundant near the head of the infected larvae and pupae and form green stone like solid mummies.
- The infected larva becomes hardened and quite difficult to crush after its death hence the name stone brood.
- The management practices followed in control of chalk brood disease are also effective against stone brood.

6.4.4 Protozoan Diseases

Protozoans are either parasitic or symbiotic on honeybees and cause greater losses to the beekeeping industry throughout the world. The microsporidian and protozoan diseases of honeybees are nosemosis and amoeba disease respectively.

A. Nosemosis

Nosemosis is one of the most widespread adult honeybee diseases caused by the microsporidian parasite, *Nosema apis*. It is distributed worldwide and has also been reported from many parts of India on *A. cerana* colonies. It is an obligate parasite which develops in the gut tissues of adult bees and has been known to shorten the life span of honeybees.

(i) Symptoms

- The bees of diseased colonies show restlessness and are unable to fly but drop loose excreta on the combs and hive parts.
- The hind wings of infected bees may get unlocked from the fore wings and held at unusual angles.
- The infected nurse bees do not produce sufficient royal jelly due to deterioration of food glands.
- The hypopharyngeal glands of the newly emerged adult bees with the pathogen fail to develop completely and eventually undergo atrophy.



(ii) Diagnosis

- Nosemosis can be diagnosed by microscopic examination of ventriculus of the infected bees. The ventriculus, which is normally brown in colour becomes white and fragile on infection.
- Giemsa (10% 0.02 M phosphate buffer) stained air-dried ethanol fixed smears of infected tissues shows spores with thick unstained walls without visible nuclei.

(iii) Management

- Maintenance of bee colonies strong with a prolific queen and sufficient food stores.
- Old combs which are constant source of pathogen may be replaced with new combs.
- Fumes of acetic acid (60 per cent) would inactivate the *Nosema* spores.
- The antibiotic, fumagillin suppresses *Nosema* infection when fed to bees at the concentrations of 0.5 to 3 mg/100 ml sugar syrup.

B. Amoeba Disease

Amoeba disease is caused by the protozoan, *Malpighamoeba mellifcae*. It is widely distributed in temperate regions. The *M. mellifcae* cysts ingested by the adult bees germinate possibly at the posterior end of the ventriculus of bees where solid food particles are accumulated.

(i) Symptoms

- Gradual decline in adult bee population.
- Infected Malpighian tubules are slightly distended, glassy in appearance and easily broken.
- The infection causes the epithelium of malpighian tubules to undergo atrophy.

(ii) Diagnosis and Management

- Presence of cysts in the abdominal suspension of the suspected bees examined under microscope.
- Phenyl salicylate, quinosol, fumagillin, furazolidone and dichloroxyquinaldine are effective against the amoeba disease.



INTEXT QUESTIONS 6.2

(✓) Tick the correct answer

1. The symptoms of Thai sac brood viral disease are:
 - Dead larvae with the head typically turned up.
 - Pupae with perforations on the capping.
 - Colonies with sluggish adult bees.
 - All of these



Notes

2. Appearance of brood in the form of 'pepper box' is found in bee colonies infected with :

(a) Sac brood	(b) American foul brood
(c) European foul brood	(d) Stone brood
3. Hard, shrunken white chalk mummies are characteristic of :

(a) Stone brood	(b) Para foul brood
(c) Chalk brood	(d) Septicemia
4. Nosemosis is caused by the pathogen:

(a) <i>Nosema apis</i>	(b) <i>Bacillus paraalvei</i>
(c) <i>Malpighamoeba mellifica</i>	(d) All of these
5. Septicemia is a disease caused by:

(a) Viruses	(b) Protozoans
(c) Fungi	(d) Bacteria
6. The major viral diseases of honeybees are:

(a) Thai sac brood	(b) Sac brood
(c) Kashmir bee virus	(d) All of these
7. Sac brood infects the following stages of the honeybee:

(a) Brood	(b) Egg
(c) Adults	(d) All of these
8. Shook swam technique is used in management of:

(a) Thai sac brood	(b) Sac brood
(c) American foul brood	(d) European foul brood
9. Oxytetracycline hydrochloride is used in control of:

(a) Viral diseases	(b) Bacterial diseases
(c) Fungal diseases	(d) Protozoan diseases
10. Stone brood is a:

(a) Bacterial disease	(b) Viral disease
(c) Fungal disease	(d) None of these



WHAT YOU HAVE LEARNT

Let us recapitulate and enlist salient points we have learnt through this lesson:

- Honeybee colonies are vulnerable to various pests and diseases for bee brood, adult bees and hive products.

Pests and Diseases in Beehive



Notes

- Parasitic mites cause significant loss to honeybee colonies. *Acarapis woodi*, *Varroa destructor*, *Varroa jacobsoni* and *Tropilaelaps clareae* are found to be destructive parasites on honeybee colonies.
- Honeybee colonies are prone to different insect pests which cause serious losses to beekeeping. The wax moths, ants and wasps are the major insect pests in Indian conditions.
- The greater wax moth, *Galleria mellonella* is a serious pest of honeybee colonies in India.
- Ants are destructive predators of honeybees and cause heavy loss to beekeeping in tropical and sub-tropical regions.
- Wasps are widely distributed highly destructive predators of honeybees. They attack on bees at hive entrance and also on the flowers.
- Honeybee colonies are affected by variety of vertebrate pests such as amphibians, reptiles, birds and mammals. Among these pests birds cause severe damage to bee colonies.
- Few viruses infect brood but most of the viruses infect both brood as well as adult bees. The major viral diseases of honeybees are Thai sac brood, Sac brood, Kashmir bee virus, paralysis and *Apis iridescent virus*.
- The correct identification of symptoms and diagnosis of honeybee diseases is required to manage honeybee pests and diseases.



TERMINAL EXERCISE

1. Name the parasitic mites attacking honeybees. Describe symptoms and management of following parasitic mites of bees:
 - (i) *Acarapis woodi*
 - (ii) *Varroa destructor*
 - (iii) *Varroa jacobsoni*
 - (iv) *Tropilaelaps clareae*
2. Which is the serious pest of honeybee colonies in India? In which condition it infests?
3. Explain the types of wasps attacking honeybees. What is their nature of damage and management?
4. Describe the attack of birds on honeybees. How it may be managed?
5. What are the major viral diseases of honeybees? Enlist.

Notes

6. Describe different methods of viral disease management in honeybee colonies.
7. Enumerate the symptoms of bacterial diseases in honeybee colonies.
8. Write short notes on the following:
 - (i) Thai brood disease
 - (ii) American foul brood
 - (iii) Chalk brood
 - (iv) Nosemosis



ANSWERS TO INTEX QUESTIONS

6.1

- | | | | | |
|--------|--------|--------|--------|---------|
| 1. (b) | 2. (d) | 3. (d) | 4. (c) | 5. (d) |
| 6. (c) | 7. (a) | 8. (d) | 9. (b) | 10. (d) |

6.2

- | | | | | |
|--------|--------|--------|--------|---------|
| 1. (d) | 2. (b) | 3. (c) | 4. (a) | 5. (d) |
| 6. (d) | 7. (a) | 8. (c) | 9. (b) | 10. (c) |



Notes

7

BEE BREEDING AND QUEEN REARING

Bee breeding and queen rearing is one of the latest techniques to produce profitable bees. This may mean more honey per colony and more efficient pollination. Since colonies of bees differ in many characteristics, you have variability from which to select. This variability may be due to both genetic and environmental factors. The aim is to mate the selected individuals of bees to obtain genetic improvement. From these colonies attempts are made to unite the genes for better qualities from many stocks and eliminating less desirable characters. The performance of the honey bee colonies depends on the inherited qualities of its queen. The queen transmits to the offspring her characteristics pertaining to longevity, industriousness, disease resistance, temperament, swarming, absconding and other behavioural attributes.



OBJECTIVES

After reading this lesson, you will be able to:

- explain principles of bee breeding;
- discuss rearing of queen bees;
- practice queen rearing;
- produce better quality queen
- perform instrumental insemination techniques in queen bee;
- identify instrumental insemination equipments;
- demonstrate the benefits of honeybee breeding.



7.1 BEE BREEDING

Breeding may be defined as the systematic mating of selected males (males) and females (queens) to produce offspring which possess desirable traits. There are two types of breeding in honeybees:

1. Inbreeding
 2. Cross breeding
1. **Inbreeding** is the mating of two individual bee colonies which are closely related to each other. It obviously results in reduction of vitality, susceptible to diseases, low honey production etc. This is also called as **inbreeding depression**.
 2. **Cross breeding** is the mating of better performing queens with the semen of the selected desirable drones in bee colonies. Use of instrumental insemination permits cross breeding and it enables to use many varieties of selected drones in insemination of queen bee. Cross breeding is successful in producing bee colonies with economic traits in respect of higher honey production and better pollination of crops.

For successful and profitable beekeeping select young freshly mated and quality queen bees with known pedigree because of the following reasons:

- A young vigorous queen generally is more prolific and lays more number of eggs and for longer duration as compared to the old queen.
- Moreover, colonies headed by young queens swarm less in comparison with those having old queens. In order to harvest large benefits, you, therefore, must maintain young and prolific queens in their colonies.
- Besides, queens also need to be replaced in case of sudden loss during transportation and due to the attack of enemies.
- Reserve stocks of queens need to be maintained not only for routine replacements but also for rapid and commercial multiplication of honey bee colonies.
- Young and quality queen bees produced in mass are also required for breeding programmes and for sale to the other beekeepers/ bee breeders.

7.2 REARING OF QUEEN BEES

The queen bees are produced both under natural as well as artificial conditions. The natural periods of the queen rearing are those when the bees prepared to swarm, replacing a failing queen or accidental death of the queen (queen supersedure). In artificial conditions also queens may be reared in queenless colonies.

The desired qualities of the colonies to be considered during breeding programmes are gentleness, prolificness, industriousness, ability to resist diseases and enemies, less swarming tendency, less absconding etc. The newly reared queens can be used in the required colonies. The procedure to be followed in artificial queen rearing is as follows:



Notes

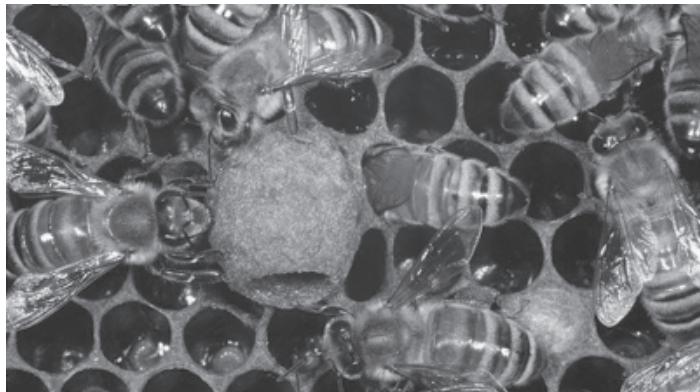


Fig. 7.1: Formation of an emergency queen cell in the centre of the comb during supersedure

(i) Preparation of artificial queen cell cups

- The dimensions of the queen cell cups built under natural conditions are taken for making artificial queen cells.
- The internal diameter of queen cell cup is 8-12 mm for *A. mellifera* and 6-9 mm for *A. cerana indica*.
- Beeswax is used for making queen cell cups.
- The queen cups are formed using suitable cell forming rods.

(ii) Collection of royal jelly

- A strong bee colony with sufficient nectar and pollen stores and young brood is temporarily dequeened and the workers are allowed to raise new queen cells.
- Before sealing, the larvae are removed and a drop of distilled water is added in each cell.
- The diluted royal jelly is collected in a vial with the help of a dipper and kept in freezer for further use.
- The queen cups are primed with royal jelly before grafting the larvae.

(iii) Collection of larvae of desired age

- The worker cells with freshly laid eggs are marked to know the age of the larvae.
- Marked egg combs are introduced into an ‘incubator colony’ for the development of larvae.
- The larvae of the desired age are obtained from this incubator colony at the time of grafting.

(iv) Grafting of the larvae into the queen cell cups

- A strong colony with sufficient stores, sealed and emerging brood is selected as a cell ‘builder colony’ for the rearing of queens from the grafted larvae.

- Such a colony is first dequeened and young brood if any is removed and the colony is fed with 40% sugar syrup.
- Wax queen cell cups of desired size are attached to a bar made to fit in a special frame.
- Larvae less than 3 days of age are suitable for grafting but for excellent results, larvae less than 24 hrs of age are more appropriate. The larvae can be grafted with the help of grafting needle.
- After emergence and mating, the queen is put in a queen cage with few attendant worker bees supplied with honey and pollen.

(v) Drone production

- The drones are usually reared in a ‘parent colony’ supplied with sufficient pollen stores.
- If drones are required from a colony of known queen with economic traits, then that queen must be moved to a colony that is producing drones.
- The workers take care of the rearing of the drones by feeding royal jelly, honey and pollen and may be caged.

(vi) Caging drones

- Drones are matured and produce semen at the age of 6-12 days old.
- The age of the drones can be determined by marking with a dot of paint on their thorax at the time of emergence.
- A group of drones can be marked with spray paint. These painted drones can be released into a colony and collected.
- Similarly, the drone rearing colony also serves as a drone storing colony. Drones with these colonies can be managed for one to two weeks.

7.2.1 Types of Queen Rearing

There are two types of queen rearing as:

(i) Small scale queen rearing

- The sealed queen cells are normally found in a colony preparing to swarm or superseding the queen.
- A frame containing queen cells can be transferred to a required colony.
- The queen emerges from the cell and starts to lay eggs a few days after mating.

(ii) Large scale queen rearing

- In this method, hundreds of queens are reared at a time.
- They can be introduced to required colonies as and when required.



Notes

7.2.2 Biological Basis of Queen Rearing

- Queen bee lays fertilized as well as unfertilized eggs. Both the workers and queens develop from fertilized eggs. However, drones are developed from unfertilized eggs.
- Diet is the major caste determining factor.
- At the age of three days, there is a shift in food to worker larva, whereas, queen larva continues to eat royal jelly.
- Honey and pollen is mixed in the food of worker larva and also the feeding is progressive.

7.2.3 Selection of Mother Stock

- Your primary aim as a beekeeper is higher honey production. This is directly correlated with amount of brood rearing, industriousness of workers, swarming and absconding tendency and disease resistance in honeybee colonies.
- Apiary records for these attributes are essential to select the best colonies for queen rearing.
- In the absence of records for these attributes, only the honey yield records can serve an important criterion for selecting colonies for mass queen rearing.
- Superior colonies can also be induced to rear drones.
- The details on the colonies recorded on hive record card gives correct information on selection of various attributes for queen rearing. Based on the recordings queens may be reared for different economic traits.

Hive No:

History:

Queen marked:

Date	Queen	Queen cell	Frames used	Brood frames	Varroa	Temper	Super	Weather	Notes

Fig. 7.2: A model format of hive record card used for recording different attributes of bee colonies



Notes

7.2.4 Production of Better Quality Queens

- **Genetic colony:** The larvae to be used for rearing queens are taken from worker cells of a colony headed by a breeder queen, selected for chosen genetic characters.
- **The cell starter colony:** Very young worker larvae are transferred into cell cups mounted mouth down on wooden bars. The cups are sometimes primed with a little royal jelly. The bars are placed in a cell starter colony that has been queenless for 2 to 4 hours. This colony may be provided with many nurse bees and little or no brood to rear. The bees build the cell cups and feed the young larvae.



Fig. 7.3: A well populous colony of *Apis cerana indica* suitable for queen rearing

- **The finishing colony:** As the larvae grow, they receive more food and are better cared if the number of nurse bees per larva is high. So it is better to put only about 15 cells in each finishing colony, which is queenright, the larvae being separated from the colony's queen by a queen excluder.
- **The incubator:** When the bees have finished feeding the larvae and are sealed in their cells, the only requirements for the next 7 days are appropriate conditions of temperature and humidity. These can be provided as well in an incubator as in the finishing colony. Whether the queens will emerge from their cells in an incubator or in a colony, each must be in a separate cage to give protection from attacks by other queens already emerged.
- **The mating colony:** The next environment for each queen is a separate small colony containing a few hundred or more workers, but no other queen, in a mating hive from which the virgin queen flies out and mates. Each queen is left in her mating hive until she has started to lay eggs, and thus shows that she is ready to head a new colony. This usually takes about 12 days.

7.2.5 Methods of Queen Rearing

There are three types of queen rearing methods, as explained below:



Notes

(i) Alley's method

- In this method, the comb with young larvae is cut into small strips.
- Larvae in alternate cells are destroyed to provide enough space for raising queen cells.
- The cells of desired larvae are shaved off and the pieces of comb are attached to the bar on comb so that the desired larvae hang with their openings facing downwards.
- The queens emerged are collected and caged.

(ii) Miller's method

- In Miller's method 2 or 3 inches wide strips of foundation with V-shaped top are attached to the top bar of a frame.
- This frame with many strips is kept in the colony. Comb is built on these foundation strips and queen lays eggs.
- Later, the cells of desired larvae are shaved off and the frame is transferred to cell builder colony.
- The cell builder is queenless colony with sufficient young nurse bees.
- Combs with young brood should preferably be removed so that the queens are reared only from the brood of prepared frame from breeder colony and are caged.

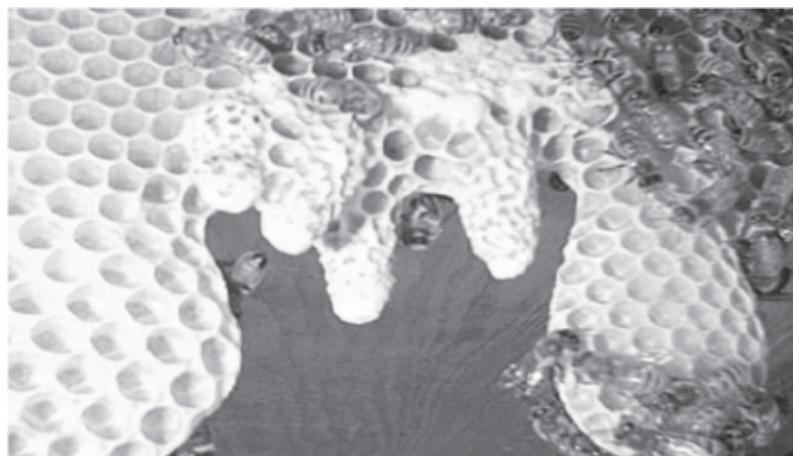


Fig. 7.4: Natural queen rearing in a honeybee colony

(iii) Grafting Method (Doolittle Method)

- It is most commonly used method for mass queen rearing.
- It requires the grafting of young larvae into queen cups.



Notes

- Single forming stick can be used for preparing queen cups when only few queens are to be raised
- For preparing large number of cups, multiple forming sticks are useful.
- The multiple forming stick is a bar made by attaching 10-15 cell forming sticks of same length to a thick strip of wood with spacing of about 2.5 cm from centre to centre.
- The wax for attaching the cups to the bars is melted just above the melting point. The cell bar laid over the pan of wax, is attaching the cell cups to bars.

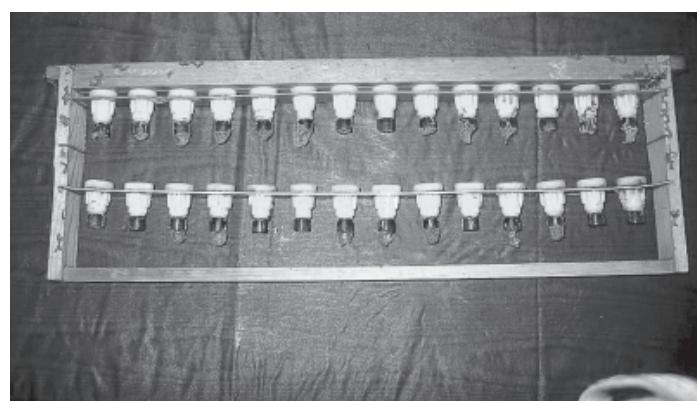


Fig. 7.5: Rearing of *Apis cerana indica* queens by grafting method

- The bees are shaken off and the frame containing sufficient young larvae is taken to grafting room.
- For grafting, a grafting needle with flat upward bent is used and the use of automatic grafting needle is effective.
- This grafting tool also transfers sufficient royal jelly along with the larva and is very successful in dry grafting.
- The queens are reared successfully and stored in cages released with worker bees.

7.2.6 Queen Rearing Time Table

A time table may be prepared for queen rearing in honeybee colonies. By following the time table, queens may be reared successfully at right stage in honeybee colonies.

The queen develops in 16 days. If the queen lays egg on day one, it will be hatched on day three. The first grafting of the larvae may be on the day five or six.

The following model time table gives the detailed information on preparation of queen rearing time table.



Notes

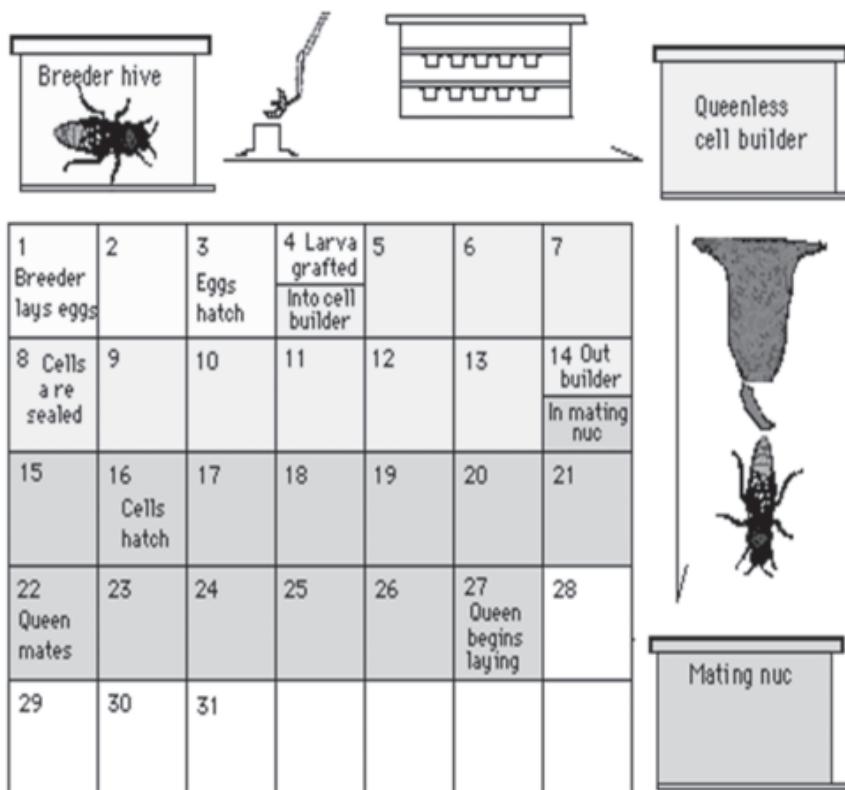


Fig. 7.6: A model Performa showing the information on time table for queen rearing

7.2.7 Queen Cell Builders

There are several methods for starting the queen cells out of which swarm box is a common method.

- Little before the newly grafted queen cells are given, the box is stocked with sufficient numbers of worker bees taken from active colony.
- Two pollen combs are given on either side of the frame with grafts. Combs with stored honey are given to the cell starter and continuous supply of sugar syrup is recommended.
- The modified swarm box is a cell starter in which the bees are confined above the two story colony for 24-36 hrs while cells are being started.
- Queen is confined beneath the excluder in the bottom body with sealed brood and empty combs and combs with young brood are moved to the upper body.
- A full depth body is prepared by putting two pollen combs, two or three combs with honey stores and division feeder full of sugar syrup. The frame with grafted cell cups is placed in between the two combs with pollen stores.

Notes

- All the young bees from above the pollen excluder, that is, second hive body, is shaken off in the prepared starter body below a 8-mesh hardware screen is fastened. The combs with young brood are returned to the second hive body.
- The bees cannot move from the second to the third hive body and bees are confined there for 24-36 hrs by which time the cells are drawn and queen larvae are being reared.
- The screen is then removed and the hive is reduced to two body with an excluder in between the two. The cells are sealed and removed a day before emergence and put in incubator for emergence.
- Cell builder colonies can be repeatedly used for starting the cells. The cells once started can be given to cell finisher colonies for completion.
- The cell finisher colony can be a strong 2 storey queen right colony.
- Queen is confined to the lower body by an excluder and cells are completed in the upper body.
- Double grafting is also practiced to ensure good quality queens. In double grafting the first grafts are removed after the cells have been started and second graft is given in the same cup. This is done to avoid starving of the graft and the second graft will get food supply immediately.

7.2.8 Rearing queens of *Apis cerana indica*

- Queen rearing with *Apis cerana indica* is well established in India and China and follows similar principles to those used in *Apis mellifera*.
- These queen cups should have a smaller internal diameter (7.5 mm). Only a few queen cells (16-20) should be reared per colony.
- The best results seem to be obtained by double grafting i.e. inserting temporary larvae in the queen cups, leaving them in the rearing colony for 24 hrs. and then replacing them with larvae selected for rearing.
- Some beekeepers choose colonies in swarming condition, and without eggs, to rear the larvae.

INTEXT QUESTIONS 7.1

(✓) Tick the correct answer

1. Bee breeding refers to production of
 - Better honey producing bees
 - Efficient pollinating bees
 - Disease tolerant bees
 - All of these
2. The honeybee queen mates with
 - One drone
 - Two drones
 - More than 15 drones
 - All of these



7.3 INSTRUMENTAL INSEMINATION

Controlling the mating process of honey bees is somewhat difficult. The queen mates with more than 15 drones preferably from different colonies in the air, normally in well established drone congregation areas. Queens mating with a large number of drones from different and distant colonies as possible will maintain genetic diversity and species fitness.

Instrumental Insemination is a useful technique for producing positively known crosses of honey bee strains. This will produce specific crosses of known parentage.

The important points for instrumental insemination are:

7.3.1 Storage of Queens

- Normally a colony tolerates only one queen. However, a large number of queens could be stored for few weeks or even months by using a separate colony to house each queen.
- This method achieved some success, but subsequent efforts have been directed towards keeping a number of queens in a queen right or a queenless colony, containing plenty of workers, which feed and tend all the queens.
- These efforts led to methods for transporting, storing and overwintering queens in large numbers that are successful on a commercial scale.

7.3.2 Queen Banks

- Queen Banks were developed for the transport of young mated queens from the queen rearer to the purchaser i.e. you.
- You could also store the queens received in the bank for a short time during the active season, until he could conveniently introduce them to colonies.
- An extra thick brood frame holds three rows of 13 queen cages on each side, 78 in all.
- The outer face of each cage is covered by wire gauze holes large enough to allow workers to feed and lick the queens through them.
- The holes may be 2 to 3 mm and the frame is suspended in a ventilated expendable cardboard box and on either side of it is a framed comb containing honey and pollen, and covered with worker bees.
- The box has a flight entrance at one end that can be fixed either open or closed. No workers are put inside the cages with the queens, but an ample number must be present in the box to keep all the queens warm and well fed.

7.3.3 Reservoir Colonies

- Queens may be stored for several months during the active season in individual cages, mounted in extended brood frames, one or more frames per colony.
- Both queenright and queenless colonies were used, and both virgin and mated queens were stored.
- An ample supply of young bees was essential, and after the end of the main flow the colonies had to be fed with syrup.

7.3.4 Mating of Queen Bees

- Many attempts have been made to mate queens in cages or confined areas without success.



- Isolated places such as mountains and islands have been used in controlled mating. Islands have been the most successful in obtaining pure matings as honey bees will not fly across large stretches of water.
- However, the island must not have an indigenous honey bee population and must be at least 5 km away from land to be sufficiently isolated.
- Mountain mating sites have also been successfully used but here the colonies need to be a minimum 15 km from any other colonies.

7.4 SCOPE OF INSTRUMENTAL INSEMINATION

- Under natural conditions it is difficult to control on parentage and drones from the vicinity to take part in fertilizing a queen.
- Good queens can be reared from better performing colonies so that the heredity characters contributed by the mother can improved to a greater extent.
- In an apiary many queens may be required for requeening and colony divisions.
- Instrumental queen bee insemination technique is now available and mating in the open can be bypassed.
- The virgin queens can be inseminated with the semen from desired drones and hence the technique is the only method for bee breeding.
- The queen insemination can be possible at any time of the day and even in bad weather.
- This insemination technique was first devised in the USA by Watson (1927) and has been improved by many other scientists elsewhere.

The procedure is now a routine one and many thousands of queens are inseminated annually in bee breeding programmes throughout the world.

7.5 INSTRUMENTAL INSEMINATION EQUIPMENTS

Mackensen and Robert's were the first to develop Instrumental Insemination equipment in 1948. During the same year, Laidlaw also developed another type of instrumental insemination equipment. Mackensen and Robert's apparatus is more widely used because of its simple construction and easy handling.

(i) Mackensen and Robert's equipment

- It consists of a stand with a plate and two vertical round posts. Queen block is fastened to the stand by its main component.
- The gas tube passes through the main component and opens into a disc in front of which queen holder is attached.

Notes

- The queen holder is a tube of transparent Plexiglas with an inside diameter of 6.6 mm at one end.
- At the narrow end there are three longitudinal grooves on the inside surface to facilitate escape of CO₂ gas around the queen abdomen.
- Queen is mounted into the queen holder with the help of a short tube.
- A stopper is attached to the end of the gas tube which fits into the queen holder, so that the CO₂ may pass out through groove opening and keeps the queen in position.
- Syringe is moved up and down with hand for positioning to insert into the reproductive system of the queen.
- String and vertical hooks are mounted to permit finger tip control for smooth movement in all directions.

(ii) Laidlaw insemination equipment

- In this equipment, the queen manipulator has a heavy circular base whose bottom surface is smooth and slides easily on the glass stage of a microscope for positioning the queen in relation to the syringe.
- The queen holder consists of two vertical surfaces. Pieces of foam are glued to each of these surfaces, between which the queen is clamped.
- The fixed surface is recessed into a block to make a closed anaesthetization chamber about the queen when she is clamped in position.
- Syringe manipulation is operated by rack and pinion movement and allows up and down movement to an adjusted angle.
- String and ventral hooks are mounted by chunks on vertical rack and pinion, which are mounted on horizontal racks and pinions to either side of the centrally located queen holder.

7.6 QUEEN BEES USED IN INSEMINATION

Some important considerations are essential for the success in queen bee insemination as:

- Queens reared from different breeder colonies differ with respect to the ease of insemination.
- Large sized queens with long tapering abdomens are easy to inseminate than short, stubby queens.
- Virgin queens of the age of about one week are better as it is easy to locate their vaginal orifice but in older queens the operation becomes difficult.

7.6.1 Preparation of Queens for Insemination

- Preparing the queens for instrumental insemination is important. Queen is made to move into the tube similar to the queen holder.



- When queen reaches the narrow end of the queen holder, the stopper through which CO₂ is flowing is pushed in so that the last segments of the abdomen protrude.
- As soon as the queen is quite, two hooks are put in position to open the abdominal end.
- Syringe is prepared by filling the syringe tip with solution to serve as a liquid plunger. Sodium chloride (0.9%) is satisfactory but Ringer's solution is good.
- These avoid the mortality of the sperms. Air in the syringe is avoided as it nullifies the purpose of the liquid plunger.

7.6.2 Collection of Semen from the Drones

- Drones vary in the ease with which they are induced to ejaculate and also in the amount of semen produced.
- All the drones caught to the hive entrance do not evert and deliver semen, some evert too violently that the semen is lost or sometimes even penis bursts.
- For quicker collection of semen the drones are caught from the entrance in the afternoon and from caged in the cages.
- These drones are used for semen collection after few days so that all are sexually mature.
- Before using drones for semen collection, they are advantageously made to fly in drone flying cages, so that they get excited.
- Drone is held from the head and thorax between the thumb and index finger and with little tickling it everts.
- The tip of the syringe is applied to the semen and is drawn by retracting plunger of the syringe. The semen should be quickly collected after eversion.
- The operator should avoid collecting every bit of the semen on the penis because in that case there are chances of drawing the mucus into syringe.
- As soon as the syringe tip is filled, a small amount of physiological saline is drawn into the syringe tip.
- Washing technique for semen collection involves scrapping of semen and mucus in physiological diluents in semen washing funnel and a collecting tube.
- The mixture of semen, mucus and diluents is centrifuged at 2,500 rpm for 10 minutes to separate semen from mucus and diluents.

7.6.3 Instrumental Insemination

- For the insemination of semen, the syringe tip is posed above the vaginal opening of the queen bee.

Notes

- It is inserted into the dorsal part of vagina and the valve fold is pushed ventrally until the tip of syringe has passed beyond the valve fold.
- If the column of semen does not begin to move by moving the plunger, then the syringe is not in median oviduct and must be withdrawn for another attempt.
- Number of sperms stored in the spermatheca increases with the increase in the quantity of semen injected. Eight microlitres of semen is adequate.
- Semen given in two inseminations with equal amount is better since more number of sperms is stored as compared to single insemination.
- Inseminated queens are kept in cages and held in nursery colonies.
- They start laying eggs after 2-4 days but CO₂ treatment reduces this period.

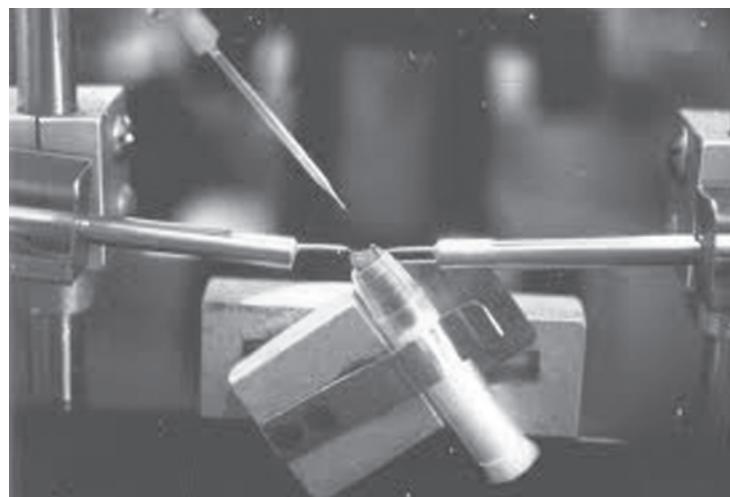


Fig. 7.7: Instrumental insemination of a queen bee of *Apis mellifera*

7.7 BENEFITS OF BEE BREEDING

- Bee breeding increases honey production.
- The queens of bred colonies lay more number of eggs and such colonies show low swarming and absconding tendency.
- The bee colonies are gentle in nature and bees of such colonies remain on the combs when colonies are inspected or manipulated.
- The colonies exhibit good overwintering, early spring development, and a compact brood nest.
- Bred colonies are almost resistance to brood diseases and adult diseases
- The bees of such colonies are efficient pollinators of both wild and crop plants.



INTEXT QUESTIONS 7.2

(✓) Tick the correct answer

1. Instrumental Insemination is
 - (a) Inseminating semen with an instrument
 - (b) Insemination through mating
 - (c) Both (a) and (b)
 - (d) None of these
2. Controlled mating in honeybees is possible by
 - (a) Instrumental Insemination (b) Island mating
 - (c) Mountain mating (d) All of these
3. The technique of Instrumental Insemination was first developed by
 - (a) Watson (b) Mackensen and Robert
 - (c) Laidlaw (d) None of these
4. Queen Banks means
 - (a) Storing mated queens (b) Storing unmated queens
 - (c) Both (a) and (b) (d) None of these
5. The suitable age for Instrumental Insemination of virgin queens is
 - (a) One week (b) Two weeks
 - (c) Three weeks (d) One month
6. The most widely used equipment in Instrumental Insemination of queen bee is
 - (a) Laidlaw insemination equipment
 - (b) Mackensen and Robert's equipment
 - (c) Both (a) and (b)
 - (d) None of these
7. Instrumental insemination is widely practiced in
 - (a) *Apis mellifera* (b) *Apis cerana indica*
 - (c) *Apis florea* (d) *Apis dorsata*
8. Number of queens in a normal honeybee colony is
 - (a) Three (b) Two
 - (c) One (d) All of these



Notes

Bee Breeding and Queen Rearing



WHAT YOU HAVE LEARNT

Let us recapitulate and enlist salient points we have learnt through this lesson:

- Inbreeding and cross breeding are the two types of bee breeding.
 - Cross breeding is successful in producing bee colonies with economic traits in respect of higher honey production and better pollination of crops.
 - Under artificial conditions, queens may be reared in queenless colonies.
 - There are two types of queen rearing as small scale queen rearing & large scale queen rearing.
 - Methods of queen rearing involve Alley's method, Miller's method & Doolittle or Grafting Method.
 - Use of instrumental insemination permits cross breeding and it enables to use many varieties of selected drones in insemination of queen bee.
 - Bee breeding improves the colony by increasing the honey production, resistant to biotic and abiotic stress and increasing the efficiency of pollinators.



TERMINAL EXERCISE

1. Explain bee breeding and its types.
 2. What is the desired quality of queen selected for queen breeding?
 3. What are the criteria for selecting colonies for bee breeding programmes?
 4. Describe the types of queen rearing?
 5. Describe different methods of queen rearing?



6. Write a short note on the following:
 - (i) Doolittle Method
 - (ii) Grafting method of queen rearing
 - (iii) Instrumental insemination
 - (iv) Mackensen and Robert's equipment
7. Explain Instrumental insemination equipments.
8. What are the important considerations essential for the success in queen bee insemination?
9. Enlist the benefits of bee breeding.



ANSWERS TO INTEXT QUESTIONS

7.1

- | | | | | |
|--------|--------|--------|--------|---------|
| 1. (d) | 2. (c) | 3. (a) | 4. (c) | 5. (a) |
| 6. (a) | 7. (c) | 8. (a) | 9. (a) | 10. (a) |

7.2

- | | | | | |
|--------|--------|--------|--------|---------|
| 1. (a) | 2. (d) | 3. (a) | 4. (a) | 5. (a) |
| 6. (b) | 7. (a) | 8. (c) | 9. (a) | 10. (d) |



MIGRATION OF BEE COLONIES

What will you do when there is scarcity of suitable flora for bees? How the bees would survive without food? Can we shift the beehives to some other area with abundant flora? Yes, shifting of bees colonies in search of suitable flora as food for bees is an essential part of the beekeeping activity. The migration of bee colonies in a planned manner from one area to another where sufficient nectar and /or pollen providing plants are available round the year is called migratory beekeeping. Migratory beekeeping is an old practice and was under practice from ages throughout the world.



OBJECTIVES

After reading this lesson, you will be able to:

- explain the honeybee species used in migratory beekeeping;
- evaluate the importance of bee colony migration;
- identify the routes of colony migration;
- assess the procedure for transport of bee colonies;
- understand the quarantine measures followed in migratory beekeeping.

8.1 MIGRATING HONEYBEES

Natural migration of wild honeybee species, *Apis dorsata* and *Apis florea* is observed in Indian conditions depending on availability of pollen and nectar sources in a locality. The honeybees used in migratory beekeeping are domesticated honeybee species. *Apis cerana indica* and *Apis mellifera* are reared in their respective movable frame hives. These colonies build multiple combs and their hives can be moved to required places for pollination services and honey production.



8.2 WHY COLONY MIGRATION?

The richness of pollen and nectar in an area depends on availability of bee flora and blooming of their flowers. There is greater availability of pollen and nectar during blooming seasons of bee flora. Pollen is available throughout the year in the areas blessed with coconut, areca nut, and palms etc. There is no constant production of pollen and nectar in a known locality throughout the year. Therefore, there is a greater scope of migrating bee colonies during dearth season for bees to the locations where plenty of nectar and pollen are available.

Migratory beekeeping will provide following multiple benefits to honeybees as well as to you, as a beekeeper:

- Migratory beekeeping increases honey production.
- It keeps colonies strong hence absconding of colonies is prevented.
- More number of daughter colonies can be produced through colony multiplication.
- The migration helps saving 60 percent of colonies from perishing due to pests and predators.
- It increases three or four times more yields in the crops of the migrated fields.

8.3 FACTORS TO BE CONSIDERED DURING BEE COLONY MIGRATION

Consider following factors while preparing the honey bee colonies for migration:

- (a) Season of the year
- (b) Distance of migration site
- (c) Number of hives to be migrated
- (d) Colony strength
- (e) Preparation and packing the colonies for migration
- (f) Type of vehicle to be used
- (g) Time of the day
- (h) Timing in relation of flowering of crops
- (i) Sitting the migrated stock
- (j) Attractiveness of the crops
- (k) Conditioning of the colonies and
- (l) The anticipated profits

**(a) Season of the year**

Migration of honey bee colonies during winter is not a great problem. Just fasten the various hive parts and move the colonies during late evening, night or early morning, when all the bees are inside the hive, after closing the hive entrances with wire screen, ensuring required ventilation. In cold and rainy weather, the hives should be covered with a tarpaulin when being moved.

During summer or monsoon season, colonies should be migrated during night when it is cooler and in hives with enough ventilation by exchanging the inner cover with travelling-migration-screen. A piece of screen wire mesh nailed on, or thrust into, the hive entrance will not only keep the bees inside the hive but will also facilitate the cross ventilation enroot. It is also wise to sprinkle a little water at the hive entrance and travelling (migration) screen at intervals if travel is long distance but do not over do it, for if the hive becomes wet, inside temperature will rise instead of falling. It is worth emphasizing that it is not the cold but heat that injures bees while confined to their hives for migration. In fact very little harm ever results from chilling of the packed colonies while moving the bees. So the golden rule in moving bees is to ***provide ample ventilation, plenty of inner space and to keep them cool.***

Making short time halts and temporary placement of the apiaries enroute on some suitable flora for a day or so is also advisable when long distances and several journey days, especially in summer season, are involved. It may not only alleviate the problem of food dearth in the colony but will also avoid absconding instinct among the bees due to unnatural/unfavorable conditions. For colony migration in summer or monsoon season, the bottom board of the hives can also be modified for providing extra ventilation. The bottom board can be divided into two parts by nailing a lengthwise bar on its inside in the centre. One half is provided with a regular entrance for bees, whereas the other half can be covered with a full wire screen to prevent the bees from landing on its floor and portion of the entrance rod in front of this screened half is cut and totally removed so that only the air can pass freely through that screened half-but bees can not escape out of the hive.

Exposure to cold has the effect of causing bees to consume stores heavily to produce more heat and cluster together on the nest as they do in winter. In this weather, simply close the hive entrances and carte them anywhere, but if there is some warmth in the air, then entrances should always be closed with a wire screen or perforated zinc sheet and hive body (frames) be covered with full size travelling-screen to avoid overheating of the colonies.

(b) Distance of migration site

Very long distance migration of bee yard during winter season at a stretch is possible provided the bees have sufficient food reserves and required ventilation. During summer, it is worthwhile to have one or two halts/journey breaks for short temporary sitting of the apiary for a day or two at some suitable place having some bee flora for easing out the confined bees. Moving the colonies continually for more than 48 hrs, often leads to their brood mortality. Such colonies produce poor results, particularly when migrated for pollination.

**Notes****(c) Number of hives to be migrated**

If the number of colonies to be migrated is small, it will not be economical. So the number of colonies making full vehicle load should be migrated. However, in case the number of colonies is small, and migration at all has to be done, make it a full truck load by joining with fellow beekeepers who also intend to take up migration to the same or nearby areas. To accommodate more colonies in the vehicle, and for quick dissipation of heat, the top covers of the packed colonies are removed and inner covers replaced with travelling screens, before stacking. For stacking the other row over the lower row of the colonies to be migrated, rectangular wooden bars one over the anterior edge and another over the posterior edge of the travelling screen be placed. Same may be repeated for stacking the subsequent (upper) rows of colonies over the lower ones in the vehicle. This will check chocking of ventilation through travelling screen. Alternatively, some built in provision must be there so that bottom boards of the upper row of stacked beehives do not jam the travelling screens of the lower row of the stacked beehives. The left over spaces towards the end of the rows of stacked colonies may be jammed by inserting the removed top covers.

(d) Colony strength

If weather is very hot, the colony is populous and hive is not spacious enough to allow expansion of the cluster, bees may very quickly smother/ get suffocated even when the top of the hive is covered with full wired travelling-screen. For safety, the heat must be dissipated sufficiently and rapidly to keep the temperature of the interior low enough for the bees to be comfortable. The moment the temperature rises high enough, the bees get upset and crowd all over the travelling screen, thereby, preventing the heat from escaping. This may result in the rise of inside hive temperature higher than the melting point of beeswax, the combs might melt, the bees immediately discharge the gorged honey and in a matter of seconds they start dying leaving sticky mass of half-animate bedraggled bees. Putting additional suppers (filled with drawn combs or empty frames) in position will allow plenty of room for expansion of cluster. Alternatively, the populous colonies may be divided and empty combs may be added for the expansion of the cluster in the hives before migration. If empty combs are not available, empty wooden frames alone or with well fixed comb foundation sheets can be added in between brood/ bee frames to ease out congestion and facilitate ventilation.

(e) Preparing and packing the colonies for migration

Extract the surplus honey, if any, a few days prior to migration. Seal all cracks and crevices in the hive. Replace excessively broken hive parts with new ones. Fasten the hive bodies, bottom boards and inner covers together by stapling/ nailing. Always use two staples in stunting position on each side of each juncture. These two staples should slant in opposite directions to prevent the hive parts from/ slipping away. An alternative to the staples is to use metal or nylon travelling belts (migration belts) around the hive. It is, however, not wise to use rubber belts as being elastic in nature, the rubber belts cannot withstand slipping of hive parts.



Sometimes some beekeepers move bees at night with their entrances open and covering the whole vehicle with nylon netting so that bees are not confined to the hives any way. In such case, the bees cluster outside the hive and make unloading at destination very difficult. If unloading is done during day time, the bees will get confused and are lost. Moreover, if because of some reason or the other, the vehicles need to be stopped on route, the leaking bees may get lost and can also pose serious problems to the passersby. Therefore, it is better to make the colonies bee leak proof but sufficiently ventilated before the same are loaded for migration.

(f) Type of the vehicle, loading and unloading the colonies

Generally bee colonies should be migrated by using vehicles with shock absorbers such as trucks and four wheelers (tempo). However, sometime beekeepers use their own tractor-trailers. While migrating the colonies in vehicles such as trucks, the jerking movements will be forward and backward, hence, the length side of the hives should be kept parallel to the body length of the vehicle (i.e. length of the hive should be perpendicular to the axle of the vehicle). While loading the colonies in a tractor-trailer, where the jerking movements are sideways, the beehives (colonies) should be loaded with their length side parallel to the breadth of the vehicle or the axle of the vehicle. Such type of loading will avoid striking of the bee frames on route with each other, thereby, avoiding the bee mortality due to crushing during migration.

It is best to have engine of the vehicle running during the loading and unloading process. The vibrations caused by the engine have an effect on the bees which causes them to move up and away from the hive entrance. This makes it less likely for the bees fly out of the hives during loading and unloading. For extra precaution, cover the sides of the vehicle with wire mesh and the entire load of beehives from the above with some type of nylon netting. Some extra provisions of ventilators on the sides of the vehicles near its floor may also be built to ventilate the bottom of beehives of the stacks loaded in the vehicle.

It is best to place the hives in the new location late in the evening or at night so as to reduce the tendency of some of the foragers to fly away from the hive and get lost in search of food before they have learned the navigational cues at new location of the hive. After unloading, wait for a few minutes to open the entrance learning. New site location can be reinforced by placing a board against the hive entrance. This will tend to confuse the foragers and encourage them to take orientation flights and learn the new hive location.

(g) Time of the day

If the whole of the apiary is to be shifted, it is better to move the bees in the evening or at night (when all the bees are inside the hive and temperature is low) or during inclement or cold weather when the bees are not foraging. However, if a part of each colony (i.e. nucleus colony) purchased is to be shifted, it can be done even during day time as the field bees gone out for foraging will return to the parent hive left behind and will not be lost. As already discussed above, the colonies at the new site should be opened preferably in the late evening so that the bees leave the hive with prior orientation flights for foraging the following day and are not lost in an endeavour to forage.



Notes

(h) Timing in relation to flowering of crops

Colonies should not be taken to crop needing pollination until it is flowering sufficiently to be the predominant species in the locality. It has been concluded that delay in shifting colonies to the crop until flowering has begun, always increases pollination, when the crop has short flowering period and is less attractive to bees than the other crops in the area. The same is true for honey production. In either circumstance, few colonies should be released at the crop before successive days of flowering. However, it should be pointed out that if a great proportion of flowers of crop are open before colonies are taken to it, an important part of crop may fail to be pollinated as the receptivity to fertilize the flowers of many species diminishes. A flower tends to present most of its nectar and pollen at a time characteristic to its species. Some plant species produce nectar or dehiscent pollen in morning hours and other species release nectar/ pollen in afternoon. In case of *Pyrus* and *Malus*, most of pollen is released in the afternoon but cucurbits it is released in the early morning and early morning, respectively. If the colonies are to be shifted to these plants, they should be shifted accordingly in the afternoon. If the colonies are shifted during other times, bees will approach the flowers of the plant species that are releasing pollen during that time of the day. The bees will then get conditioned to that crop which we do not need to pollinate. Alternatively hive entrances of colonies should remain closed after transportation and the colony gates be opened only when the crop in question release nectar/ pollen. Following this type of practice, we can increase both the nectar collection and the pollination efficiency of the honey bees.

(i) Sitting the migrated stock

The migrated honey bee colonies should be sited away from the passages/ walkways where human or domestic animals' movements are expected. If there is no choice but to site along passages, the hive entrances are kept in the outward direction to the passages. If migration is for pollination purpose, the bee colonies be placed within the crop and should be evenly distributed in the area to harvest the maximum pollination benefits and should not be crowded at one place. Even for production, care should be taken that the site is away enough from any other migrated bee yard to avoid competition due to overcrowding of colonies.

The colonies should not be opened immediately after sitting. Give time to the bees to calm down lest they would be aggressive and sting. Colonies should preferably be opened in the late evening to avoid the loss of foragers in the field otherwise foragers may take off to the crop for food immediately without any orientation flights.

(j) Attractiveness of the crop

When honey bee colonies are migrated for pollination purposes, attempts should be made to direct bees to a certain crop by feeding colonies with simulative feeding or a little sugar syrup containing the scent of target crop intended to be visited and pollinated by the bees. The technique is to immerse flowers of the crop in sugar syrup for some hours, then strain the flowers and feed the sugar syrup to the colony. Often fresh flowers of the crop are also



provided for bees to stand on while drinking the syrup. Periodically bees that take syrup communicate odour of target crop to other bees in hive which then leave the hive to visit the communicated food source. Spray of the crops with bee cues/ lures and use of reflected UV light on the crops have been reported to increase the crops' attractiveness to the bees.

(k) Conditioning of the colonies

For pollination purposes, the pollen gatherers are more useful than nectar gathering bees for increased pollination of the crop on which the colonies are intended to be migrated. Therefore, it is beneficial to increase number of pollen gatherers for higher efficiency in pollination. Since the proportion of foragers that collect pollen increases with the amount of brood in the colonies, the colonies for pollination should contain plenty of young larval brood. Simulative sugar feeding is valuable means of increasing colony's brood rearing and, hence, its pollen foraging potential. Colonies can be induced to pollen collection by removing some of their pollen stores and giving them extra combs of larval brood. Restricting incoming pollen with pollen traps into the colonies is also helpful in increasing pollen foraging.

(l) Anticipated profits

From the beekeeper's point of view, one must be able to have good honey crop and colony growth as well on the migrated crop, not only to offset the expenditure incurred on migration but also to have sufficient monetary and physical benefits. Good colony growth would help the beekeeper in selling the bees or would ensure division for increase in colony number or better exploit the ensuing honey flow elsewhere owing to colonies' increased strength. Thus, to achieve above benefits you must be conversant with the climatic conditions of the area, available flora and all the more its relative utility to bees. You must be aware of the honey production potential of the bee flora per unit area basis, honey collection potential of the honey bee colonies and the expected level to which his colonies would develop. The migration should be undertaken after estimating ensured profits/benefits.

8.4 PROCEDURE FOR BEE COLONY MIGRATION

Honeybee colonies are migrated to the areas with agricultural and horticultural crops, fruit orchards, plantation crops and forest areas where plenty of nectar and pollen sources are available. You have to identify such suitable places well in advance and obtain prior permission from the owners of the crops if required.

The areas where honeybee colonies are migrated should be free from human interference, domestic animals, bee pests and diseases. Required number of bee colonies may be migrated to identified areas based on the availability of food sources. Let us learn the procedure for bee colony migration, which is as follows:

8.4.1 Preparation of Bee Colonies for Migration

- The hives used in the colony migration should be of good quality.

Migration of Bee Colonies



Notes

- The hive parts should be secured tightly so that they may not shift position when raising and handling the colonies.
- The hive entrance is closed after all of the bees are moved within the hive.
- Wire screen can be tucked into the full width of the entrance, to keep bees inside but to allow a flow of air. The screen remains in place during transport without any special fixing and it is easy to remove.
- All the cracks and crevices if any the hive should be closed by filling them with paper, rags, or similar materials.
- The bee colonies should be healthy and strong with young queens.
- The colonies should have sufficient pollen and honey storage.
- The hives are provided with a top moving screen to provide a clustering surface and air passage for the bees to prevent overheating.
- Arrangements should be made for adequate hive ventilation while the bees are confined.

8.4.2 Loading and Unloading of Bee Colonies

- Load the colonies manually if handling only few colonies. However, if there are large numbers of colonies, suitable power operated equipments may be used.
- Hives are transported upright and may be stacked up to four high with suitable gaps in between the hives in the same tier.
- Smaller colonies can be placed in the centre of the load, as they are less likely to overheat.
- The frames of the hive should be parallel to the length of the vehicle.
- The layers of colonies loaded should sufficiently be separated by wooden logs for the sake of aeration.

8.4.3 Transportation of Bee Colonies

- Always wear protective clothing during transportation of bee colonies, to overcome bee stings, if any.
- Hives that are inside a vehicle with the driver must not be moved with their entrances open.
- Hives transported with open entrances are left until sunrise, and smoked before unloading.
- A bee net of strong nylon reinforced with webbing is often covered over the load on the vehicle as a safety measure during the colonies transported with open entrances.
- The net is also useful for covering a truckload of honey supers, to keep robber bees out during an enforced stop.
- During a stopover, hives can be cooled temporarily by plying water over them from a hose pipe.



Fig. 8.1: Colonies of *Apis mellifera* migrated to Coconut plantations, a rich source of pollen.

- The colonies may be preferably being kept in batch of 20-30 at an introduced area.
- After all the colonies have been unloaded at the new location, the entrances can be opened and screens removed.
- The broken combs should be replaced and all the bottom boards cleaned.
- Once the bees are free to fly, they are seen foraging within a few minutes.

8.4.4 Moving Hives for Short Distances

- If a hive is moved well beyond the bee flight range, the bees do not encounter remembered territory on subsequent flights, and do not return to the old site.
- If the new site is near the bees' old flight range, some of the bees may revisit the original site.



INTEXT QUESTIONS 8.1

(✓) Tick the correct answer

1. Honeybees used in migratory beekeeping are

(a) <i>Apis cerana indica</i>	(b) <i>Apis mellifera</i>
(c) Both (a) and (b)	(d) None of these
2. The naturally migrating bee species are

(a) <i>Apis florea</i>	(b) <i>Apis dorsata</i>
(c) <i>Apis andreniformis</i>	(d) All of these
3. Migratory beekeeping is useful in

(a) Honey production	(b) Crop pollination
(c) Colony multiplication	(d) All of these



8.5 MIGRATORY BEEKEEPING -THE PROBLEMS

Although migratory beekeeping has bright prospects, you may face several problems too. Few are mentioned below:

- Because of lack of awareness in the farming fraternity about the utility of honey bees in increasing crop yields through bee pollination, many farmers do not allow or hesitate to allow the beekeepers to site their migratory apiaries in or around their fields.
- Oilseed crops such as *Brassica*, sunflower etc. constitute major utility bee flora. However, because of import of cheaper vegetable oils under WTO regime, domestic cultivation of these oilseed crops is not remunerative now, resulting in drastic reduction in area under these bee forage crops. Area under many other non-oilseed bee plants is also declining. This has reduced the carrying capacity of the localities with respect to the honey bee colony density and, thereby increasing competition among migrated bee yards in those localities.
- In India, there is no agency unlike those in Israel, who would effectively register the beekeepers and allot them the specific sites for colony migration so as to distribute the colonies evenly in the area and reduce the above referred competition.
- Because of decline in cultivated bee flora, the forest based beekeeping has great scope in the country. There is an urgent need to adopt multipurpose agro-forestry and plant avenue trees that would, in addition to other utilities, serve as good bee flora too.
- While evolving new varieties of plants, which serve as good bee flora, due consideration must be given to its nectar/pollen production potential i.e. they should also be evaluated from beekeeping point of view before their release.
- Migratory beekeeping also carries a risk of spreading potential bee diseases and enemies from one region to the other as there is neither any functional agency nor any concept of **Apiary Health Inspectors** who would enforce domestic quarantine and monitor the health of bee colonies. In fact, the aspect of bee pathology and domestic/international quarantine need to be given special emphasis in the country.
- Excessive use of pesticides in the areas of colony migration by the farmers without any prior information to the beekeepers is another serious concern for the migratory beekeepers.
- Unlike advanced countries, there are no specific vehicle-types and other allied equipment required for loading and unloading of colonies. Beekeepers also lack the honey house facilities, blowers to dislodge the bees from the honey combs, motorized/power driven radial honey extractors, automatic uncapping machines etc. at the migration sites. In the Punjab, however, some commercial/ migratory beekeepers modify their, to be used movable honey house at the time of honey extraction by



fixing a wire mesh all around and temporarily covering it at the top with nylon netting. Alternatively, many beekeepers use large sized mosquito nets specially fabricated for this purpose.

- Poor adoption of scientific management technologies such as timely replacement of old/ exhausted queen bees, supering the colonies is also a limiting factor in realizing the full honey potential of migratory beekeeping. Most of the commercial beekeepers extract the honey from single chambered colonies and even from the brood combs which may lead to brood mortality and colony dwindling.
- Many times, migratory beekeepers are harassed at the inter-state borders. Since apiculture is not recognized as an agriculture activity, octroi has to be paid by beekeepers while moving their yield back home. The beekeepers are also harassed by octroi people while the former are moving colonies and the required equipment to and fro for migratory beekeeping.

8.6 CROP FIELDS WHERE THE BEE COLONIES CAN BE MIGRATED?

The large agricultural areas, horticultural and wild forest flora with wide range of climate provides ample sources of pollen and nectar to bees. The nectar and pollen yielding plants are significant in certain areas due to their abundance and blooming period.

- The bee floral sources like Litchi (*Nephelium litchi*), Mustard, Rapeseed (*Brassica* sp.), Sunflower (*Helianthus annus*), Jamun (*Syzygium cumini*), Rubber (*Hevea brasiliensis*), Shisham (*Dalbergia sissoo*), Eucalyptus (*Eucalyptus* sp.), Berseem (*Trifolium alexandrium*), Karanju (*Pongamia pinnata*) contribute to abundant nectar flow.



Fig. 8.2: Mustard crop in bloom attracting migration of bee colonies

- In Haryana, beekeepers migrate colonies to ‘toria’ crop from September to November, during December and January to eucalyptus, clover, citrus and cucurbits during

Migration of Bee Colonies



Notes

February and March and to sunflower from April to June. This would earn an average of 70 kg honey per colony per year.

- Beekeepers of Himachal Pradesh and Punjab move colonies between the states. In summer, they move colonies to cooler regions where various fruit crops flower. During May and June sunflower crop is available over large areas.
- *Cassia* provides surplus honey in June and July. During October and November oil seed crops are ideal source for migratory beekeeping.
- During October and November colonies are migrated to the plains of Uttarakhand, Uttar Pradesh, Punjab, Rajasthan to exploit nectar from rapeseed and mustard.
- Migration is performed to litchi orchards at Dehradun from February to March. Beekeeper reports an average 50 to 60 kg honey production per colony from these regions.



Fig. 8.3: Eucalyptus in bloom an important source of honey in Karnataka during November and December

- Generally numbers of colonies ranging from 100 to 300 are migrated in single truck and by covering a distance of 500 to 800km.
- In West Bengal, large numbers of colonies are migrated to Sunderban mangrove forests for organic honey production.
- In Kashmir, the colonies are migrated to *Isodon rugosus*, saffron, *Crochus sativus* for major flows.
- In Bihar, the commercial beekeepers adopt migratory beekeeping mainly for litchi and Karanju honeys.
- The colonies are migrated from various pockets of the state to Muzzaffarpur and East Champaran during March and April for litchi flow.



Notes



Fig. 8.4: Sunflower plot, an important nectar source for honeybees

- In the southern states of Kerala and Tamil Nadu, intensive migration is practiced to rubber plantations from January to April since it is the only dominant source in this region.
- It is estimated that 4 lakh hectares of rubber plantations are available for exploitation of honey and the potential for honey production is about 80,000 tons.
- Beekeepers from Kerala and Tamil Nadu migrate their colonies mainly to Quilon, Kottayam, Changanacherry, Trichur, Palghat, Kozhikode and Cannanore districts for rubber honey flow.
- Few beekeepers of Tamil Nadu migrate to tamarind flow from May to June. Colonies are also migrated to high ranges of Devikulum, Peerimedu, Idukki cardamom estates for build up of the colonies.
- The colonies can also be migrated to cashew, coffee, and eucalyptus common in the region. The vast coconut belt and ground flora sustains the colonies during the rest of the period.
- In Karnataka, eucalyptus during November and December, sunflower during October and November, rubbers during January and February, forest flora during March and April are suitable for migratory beekeeping.
- Local migration is also practiced in different parts of the country within 50 to 80 km radius for the survival, strengthening and breeding of the colonies.

8.7 QUARANTINE MEASURES IN MIGRATORY BEEKEEPING

Quarantine is a strict isolation imposed to prevent the spread of disease. Quarantine measures are pre-requisite during migration of bee colonies to new areas to monitor the level of pests and diseases in honeybee colonies. Such quarantine measures are strictly

Migration of Bee Colonies



Notes

followed in developed countries such as Australia, USA, and Europe during bee colony movements. However, strict implementation of such quarantine measures is poor in Indian conditions.

- Four species of wild honeybee species (*Apis dorsata*, *A. laboriosa*, *Apis florea* and *A. andreniformis*) are almost free from diseases and pests as they monitor them through their own defensive mechanisms. These species migrate from one place other depending on the availability of pollen and nectar sources.
- The colonies of *Apis cerana indica* are continued to suffer from infection of Thai sac brood viral disease in some states of India. Therefore, infected colonies should not be migrated to disease free zones as it infects healthy colonies.
- In some parts of the India, *Apis mellifera* is suffering from American and European foul brood bacterial diseases. The infection spreads to healthy colonies when come in contact with diseased colonies. Therefore, infected *A. mellifera* colonies should not be migrated to disease free zones.
- *Apis mellifera* is parasitized by the brood mites, *Varroa destructor* and *Tropilaelaps clareae* in Indian conditions. Therefore, mite infested colonies should not be moved to mite free area as they spread to healthy colonies.
- *Apis mellifera* is susceptible to predation of wasps and birds in hilly regions in newly introduced areas. Hence, these species may not be shifted to hilly regions as found in Karnataka.

If strict quarantine measures are followed, the health of the honeybee colonies can be monitored.



INTEXT QUESTIONS 8.2

(✓) Tick the correct answer

1. Major nectar sources of honeybees are
 - Eucalyptus
 - Pongamia
 - Both (a) and (b)
 - None of these
2. Quarantine measures are required at the time of colony migration:
 - Yes
 - No
3. *Apis mellifera* is well suited for migration because
 - It builds multiple combs
 - It is hive honeybee
 - Its combs are movable
 - All of these

**Notes**

4. The giant honeybee, *Apis dorsata* builds
 - (a) Single comb
 - (b) Two combs
 - (c) Multiple combs
 - (d) None of these
5. Honeybee colonies can be migrated to
 - (a) Agricultural crops
 - (b) Horticultural crops
 - (c) Forest areas
 - (d) All of these
6. During transportation of bee colonies
 - (a) Hives are kept upright
 - (b) Hive parts are secured tightly
 - (c) Hive entrances are closed
 - (d) All of these

**WHAT YOU HAVE LEARNT**

Let us recapitulate and enlist salient points we have learnt through this lesson:

- The honeybees used in migratory beekeeping are *Apis cerana indica* and *Apis mellifera*.
- Migratory beekeeping increases honey production and keeps colonies strong and increases the yield of migrated field.
- Place where bee colony is to be migrated (having requisite qualities) must be identified & booked well in advance.
- Migration of bee colony involves: Preparation of bee colonies for migration, loading and unloading of bee colonies and transportation of bee colonies.
- The large agricultural areas, horticultural and wild forest flora with wide range of climate provides ample sources of pollen and nectar to bees.
- Quarantine measures are pre-requisite during migration of bee colonies to new areas to monitor the level of pests and diseases in honeybee colonies.

**TERMINAL EXERCISE**

1. What is migratory beekeeping? Why it is necessary?
2. Which honeybee species are used in migratory beekeeping?
3. What are the factors responsible for preparing the honey bee colonies for migration?
4. How season is considered as an important factor for bee colonies migration?



5. What is the best time for migrating bee colonies?
6. Describe the procedures of honeybee colony migration.
7. Enlist the problems of migratory beekeeping.
8. Enlist the crops suitable for bee colony migration.
9. Explain the quarantine measures in migratory beekeeping.



ANSWERS TO INTEXT QUESTIONS

8.1

1. (c)
2. (d)
3. (d)

8.2

1. (c)
2. (a)
3. (d)
4. (a)
5. (d)
6. (d)



HARVEST, PROCESSING AND MARKETING OF BEEHIVE PRODUCTS

In the previous lessons we have learnt about bees, beekeeping equipments, apiary site selection and management, seasonal management of bees, pests and diseases of bees etc. Let us learn about one of the important procedures of beekeeping, i.e. **harvesting of beehive products**. This is normally done during and shortly after two main honey flow seasons, namely October/November and February-June. Once the bees have ripened honey completely in the hive, it is harvested for further use. Then processing of honey is done followed by its marketing.

Honey, beeswax, royal jelly, bee venom, propolis and pollen are the important bee products.



OBJECTIVES

After reading this lesson, you will be able to:

- ascertain right time and right equipment to harvest the honey and other raw products;
- extract honey hygienically using honey extractor;
- explain grades of honey;
- pack & store honey in suitable containers;
- describe trademarks and quality maintenance of honey;
- follow the procedure for processing of different bee products and their grading.

9.1 HONEY

Nectar of flower is a solution of sugars and other minor constituents that bees collect and concentrate into honey. It is a sweet, viscous fluid, produced by honeybees. It is collected



Notes

as nectar from nectarines at base of flowers. It may also be collected from nectar secreted by plant parts other than flowers (known as extra floral nectarines), fruit juice, cane juice etc.

9.1.1 Collection of Nectar and Ripening of Honey

Honey contains a wide range of sugars, varying according to the nectar source, and small amount of other substances such as minerals, vitamins, proteins and amino acids. The temperature in a nest near the honey storage area is usually about 35°C.

Field bees draw nectar by its lapping tongue known as proboscis. Field bees regurgitate the nectar which is later collected by hive bees and deposited in cells in comb. Nectar contains 20 to 40 per cent sucrose. The enzyme invertase converts sucrose into dextrose (glucose) and levulose (fructose). Invertase is present in nectar itself and also in saliva of honeybees. Finally, ripening of honey takes place by the action of enzyme and by evaporation of water from honey by temperature and the ventilation produced by fanning of wings by bees. When the water content is reduced to about 20 percent, the bees seal the cell with a wax capping. The honey is now considered "ripe" and will not ferment. In this way the bees prepare for themselves a concentrated food source packed in minimal space. It is free from problems of fermentation; therefore bacteria cannot grow in the honey and it will not deteriorate during storage. This food sustains the bees during dearth periods.

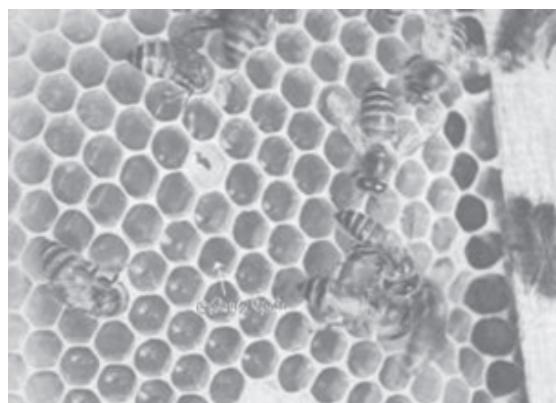


Fig. 9.1: Unripened honey in the comb

9.1.2 Harvesting of Honey

Honey is harvested at the end of flowering season. In traditional or top-bar hives, select combs which contain ripe honey covered with a fine layer of white beeswax, usually those nearest to the outer side of the hive. Honey is extracted only from super combs using honey extractor. The sealing of cells on combs is removed with sharp knife before placing in the extractor. Extractor should work slowly at the beginning and at about 150 rpm at the end for about 1 to 2 minutes. Then the sides of the frames are reversed and the extractor is again worked. Extracted honey is filtered through a muslin cloth. Providing a bee escape between the brood and super on the day prior to honey extraction keeps the bees away from super. Remove the escape soon after honey extraction. During the lean season



Notes

Harvest, Processing and Marketing of Beehive Products

(May-August), remove the super chambers, arrange the available healthy brood combs in the brood chamber and use division boards to restrict the space. Provide artificial feeding once in a week by way of 1:1 sugar syrup in water. Each colony may require syrup prepared from 500-750 g sugar a week depending on the size of the colony and availability of stored food. When there is dearth of natural source, pollen substitutes may be provided in the colony.

9.3.3 Composition of Fully Ripened Honey

Constituents	Per cent (Approx.)
Levulose	41.0
Dextrose	35.0
Sucrose	1.9
Dextrin	1.5
Minerals	2.0
Water	17.0
Undetermined (Enzymes, vitamins, pigments, etc.)	16.0

Pigments: Carotene, chlorophyll and xanthophyll are the important pigments present in honey.

Minerals: Potassium, Calcium, Phosphorus, Sodium, Magnesium, Manganese, Copper, Sulphur, Silica and Iron are the minerals present in honey.

Vitamins: Vitamin B₁ (Thiamine), B₂ (Riboflavin), Nicotinic acid, Vitamin K, Folic acid, Ascorbic acid and Pantothenic acid are the vitamins present in honey.

9.1.4 Physical Properties of Honey

- Honey is hygroscopic. If exposed to air it absorbs moisture.
- Honey is a viscous fluid.
- Heating of honey reduces viscosity.
- Specific gravity of pure honey is 1.35 to 1.44 gm/cc.
- Refractive index of honey helps to find moisture content which is measured using refractometer.

Purity Test for Honey

- Measure specific gravity of honey using hydrometer.
- If the specific gravity is between 1.25 to 1.44, honey is pure.

Aroma and Flavour of Honey

- It is acquired from the nectar of the flower.
- It is lost if heated or exposed to air for long time.



Notes

Colour of Honey

- Depend upon the nectar of flower and the plant species.
- Dark honey has stronger flavour.
- Lighter honey has more pleasant smell.

Crystallization or Granulation of Honey

This is a natural property of honey particularly at low temperature. Dextrose present in honey granulates and settles down. Levulose and water remain at top which is more prone to fermentation. High ratio of Levulose: Dextrose (L:D) results in less granulation. High ratio of Dextrose: Water (D/W) results in more granulation.



INTEXT QUESTIONS 9.1

Fill in the blanks

1. The temperature in a nest near the honey storage area is usually about
2. Field bees draw nectar by its lapping tongue known as
3. Ripening of honey takes place by the , and
4. The bees seal cells with a wax capping, when the water content is reduced to about percent
5. Honey is and absorbs moisture when exposed to air.
6. of honey, helps to find out the moisture content of honey.

9.1.5 Uses of Honey

Honey has value as a food, as a medicine, as a cash crop for both domestic and export markets and as an important part of some cultural traditions.

As a food: Honey is valued everywhere as a sweet and tasty food. At times of food shortage it is a useful carbohydrate source that contains trace elements and adds nutritional diversity to poor diets. Honey often has an important place in traditional food preparation.

As a medicine or tonic: In many parts of the world, honey is used as a medicine or tonic and as a special treat for children. Modern medicine is increasingly using honey for a variety of treatments.

As a cash crop: Fresh local honey is always more highly valued than imported honey. Many beekeepers sell their product directly to consumers. Honey is often used as a barter commodity in villages, especially in remote areas or areas isolated by war or sanctions. Honey is a stable commodity with a long shelf life. If harvested carefully, it will remain wholesome for many years.



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As an export crop: As standards of living rise, honey consumption increases. Most industrialized countries import honey to meet demand. This requirement can provide developing countries with a useful source of foreign exchange from honey exports. The countries with the highest honey exports are Mexico, China and Argentina. Because beekeeping does not use land, production of honey for export need not conflict with growing crops for local consumption.

9.3.6. Grading of Honey

The honey grade scale is:

Grade	Water content	Flavor and aroma	Absence of defects	Clarity
A	< 18.6%	Good—has a good, normal flavor and aroma for the predominant floral source and is free from caramelization, smoke, fermentation, chemicals and other odor causes	Practically free—practically no defects that affect appearance or edibility	Clear—may contain air bubbles that do not materially affect the appearance; may contain a trace of pollen grains or other finely divided particles of suspended material that do not affect appearance
B	> 18.6% and < 20.0%	Reasonably good—practically free from caramelization; free from smoke, fermentation, chemicals, and other causes	Reasonably free—do not materially affect appearance or edibility	Reasonably clear—may contain air bubbles, pollen grains, or other finely divided particles of suspended material that do not materially affect appearance
C	< 20.0%	Fairly good—reasonably free from caramelization; free from smoke, fermentation, chemicals, and other causes	Fairly free—do not seriously affect the appearance or edibility	Fairly clear—may contain air bubbles, pollen grains, or other finely divided particles of suspended material that do not seriously affect appearance
Substandard	> 20.0%	Fails Grade C	Fails Grade C	Fails Grade C

9.1.7 Packaging and Labelling

The honey shall be packed in new clean glass containers, china-ware lacquered cans, acid resistant lacquered tin container, cartons, pet jars of food grade quality or any other containers or packing material of food grade quality. Though, glass is the most preferred material for retailing of honey. For large scale storage of honey properly sanitized and sealed stainless steel drums are preferred. Following is the checklist for selecting the quality packaging container:

**Notes**

- The containers should be leak proof and airtight to prevent absorption of external moisture.
- Bottled honey should be free of air bubbles or any foreign particles and the containers must be spotlessly clean.
- The containers shall not be composed wholly or partly of any poisonous or deleterious substances which renders the contents injurious to health.
- The containers shall also be free from insect infestation, fungus contamination or any obnoxious and undesirable smell.
- The screwed caps shall be of non-corrosive and non-reactive material to honey.
- The grade designation mark shall be securely affixed to or clearly and indelibly printed on each package or container as per instructions of the Agricultural Marketing Adviser.
- In addition to the grade designation mark, the following particulars shall be clearly and indelibly marked on each package or container, namely.
 - (i) Name and address of the packer
 - (ii) Address of the packing place
 - (iii) Source of honey
 - (iv) Date of packing
 - (v) BEST BEFORE..... MONTH..... YEAR from the date of packing
 - (vi) Lot/batch number
 - (vii) Net weight
 - (viii) Maximum retail price (inclusive of all taxes)
 - (ix) Nutritional information
 - (x) Storage condition, if any.
- While bottling, the tip of funnel should touch the bottle and should remain submerged in honey to check the air trapping.
- While purchasing honey, it must be stressed upon that the honey does not have froth at its surface as it enhances its fermentation thereby reducing its shelf life.
- Honey may be designated according to floral or plant source if it comes wholly or mainly from any particular source and has the organoleptic, physicochemical and microscopic properties corresponding with that origin.

9.1.8 Storage

Honey quality deteriorates during storage with time which is actually governed by the storage temperature, moisture content of honey, storage structure and ambient relative humidity. During storage honey becomes darker in colour particularly at higher



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temperatures. Sugars and vitamin content in honey decrease and acidity increases during storage. The breakdown of various sugars results into increase in hydroxyl methyl furfural (HMF) which is a very sensitive indicator of honey quality. Higher HMF is also an indication of heated honey. During prolonged storage, flavour of the honey is also lost. Honey with moisture content above 19 per cent is known to ferment if stored at temperatures between 11-20°C. Following points should be noted to ensure that honey doesn't deteriorate during storage:

- Honey should be stored in food grade glass or stainless steel containers.
- The honey stored under refrigerated conditions does not spoil and shelf life remains quite long.
- Honey should be stored in an airtight container and the pack should immediately be closed after its use. It is so because honey being hygroscopic, may absorb moisture in an atmosphere with more than 20 percent relative humidity, which may trigger off some fermentation and spoilage may occur. The colour and taste may also change.
- Care should be taken to ensure that stored honey is free from contaminants.
- The room used to store honey should be dry, clean, and closed. The ideal room temperature for storing honey is 20°C.
- Always label the stored containers and include details of the harvesting date, treatment, and expected storage life.
- Studies on various unifloral melliferous honeys have revealed that the honeys do not conform to the quality when stored at 40°C even for 3 months, and the honey start losing their quality after 9 months when stored at room temperature. So it is always better not to store the honeys for too long and should be finished at the earliest possible.

9.1.9 Quality Testing of Honey

The aim of quality control is to achieve good and consistent quality in the product which should be compatible with the market for which it is designed. Following are the characteristics of a good quality honey:

- Sweet flavour, pleasant odour and taste, characteristic aroma, uniform colour throughout which may vary from light to dark brown.
- Free from visible mould, inorganic or organic matters such as insects, insect debris, brood or grains of sand dirt, pieces of beeswax, fragments of bees and other insects and free from any other extraneous matter.
- Free of any added food additives such as colour, vitamins, minerals and saccharin.
- Free of toxic substances arising from the micro organisms or plants which may constitute a hazard to health.
- Honey shall not have begun to ferment or effervesce.



- Honey shall not be heated to such an extent that its essential composition and quality are impaired.
- The pH of honey shall be between 3.2 to 4.5.
- HMF is a break-down product of fructose (one of the main sugars in honey) formed slowly during storage and very quickly when honey is heated. HMF provides an evidence that honey has been heated or ‘cooked’.

Precautions: Production of large amounts of high quality honey can be achieved by paying attention to the following points:

- Raw honey should be taken from those combs in which there is more than 75 per cent sealed honey. Extraction from unsealed cells reduces keeping quality of honey which eventually will ferment.
- During honey flow season, queen excluders should be used to get superior quality honey in super chambers.
- Old and blackish frames used for honey production, decreases the yield and colour of honey.
- Excess sugar feeding given to bees before extraction also affects the quality.
- Extraction should always be done under hygienic and sterilized conditions to avoid contamination.
- Direct heating should be avoided in bee products to maintain their texture.
- Re-queen the colony with a quality queen two months before the start of the honey flow season.
- Migrate the colony to an environmentally safe pasture. Pay attention to the carrying capacity of the local pasture and exploit different sources of pasture based on market demand. Do not migrate bee colonies to pasture areas sprayed with pesticides. If pesticide spraying is observed, pack up the colonies and migrate them 5 km away.
- Adopt biological or botanical control measures instead of chemical pesticides for crop protection. If chemical pesticides have to be used, then only use them before or after flowering. Do not use pesticides in the apiary area.
- Create awareness among neighbours' and growers of crops so that they give notice to beekeepers if they are going to use dangerous pesticides. Confine the bees inside the hive for 2-3 days with sugar feeding when pesticides are sprayed on crops used as bee pasture.

9.1.10 Honey Standards

Honey standards and certification are an important way for consumers to know what they are getting. With standards it is easier to trust the quality and source by simply checking the label of the honey we buy. Without standards, if it is labelled, “Pure Honey”, what does that mean? Does it really contain pure honey? Unfortunately there is a possibility of contamination.



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Standards begin with a common definition and description. An excellent definition of honey comes from the World Health Organization (WHO) Codex Alimentarius (CA) for Honey, “*Honey is the natural sweet substance, produced by honey bees from the nectar of plants or from secretions of living parts of plants or excretions of plant-sucking insects on the living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in honeycombs to ripen and mature.*”

Factors that comprise the standards of honey

1. Composition and quality factors
2. Authenticity in respect of production
3. Authenticity in respect of labelling and descriptions
4. Contaminates
5. Hygiene

International Honey Standards

Codex Alimentarius : valid for honey trade in the whole world

European Honey Regulation: valid for Europe

Indian honey regulations

In India, honey is currently regulated under three legislations:

- Prevention of Food Adulteration Rules (PFA), 1955, which is a mandatory standard.
- The Bureau of Indian Standards (BIS) norms for extracted honey.
- Honey Grading and Marking Rules, 2008 under the Agricultural Produce (Grading and Marking) Act, 1937.

All three define honey as a “natural product” and lay down standards for its composition and quality (sucrose content, total reducing sugars, hydroxymethyl furfural, moisture content etc).



INTEXT QUESTIONS 9.2

Tick True or False

1. Quality of honey deteriorates during storage with time.
2. Tin containers are the best for honey storage.
3. Honey becomes darker in colour during storage particularly at higher temperature.
4. pH of quality honey should be between 3.2 to 4.5.
5. Raw honey should be taken from those combs in which there is more than 65 percent sealed honey.

**Notes**

9.2 BEESWAX

Beeswax is the material that bees use to build their nests. It is produced by young honeybees that secrete it as a liquid from special wax glands. Worker bees secrete wax when they are 14 to 18 days old. On contact with air, the wax hardens and forms scales, which appear as small flakes of wax on the underside of the bee. About one million wax scales make 1 kg of wax. Bees use the wax to build the well-known hexagonal cells that make up their comb, a very strong and efficient structure. Bees use the comb cells to store honey and pollen; the queen lays her eggs in them, and young bees develop in them. Beeswax is produced by all species of honeybees, although the waxes produced by different species have slightly different chemical and physical properties.

9.2.1 Composition and Property

Composition of beeswax is explained as follows:

- Alcohols and fatty acids: 70 to 74 per cent
- Free acids: 13 to 15 per cent
- Saturated hydrocarbons: 12 to 15 per cent
- Vitamin A: 40961U
- Specific gravity: 0.95
- Melting point: 65°C.

9.2.2 Processing

Beeswax is obtained from the cappings collected during honey extraction. The bees wax can be obtained from cappings, burs, brace combs and old discarded combs of domesticated as well as wild bees and slum gum. Cappings are removed during honey extraction. Light coloured broken comb pieces, burs and brace combs yield good quality wax. Each 100 kg extracted honey results roughly in 2.0 to 2.5 per cent of wax. In India, major proportion of wax is from combs of *Apis dorsata*.

For purifying the wax, the source material are melted in hot water at a few degrees higher than the melting point of wax and then sieved in a utensil with narrow base and broader open end. The wax being lighter floats on the surface of the water and finally after overnight cooling solidifies into a wax cake over the water surface. The other methods of wax rendering are submerged sac method, heated wax press, heated centrifugal method and solar wax melter.

9.2.3 Uses of Beeswax:

- Mainly used by candle industry.
- Used for preparing comb foundation sheets.
- Used in cosmetics like cold creams, lipsticks and rouges.



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- Used in pharmaceutical and perfume industry (ointments, capsules, pill coating and deodorants).
- Used for preparing shoe polish, furniture etc. for water proofing.
- Used in adhesives, chewing gums and inks etc.

9.3 Bee venom

The sting of worker bee is attached to a poison sac where venom is stored. Newly emerged bee is unable to sting because she cannot insert the sting which is not fully chitinized. Also little amount of venom is stored in the venom sac. A bee, when two weeks old has maximum venom in her poison sac.

9.3.1 Properties

Bee venom is a clear watery material having somewhat sharp and bitter taste, hydrolytic blend of proteins with basic pH and is used by the bees for their defense. Bee venom contains histamine, apamine, hydrochloric acid, formic acid, orthophosphoric acid, sulphur, calcium, copper and magnesium sulphate.

9.3.2 Production

Bee venom is commercially obtained by the use of electric shock. An electric current of about 12 volts is passed through copper wires. The bees get shock, irritated and release venom by inserting the sting into a thin nylon cloth below the copper wires. Venom is deposited on a glass plate placed below the nylon sheet. The venom on drying is scrapped from the glass plate. One *Mellifera* colony yields about 50mg of venom.

9.3.3 Uses

- Rheumatism can be cured by *apitherapy* where bees are made to sting the patient.
- Venom can be used as sub-cutaneous injection for treating rheumatism.
- Ointment made by mixing apitoxin, vasaline and salicylic acid (1:10:1) can be applied on affected areas.
- It has stimulating effect on heart muscles and decreases cholesterol level and lowers blood pressure.
- It can cure neurosis, endoarteriosclerosis, endoarthritis and neuraglia.
- Antihistamine creams or injections are used as anti-allergents.

9.4 PROPOLIS

Propolis gathered by bees from resinous exudes of tree. In the bee colony propolis is used for sticking frames, sealing cracks and crevices but it is a contaminant of comb wax. Only European honey bee (*Apis mellifera*) is in the habit of collecting propolis and that is why this species is less prone to the attack by wax moth.



Notes

9.4.1 Propolis Collection Technology

You may collect propolis by various methods as mentioned below:

1. **Scraping:** The simple, easiest, most common as well as dirtiest method of propolis collection is by scraping the deposited propolis with the help of the hive tool from the frames or sides of chambers etc. except floor scraping as it leads to impurities.
2. **Propolis traps under inner cover:** This method is comparatively more scientific and better than scraping off in order to obtain pure propolis. A wire screen (10-15 mesh size), nylon nets, temp/vinyl/ gummy bags can be placed under inner cover for collecting propolis. For collecting maximum propolis, turn the cloth or net at 90° once or twice a week.

9.4.2 Properties

It contains resins and balsams 55 per cent, ethanol and scented oils 10 percent and pollen 5 percent.

9.4.3 Uses

- Used in preparing ointments for treating cuts, wounds and abscesses in cattle.
- Mixed with vaseline to soothen burns.

9.5 ROYAL JELLY

Royal jelly is secreted by gland of nurse bees of the age of 6 to 12 days when the glands are fully active. It is very nutritious food and is fed to the young worker larvae, the queen larva and adult. Royal jelly is milky or light pale in colour.

9.5.1 Properties

It contains proteins 15 to 18 per cent. Proteins are mainly amino acids (alanine, arginine, aspartic acid, glutamic acid, glycine, isoleucine, lysine, methionine, phenyl alanine, tryptophane, tyrosine and serine). It also contains lipids 2 to 6 per cent, carbohydrates 9 to 18 per cent (glucose, fructose, melibiose, trehalose, maltose and sucrose) and ash 0.7 to 1.2 per cent. Vitamin A, B and C, iron, copper, phosphorus, silicon and sulphur are also present.

9.5.2 Production

The queen cell is trimmed to the level of the royal jelly. After 2 or 3 days of grafting, larvae are gently removed with forceps and the royal jelly is removed with royal jelly spoon. This is stored in refrigerated conditions. In case of *Apis mellifera* 200mg of royal jelly is obtained from a queen cell.

9.5.3 Uses

- Responsible for queen determination.
- Very nutritious food for human beings.



9.6 POLLEN

Pollen is another important product collected by bees from the stamens of flowers. It is the chief source of protein, lipids, amino acids, minerals, vitamins etc. in the honeybee diet.

9.6.1 Composition

Protein is the major component of pollen with an average value of 24 percent. Pollen on an average contains substantial quantities of minerals (K, Ca, Mg, Fe, Zn, Mn and Cu).

9.6.2 Pollen Collecting Technology

Pollen is removed as corbiculae pellets from the legs of returning bees by using pollen traps. A great variety of pollen traps have been developed and used for this purpose.

For pollen harvesting, pollen loaded worker bees are made to pass through the pollen trap screen or strip of perforated restrictor fitted to a pollen trap which is already fixed on the hive after removing the entrance rod. While the pollen loaded bees return to the colony through the holes of the pollen trap, the pollen balls attached to the hind legs get dislodged on a mesh behind and are collected in a tray beneath the mesh. Design of the pollen trap should be crucial both for effectiveness of pollen collection and for the welfare of the colony. It should also not stress the colony by trapping too much of pollen otherwise it will lead to reduced brood rearing and honey production. A trap that removes 50-60% incoming pollen during nectar flow is ideal and can be kept in place for the year round with little adverse effect on the colony. Such traps also improve the pollen foraging activity and pollination service.

9.7 MARKETING OF HONEY

Honey has so far been consumed mainly as a medicine and for religious purposes. A small quantity has been used in kitchen as an ingredient of pickles, jams and preserves. With the increasing production in recent years, there is an increasing trend to use honey in food. Forest honey is used in pharmaceutical, food, confectionery, bakery and cosmetic industries.

9.7.1 Tips for honey marketing

Following tips will help you in marketing your bee products:

1. Site for honey for marketing should have bold, bright sign. The lettering must be large and clear enough to read from a passing vehicle. The minimum height for lettering is 15 centimetres. Keep the message simple: 'HONEY' or 'HONEY FOR SALE'.
2. Honey for sale must always be of top quality and pure: no bees' legs, scraps of beeswax, or any contaminant specks at all.
3. Honey containers must be perfectly clean. Jars must never be sticky with honey. Sticky containers will also attract bees and other insects: a discouragement to most customers. Nobody wants to buy honey in a sticky or dusty container.



4. Local purchasers can become regular customers if they know and trust the brand of honey they are buying. If they like the honey you are selling, they will come back for more. Explain about the honey source (which plants it is from) and how it is harvested from the bees. Make customers feel good about finding such an excellent supply of local honey!
5. Emphasise the extra freshness of the product: the buyer rightly wants to have bought something freshly harvested.
6. Offer both liquid and granulated honey for sale if possible. Explain to customers the difference between these products. Replace any jars on display that are starting to granulate in an irregular way.
7. Improve sales by offering different sizes and styles of packaging. However, never compromise on quality of packaging.
8. Pay attention to the display. Customers feel more encouraged to buy from a stack of attractive jars than from just a few tired-looking jars. Always arrange jars with the labels facing the front.
9. Link honey with other products. Sell honey with, for example, a pack of lemons and give a recipe leaflet for honey lemonade. Other combinations of seasonal produce and recipes could be: honey & almonds, honey & oranges, honey & dates, honey & spices. Think a few weeks ahead. Plan promotions with the season and cultural or religious festivals.
10. Local honey can be a popular gift item for the tourists. Attractive labelling is essential here and must convey the local or national nature of the honey. Unusual, locally made containers filled with honey can attract a premium price. A good product can be pairs of jars, packed inside a small, locally made wooden crate or basket. Tourists are more likely to buy smaller units: tourists do not want to carry large, heavy jars of honey home.
11. If supplying a local market, the supplier must ensure that it is kept constantly stocked. This may mean sometimes buying honey from another local beekeeper. However, never let the authenticity and quality.

9.7.2 Marketing Constraints

You are most likely to get market constraints, whether you become an independent beekeeper or a trader after completing this course. Let us discuss these constraints in detail.

Constraints faced by individual beekeepers and honey hunters

Beekeepers and honey hunters living in or near to forest, or working in other remote and poor areas are likely to encounter many constraints when it comes to finding a market for their products. These constraints are likely to include some of the following:

- Lack of access to suitable containers for storing, transporting and marketing honey.



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- Poor diversity of retail packaging materials.
- Lack of roads.
- Lack of transport.
- Lack of communication possibilities.
- Lack of bargaining power.
- Lack of organizational support.
- Lack of training and technical advice, or poor quality training.
- Poor market access.
- Lack of appropriately-trained support personnel or information materials.
- Low product prices.
- Few social linkages with other producers.
- Few social linkages with potential buyers

Issues faced by traders

In turn, traders who deal in honey (or beeswax), find it difficult to buy from a scattered population of small-scale producers. These are the constraints typically faced by traders:

- Lack of access to products of sufficient quality.
- Lack of access to products of sufficient quantity.
- No linkages between producers and buyers.
- Lack of access to, or non-availability of credit.
- Poor diversity of retail packaging materials.
- Different buyers having differing quality requirements.

Honey retailers in cities are often hesitant to pay cash on delivery: traders providing honey for retail sale must wait until their honey is sold before they receive payment. This explains why traders sell honey where they can - even though the price paid is low.

Constraints for the Industry as a whole

Apiculture as a sector is growing steadily and faces following constraints:

- Lack of appropriate extension material.
- Lack of appropriate marketing information.
- Lack of appropriately-skilled trainers.



- Lack of strong organizations representing the interests of beekeepers.
- Poor linkages between producers and buyers.
- Little coordination between beekeeping and other sectors, including the horticulture, forestry, health, and environment sectors.
- Little or no product promotion.
- Few developing countries have beekeeping policies for protection of the industry.
- No global agreement on honey criteria.

For all of the above reasons, beekeepers and honey hunters can gain much by forming Self Help Groups or Cooperatives.



INTEXT QUESTIONS 9.3

Fill in the blanks

1. In India, major proportion of wax is from combs of
2. Bee venom is commercially obtained by the use of
3. is used in preparing ointments for treating cuts, wounds and abscesses in cattle.
4. is secreted by gland of nurse bees.
5. Honey production is a lucrative business and it generates



WHAT YOU HAVE LEARNT

Let us recapitulate and enlist salient points we have learnt through this lesson:

- Harvesting of beehive products is normally done during and shortly after two main honey flow seasons, namely October/November and February-June.
- Once the bees have ripened honey completely in the hive, it is harvested using honey extractor. Then processing of honey is done followed by its marketing.
- Honey, beeswax, royal jelly, bee venom, propolis and pollen are the important bee products.
- Among all honey is the prime product produced by honeybees. Besides their nutritive role, the bee products have been used for therapy as medical agents and have potential to cure multiple human diseases.
- Honey can be graded as A, B, C & substandard.



Notes

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- Glass is the most preferred material for retailing of honey. For large scale storage of honey properly sanitized and sealed stainless steel drums are preferred.
- It is required to achieve good and consistent quality in the hive product which should be compatible with the market for which it is designed.
- Beeswax is obtained from the cappings collected during honey extraction. The bees wax can be obtained from cappings, burs, brace combs and old discarded combs of domesticated as well as wild bees and slum gum.
- Sting of worker bee is attached to a poison sac where venom is stored. Bee venom is commercially obtained by the use of electric shock.
- Propolis is gathered by bees from resinous exudes of tree. Scrapping and collection of Propolis traps under inner cover are the propolis collection technology.
- Royal jelly is secreted by gland of nurse bees of the age of 6 to 12 days when the glands are fully active. The queen cell is trimmed to the level of the royal jelly. After 2 or 3 days of grafting, larvae are gently removed with forceps and the royal jelly is removed with royal jelly spoon.
- Pollen is an important product collected by bees from the stamens of flowers. Pollen is removed as corbicular pellets from the legs of returning bees by using pollen traps. A great variety of pollen traps have been developed and used for this purpose.
- By using recommended beekeeping equipments scientific methods of honey collection, storage, honey processing plants and bottling technologies the income from beekeeping business may be enhance manifold.



TERMINAL EXERCISE

1. Name different types of products obtained in beekeeping.
2. Mention physical properties and economic importance of honey.
3. Describe the process of extraction and ripening of honey.
4. What is beeswax? Describe its properties and uses.
5. Explain the extraction process of following:
 - (a) Beeswax
 - (b) Propolis
 - (c) Royal jelly
 - (d) Pollen
6. Describe the production and uses of bee venom.
7. Describe the marketing of honey bee.
8. What are the constraints you may face while marketing the beehive products?



ANSWERS TO INTEXT QUESTIONS



Notes

9.1

1. 35°C
2. proboscis
3. action of enzyme, evaporation of water from honey by temperature and the ventilation produced by fanning of wings by bees.
4. 20
5. hygroscopic
6. Refractive index

9.2

1. True
2. False
3. True
4. True
5. False

9.3

1. *apis dorsata*
2. electric shock
3. Propolis
4. Royal jelly
5. employment



Notes

10

KEY – ENTREPRENEURSHIP SKILLS

To set up a beekeeping enterprise you should first prepare a plan about your proposed business before you begin to work on it. To be a successful entrepreneur you should be committed, motivated and skilled in running and managing a business. You should also look into the financial aspects of setting up an enterprise i.e., start up capital, which would include the funds available with you or your family and the loan amount that you can arrange from financial institutions.



OBJECTIVES

After reading this lesson, you will be able to:

- make a business plan to start a beekeeping business;
- make a financial and budget plan to start a beekeeping farm;
- get prices of various inputs from the market;
- assess the need and requirement of the client and make a proposal;
- prepare financial outcome record;
- establish cordial relations with various clients for developing the business;
- identify appropriate buyers for the produce;
- ensure quality of the produce and trademarks.

10.1 PREPARING A BUSINESS PLAN FOR BEEKEEPING

A business plan describe all aspects related to business including building, machines and equipment to be purchased, costing, start-up capital, marketing plan, financing, legal aspects, type and number of people to be employed and business organization. You may



take the help of an expert/ an entrepreneur or visit a Government organization such as District Industry Centre (DIC), Khadi and Village Industries Centre (KVIC) or Krishi Vigyan Kendra (KVK) for preparing a business plan.

It is necessary to understand the legal requirements and advantages and disadvantages of these legal requirements before starting a beekeeping enterprise. All the laws and regulations governing honey production and sale should be clear before planning the business. As, the success of an enterprise depends on the productivity and performance of the staff, therefore, educated and trained people who are willing to work as a member of a team should be employed.

Starting a Beekeeping Enterprise

Following information are needed to collect, analyze and process before starting an enterprise:

(i) Assessment of Demand

Assessment of demand is done to estimate the amount of honey that is needed to be produced and size of enterprise. Following should be assessed:

1. Who is going to buy the produce? (If you can sell your honey directly to the customer or an end user, you will naturally receive a better price than if you sell to a wholesaler)
2. Where does most of the supply of honey come from?
3. Where customers want honey to be delivered?
4. How are you going to deliver it?
5. How much honey stock is a distributor willing to take from you? (If you want to sell your honey indirectly i.e. through a distribution system).
6. How much honey should be produced in the initial stages?
7. How much honey is made available at a time in the local market?
8. How much honey should be produced and made available monthly?
9. How much honey should be in stores?
10. Factors that should be kept in mind to maintain sustained supply of honey products e.g., maintaining quality, ensuring timely supply, etc.

Method of assessment of demand for a product or service could include:

1. Enquiring from people about the need of honey and other bee products
2. Informal surveys in the marketplace
3. Formal mail surveys using questionnaires
4. Local focus groups, etc.



(ii) Feasibility Study

It is suggested to assess the feasibility of the business (practically possible and would yield profit). Small scale production of honey for direct marketing at local market is recommended for beginners. Two colonies is an ideal number to begin with beekeeping business.

(iii) Scale of production

Consider the following factors for choosing the scale of production of bee products:

1. How much funds are available?
2. What kind of infrastructure facility is available?
3. How much will the necessary equipment cost?
4. What is the market demand for the honey?

(iv) Preparing a Business Plan

A business plan is a necessary document for summarizing the entrepreneur's business aspirations, securing legal authorization and mobilizing the resources to launch the business. A business needs two categories of items:

1. Items that enable the business to produce its goods or offer its services.
2. Items to manage the administration of the business, such as pens, paper, calculator, computer, etc.

A business plan should consist of the following components:

1. Title page (name proposed for the business, entrepreneur's name, contact address, phone no., e-mail address, etc.)
2. Summary of business objectives
3. Table of contents
4. Structure of the proposed business
5. Intended product that is to be sold
6. Marketing plan (based on a market survey)
7. Financial plan
8. Expected returns
9. Other supporting documents, such as letters of recommendation, certificates of education and training, community service documents, etc.

After preparing the business plan it is required to:

1. Obtain permission from the local authority to set up the business
2. Convince funding institutions to provide finance
3. Rent a space for business premises
4. Convince business partners to supply materials or services.

**(v) Purchasing Materials**

Starting and running a business requires materials. The entrepreneur must determine very carefully what items or types of materials are needed to run the business, and in what quantities. The amount of items required is depended on the size of the business.

(vi) Marketing Strategy

Marketing strategy is needed for promoting and selling products by emphasis on benefits to users of the product, etc. A marketing strategy must take into consideration:

1. Who is your target customer?
2. The location of the business.
3. Advertising strategy.
4. Enhancing attractiveness of package.
5. Good relationship with other business persons.
6. Competitor's price.

(vii) Fixing the Selling Price

Fixing the selling price of a product or service must take into consideration the following:

- (a) Cost of production
- (b) Overheads
- (c) Profit

It is, therefore, important to accurately calculate each of these, so that the selling price is realistic.

(a) Cost of Production

It is necessary to estimate the cost of starting operations. These may include the cost of

1. Premises
2. Utilities equipment
3. Initial stock of raw materials
4. Insurance

Let us now try to understand what are the different costs i.e. non-recurring and recurring costs to be estimated for fixing the selling price.

1. Estimate the non-recurring or fixed cost of starting your apiary, which will include the site for the honey house (building, honey house, office, store, cemented water tank, tc.) and the tools and equipment.
2. Estimate the recurring or variable cost, which will include utilities such as electricity, water, chemicals, etc.



3. What measures are you going to adopt to cut down on expenditures on production of honey?
4. Labour and depreciation of equipment (when) equipment loses its value over time) may also need to be taken into account.
5. In calculating the cost of labour, the prevailing basic wage rates, government rate and social security contributions should be considered.
6. Paying a lower price for materials and/or production could enable the entrepreneur to reduce the selling price.

(b) Overheads

Calculate each component that goes into overheads carefully, and add them up.

1. Cost Estimation Sheet for Materials

S.No.	Description	Basic quantity required	Extra allowed	Total requirement	Cost per unit	Estimated total cost (Rs.)

2. Human Resource Hiring sheet

S. No.	Description of activity	Estimated time for hiring services	Estimated cost for hiring on per day/hour basis	Estimated total cost (Time × Cost per day/hour) (Rs.)

3. Overheads

S.No.	Description	Basic quantity required	Extra allowed	Total requirement	Cost per unit	Estimated total cost (Rs.)

**(c) Profit**

As an entrepreneur, you should be careful in setting the level of profit made on the sale of a product, taking into account the relationship between demand for the product (how many people want it) and the available supply (amount of product available to be sold). If demand is great for the available supply, the price (and thus the profit) may be increase. If there is large supply, but few people want to buy, then prices may drop. An excessively high price due to a big margin of profit will not attract customers towards your product. When sales increase, profit margins may be reduced as a marketing strategy to increase profits on turnover. This can enable you to lower the selling price, therefore allowing the business to ‘capture’ the market and even expand it.

(viii) Observing Rules and Regulations

Rules and regulation may include the following:

1. Requirement for registering a business
2. Laws that govern business
3. Legal classification of a business, e.g.,
4. Taxes to be paid for businesses e.g., value added tax (VAT), income tax, etc.

(ix) Government Schemes

The authorities usually offer certain tax subsidies, facilities and incentives as part of the schemes to entrepreneurs for starting a new business.

(x) Managing workplace

A workplace is where goods and services are produced or sold, such as a factory floor or shop. Good workplace management helps small businesses to become efficient by:

1. Creating comfortable and safe working conditions for employees.
2. Reducing material damage and loss (wastage).
3. Preventing work-related accidents.
4. Increasing work space.

Workplaces must be kept clean and safe for workers and clients. The entrepreneur should pay particular attention to space, lighting and ventilation, etc.

(xi) Mobilizing resources

The funds for launching the business may be obtained from one or a combination of sources:

1. Personal savings or family funds for seed money
2. Community or co-operative organizations
3. Micro-finance organizations
4. Banks



INTEXT QUESTIONS 10.1

Fill in the blanks:

- (a) is done to estimate the amount of honey that is needed to be produced and size of enterprise.
- (b) is an ideal number to begin with beekeeping business.
- (c) A is a necessary document for summarizing the entrepreneur's business aspirations, securing legal authorization and mobilizing the resources to launch the business.
- (d) The amount of items required is depended on the
- (e) Paying a lower price for materials and/or production could enable the entrepreneur to reduce the

10.2 KEEPING RECORDS

Business accounts should be different from personal accounts. The financial records need to be tallied with periodic statements that the lending institutions send. Payments of interest and principal amount towards the loan should be made as per the mutually agreed schedule in order to avoid penalties and higher interest rates. Colony and operational records should also be maintained.

- (i) **Colony record:** the information kept in this record would be useful in identifying good colonies and multiplying them. This record should include the following:

Colony no.

1. When was the beehives colonized?
2. How the beehives were colonized.
3. Number of beehive and frames in each hive
4. When the queen and/or eggs were last seen
5. The dates of inspection of bees
6. What was the condition of the bee colony of the hives when they were inspect periodically?
7. The age of the present queen

- (ii) **Operational Record:** this information would be useful in knowing whether the business is running in profit or loss. This record should include the following:

Key – Entrepreneurship Skills



Notes

- (a) Non-recurring expenditure: It includes expenditure made on purchasing beehives, bee colony, hive tools, overall, bee veil, rubber boots, gloves, tray, uncapping knife, scrapping knife, swarm basket, bee brush, smoker, etc.
- (b) Recurring expenditure: it includes expenditure made on raw materials like sugar, pollen substitutes, chemicals, cow dung cake, wage to employees, etc.

(iii) Employee record

S. No.	Date of Observation	Name of the employee/ Identity no	Particulars of work done	Time spent	Remarks

(iv) Income statement

Income = Yield X Price – Production Cost

An income statement is a simple summary of the business cash generating ability. It should be prepared on a monthly basis and should contain at least the following information:

1. Income (funds procured to start the business, such as the loan, and money earned by selling bee products or colony)
2. Cost of materials (includes all costs incurred in buying materials)
3. Operating expenses (own salary, labour costs, overheads such as electricity and water, etc.)
4. Repayment of loan (capital + interest)
5. Gross profit is calculated by subtracting cost of goods sold from net sales. (gross profit = sales – total cost)
6. Taxes paid
7. Net profit (the earnings of the business after taxes have been paid).

(v) Cash flow statement

A cash flow statement gives an idea of the amount of liquid cash available in the business at any given time. It is prepared by recording all income received by the business on the one hand, and all expenditures incurred by the business on the other. The difference between the two gives an indication of the positive or negative cash flow situation in the business at the end of a given period.



Notes

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total for the year	Outstanding for the year end
Cash sales														
Other income														
Total income														
Outgoings/expenses														
Material cost	1	2	3	4	5	6	7	8	9	10	11	12	Total for the year	Outstanding for the year end
Cost on hiring human resource														
Overheads														
Marketing costs														
Loan payments														
Taxes														
Total expenses														
Cash flow value														
Cumulative cash flow value														

(vi) Balance sheet

The balance sheet maintained periodically indicates the performance of the business. This information is of interest not only to the entrepreneur, but also to concerned organizations such as investors, lending institutions, suppliers of materials, staff, etc.

10.3 HIRING PEOPLE

As per the nature of work that is to be done, qualifications and skills, person should be hired. Staff may need to be given training when they start work and then periodically during their working life. Workers may be hired to carry out the following functions in the business:

1. Production



2. Quality control
3. Administration
4. Transport
5. Customer relations, etc.

10.4 ECONOMICS OF BEE KEEPING (FOR 50 COLONIES)

Let us understand the economics of beekeeping (for 50 colonies) with the following examples:

Non-Recurring cost (Rs.)

1. Cost of hives (Newton's Beehive of teak wood) @ Rs.400/hive	=	20,000
2. Cost of 10 nucleus box @ Rs.300/hive	=	3,000
3. Hive stand @ Rs.50 for 60 boxes	=	3,000
4. Honey extractor, smoker and other appliances	=	1,000
<hr/>		27,500

Recurring cost (Rs.)

1. Cost of sugar @ 2 kg/colony during death period @ Rs.15/kg	=	1,500
2. Comb foundation sheet 2kg @ 100/kg	=	200
3. Interest for non-recurring amount @ 10%	=	2,750
4. Depreciation @ 10%	=	2,750
5. Cost of colonies @ Rs.100/colony	=	5,000
6. Miscellaneous	=	1,000
<hr/>		13,200

Income (Rs.)

1. Income through honey yield @ 3.5 kg/colony and Rs.150/kg	=	26,250
2. Income through bees wax @ 5kg/50 colony and Rs.200/kg	=	1,000
<hr/>		27,250

Net income (Rs.)

$$\text{B (Recurring cost)} - \text{C (Income)} = 27,500 - 13,200 = 14,300$$

As the subsequent years do not require any non-recurring materials, the income would be more from the second year. Besides the cash benefit through honey and beeswax, bees also render pollination service to the crop plants and help in getting increased fruit setting and yield. It is generally referred that the value of pollination service by the bees is 10 times more money value than contributed from the honey and beeswax.

(Ref.: TNAU Agritech Portal Sustainable Agriculture.mht)



WHAT YOU HAVE LEARNT

Let us recapitulate and enlist salient points we have learnt through this lesson:

- A business plan is a necessary document for summarizing the entrepreneur's business aspirations, securing legal authorization and mobilizing the resources to launch the business.
- Assessment of demand is done to estimate the amount of honey that is needed to be produced and size of enterprise.
- Small scale production of honey for direct marketing at local market is recommended for beginners. Two colonies is an ideal number to begin with beekeeping business.
- Starting and running a business requires materials. The entrepreneur must determine very carefully what items or types of materials are needed to run the business, and in what quantities. The amount of items required is depended on the size of the business.
- As an entrepreneur, you should be careful in setting the level of profit made on the sale of a product, taking into account the relationship between demands for the product.
- Good workplace management helps small businesses to become efficient by creating comfortable and safe working conditions for employees, reducing material damage and loss, preventing work-related accidents and increasing work space.
- The financial records, colony and operational records should be maintained for a profitable business.
- Colony record would be useful in identifying good colonies and multiplying them.
- Operational Record would be useful in knowing whether the business is running in profit or loss
- A cash flow statement gives an idea of the amount of liquid cash available in the business at any given time. It is prepared by recording all income received by the business on the one hand, and all expenditures incurred by the business on the other.
- As per the nature of work that is to be done, qualifications and skills, person should be hired. Staff may be given training when they start work and then periodically during their working life.



Notes



TERMINAL EXERCISE

1. How the assessment of demand is done to start a beekeeping business?
2. What are the components of a business plan?
3. What marketing strategy you must consider for a beekeeping business?
4. How the selling a produce and profit margin are related?
5. What are the components involved in cost of production in beekeeping?
6. Explain the qualities of a good workplace to make a business efficient?
7. What are the types of records are made for beekeeping business?



ANSWERS TO INTEXT QUESTIONS

10.1

- (a) Assessment of demand
- (b) Two colonies
- (c) business plan
- (d) size of the business
- (e) selling price