5TH SEM B.SC. ZOOLOGY

CALICUT UNIVERSITY

ZOOLOGY OPEN COURSE

APPLIED ZOOLOGY

Code: ZOL5D03T

2019 ADMISSION

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FIFTH SEMESTER B. Sc. ZOOLOGY PROGRAMME

ZOOLOGY OPEN COURSE- III (Theory)

APPLIED ZOOLOGY

Code: ZOL5D03T

[54 hours] [3 hours per week] [3 credits]

COURSE OUTCOMES [COs]

COs Course Outcome Statements

CO1 List and describe the pests and vectors, their habits, damages and control measures and mechanisms of insect pest management. (18 hrs)

CO2 Develop personal, academic, employability and self-management skills in apiculture, lac-culture, sericulture and vermiculture (11 hrs)

CO3 Demonstrate an understanding of the various strategies in pisciculture, prawn culture, mussel culture and pearl culture (4 hrs)

CO4 Recognize the significance of poultry farming and its economic implications in rural India (6 hrs)

CO5 Reviews Indian breeds of cattle and goats and the strategies in their breeding (6 hrs)

CO6 Recognize the significance of parasitic mode of life and their implications in human health (9 hrs)

Question paper pattern for external examination

[Module 1: Short answer 3x2=6 marks, Paragraph 2x5=10 marks, essay 1x10=10 marks; Module 2: Short answer 1x2=2 marks, Paragraph 1x5=5 marks, essay 1x10=10 marks; Module 3-6: Short answer 8x2=16 marks, Paragraph 4x5=20 marks]

MODULE 1. Vectors and Pests (18 hrs)

Insect Pests (8 hrs)

Definition of pest and Types of pests. Nature of damage caused and control measures of the following pests:

(a) Pests of paddy: *Spodoptera mauritia* (Rice swarming caterpillar), *Leptocorisa acuta* (Rice bug); (b). Pests of coconut: *Oryctes rhinoceros* (Rhinoceros beetle), *Rhynchophorus ferrugineus* (Red palm weevil); (c). Pests of stored products: *Sitophilus oryzae* (Rice weevil), *Callasobruchus chinensis* (Pulse beetle); Termites.

[Short answers/Paragraphs/Essays]

Insect Pest Management (5hrs)

Principles of Cultural control, Mechanical controls, Biological control, Chemical control, Integrated pest management (IPM)

[Short answers/Paragraphs/Essays]

Vectors of Human Diseases (5 hrs)

Mention habits, disease caused and control measures of the following

Blackflies, Sandflies, Tsetse flies, Mosquitoes: *Anopheles, Culex & Aedes,* Soft ticks and Hard ticks, Ectoparasitic insects: human lice, rat flea.

[Short answers/Paragraphs]

MODULE 2. Animal Breeding and Animal Cultures (11 hrs)

(a) Apiculture: Brief description of adaptations of social bees used for honey

harvesting – mention *Apis dorsata, Apis cerana, Apis florea,* and *Tetragonula iridipennis;* Bee keeping equipments and methods; Honey bee products: bee wax and its uses, chemical composition of honey and uses; Bee pollination, Economics of bee keeping.

(b). Sericulture: Brief description of *Bombyx mori* (Mulberry silk moth); Silkworm rearing and extraction of silk, Economics of sericulture; Types of silk: Tassar, Muga and Eri silk.

(c). Lac-culture: History, Morphology of lac insect, host plants, Natural infection, Artificial infection (inoculation), methods in lac-culture and economics of lac products.

(d). Vermiculture: Varieties of earthworms and their economic importance, Methods of vermicomposting: basic requirements, preparation of vermibed, collection of compost, vermiwash, Effect of vermiwash on yield and quality of crops.

[Short answers/Paragraphs/Essays]

MODULE 3: Aquaculture (4hrs)

Brief account on Pisciculture, Prawn culture, Mussel culture, Pearl culture and ornamental fish culture (with examples).

[Short answers/Paragraphs]

MODULE 4: Poultry Farming (6 hrs)

Introduction, Importance of egg production, Nutritive value of eggs, factors affecting egg size; Breeds of fowl: a) Exotic breeds: Rhode Island Red, Plymouth Rock, New Hampshire. b) Indigenous breeds: Chittagong, Gangus; Brief notes on Poultry Housing and Equipment.

[Short answers/Paragraphs]

MODULE 5: Animal Husbandry (6 hrs)

Introduction, Exotic and Indian breeds of Cattle and Goats, Artifical insemination, Storage of semen, Embryo transfer technology, Short notes of common diseases: Anthrax, Foot and mouth diseases, Rinderpest, Brucellosis, Peste des Petits Ruminants (PPR).

[Short answers/Paragraphs]

MODULE 6: Parasitology (9 hrs)

Introduction – Commensalism, Phoresis, Parasitism, Symbiosis, Host-parasite Relationship, Physiology, immunology and biochemistry of parasitism, Mention Definitive host, Intermediate host, Reservoir and Zoonosis.

Human Parasites: Mention the habits, habitat, life cycle, mode of infection, control measures of the following parasites: *Entamoeba hystolytica, Giardia lamblia, Leishmania donovani, Plasmodium vivax, Taenia solium* and *Wuchereria bancrofti.*

[Short answers/Paragraphs]

MODULE 1

VECTORS AND PESTS

PESTS

- Harmful species whose population size goes beyond the *damage threshold level* either throughout the year or during specific seasons , adversely affecting the availability , quality and value of useful human resources

KINDS OF INSECT PESTS

1. **Potential pests**

With inherent potential to rise to the pest status though under natural regulations

2. **Key pests**

Major pests of specific crops

3. **Occasional pests**

Occur above the damage threshold level rather infrequently

4. **Regular pests**

Key pests on a crop above damage threshold level most frequently

5. **Persistent pests**

Key pests, which spend whole of their lifetime on specific crops

6. **Sporadic pests**

Occasional pests , rise to pest status unexpectedly

7. **Major pests**

Seriously damaging pest species whose general equilibrium position (GEP) is close to economic injury level(EIL) & sometimes both at same level

8. **Minor pests**

GEP is lower than EIL & Damage Threshold Level

9. **Monophagous pest**

Subsist on single species of host plant

10. **Polyphagous**

Subsist on wide range of host plants

CAUSES OF PEST OUT BREAK

- There is a balance between pest and their natural environment
- Pest outbreak : population size of some species : increases beyond the damage threshold and become pests
- Major causes :
    1. Destruction of forests , conversion of forest areas into farm lands , changes in land use
    2. Destruction of natural enemies
    3. Monoculture
    4. Intensive and extensive cultivation of crops
    5. Introduction of new crops
    6. Improved agronomic practices

7. Improper plant protection method
8. Introduction of new species
9. Accidental introduction of foreign pests
10. Resurgence of sucking pests

PESTS : NATURE OF DAMAGE & CONTROL

A. PESTS OF PADDY :

1 . ***Spodoptera mauritia*** **(Rice swarming caterpillar)**

1. Spodoptera mauritia(Rice swarming caterpillar)

Pest **Damage**

- Pests of paddy
- Leaf eater
- Direct development and complete metamorphosis

Damage

- Sporadic pest
- Defoliation
- Larvae cut the seedlings in large scale
- Cattle grazed appearance is found at severely infested fields
- They feed gregariously and march from field to field
- Makes Leafless stumps

Management:

- Drain the water and Spray chlorpyriphos 20 EC 80ml + 20 lit of water for 8 cents
- Physical removal using hand nets
- Allow ducks into the field to feed on the larvae
- Spraying DDT , BHC, endosulphan
- Flood the nursery to expose the hiding larvae to the surface for birds to pick them up.
- Kerosenate water during irrigation to suffocate and kill the larvae.
- Drain water from nursery and spray chlorpyriphos 20 EC 80 ml during late evening

2. ***Leptocorisa acuta*** **(Rice bug / paddy stink bug)**

2.*Leptocorisa acuta*(Rice bug)

Pest **Damage**

- Pests of paddy
- They are diurnal but most active during morning and evening when they look for the flowering crops. Their presence can be easily detected by the characteristic foul odour that they emit.

Damage :

- Sporadic pest which appears before flowering stage and stays upto milky stage; attacks at milky stage
- Nymphs and adults are destructive
- The pest immigrates in the crop in the flowering stage and feeds on the milky grains and on the sap of the peduncle and leaves.
- Feed on sap of tender stem , peduncle and milky grains
- Some grains on the ear heads appears chaffy
- Yellow spots appear on the leaves due to excessive sucking.
- The empty grains turn whitish and show a puncture mark.
- The characteristic damage is called chaffy grains. Infestation is severe in irrigated and heavy rainfall areas.

Control:

- Collection and destruction of the bugs by netting or in light traps can be done in smaller areas.
- Removal of grasses and other weeds from bunds and surrounding areas reduces population.
- Spraying DDT , BHC
- Light traps
- Dusting of the crop with 5% BHC, Malathion or aldrin @ 15 kg per hectare effectively controls the pest. Application of granules of carbofuran or diazinon has also been found effective.
- Biological control : tiger beetles and robber flies

B. PESTS OF COCONUT

3. *Rhynchophorus ferrugineus* (Red palm weevil)

2. *Rhynchophorus ferrugineus*(Red palm weevil)

Pest **Damage**

- Pests of coconut

Damage

- Holes on trunk with with brownish ooze
- Yellowing of inner leaves
- Gradual wilting of central shoot in the crown
- Brownish oozing
- Central shoots wilting - Later
- Leaf damage - Initial

Management

- Remove and burn all wilting or damaged palms in coconut gardens to prevent further perpetuation of the pest.
- Burn off severely affected palms
- Avoid injuries on stems of palms as the wounds may serve as oviposition sites for the weevil. Fill all holes in the stem with cement.
- Avoid the cutting of green leaves. If needed, they should be cut about 120 cm away from the stem.
- Fill the crown and the axils of top most three leaves with a mixture of fine sand and neem seed powder or neem seed kernel powder (2:1)
- Setting up of attractant traps (mud pots)
- Install pheromone trap

4. Oryctes rhinoceros (Rhinoceros beetle)

Damage

- Persistent coconut pest
- Damaged leaf : shows holes
- Causes stunted growth
- Bore deep into unopened frond , feed on soft tissues
- Central spindle appears cut or toppled
- Fully opened fronds showing characteristic diamond shaped cuttings
- Holes with chewed fibre sticking out at the base of central spindle.
- Initial - Young palm damage
- Later - Non typical V shaped damage

Management

- Remove and burn all dead coconut trees in the garden (which are likely to serve as breeding ground) to maintain good sanitation.
- Remove decaying organic matter from coconut fields
- Collect and destroy the various bio-stages of the beetle from the manure pits (breeding ground of the pest) whenever manure is lifted from the pits.
- Incorporate the entomopathogen i.e, fungus (Metarrhizium anisopliae) in manure pits to check the perpetuation of the pest.
- Soak castor cake at 1 kg in 5 l of water in small mud pots and keep them in the coconut gardens to attract and kill the adults.
- Treat the longitudinally split tender coconut stem and green petiole of fronds with fresh toddy and keep them in the garden to attract and trap the beetles.
- Examine the crowns of tree at every harvest and hook out and kill the adults.
- For seedlings, apply 3 naphthalene balls/palm weighing 3.5 g each at the base of inter space in leaf sheath in the 3 inner most leaves of the crown once in 45 days.
- Set up light traps
- Apply mixture of either neem seed powder + sand (1:2) @150 g per palm or neem seed kernel powder + sand (1:2) @150 g per palm in the base of the 3 inner most leaves in the crown
- Iron rods use for hooking rhinocerus beetles
- Biological control : *Sarcophaga fuscicauda and Pheropsophus hilaris*

C. PESTS OF STORED PRODUCTS

5. *Sitophilus oryzae (Rice weevil)*

1.*Sitophilus oryzae*(Rice weevil)

Pest **Damage**

- Pests of stored products

Damage

- Adults and larvae bore into grains & feed on their interior , hollowing them/emptying out
- Cause complete destruction

Control measures

- Maximum drying of grains before storing
- Cleaning of go-downs/store rooms before storage
- Fumigation
- Dusting BHC & other insecticides

6. *Callasobruchus chinensis* (Pulse beetle)

Damage

- Adult and larvae causes damage to pulses and grains.
- They bore in to pulses and grains and feed in said them making tunnels
- This severally hollows out and damages pulses and grains.
- In heavy infestation, a considerable amount of frass is formed, which form the food for young larvae. Often, the pest attack leguminous pods of in the field, before they are carried to storage godowns.

Control measures

- Thoroughly dry grains and other food products before storage.
- Clean and disinfect godowns,flourmills, storage bins…before storing food products.
- Destroy infested food products.
- Treat food products with mild insecticide before storage.
- Periodic fumigation with methyl bromide, ethylene dibromide etc to kill larvea and adults.

TERMITES

Damage

- Not only wood , termite can traverse through plaster , metal siding and more
- Damage laminate floorings
- Causes damage to wall , ceiling , foundation , garden & floorings
- Buckling wood
- Swollen floors and ceilings
- Also ecxude a scent similar to mildew
- Forms cracks and tunnels
- After consuming wood , termites often leave behind brown-clored and grainy faecal mounds

Management

- Apply termite – killing products
- Set up termite bait
- Apply vinegar / kerosene
- Spray boric acid

INSECT AS VECTORS OF HUMAN DISEASES

VECTORS OF HUMAN DISEASES

VECTORS

- Vector are the invertebrate hosts, which harbour parasites and
- Pathogen and transmit them from one primary host to another.

- They provide favourable ecological and physiological requirements for the multiplication and growth of a Parasite.
- Transmits pathogen from primary hosts to another.

1. BLACK FLIES

Habitat :

- Large rivers
- Icy mountain streams
- Trickling creeks
- Waterfalls.

Diseases :

- Onchocerciasis or River blindness
- Parasitic worm Onchocerca volvulus.
- It is transmitted through repeated bites by blackflies of the genus Simulium

Symptoms:

- Their bites leave a small puncture wound
- Slight swelling to a swollen bump
- Nausea
- Fever
- Swollen lymph nodes.
- Headache
- Itching , localized swelling and inflammation on the region of bite .
- Intense feeding of fly make cause black fly fever with headache, nausea, fever, swollen lymph nodes, aching joints.
- They transmits blind river disease

Control :

- Picaridin
- Wearing bright colors or white clothes.

2. SAND FLIES

Habitat :

- Beaches
- Lagoons
- Mangroves

Diseases :

- Leishmaniasis
- Caused by infection with Leishmania parasites, which are spread by the bite of phlebotomine sand flies
- Kala azar

Symptoms :

Major symptoms:

- Proliferation of histocytes and secondary infiltration of spleen, liver, lymph nodes and bone marrow.
- Other symptoms includeruptive pyrexia,over pigmented skin, brittle hairs, emaciation and anaemia
- Leucopenia resulted by the disturbance in the haemopoietic region of born Marlow due to the extensive hyperplasia.
- Death may occur due to pneumonia of any heart disease.

Common symptoms :

- Red bumps
- Blisters
- Fever
- Malaise
- Eye pain
- Headache

Control :

- Insecticide
- Destroy active qualities of reservoir species

3. TSETSE FLIES

Habitat :

- Rain forest

Diseases :

- African Trypanosomiasis or sleeping sickness
- Types :

1. Gambian sleeping sickness/West African Tripanosomiasis : pathogen-*Trypanosima gambiense*
2. Rhodesian sleeping sickness : Pathogen-*Trypanosoma rhodesianse*

Symptoms :

- Infective bite develops into a red sore(Chancre)
- After some week the patient may suffer fever, rash, swelling of the face and hands, headache,fatigue, aching muscles and joints,itching skin and swollen lymph nodes.
- progressive confusion,personality changes, daytime sleepiness with night time sleep disturbance and other neuralgia problem occurs after the infection invaded.
- If it is not treated it became fatal to patients

Common symptoms:

- Fever
- Headache
- Irritability
- Extreme fatigue
- Swollen lymph nodes
- Aching muscles and joints

Control :

- Wear long sleeved dress of medium weight in neutral colors that blend with the background environment.
- Avoid bushes
- Use insect repellent
- Inspect vehicles before entering.

4. ANOPHELES MOSQUITO

Habitat :

- Freshwater

Causes :

- Plasmodium parasite

Diseases :

- Malaria
- Causative organism : plasmodium parasite

Symptoms :

- Initial manifestation(prodromal symptoms)
- Include nausea, anorexia, constipation, insomnia, thickly coated tongue,
- head ache, myalgia,feeling chillness, etc.
- Paroxysm(repeated attacking stage)-3 stages
    1) Rigor stage –symptoms-chill, acute shivering, rapid pulse, high breathing rate, lumbar and limp pain, etc.
    2) Febrile stage :-symptoms-body temperature reaches up to 105°F or more.
    3) Defervescence stage:-Body temperature falls very law.
- In severe case malaria became fatal.
- Abdominal pain or muscle pain
- Chills
- Fatigue
- Fever
- Shivering
- Sweating
- Diarrhoea
- Nausea
- Vomiting
- Fast heart rate
- Headache

Control :

- Reduce the number of breeding sites
- Kill mosquito larvae
- Use mosquito repellent
- Increase the number of mosquito predators
- Fumigation

5. CULEX MOSQUITO

Habitat :

- Forests
- Marshes
- Tall grasses

Diseases :

- Filariasis
- Causative organism : *Wuchereria bancrofti,*
- Japanese encephalitis

Symptoms :

Earlier symptoms :

- Fever
- Headache
- Nausea
- Vomiting
- Pruritis
- Urticaria(red rashes on skin)

Late symptoms

- Lymphorrhagia(inflammation if lymph vessels),
- Lymphadenitis(inflammation of lymph glands),
- Lymphoedema(Dropsical swelling),
- Hydrocoel(fluid collection in testicles),
- Filarial fever (High fever of sudden onset relapsing with an interval of weeks or months) ,etc.
- Elephantiasis –late complication of filariasis : Characterised by gross outgrowth,outgrowth and thickening of the skin and firm and rubbery
- Enlargement of affected part. This sometimes leads to atropy
- Sometimes asymptomatic filariasis also present, this is detected by microfilariaemia,microfilariaemia and antigenaemia.

Control :

- Reduce the number of breeding sites
- Kill mosquito larvae
- Use mosquito repellent
- Increase the number of mosquito predators
- Fumigation

6. AEDES MOSQUITO

Habitat :

- Tropical regions
- Subtropical regions
- Temperate climates.

Diseases :

- Chikungunya
- Dengue fever
- Yellow fever

Symptoms :

- Early Symptoms:
- Severe headache
- Chill,
- Pain in back and limbs,
- Rising temperature,
- Blood short eyes,
- Nausea, recurrent vomiting,
- Constipation,
- Reduced urine production,
- Albuminuria, etc. (last for 3days)

Late symptoms

- Patient became fatigued and very weak, black vomit,
- Jaundice, small haemorrhages under skin and mucosa, etc.

Common symptoms :

- Nausea
- Vomiting
- Aches
- Body pains

Control :

- Reduce the number of breeding sites
- Kill mosquito larvae
- Use mosquito repellent
- Increase the number of mosquito predators : like guppy
- Fumigation

7. SOFT TICKS

Habitat :

- Animal burrows
- Den
- Caves
- Human dwellings

Diseases :

- Colorado Tick Fever
- Causative organism : Borelia bacteria

Symptoms :

- Lethargy
- Abdominal pain
- Skin rash

- Nausea

Controls :

- Use fine tipped tweezers to grasp the tick by the head next to the skin and slowly pull backward

8. HARD TICKS

Habitat :

- Brushy
- Wooded or weedy area

Diseases :

- Lyme disease

Symptoms :

- Fever
- Chills
- Aches
- Rash

Controls :

- use insect repellent on clothes

9. HUMAN LICE

Habitat :

- Human hair

Diseases :

- Typhous fever
- Trench fever
- Relaxing fever
- Vagabond disease

Symptoms :

- Itching
- Irritation
- Pigmentation
- They spread Epidemic fever,relapsing fever , trench fever, etc.
- Prolonged louse bite causes vagabond disease,characterised by local pigmentation and itching of the skin around neck.

Trench fever

- pathogen-*Rickettsia quintana*
- Symptoms: skin rash,recurrent fever, leucocytosis,splenomegaly , etc.

Epidemic types

- Pathogen:-*Rickettsia prowazekii*
- Vector:-head louse
- Symptoms: Early symptoms-preceded headache, pain in the back and limbs and rigor,then gradually the temperature rises,and congestion in faces and eyes.

- Appearance of mulberry rashes on the abdomen,chest, in her side of arms and back.
- At last death may occur due heart failure.

Controls :

- Personal cleaning
- Sanitising
- Use of chemicals

10. RAT FLEA : Xenopsylla

Habitat :

- Infected Rats

Diseases :

- Plague
- Typhous fever

Symptoms :

- Fever
- Extreme weakness
- Abdominal pain
- Diarrhea
- vomiting
- Bleeding from your mouth, nose or rectum, or under your skin
- Shock
- Blackening and death of tissue

Controls :

- Make sure to not to have Rat
- Spray chemicals

INSECT PEST MANAGEMENT

PRINCIPLES

- Pest management : maintanence of pest population below damage threshold
  1. Exclusion :prevention of entry / spreading of pests to a given area .eg; quarantine
  2. Eradication : elimination of established and successful pests
  3. Protection : isolation & protection of host plants from pests / pathogens.eg;chemical
  4. Resistance : defending the attack of pests .eg; genetically ; new breed

a. Principles of cultural pest control

- The goal of cultural control is to make the crop environment less suitable for insect pests.
- Most of the time, cultural control is used as a preventative measure.
- By anticipating insect problems before they occur, the control techniques avoid or minimize the pest's impact on the crop.

- Cultural control techniques are most effective when the target insect pests have few suitable host plants, do not disperse far or frequently, and/or have complex nutritional or environmental requirements during their life cycle.
- These methods are aimed either at reducing the sources of inoculum or at reducing the exposure of plants to infection.
- Its primary objective is the prevention of pest damage and not the destruction of an existing and damaging pest population.

    - When using cultural control techniques, it is important to be aware of the environmental context of the field,Production efficiency, yields, soil conservation, natural enemy habitat need to be taken into account for each crop/pest complex, climate, and surrounding environment.
- This is because cultural control techniques that maximize insect control may at times be impractical in particular contexts.

- There are four main strategies for cultural control of pest insects:
    1. Reduce and/or disrupt pest habitat in and around crop : example :sanitation , tillage
    2. Adjust crop planting to disrupt pest habitat and nutrition requirements : example : planting a crop at a time when the likelihood of damage from a key pest is reduced. Planting or harvesting a crop before (or after) a pest is present reduces insect damage by avoidance
    3. Divert pest population away from crop : trap cropping
    4. Reduce yield loss from insect injury : planting genetically resistant and tolerant crop varieties. Also, proper irrigation, fertilization, and weed control can improve plant vigor, reducing yield loss when damage occurs.

Methods :

1. Good soil preparation
- This is the first important element in pest control strategy. A healthy soil means healthy plants which are relatively more resistant to pests. A soil rich in humus hosts a wide variety of beneficial microflora that trap nematodes and destroy or keep in dormancy disease organisms, thereby encouraging beneficial insects.

2. Use of indigenous varieties
- Traditional varieties are hardier and relatively more resistant to pests. They can withstand harsh environmental conditions better than modem hybrids.

3. Pest control through the use of mesh screen (nylon nets)
- Younger plants are usually preferred by insects and they suffer significantly from such attacks when compared to older plants.
- Also, the net helps diffuse sunlight thereby improving the quality of some vegetables.
- Finally, the net breaks the impact of raindrops thus (i) reducing physical damage to the plant and (ii) reducing soil erosion from the beds

4. Pruning
- Removal of diseased plants or plant parts prevents the spread of microorganisms to uninfected areas.

5. Intercropping with aromatic herbs
   - Several types of odorous plants can be grown together with the main crop to repel insects.examples:Allium cepa (onion) , Allium sativum (garlic)
6. Encouraging insect predators
   - Pests can be controlled by their natural enemies.
   - By growing a variety of flowering plants, specifically those belonging to Umbelliferae family, such as, fennel (Foeniculurn vulgare) and celery (Apium graveolens), insect predators will be attracted to stay in the garden.
   - These beneficial insects feed on pests, keeping the pest population below economic injury level.
7. Multiple cropping
   - This provides genetic diversity to minimize pest increase.
   - Variation in susceptibility among species or varieties to a particular disease is great. Given abundant hosts of a single species or variety, a pest could easily be spread from host to host.
   - When the number of hosts declines, the pest incidence will also decrease for lack of necessary food for the organism.
8. Crop rotation
   - This is a practice of following a crop susceptible to a pest by a resistant crop. There is no build-up of the organism to a high level since the growth cycle of the organism has been broken.

b. Biological pest control

- Biological pest control is the suppression of pest populations by living organisms such as **predators, parasites** and **pathogens**. These agents are responsible for keeping pests under control most of the time.
- Predators are usually other insects and spiders. Both, but particularly spiders, feed on a wide range of insects.
- Adults and immatures are often predatory.
- Predator : kill multiple prey and both adults and immature
- Parasite : usually kill one prey as it develops : eg; wasp
- Pathogens : disease causing agents
- 3 main practices : conservation , augmentation & importation
- Example : Praying mantis, Dragonfly, Damselfly,Ladybird beetles , Toads, snakes and spiders eat insects and other garden pests , Birds , Trichogramma spp.

The four approaches are:

- **Natural biological control,** i.e., the natural suppression of potential insect pests by resident natural enemies that requires no human facilitation
- **Importation biological control**, i.e., the deliberate importation and establishment of specialized natural enemies from the region of origin of an exotic invasive insect pest to provide long-term suppression over broad geographic regions

- **Conservation biological control**, i.e., the localized manipulation of the crop environment to protect or enhance the activity of resident natural enemies for short-to longer-term suppression of insect pests
- **Augmentative biological control**, i.e., the mass production and localized release of resident natural enemies to augment their abundance for either immediate (inundation) or season-long (inoculation) suppression of insect pests.

Merits:

- Harmless to beneficial and non-target organisms
- Highly specific
- Development resistance is slow
- Self sustaining system and brings down expenditure
- No residual effect
- No environment problem
- Does not cause ecological imbalance
- Adds to stability of ecosystem
- Maintain dynamic balance of nature
- Promotes adaptation

Demerits :

- Needs very high initial expenditure
- Needs full scale ecological evaluation
- Slow and time consuming
- Heavy economic loss
- Unpredictable climatic changes : affects
- Degree of biological control by natural enemies is rarely adequate

Example : biological control project undertaken in India

Opisina arenosella

- Coconut pest .larva called black headed coconut caterpillar is harmful
- Parasitoids ***Goniozus nephantidis*** **,** ***Bracon brevicornis*** are the natural enemies

c. Principles of chemical pest control

- Chemical pest control is the controlling of pest populations using toxic chemicals, called pesticides, which can kill, deter, attract, or influence pests to check their ravages
- The pesticides used to control insect pests are called insecticides.
- Chemicals are often used in both preventive and curative methods of pest control.
- These chemicals kill pests by their toxic and lethal effects.
- But their other effects they alter the behaviour of pests, induce sterility in them, interfere with their metabolism, impair their normal activities, or disrupt and distort their development.
- A broad-spectrum pesticide, that can kill many species of organisms : ***biocide***.
- Generally, narrow-spectrum pesticides, that attack only specific types of pests, are preferred in agricultural pest control.

Classification based on application

1. Attractants

- Attractants are the chemical substances towards which insects make preferential and oriented movements.
- Use of insect attractants :
- Synthetic chemical attractants, specific for insect pests, are important in insect pest control. Insects respond to them either for feeding purpose, or egg-laying, in the former, both males and females are attracted, while in the latter only mature females are attracted.
- Chemical insect attractants are used as an ingredient of insecticides, as a constituent of poison baits, or as a part of mechanical trapping devices.

2. Repellents

- Repellents are offensive chemicals which repel insects away from them.
- Use of insect repellents :
- Chemical repellents are effective for the protection of man and domestic animals from blood-sucking insects. However, they have never been successful for controlling the pests of plants. This is because their continuous emission is essential for effective protection.

3. Synthetic pheromones

two major kinds of synthetic pheromones are used in pest control

- **Alarm pheromones** : alarm pheromones are sometimes used against sap-feeding aphid pests. They cause the insects to drop from the plant,
- **Sex attractant pheromones** : sex attractant pheromones are mostly male-attractants. They are highly species-specific. Their high potency and extreme selectivity and specificity are of great significance for the manipulation of selected pests.

Classification of insecticides based on chemical nature :

Their major active groups include

- Organochloride
- Organophosphates
- Carbamates
- Synthetic pyrethroids
- insect growth regulators
- plant derivatives, oils etc.

A. Inorganic insecticides

Inorganic insecticides are mainly made up of elemental sulphur and mineral compounds.

B. Organic insecticides

a) Hydrocarbon oils

These are the insecticides, formed of hydrogen and carbon, Mineral (petroleum)oils and coal-tar are examples. Mineral oils are obtained from sedimentary rocks.

b) Organic insecticides of animal origin

there are only very few insecticides of animal origin.

c) Organic insecticides of plant origin

Organic insecticides of plant origin are generally called "**botanicals"**

Eg;Nicotine

- **Classification of insecticides based on the mode of entry**
  - Contact Insecticides :oral / dermal .Eg. DDT
  - Stomach poisons : Oral .Eg. arsenic
  - Fumigants : volatile .Eg. Hydrogen cyanide
  - Systemic insecticides :get absorbed to the sap stream of plants from leaves , fruits , stem and roots and moves along vascular system

Mechanism of action of insecticides

The mechanism of action of insecticides is highly variable.In general, they may act as physical poisons, protoplasmic poisons, never poisons, respiratory poisons, or as asphyxiating agents.

Spectrum of insecticide activity

The range of the pest species, affected by an insecticide, is known as its spectrum of action.

Insecticide resistance

Some populations or strains of insects may exhibit a natural tolerance to particular insecticide.

Pesticide hazards

- In Modern times, pesticides are considered as major pollutants, contaminating air soil and water.
- The pollution problem, associated with the use of pesticides, started with the extensive use of DDT and other organochlorines.
- Kills natural enemies
- Causes sec outbreak of pest
- Pesticide poisoning of top soil kill soil microorganisms
- Aquatic environment pollution : affects primary productivity , ecological energetic and dynamics of ecosystem
- Destroy insect pollinators
- Increases susceptibility of organisms to diseases
- Biological magnification
- Interfere with enzyme action , metabolic processes and behavior of animals
- Pesticides, in general, seriously affect human health.
- Their effects include *short-term effects and long-term effect.*

Pesticide residue

- *Pesticide deposit*: quantity of an insecticide remaining attached to the plant surface or other surfaces soon after the application
- *Pesticide residue* : Pesticide deposit progressively decreases due to chemical breakdown , volatalization and other weathering processes . The amount still remaining at crop maturity
- Expressed in parts per million (*ppm)* fresh weight of produce
- *Tolerance level*: max permissible insecticide residue level in harvested produce

INTEGRATED PEST MANAGEMENT (IPM)

- Ecologically based pest-control strategy

- Advocates application of a combination of techniques and relies more on natural enemies , weather , cultural control and restricted use of pesticides
- Specific times-specific pest- specific crop

Features :

- 2 or more techniques in an integrated manner
- Max use of mortality rates
- Based on ecological principles
- Applies specific control measures only when they become unavoidable

Advantages :

- Reduces chemical pesticide usage – reduces environmental pollution-no pesticide residue
- Least possibility of developing resistance by pests
- Reliable because it considers ecological aspects and population dynamics of pests

MODULE 2

ANIMAL BREEDING AND ANIMAL CULTURES

1. APICULTURE

- Scientific method of rearing honey bees
- Caring and management of honey bees for honey and wax
- Bees are bred commercially in apiaries
- The word 'apiculture' comes from the Latin word 'apis' meaning bee.

Products obtained

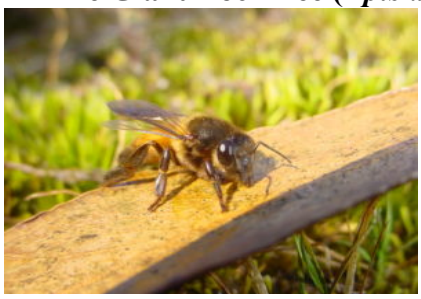
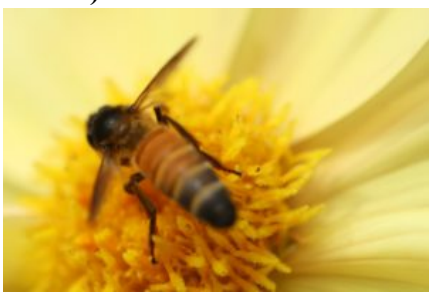
- Bees are mainly reared for their honey. Bees produce honey from the sugary secretions of plants.
- Although honey is an important ingredient in many food dishes, beeswax holds a lot of commercial significance too. It is used in the cosmetic and medical industry, as well as a coating for cheese, and as a food additive. It is also used as the main component for making candles, preparing polishes for the shoe, furniture, etc
- beeswax..

Importance of Beekeeping

- Provides honey, which is the most valuable nutritional food.
- Provides bee wax which is used in many industries, including cosmetics industries, polishing industries, pharmaceutical industries, etc.
- Plays an excellent role in pollination. Honey bees are the best pollinating agents which help in increasing the yield of several crops.
- According to the recent studies, the honey bee's venom contains a mixture of proteins which can potentially be used as a prophylactic to destroy HIV that causes AIDS in humans

There are different types of honeybee species found . They vary in size, behavior, how they build nests, and there is even some variation in the Genus that they come from.

2. The Giant Rock Bee (*Apis dorsata*)

- Their name derives from the fact that they often construct their nests underneath rock overhangs, such as large cliff faces.
- Also be found on high tree branches and the ceilings of large buildings.
- Often the Giant Rock will build its hives in aggregates, as in numerous colonies will construct their combs close to one another.

- When this honeybee constructs its nest it will do so within 1 km of a water source, and also tend to be near areas with plentiful pollen and nectar sources.
- In addition, these nests are quite large and are required to be built vertically in order to hold the massive colony size, which ranges from ~60,000-100,000 worker bees.
- The Giant Rock Bee builds its nest out in the open, in order that the hive receives direct sunlight but is also kept protected from the rain (hence, often being underneath overhangs).
- Being the largest social bee in the Nilgiri Biosphere Reserve, as well as one of the largest honeybees in the world, this species produces large quantities of honey.
- The honey gathered from *Apis dorsata* contributes 2/3 of the total production of honey in Indi
- On average, a single hive will give an annual yield of 2-40 kgs of honey.
- The Giant Rock Bee is also notorious for being one of the most dangerous of bee species,
- These honeybees are also able to migrate long distances (50-250 kms) and will travel to the plains when there is limited flowering in the mountains.

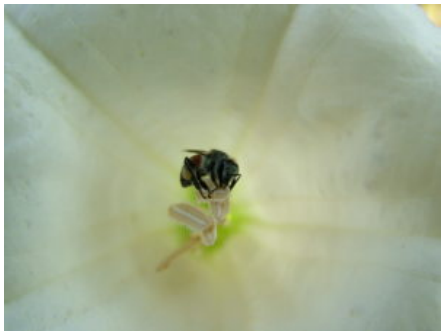
2. **The Asian Honey Bee (*Apis cerana)***

- The Asian Honey Bee is smaller in comparison to the Giant Rock Bee, however it is much more widespread.
- Typically the size range is 20,000-30,000 individuals per colony.
- This species does not nest out in the open but prefers dark enclosed places such as cavities within rocks, trees, stone walls, or even inside of buildings.
- Honeybee will build multiple, and construct it such that the outer combs hold the surplus honey while the inner combs hold the brood and pollen.
- The honey section a single hive can give an annual yield of 3-16 kgs of honey.
- They do not migrate naturally but will do so once honey is gone and they need to resupply food.
- Thus they will abscond the nest in the case of lack of resources or if there is a disturbance.
- The Asian Honey Bee is a generalist species thus it can adapt to multiple different landscapes as well as a large variety of plants.

3. **The Little (or Dwarf) Honey Bee (*Apis florea)***

- Another honeybee that builds single comb nests.
- These hives are found in dense, shrub vegetation as well as in cavities of rocks and trees, and even under the roofs of palm trees.
- When constructing the comb on a tree branch the Little Honey Bee often puts the honey at the upper region of the comb, which is placed on the top part of the branch, thus leaving the remaining part of the comb found below the branch to the brood, pollen, and drone cells.
- Ants. The colony size of *Apis florea* often ranges between 8000-3,500 individuals.
- On average a single hive will produce 1-3 grams of honey in a season (typically from April to June).
- If the hive is being disturbed this species will desert the nest, but only temporarily, and return shortly.
- This honeybee will migrate locally at small distances of 500 meters and even as far as 20 kms.
- The honey from the Little Honey Bee will often sell at a higher price because it is reputed for medicinal properties.

4. Dammer Bees (Trigona spp and Melipona spp.)



- Smallest of the honeybee species found
- They are also known as stingless bees because they do not sting but bite.
- They too build their nests in darker spaces such as trunks of trees, wall crevices, within logs, and even under roofs.
- They are also one of the honeybee species in the nilgiri that people can do beekeeping with and there is a tradition in tamil nadu of keeping dammer bees insides of bamboo hives.
- From single pot, honey can be gathered for 5-8 years with a quantity of about 6 kilograms of honey each year.

- However, most often in the wild they produce about 1kgs – 20 grams of honey per hive.
- Hence, this bee makes for excellent domesticated species since it can be so easily hived and rarely absconds the nest.
- When building a nest the dammer bees use propolis, also known as plant resins, along with wax.
- The honey produced by this honeybee species is dark and bitter and is highly valued for its medicinal properties.
- Their colony size ranges between 1500-100 individuals per hive.
- Another intriguing feature of dammer bees is that they have a swarming and mating system that is unlike other honey bees.

Social organization

- The social organization of the honey-bees is established by the living of all individuals within the colony and they show the mutual cooperation among the members of the colony, and exhibit the overlapping generations.
- there is a division of labour among the different types of honey-bees in the colony or hive.
- The different forms or types of insects having a particular function live in the colony, called the castes.
- **Caste System:**

Thousands of bees (50,000 to 1,00,000 or more) which live in a hive are of three different forms:

1. **Workers (infer-tile females)**
2. **Drones (males) and**
3. **Queens (fertile females)**

Workers:

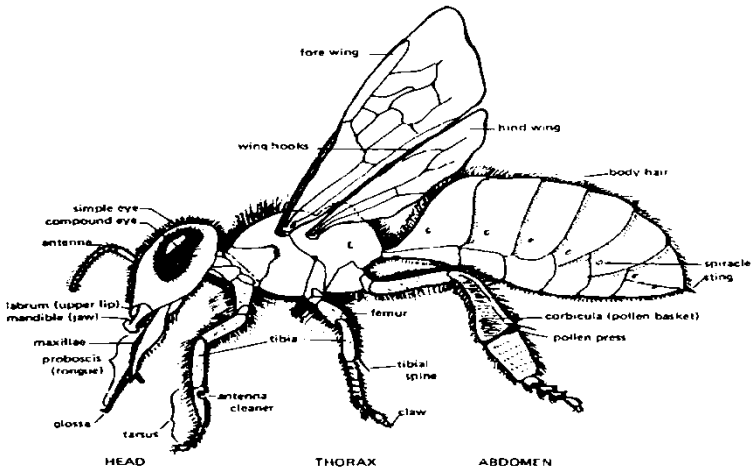
- The size of worker bee is small but they constitute the majority in a hive.
- Called *neuters*: degenerated gonads:no instinct to mating and reproductive powers
- They are produced by the fertilized eggs laid by the queen. It takes 20 days from egg to adult and life span is about 6 weeks.
- 2 categories : ***house bees and foragers***
- Foragers : 2 types : *searchers and collectors*
- Duties :
    - Builders
    - Repairers
    - Cleaners
    - Fanners
    - Store keepers
    - Nurses
    - Waiters
    - Brewers
    - soldiers

Structure of worker bee

Worker bees are shorter and more slender than drones and the queen, and their back legs have special baskets to help them collect pollen. Like the queen, they also have stingers, but they can only sting mammals once and then they die. They can, however, sting other insects over and over again to protect the hive.

1. Head
2. Thorax
3. Abdomen

External morphology of a worker bee



Head

- Bears :
  - Antennae: tactile / olfactory
  - Compound eyes (2) : formed of 5,000 ommatida , perceive moving objects and distinguish only blue , yellow and white colors and UV rays,
  - 3 ocelli : photoreceptors
  - Mouth parts

Mouth parts

- chewing and lapping
- consists of ,
  - *labrum* : upper lip
  - *epipharynx* : organ of taste
  - a pair of *mandibles* : large , toothless and spatulate : used for kneading pollen , moulding wax , removing wastes , cleaning cells
  - *1st maxillae* : has cardo and stipes (has *maxillary palp , palea and lacinia)*
  - enlarged *labium* : has *sub-mentum , mentum and pre–mentum* (has *labial palps , paraglossae and glossae*)
  - glossae forms flexible hairy proboscis or tongue with terminally expanded *labellum*

Thorax

- *prothorax :* pair of legs
- *mesothorax and metathorax* : both bears a pair of legs and wings
- *wings* : membranous with hamuli

- *legs* : specialized for gathering , storing and carrying pollen . 5 regions : *coxa , trochanter, femur tibia and trasus*
  - *prothoracic legs* : contains eye brush , pollen brush , tarsal notch ,antenna comb and , tibial spine.Antenna comb and spine form antennae cleaner
  - *mesothoracic legs* : provided with tibial spur (used to remove wax plates) and pollen brush
  - *metathoracic legs* : has *pollen basket , pollen brush ,wax pincher & pollen packer* (auricle and pecten) , *pollen combs*

Abdomen

- Ten segmented
- Bears 4 pairs of *wax glands , scent gland and a sting* (sting is absent in drones)

Wax glands

- 4 pairs
- Lower side of last 4 abdominal segments
- *Wax mirrors* has openings from which wax secreted from wax glands reaches sternite and forms *wax pockets*

Scent glands

- Beneath tergite of 7^{th} abdominal segment
- Pheromone

Sting apparatus

- Only in female bees and absent in drones
- Consists of :
  - Venom glands
  - Venom duct
  - Alkaline gland
  - Venom receptacle
  - Chitinized sting

Specialized structures and glands

- *Pollen brush* : for gathering brushes
- *Pollen basket :* for storing and transporting pollen
- *Honey sac* : for storing and carrying nectar
- *Pharyngeal glands* : for producing royal jelly
- *Wax glands :* for wax production
- *Salivary glands* : one pair cephalic and thoracic . Contains *invertase :* for honey modification(sucrose to levulose and dextrose) and for comb building : for chemical modification of nectar for making honey
- *Food glands* : in head for royal jelly production
- *Mandibular glands* : in head ; produces enzymes for cocoon softening
- *Honey sac:* crop , specialized for storing carrying honey and water

BEEKEEPING METHODS

- Two methods,
    1. Indigenous method
    2. Modern method.
- To obtain pure and more amount of honey modern methods of apiculture are in practiced.

1. Old or indigenous method

- This is primitive and unplanned method of apiculture.
- In this method two types of hives are used,
- Natural fixed combs prepared by bees on the walls or the branches of trees
- Artificial or man-made movable hive: These hives are made from wooden logs or earthen pots etc.
- In the indigenous method, the bees are first killed or made to escape from the hive with the help of smoke when the bees are at rest during night.
- This method has many drawbacks and it is not suitable for commercial large-scale production of honey.

The following are the disadvantages of indigenous method:

- The honey cannot be extracted in the pure form. The extracted honey also contains the larvae, pupae and pollen cells.
- The future yield of the honey is affected as the colony has to be destroyed to extract the honey. takes lot of energy of the bees to build new hive.
- The bees may not construct the new hive in the same place as the old one.
- The natural hives also have the danger of attack by the enemies like rats, monkeys, ants etc.
- The natural hives can also be damaged by the climatic factors.
- Also scientific intervention is difficult in the indigenous method and thus improving of the bee race is impossible.

- Though the indigenous method has many drawbacks, it still persists.

2. Modern method

- In the modern method of apiculture the honey bees are reared in movable artificial hives.
- This was designed and invented by Longstroth in 1951.
- This invention has turned apiculture into a cottage industry and has provided employment to lakhs of people.
- The modern beehive is made up of a series of square boxes without tops or bottoms, set one above the other.
- These hives have a floor board and a bottom stand at the bottom and a crown board at the top.
- Inside these boxes, frames are vertically hung parallel to each other.
- The frames are filled with sheets of wax foundation on which the combs are built by the bees.
- The entrance of the hive can be reduced with the help of the entrance reducer. The queen is usually confined to the brood chamber.

- The boxes termed honey supers are used for storage of honey.
- The queen is prevented from going to honey supers by the queen excluder that allows only the workers to move.

Steps included in apiculture or commercial production honey

1. Catching a swarm: Swarm is an old queen accompanied by huge population of workers flying to start a new hive. The swarm is generally collected with a straw basket called as skep with a lid.
2. Hiving a Swarm: It is the process in which the collected swarm is transferred to the hive to build up the colony and produce honey.
3. Initial feeding: After the hiving of the swarm, they are fed with sugar syrup. This feeding will help the bees to settle down to work in their new home.
4. Starting the work: After settling down in the new hive the bees start to work in their respective job roles in the new hive. The worker bees move about in the surrounding flora collecting nectar and pollen. Consequently the colony expands and starts the production.

BEEKEEPING EQUIPMENTS

1. Hives

Hives are where the bees live.

2. Frames

Frames are rectangles that hang inside of a hive like a filing system. The bees will build their comb inside of these frames. This is where they will make honey, lay brood, and live their lives constantly preparing for winter.

3. Smoker

Having a smoker should be a pretty big priority if you decide to take on beekeeping. The reason is the bees don't care about the smoke.

4. Hive Tool

A hive tool is another very inexpensive tool but it is one I would consider a necessity. The reason is that bees line their hives with propolis. It is basically the glue that holds everything together, and they also use it for insulation purposes as well

5. Queen Catcher

A queen catcher is a handy tool to have when you want to keep the queen separated for a while

6. Bee Suit

7. Gloves

Gloves are also an important tool to have.

7. Shoes

9. Essential Oils

use essential oils to attract bees to our swarm boxes. use essential oils in our homemade honeybee health recipe which we feed to the bees during the times of year that they need us to supplement their foraging with sugar water.Plus, you can use essential oils to help drive out hive beetles.

10. Feeders

There are certain times of the year when things either have quit blooming or are waiting to bloom. Those are the times your bees will need you to help them supplement their food supply.

However, it isn't difficult to do. You just mix equal parts of sugar and water. Then place the mixture in a feeder. You can open feed which means you leave a bucket of sugar water out for the bees.

Or can use an entrance feeder or a hive top feeder. The advantage to these feeders is that they are in the hive so you don't have to worry about other creatures robbing food from your bees.

11. Sugar

bees will depend upon you to supplement their food supply. They require a syrup that is equal parts of sugar and water.

12. Queen Excluder

the point behind this is that the grated excluder is placed where ever you don't want the queen to go. The slots are small enough that the worker bees can still fit through the slots.

However, the queen cannot. She is forced to stay below where the excluder is. You can also use it when you are moving your bees to a new location. You place a queen excluder in front of the hive door so the queen can't leave. This gives your bees a great chance at sticking around.

13. Queen Marker

Marking your queen will be very helpful when you are just getting started. She can be hard to find at times.

14. Bees

Unless you catch a swarm, you will most likely have to purchase your first bees. After that, you should be able to split your hives to keep things rolling and multiplying.

15. The Queen

If you already have a hive but maybe didn't have such great success with it, then it might be time to requeen. If that is the case then you'll have to purchase a queen or raise your own. Either way, she is definitely a necessary part of the whole beekeeping process.

Beekeeping Equipment

Basic Equipment

Bee hive

1. *Hive outer cover* - provides weather protection.
2. *Inner cover* - prevents bees from attaching comb to outer cover and provides insulating dead air space.

3. *Shallow honey supers* - shallow supers with frames of comb in which bees store surplus honey. This surplus is the honey that is harvested.

4. *Queen excluder* - placed between the brood nest and the honey supers. This device keeps the queen in the brood nest so brood will not occur in honey supers. An excluder is usually not necessary if two hive bodies are used.

5. *Hive body or brood chamber* - large wooden box (called a "super") that holds 10 frames of comb. This space (the brood nest) is reserved for the bees to rear brood and store honey for their own use. Either one or two hive bodies can be used for a brood nest. Two hive bodies are common in cold winter regions. Beekeepers in areas with mild winters successfully use only one hive body.

6. *Bottom board* - wooden stand on which the hive rests. Set bottom board on bricks or concrete blocks to keep it off the ground.

7. *Hive stand* - Supports the hive off the ground to keep hive bottom dry and insulates hive.

8. Frames and foundation
   Wooden frames hold sheets of beeswax or plastic foundation that are imprinted with the shapes of hexagonal cells.

9. Smoker
   A smoker is the most valuable tool for working bees. A smoker calms bees and reduces stinging. Pine straw, grass and burlap make good smoker fuel

10. Hive tool
    Ideally shaped for prying apart supers and frames

11. Veil and gloves
    These protect the head and arms from stings. After they gain experience, many beekeepers prefer to work without gloves

12. Feeders

Feeders hold sugar syrup that is fed to bees any time during the year that energy demands are high but natural nectar not available.

PRODUCTS FROM A BEE HIVE

The two main products from a bee hive are honey and wax which are valuable and marketable commodities.

1. Honey

- Honey is the most important product of apiculture. It is a food material for bees and their larvae. The bee hive stores large quantities of honey to meet the demands in scarcity. Chemically, honey is a sticky water solution of sugar.

Composition of honey
Water: 13-20%
Fructose: 40-50%
Glucose: 2-3%
Minerals: Traces%
Vitamins: B1, B2, C (minute quantities)

- However, composition of honey and its different flavours depend on the kinds of flowers from which the nectar is collected.
- Nectar is sucked from flowers and mixed with saliva. It is swallowed into a special region of the gut called honey stomach.
- Nectar is a disaccharide (sucrose) it is hydrolysed by the salivary amylase to produce monosaccharides (fructose and glucose). Inside the hive the workers regurgitate the processed nectar. The honey thus produced is still very dilute.
- After placing this honey onto the storage cells of the hive the bees "fan" with their wings to evaporate the excess water and bring the honey to its required concentration. Extraction of honey from the combs is done by the method of centrifugation.

Uses of Honey

- Honey is a nutritious food, rich in energy and vitamins. Our body readily absorb sugar, minerals, vitamins and other materials from honey.
- It is used as a carrier in ayurvedic and unani medicines
- It acts as a laxative, antiseptic and sedative.
- It prevents cold, cough and fever.
- It is also used as a blood purifier.
- It is also used in religious ceremonies.
- It goes in the making of alcoholic drinks and beauty lotions.
- Another important use is in scientific research for making bacterial cultures.
- It is also utilised for making poison baits for certain insect pests.

2. Beeswax

- Generally bees consume about 10-20 kg of honey to produce one kg of bee wax.
- Beeswax is secreted by the wax glands located on the underside of the last four abdominal segments of the worker bee.
- This wax is used by the bee in constructing bee combs in which the colony of the bees develops.

Uses of beeswax

- Making of traditional candles.
- Making pharmaceutical preparations like ointments.

- It is also used in the manufacture of cosmetics like face creams.
- Carbon papers are also mad with the help of bee wax.
- In laboratories it is used in microtomy work to prepare blood tissues.
- Preparation of varnishes and paints
- Water proofing and waxing of threads; and
- Formation of comb foundation (wax foundation in apiaries)."

Bee products

1. **Honey**

Composition and Uses of honey

- Water -17%
- Pollen grains
- Fructose :40%
- Dextrose : 35%
- Sucrose: 1.8%
- Dextrins : 1.5%
- Minerals salts : 2% : calcium, magnesium , phosphorus , sulphur , chlorine and iodine
- Organic acids : citric ,tartaric , formic acids
- Gums,enzyme s: *amylases, invertases, saccharases , lipases , peroxidases*
- Vitamins :A,C,E & K ,vitamin B complex

Uses:

- Food
- Medicine
- Beverage making
- Laboratory plants : growth
- Rooting of plants : promotes
- Bacterial culture preparation

2. **Bee wax**
    - Wax Paints , Candles , Cosmetics , Insulation, Pharmaceutical , Polish etc
3. **Bee venom** : apitoxin
    - Mellitin lowers BP, therapeutic and prophylactic remedy
    - Antibiotic
    - Control haemolysis
    - Raise immunity
    - Remedy for rheumatism , neuritis , eye disease etc

2.SERICULTURE

Different types of silkworms

1. **Mulberry silk moth (*Bombyx spp.)*** : feed on tender mulberry leaves ;both domesticated and wild species are included;produce finest natural silk

2. **Eri silk moth**: feed on castor leaves ;fully domesticated; produce eri silk
3. **Tussar silk moth** : feed on leaves of oak, fig etc ; partially domesticated; produce tasar silk
4. **Muga silk moth** : feed on several trees ;produces muga silk

BOMBYX MORI

- The adult moth is whitish in colour, 25 mm long with 40 to 50 mm wing span.
- The female is larger than the male.
- The body has three divisions—head with a pair of eyes and a pair of antennae, thorax with three pairs of legs and two pairs of wings, and one large abdomen.

Egg:

Immediately after mating the female starts laying eggs on mulberry leaves. The eggs are oval and covered by a hard, smooth chitinoid shell. At about 24°C a moth lays 300 to 500 eggs within 24 hours. In favourable temperature the larvae hatch out within 10 to 11 days.

Larva:

1. A newly hatched larva is about 3 mm long. The cylindrical body is covered with a chitinous skin and divided into 13 (or 14) segments, with a head at the anterior end and a caudal horn near the posterior end of the body.
2. It has three pairs of thoracic, four pairs of abdominal and a pair of caudal legs.
3. The larva goes to dormancy or dia-pause for four times. These are called 1st, 2nd, 3rd and 4th 'sleeps.'
4. Each 'sleep' is followed by ecdysis. The part of life in between hatching and first ecdysis is 1st stage, and between the first and second ecdysis the 2nd stage and so on.
5. Towards the end of 5th stage, the larva is mature and starts spinning cocoon. The larval age is about 20 days.
6. For a complete covering the larva rotates its head about 60,000 to 300,000 times and the silk thread is liberated at the rate of 15 cm per minute.
7. The protective Covering is called co-coon which is formed by an unbroken silk thread 400 to 1,500 metres.
8. A caterpillar larva takes about 4 days to complete a cocoon and then turns to a completely immobile larva, the pupa.
9. The pupa is transformed into a full grown adult or imago after ten days.
10. The imago secretes a fluid which dissolves the cocoon at one end and the adult emerges through it.

- Rearing of domesticated silk moths and silk worms for commercial silk production
- **Requirements** : superior races of ***Bombyx mori*** and **high quality mulberry plants**
- Rearing Equipments:
  a) Rearing house: The rearing house should meet certain specification, as the silk worms are very sensitive to weather conditions like humidity and temperature. The rearing room should have proper ventilation optimum temperature and proper humidity. It should be ensured that dampness, stagnation of air, exposure to bright sunlight and strong wind should be avoided.

b) Rearing stand: Rearing stands are made up of wood or bamboo and are portable. These are the frames at which rearing trays are kept.. The trays are arranged on the shelves, and each stand can accommodate 10 rearing trays.
c) Ant well: Ant wells are provided to stop ants from crawling on to trays
d) Rearing tray: These are made of bamboo or wood so that they are light and easy to handle.
e) Paraffin paper: It is used for rearing early stages of silk worms and prevents withering of the chopped leaves and also help to maintain proper humidity in the rearing bed.
f) Foam rubber strips
g) Chopsticks: These are tapering bamboo rods (1cm in diameter) and meant for picking younger stages of larvae to ensure the hygienic handling.
h) Feathers: These are used for brushing newly hatched worms to prevent injuries.
i) Chopping board and Knife
j) Leaf chambers: These are used for storing harvested leaves.
k) Cleaning net: These are cotton or nylon nets of different mesh size to suit the size variations of different instars of the silk worm. These are used for cleaning the rearing beds, and at least two nets are required for each rearing tray.
l) Mountages: These are used to support silkworm for spinning cocoons.
m) Hygrometers and Thermometers: These are used to record humidity and temperature of the rearing room.
n) Feeding stands: These are small wooden stands (0.9 m height) used for holding the trays during feeding and bed cleaning.
o) Other equipments like feeding basins, sprayer, and leaf baskets may also be required.

Steps:

- Selection of silk moth : disease resistant, adaptability , silk production potential etc
- Growing mulberry plantations : moriculture
- Rearing of silk worms
- Processing of cocoons : 10% of pupae are allowed to grow to raise nest generations and
- remaining are used for silk production : involves ;
  - *Stifling* : killing of pupae inside cocoons :by hot air , sun or fumigation
  - *cooking :* soaking in hot water : it softens the sericin that glues coils of fibroin thread: helps loosening and separation
  - *reeling*: separation and uncoiling of silk threads : produces raw silk / reeled silk / spools of silk
- raw silk : boiled , steamed , stretched , purified , washed and cleaned : combed and untangled
- can be used directly or bleached and colored

Stages of production

The stages of production are as follows:

1. The female silkmoth lays 300 to 500 eggs.
2. The silkmoth eggs hatch to form larvae or caterpillars, known as silkworms.
3. The larvae feed on mulberry leaves.
4. Having grown and moulted several times, the silkworm extrudes a silk fibre and forms a net to hold itself.

5. It swings itself from side to side in a figure '8', distributing the saliva that will form silk.
6. The silk solidifies when it contacts the air.
7. The silkworm spins approximately one mile of filament and completely encloses itself in a cocoon in about two or three days. The amount of usable quality silk in each cocoon is small. As a result, about 2,500 silkworms are required to produce a pound of raw silk.
8. The intact cocoons are boiled, killing the silkworm pupa.
9. The silk is obtained by brushing the undamaged cocoon to find the outside end of the filament.
10. The silk filaments are then wound on a reel. One cocoon contains approximately 1,000 yards of silk filament. The silk at this stage is known as raw silk. One thread comprises up to 48 individual silk filaments.

Composition of silk

- 75% ***fibroin*** : forms the inner core : alanine, serine, glycine , and tyrosine
- 25% ***sericin***:forms gummy coating alanine , leucine and serine
- Traces of carotenoid pigments and wax

Types of silk

1. Tussar Silk

- Tussar Silk is naturally gold in colour produced by several species of silkworm belonging to the moth family.
- These silkworms often live within trees in wild forests and it is mainly harvested in countries including China, India, Japan and Sri Lanka.
- Tussar Silk is generally considered to be more textured than Mulberry Silk, which means the overall feel is less soft, but the main reason that we do not choose to use this silk for our bedding here at Gingerlily, is that Tussar Silk is not as durable as Mulberry Silk.
- That said, you can still find it used in garments and linens around the world. It is particularly common to find it used in the production of womens' sarees.

2. Eri Silk

- Eri Silk comes from a specific species of caterpillar found in North East India as well as certain parts of China and Japan.
- This silk's thermal properties mean that it can keep you warm in winter and cool during summer, however it's not commonly the silk-of-choice for fabric production, simply because it is elastic and is also heavier than other silks.
- Eri Silk feels more 'wool-like' and also blends well with wool and cotton, so you can expect to find it mixed with these more common materials in silk-blend items such as curtains, bed covers and quilts.

3. Muga Silk (An Assam Silk)

- Muga Silk is known for its natural golden colour and is specifically from the Indian state of Assam. Steeped in its own history, this blend of silk was typically preferred by Indian royalty.

- Like Mulberry Silk, Muga Silk is also made by silkworms, but these silkworms are unique because of their location in Assam and they are also a specific species of silkmoth fed on a strict diet of aromatic leaves.

4.LAC CULTURE

- Lac producing scale insects
- Host plants : mango,fig,peepal,oak ets
- Insert proboscis on to bark and feed on sap
- Abdominal glands secrete protective resinous substance called lac that encases and protects them
- Lac insects are not domesticated
- Adult lac insects : small orange –red organisms with piercing and sucking mouth parts
- Reside inside resinous coverings : *lac cells/lac scales*
- Adult females : wingless and inactive . adult male s:m active and winged
- After mating , male dies
- Eggs : 200-500
- Larvae feed on plant sap : dermal glands secretes lac
- Larvae : becomes adult inside lac cells

Different strains of lac insects

1. *Kusumi :* superior in color and quality
2. *Rangeeni*

Lac cultivation

- 3 steps :
  - Selection and preparation of host plants
- Common in India : mango, peepal, oak , fig etc
- 4/5 months after Pruning , lac insects are introduced to tender branches
  - Inoculation of lac insects
- Young ones of lac insects are introduced into host tree and properly asscociated with succulent branches
- May be natural or artificial(lac-encrusted twigs or brood lac are tied to succulent branches of pruned host tree
  - Harvesting of lac
- 2 kinds : immature harvesting (harvested before larval swarming; ari lac)and mature harvesting (mature lac)
- Stick lac $\xrightarrow{\text{washed and powdered}}$ grain lac/seed lac $\xrightarrow{\text{melted with arsenic sulphate\& filtered}}$ kirri lac $\xrightarrow{\text{cooled and solidified}}$ pure lac $\xrightarrow{\text{sheet}}$ sheet lac $\xrightarrow{\text{chemically processed}}$ shellac

Composition of lac

- Resin:70-80%
- Water:2-3%

- Sugar
- Protein
- Soluble salts
- Wax:5-6%
- Coloring pigments :2-10%: like *laccaic acid , erythrolaccin*

Properties of lac

- Water-insoluble ,readily soluble in alcohol and ammonia
- Bad conductor of heat
- High adhesive power
- Forms binding material , when mixed with alcohol

Uses of lac

- Resinous material
- Sealing wax
- Good insulator
- Paints , polishes , varnishes, finishers , electrical insulation, metal coating etc
- Thermoplastic moulding material
- Crayons
- Optical frames

4.VERMI CULTURE

Commonly used species

1. *Eisinia fetida* (red wigglers)
2. *Perionyx excavates*
3. *Lampito mauritii*

- Vermicomposting is a process in which the earthworms convert the organic waste into manure rich in high nutritional content
- Vermicomposting is the scientific method of making compost, by using earthworms. They are commonly found living in soil, feeding on biomass and excreting it in a digested form.
- Vermiculture means “worm-farming”. Earthworms feed on the organic waste materials and give out excreta in the form of “vermicasts” that are rich in nitrates and minerals such as phosphorus, magnesium, calcium and potassium.
- These are used as fertilizers and enhance soil quality.
- two methods:
    1. Bed Method: This is an easy method in which beds of organic matter are prepared.
    2. Pit Method: In this method, the organic matter is collected in cemented pits. However, this method is not prominent as it involves problems of poor aeration and waterlogging.

Process of Vermicomposting

- **Principle** : This process is mainly required to add nutrients to the soil. Compost is a natural fertilizer that allows an easy flow of water to the growing plants. The earthworms are mainly used in this process as they eat the organic matter and produce castings through their digestive systems.

- The nutrients profile of vermicomposts are:

  - 1.6 per cent of Nitrogen.
  - 0.7 per cent of Phosphorus.
  - 0.8 per cent of Potassium.
  - 0.5 per cent of Calcium.
  - 0.2 per cent of Magnesium.
  - 175 ppm of Iron.
  - 96.5 ppm of Manganese.
  - 24.5 ppm of Zinc.

Materials Required

- Water.
- Cow dung.
- Thatch Roof.
- Soil or Sand.
- Gunny bags.
- Earthworms.
- Weed biomass
- A large bin (plastic or cemented tank).
- Dry straw and leaves collected from paddy fields.
- Biodegradable wastes collected from fields and kitchen.

Procedure

- To prepare compost, either a plastic or a concrete tank can be used. The size of the tank depends upon the availability of raw materials.
- Collect the biomass and place it under the sun for about 8-12 days. Now chop it to the required size using the cutter.
- Prepare a cow dung slurry and sprinkle it on the heap for quick decomposition.
- Add a layer (2 – 3 inch) of soil or sand at the bottom of the tank.
- Now prepare fine bedding by adding partially decomposed cow dung, dried leaves and other biodegradable wastes collected from fields and kitchen. Distribute them evenly on the sand layer.
- Continue adding both the chopped bio-waste and partially decomposed cow dung layer-wise into the tank up to a depth of 0.5-1.0 ft.
- After adding all the bio-wastes, release the earthworm species over the mixture and cover the compost mixture with dry straw or gunny bags.
- Sprinkle water on a regular basis to maintain the moisture content of the compost.

- Cover the tank with a thatch roof to prevent the entry of ants, lizards, mouse, snakes, etc. and protect the compost from rainwater and direct sunshine.
- Have a frequent check to avoid the compost from overheating. Maintain proper moisture and temperature
- After the 24th day, around 4000 to 5000 new worms are introduced and the entire raw material is turned into the vermicompost.

Advantages Of Vermicomposting

- Develops roots of the plants.
- Improves the physical structure of the soil.
- Vermicomposting increases the fertility and water-resistance of the soil.
- Helps in germination, plant growth, and crop yield.
- Nurtures soil with plant growth hormones such as auxins, gibberellic acid, etc.

Disadvantages of Vermicomposting

- It is a time-consuming process and takes as long as six months to convert the organic matter into usable forms.
- It releases a very foul odour.
- Vermicomposting is high maintenance. The feed has to be added periodically and care should be taken that the worms are not flooded with too much to eat.
- The bin should not be too dry or too wet. The moisture levels need to be monitored periodically.
- They nurture the growth of pests and pathogens such as fruit flies, centipede and flies.
- Vermicomposting turns the kitchen waste and other green waste into dark, nutrient-rich soil. Due to the presence of microorganisms, it maintains healthy soil.

Vermicomposting is an eco-friendly process that recycles organic waste into compost and produces valuable nutrients."

Vermiwash

- Liquid organic fertilizer
- Liquid that is collected after the passage of water through a column of worm action and is very useful as a foliar spray
- It is collection of excretory products and mucus secretion of earthworms along with micronutrients from the soil organic molecules

Effect of vermiwash

- Natural fertilizer
- Develop resitance against various diseases and pests in plants
- Helps in initiating good flowering and produce good yield

- Inhibits mycelia growth of pathogenic fungi
- Biopesticide
- No adverse effect on soil, plant and environment
- Increases germination of seed
- Increases soil fertility
- Stimulates root development
- Feeds microorganisms

MODULE 3

AQUACULTURE

PISCICULTURE

- Pisciculture is the rearing of fishes under controlled conditions.
- It involves the control of the growth, breeding, and quality of the fish in culture systems.
- Fishes occupy the supreme position by virtue of their highly nutritious flesh which is rich in proteins, minerals and vitamins.

Desirable qualities of culturable fishes

1. Adaptations to thrive in changing environmental conditions
2. High reproductive potential to maintain high population density throughout life.
3. Fast growth and high rate of food conversion to grow to full size in a short time
4. Ability to live with other species in poly culture or mixed farming systems
5. Adaptations to live in crowded conditions
6. Ability to accept any type of artificial feed.
7. Small and handy size.
8. Ability to spawn (reproduce) in captivity, large eggs, simple larval development, and single larval stage.
9. Endurance to withstand rough handling and transportation.
10. High resistance against pathogens and diseases.
11. High food value, excellent table quality and great demand in the local market.

- Carps are the commonest and the most popular fresh water fishes cultured in India
- Other culturable fishes include catfishes, tilapia, mullet,…

Pisciculture in Kerala

- Kerala is perhaps the most ideal state in India for fish farming.
- The reason is that it is generously gifted with numerous water bodies, such as brackish water estuaries, freshwater lakes, rivers, reservoirs, ponds, canals and paddy fields, which are all most ideal for pisciculture.
- Fish farming is a highly profitable and widely popular industry in Kerala.

Composite fish culture

- Composite fish culture, also called polyculture or mixed farming, is the stocking and culturing together of several related or compatible species of fishes with different feeding habits in the same tank or pond.
- A typical example is carp culture.
- They include surface feeders (e.g..catla), column-feeders (e.g.rohu) andj bottom feeders (e.g., mrigal).

Significance of composite fish culture

1. Enables the maximum exploitation of almost all the resources of all available niches in the culture system.
2. Artificial feeds supplied to the culture system will not be wasted at any stage. The reason is that they will be taken from the surface water by surface feeders, from mid water by columfeeders, and from the bottom by bottom feeders.
3. The total fish yield froma composite culture system will be several times greater than that from monoculture in the same system.
4. Enables much higher fish production from a composite much limited culture area.
5. The cumulative effort and expenditure of composite fish culture will be considerably lesser than the sum total of the efforts and expenditure of the respective monoculture systems.
6. Facilitates the supply of different food fishes by a single effort.

Integrated aquaculture

- Fish farming is done along with agricultural crops and live stock.
- Integrated aquaculture offers more chances for recycling the wastes and hence it is more economical than fish farming alone.

PRAWNCULTURE

- Have high commercial value
- Prawn – fresh water form
- Shrimp – marine form

Breeding & spawning of prawns

- Millions of prawn seeds, required for stocking in culture ponds, cannot be collected from nature easily.
- Most of the penaeid prawns attain sexual maturity only in natural water bodies.
- Removal of eye stalk (eye stalk ablation) from female prawn has been reported to accelerate the growth and maturation of ovaries.
- Sexual maturation and breeding of prawns are regulated by certain hormones produced in the endocrine system.
- The endocrine organs of shrimps, such as the medulla terminalis X-organ (MTGX), sensory papilla X-organ (SPX) and the sinus gland, are located in the eye stalk.
- The sinus gland is believed to store gonadotropic hormones, responsible for the maturation of gonads.
- Removal of eye stalk or sinus gland during the non-breeding season results in the rapid growth of ovaries.
- Eye stalk ablation is carried out using an electro – cautetary apparatus.
- As a general rule, only one eye stalk is removed.
- Mortality rate in single eye stalk ablation is negligible.
- Cautetarised females and double the number of acclimatized males are transferred to tanks for the maturation of gonads.
- This brood stock is fed with nutritious diet.
- Water is aerated properly and pH is maintained around 8.
- Sexual maturation may be attained within one week after the ablation.
- Then, eye stalk ablated females are transferred to spawning tanks.
- For collecting seeds, fully mature females, carrying fertilized eggs may also be collected from nature, or from culture ponds.
- Specimens with dark or grey coloured egg mass are usually selected.
- The collected shrimps are released into spawning tanks containing clear, fresh and filtered water.
- ***Macrobrachiumrosenbergi***, though a freshwater species, spawn only in slightly brackish water.
- Hence, this species is released into the waters of nearly 12 ppt salinity.
- ***Penaeusindicus*** and ***P.monodon*** breed in sea water of 28 -35ppt salinity.

Seed collection & culture

- Post-larvae and small juveniles form the seeds of prawn culture.

- The seeds are collected from natural water bodies, such as rivers, estuaries and coastal lagoons.
- Fine-meshed bag nets, with a receptacle at the cod end are used to collect the seed.
- There is difficulty in getting sufficient number of seeds for stocking in culture systems.
- The collection may contain larvae of slow growing, undesirable species of shrimps and predatory fishes also.
- Sorting of the seed is a laborious process, and it demands expertise.
- Extensive collection may also affect the natural population

Types of prawn farms

- Shrimp farming is a very profitable business, compared to agriculture and animal husbandry.
- Shrimp grows fast in culture systems and reach marketable size within 6 months.
- There are four major methods of prawn culture, namely traditional culture, extensive culture, intensive culture and semi-intensive culture.
- Prawn culture in the pokkali rice fields of Kerala and the bheries of West Bengal are examples of traditional farming.

Extensive culture

- Extensive prawn farming is carried out in large (1-5 ha), specially made ponds, stocked with fast-growing varieties of prawns in low densities.
- Feeding and pond management are not necessary.
- The annual production rate is 2-3tonnes per hectare.

Intensive culture

- In intensive prawn farming, fast-growing and high-quality prawns are cultured in relatively small (0.03-0.1 ha) and well aerated ponds.
- These ponds are stocked with prawns in high densities (5-10 lakhs per hectare) and are subjected to daily water change.
- Application of nutrient-rich feeds and scientific pond management are necessary.
- The annual production rate is as much high as 20-30tonnes per hectare.

Semi-intensive culture

- Semi-intensive prawn farming is carried out in small (0.2-0.5 ha) ponds, stocked with prawns in high densities (1-5 lakhs per hectare).
- Pond management, supplementary feeding and daily water change are necessary.
- The annual production rate is 8- 10 tonnes or more per hectare.

Traditional prawn culture in rice fields

- The traditional brackish water prawn farming technique, prevalent in Kerala is called prawn filtration.
- In this method, the prawn seeds, coming from the brackish water areas and the sea along with the tidal water flow, are collected in large stretches of rice fields, called pokkali rice fields
- Pokkali is a variety of rice capable of growing tall in flooded waters with varying salinities.
- During the south-west monsoon (June- September), the salt content of the field gets washed away by the rain water, making the field fit for rice cultivation.
- After the mild north-east monsoon (September-mid November), water in the fields becomes more brackish (salty) due to the tidal inflow of water
- The sluice gates, fixed at the bunds of rice fields, are kept open during high tide, allowing the entry of prawns into the field
- A bamboo mat or net is placed inside the sluice to prevent the escape of prawns.
- The trapped prawn seeds are allowed to grow in the rice fields.
- Harvesting is done by the middle of April or May, either early in the morning or late in the evening and a few days before or after full moon.
- For harvesting, water is filtered through a large conical bag net. The mature prawns, collected at the cod end (posterior end), are separated.

Traditional culture in bheries

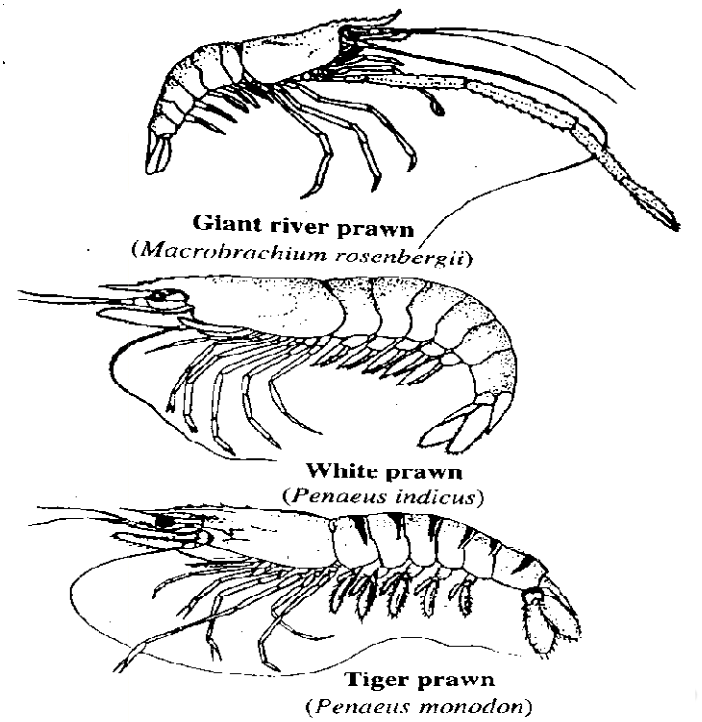
- Bheries are embanked brackish water enclosures, used for aquaculture.
- Bheries are deeper than pokkali fields.
- During high tide, water along with fish and prawn seed, is allowed to enter the bheries though sluices.
- Inverted V or W-shaped screens are fixed at the sluice gates in such a way that they allow the entry of shrimps during high tide and prevent their escape during low tide
- Culture begins in January-February, when bheries are stocked with fry.
- Occasional harvesting is done in May - June period and the main harvesting during September - November period.

Modernised culture in ponds or tanks

- Modern large-scale shrimp farming is carried out in special ponds or tanks.
- These ponds have hatchery and nursing and rearing units.
- They are usually rectangular and about I to 5 ha. in area, with depths of 0.8 to 1.2 m.
- Even though earth ponds are widely used, rearing ponds made of concrete or bricks, or lined with plastic sheets may also be used.
- Different types of shelters and artificial substrata are provided in ponds, including water plants, hollow bricks, plastic pipes, etc.
- These substrates offer hiding places for small sized shrimps and also for just moulted ('soft") shrimps.

- Intensive shrimp farming is practised in tanks.
- Water from such tanks is periodically removed and heavily aerated.
- Circular tanks, with sufficient surface area (up to 2000 m^2) and adequate water circulation and drainage facilities, are commonly used.

Common prawn species



Macrobrachiumrosenbergii

- Fresh water prawn, inhabiting rivers, from the upper to lover reaches.
- Omnivorous species prefers a shallow, muddy environment and grows up to a maximum size of 32 cm, and a weight of 200 g.
- Adults have sharp, upturned rostrum
- In culture systems, males grow to a maximum size of 25 cm and females, 15 cm,
- Though a freshwater form, river prawn migrates down stream to the estuaries (salinity 5 to 20 ppt.) for breeding.
- The young ones migrate upstream from estuaries to freshwater habitats.
- River prawn is cultured for a period of 5-6 months.

Penaeusindicus

- Commonest marine shrimp species of Indian waters.
- Body has pale white, creamy, or pale yellow coloration.
- Though smaller in size, it is highly delicious.
- The optimum salinity for its growth is 20-30 ppt.
- *P. indicus* prefers culture systems with sandy bottom.
- Culture period is about 3- 4 months.

Penaeusmonodon

- *P. monodon or tiger prawn*
- Fastest growing of all prawn species and hence it is cultivated most commonly in culture systems throughout the world.
- Body is reddish or brownish with thick black lines across the abdomen; hence the name tiger prawn.
- Tiger prawn is euryhaline
- The optimum salinity for its growth is l10-25 ppt.
- This species grows to a maximum length of 32 cm, weighing up to 400 g.
- It is cultured for a period of 4 to 5 months.

MUSSELCULTURE

- Mussels are bivalve molluscs found attached to the rocks and other hard objects in the coastal sea.
- They are often found in large crowds in rocky shores.
- Such areas are referred to as mussel beds.
- Mussels form an important source of meat food for the coastal population.
- Mussel meat is soft, tasty and rich in nutrients.
- Mussel shell is used for producing lime and also as a manure.
- In lndian coasts, mussels are represented by the green mussel and the brown mussel

Seed collection

- Young mussels, known as ***spats*** form the seeds of mussel culture.
- Seeds can be collected in large numbers during spawning season from the mussel beds of coastal waters.
- Estimates reveal that about 10-15 kg of mussel seed is available per square meter of rock substratum.
- Seeds may be collected using suitable collectors, such as cultches, ropes, poles, bamboo stakes, coconut shells, etc
- Large scale mussel farming cannot rely solely on the seeds from nature because
  1. The distribution of mussels is mostly restricted to rocky shores.
  2. Even though the spat fall occurs in abundance in nature, only very few larvae get a chance to settle and the rest suffer from heavy mortality.
  3. Massive seed collection may disturb the natural mussel populations, especially in areas with poor population density.

Artificial collection of seeds

Induced spawning

- For large-scale seed collection, mussels are induced to spawn artificially and the larvae are reared in hatcheries.
- For induced breeding, mature mussels are collected either from natural beds or from culture systems
- Induced spawning is relatively easy in mussels even slight disturbances during handling and cleaning may prompt mussels to spawn.
- Physical, chemical, thermal or electrical methods are employed for induced spawning.

Some of the common methods are the following.

1. Rough handling of adult mussles
2. Opening of the shell and pocking of adductor muscles.

3. Transfer of adult mussles to fresh sea water soon after dipping them in 6% H_20_2 solution at pH 9 for 1 or 2 hours.
4. Dipping of adult mussels in ammonium chloride or barium chloride.
5. Gradual raising of the water temperature by 4°C - This method is safe and more successful than the other methods

- ln most cases of induced spawning, males spawn first and this stimulates the females to spawn.

Rearing of larvae

- As soon as the male and female mussels start spawning
- They are transferred to tanks with pure sea water.
- The fertilized eggs develop into free swimming larvae.
- The larvae are reared in hatcheries by feeding them with unicellular algae.
- The larvae settle as spat from the 20th day onwards for a period of 5-10 days.
- Materials, such as coir rope, nylon nets, shells of large bivalve molluscs and coconut shells, are used for collecting the spat.
- They grow as young seed, feeding on phytoplankton.

Farming methods & harvesting

Culture techniques

- The commonest methods of mussel culture include bottom culture, pole culture, rack culture, raft culture and long-line culture.

Bottom culture

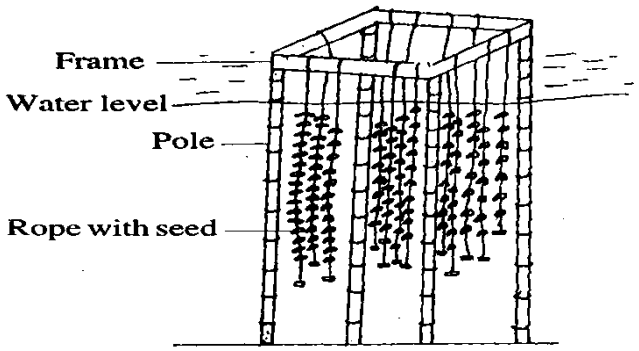
- This culture method is suitable for shallow and enclosed areas with stable and hard bottom.
- It is not prevalent in India.

Pole culture or stake culture

- This is a method of mussel farming suitable for muddy coasts with gentle slopes and marked tidal variation.
- A series of 5-6m long wooden or bamboo poles are driven into the bottom of the intertidal zone of the selected area.
- The bottom of each pole is covered with a smooth plastic sheet to prevent the entry of predators.
- Seeds are collected on ropes which are then placed in plastic net tubings and wrapped around the poles, or are suspended from a metallic nail fixed at the top of each pole.
- Mussels are harvested after 12-18 months when they grow to 6-8 cm in length.

Rack culture

- Rack is a fixed structure made up of several wooden poles driven into the sea bottom.
- A wooden platform, called rack, is made on the top of the poles, usually 0.5 m above the water level.
- From this platform or rack, 10-15 mm long ropes with mussel seeds are suspended.
- Mussel seeds are usually placed in synthetic mesh tubings of various mesh sizes.

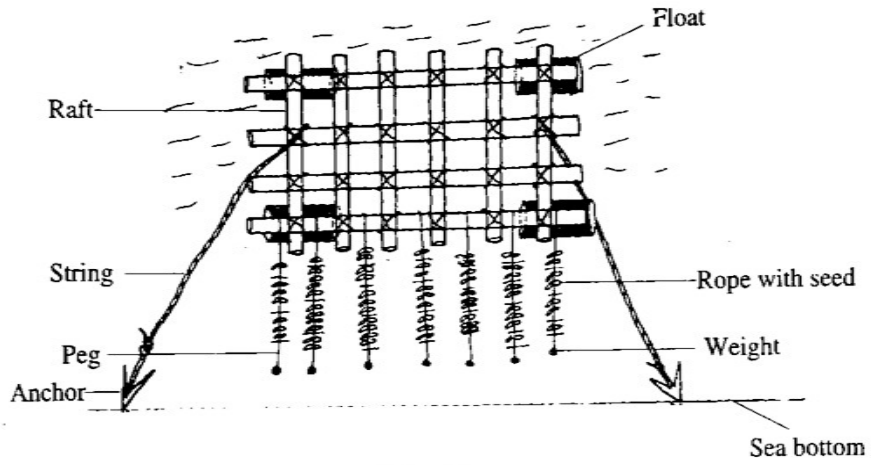


Rack culture

- Rack culture method is common in shallow coastal waters.

Raft culture

- Commonest method of intensive mussel farming
- Rafts are usually made with bamboo poles or wooden poles, tied together with ropes.
- Concrete or steel platforms with fibre glass floats are used in some countries



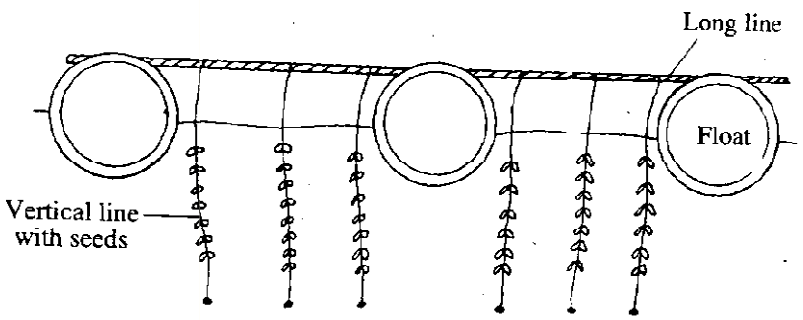
Raft culture

- Wooden rafts are placed over floats (usually air-tight barrels), which are attached to the under surface of the corners or the raft.
- The raft is anchored to the bottom using long and strong chains.
- Ropes, with the young mussel seeds collected from natural mussel beds, or from mussel farms, are hung vertically from the raft.

- The ropes may have large pegs at regular intervals to prevent the mussels from slipping down from the rope.
- Each rope may be provided with a terminal weight to keep it vertically hanging.
- Raft culture is carried out in protected seas with steep coastal areas
- Harvesting is done nearly 18 months later, specifically before spawning.

Long-line culture

- This culture technique makes use of a series of horizontal and vertical lines, which are kept floating by a number of floats.
- These floats are provided with anchoring devices.
- The long horizontal lines are called long lines.
- They are usually 150 m long and are made up of 16-20 mm wide synthetic ropes.
- Each main rope, or long line, is usually 150 m long and it may have large barrels or floats at every 5 m length.
- Vertical lines, loaded with seeds, are suspended from the long line.



Long line culture

- Long-line method is more suitable in shallow estuaries and bays with very little tidal variations.
- Fast growth rate and higher production have been reported in this method.

Harvesting

- When the cultured mussels reach marketable size, the ropes are removed manually.
- In raft culture, the rafts may be brought to the shore for removing the ropes.
- The ropes are washed with water and the mussels are dislodged with a sharp wooden wedge.
- They are sorted according to size and marketed.

PEARLCULTURE

- Pearl is a much prized natural gem, a lustrous calcareous concretion, produced by some bivalve molluscs, called pearl oysters.
- It consists of a central nucleus which organic and inorganic matters are deposited in concentric layers.
- Pearl is secreted by the highly specialized nacre secreting cells of the mantle epithelium of pearl oysters.
- Pearls differ from each other in their colour and shining properties.
- The peculiar lustre and iridescence of each type are determined by the specific arrangement of its $CaCO_3$ crystals, and also by the amount, proportion and combination of its inorganic elements.
- Pearl oysters are pearl producing bivalve molluscs.
- Most of them are marinewhile a few are inhabitants of freshwater.
- Freshwater oysters produce low-quality pearl.

Method of pearl formation

- Pearl formation is, in fact, a response to the oyster to an irritation.
- Itis a very simple and extremely slow process and it may take several years to complete.
- It occurs when a 'foreign' particle gets into the space in between shell and mantle quite accidentally.
- Then, the epithelial cells of the mantle get irritated and secrete a pearl sac around the foreign body.
- The pearl sac, in turn, secretes a pearly substance, called ***nacre***, all around the foreign body.
- This in course of time,develops into a natural pearl.
- The size or the pearl is related to the degree of irritation by the foreign particle.

Preparation of nuclei

- Nucleus is a foreign particle which can irritate and induce the oyster to secrete pearly material around it.
- The nacreous layer of the shells of other species are used for the preparation of nucleus.
- The shell is made into small spherical beads of 2-8 mm diameter using machines.
- These beads may be polished slightly, but never very smoothly.

Preparation of host & graft tissue

Preparation of host

- Healthy and adult oysters, preferably above 45 mm size, are ideal for the production of culture pearls.
- The selected oysters are then placed in specially made cages and immersed in 6 - 8 m deep sea water for 20 - 30 days.
- This is to acclimatize them with the controlled conditions within the cages.
- The oysters thus conditioned are taken out for the insertion of nucleus.

Preparation of graft tissue

- Graft tissue is a piece of the mantle epithelium from a donor oyster.
- It is used to wrap the nucleus before implantation.
- The graft tissue is taken from a healthy donor.
- The donor is opened carefully and its mantle is removed.
- The dirt and mucus on the mantle are removed using the blunt edge of a scalpel.
- A 2-3 cm wide strip is then cut out from the pallial zone of the mantle.
- The strip is then cut into 2-3 mm squares.
- These mantle strips are kept in filtered and sterilized sea water.
- It is better to use the graft tissue within 10-15 minutes after preparation.

Implantation & nursing

Implantation

- There are three common methods of nucleus implantation namely extra pallial, intra pallial&gonadial implantation.
- The entire operation has to be completed within 30 minutes.

Extra pallial implantation

- The graft tissue bag, containing the nucleus, is inserted or grafted into the space between the shell and the mantle.
- The graft tissue gets embedded or implanted in the mantle.
- This stimulates the nacre secreting gland cells of the pallial epithelium to secrete pearl around the nucleus.

Intra pallial implantation

- The graft tissue bag is inserted into the pallial tissue.
- During this, a small hole, or an incision, is made in the mantle and into that the graft tissue bag is inserted.
- The graft tissue gets implanted in the mantle tissue.

- This stimulates the glandular mantle cells to secrete pearl around the nucleus.

Gonadial implantation

- Gonad is the best site in the oyster for the implantation of nucleus.
- The reason is that the rate of pearl secretion is very high in gonads.
- During gonadial implantation, a small incision is made in the gonad with utmost care and unerring precision.
- Into this incision, the graft tissue bag containing the nucleus is inserted.
- The graft tissue gets embedded in the gonad, stimulating the gonadial cells to secrete pearl around the nucleus.
- The number of nuclei to be inserted depends upon the size of the nucleus.
- Two to five nuclei are inserted into an oyster, if they are 3 mm or less in diameter; only one nucleus is inserted when it is larger than 3 mm.

Nursing

- After the implantation of nucleus, the wooden plug placed between the shell valves is removed and the oyster is released from the mounting stand.
- After nuclear implantation, oysters are placed in a plastic tub, filled with sea water
- This is for recovering from the effect of menthol.
- Water should be changed periodically or provisions should be made for steady flow of water.
- After 50 - 60 minutes, the oysters are placed in nylon baskets and immersed in large tanks in the seawater.
- The operated oysters are kept there under observation for a few days.
- Those oysters showing disease symptoms and those rejecting the nuclei are removed
- During this period, the oysters recover from the operational shock & repair injuries.
- The oysters are then placed in culture cages of 40 x 40 x 10 cm size and transferred to the farm.
- The healthy and nucleus-implanted oysters are farmed by raft culture or long line culture method.
- After a few months of post-operation culture, the oysters are x-rayed to check the presence of pearls.
- When the cultured pearl oysters attain full growth and maximum size, they are collected, brought ashore and killed.
- Then their shells are removed and the partially decomposed body is washed repeatedly in suitable containers, with several changes of water.
- Now, water is removed and the pearls settled at the bottom of the container are collected and sorted according to size and quality.

ORNAMENTALFISHCULTURE

- Farming of ornamental fishes and keeping them in aquaria is an ancient practice
- Aquaria always adds to our visual pleasure and arouses our aesthetic imaginations.
- Ornamental fish-farming is a popular hobby and a profitable business

Aquarium management

- It is an art on one hand, and a technology on the other.
- Knowledge about the ideal conditions of the temperature, pH, oxygen content, purity and hardness of water, the quality of aquarium plants and the technique of their planting, illumination of the fish tank, feeding the fishes, etc. is also essential.

Construction of aquarium tanks

- Large, metal-framed and rectangular glass tanks are most ideal for keeping ornamental fishes, since they are strong and durable and can be handled easily.
- Since the water in the tank heavy, the tank should have a strong supporting stand, such as a wooden table, iron stand, etc.
- The location of aquarium tanks is very important.
- Better, keep the tanks away from direct sunlight to avoid overheating and excessive algal growth.
- Preferably the tank must be placed near the window for natural illumination.
- The floor of the aquarium tank must have a bed of sand, gravel, pebbles, mosaic chips, small pieces of stones, etc., sloping gradually from the back wall to the front wall.
- Mild coloured and medium-sized gravels are most ideal for this purpose.
- The stones which disintegrate or dissolve in water (e.g., lime stone) should be avoided.

Water in aquarium

- Water quality is very important m aquaria.
- Any type of pure and unpolluted natural water is ideal for keeping ornamental fishes in aquaria.
- Chlorinated tap water is harmful to fishes.
- The optimum desirable hardness and pH vary with different species of ornamental fishes,

Light and temperature

- Keeping the aquarium tanks away from direct sunlight and illuminating them with artificial light offers more safety and attraction.

Purity of water

- The excreta of fishes, decomposition of dead plants and animals, uneaten food, etc. are the major sources of this pollution.
- Ammonia is the major pollutant.
- Excessive concentration of it (beyond 0.5 mg per litre) is toxic to fishes.

Filtering of water

- Periodically, aquarium water has to be removed and renewed, or filtered to clear it from suspended wastes.
- External and internal filters are available for this purpose.
- "Biological filters" which favour the growth and multiplication of bacteria are most ideal.
- These bacteria can convert ammonia to nitrite and nitrate.

Aeration of aquarium

- Aeration of aquaria is essential, particularly during night, when the CO_2 level goes high.
- The air bubbles, produced by the aerator, create ripples on the water surface.
- This enables easy gas exchange between the carbondioxide in the water and the oxygen in the air above the water.

Aquarium plants

- Aquarium plants have a duał role
- They serve as water purifiers and also beautifiers.
- They remove CO_2 and release O_2 through photosynthesis
- Absorbs nitrates as nutrients
- Provide shade and shelter for the spawning of fishes
- Inhibit the growth of algae

Feeding of aquarium fishes

- Aquarium fishes are fed with live or artificial feeds.
- Live feed includes the larvae of mosquitoes, earthworms, some protists (e.g., Paramecium), etc.
- Artificialfeed includes synthetic preparations in the form of powder, flakes, granules, pellets and liquids.
- Usually, aquarium fishes are fed twice a day, early in the morning and late in the evening (in colder months only once a day).
- Over feeding and underfeeding are equally harmful.
- Excess and unused feed in the aquaria must be removed immediately to avoid pollution.

MODULE 4

POULTRYFARMING

Introduction

- **Poultry farming** is the form of animal husbandry which raises domesticated birds such as chickens, ducks, turkeys and geese to produce meat or eggs for food.
- It has originated from the agricultural era.
- Poultry – mostly chickens – are farmed in great numbers
- Chickens raised for eggs are known as layers, while chickens raised for meat are called broilers.

Importance of egg production

- Eggs are part of healthy, balanced nutrition and particularly important for vulnerable populations like children, the elderly and pregnant women due to the fact that eggs are a **good source of vitamin A, E, D niacin, and folate**, while containing 6g of protein and only 70 calories per egg.
- The egg industry was responsible for **as much as $29.29 billion in total economic** activity throughout the country, creating or supporting as many as 112,470 total jobs.
- The egg industry also generates sizeable tax revenues.

Nutritive value of eggs

- The egg is one of the most complete and versatile foods available.
- It consists of approximately 10% shell, 58% white and 32% yolk.
- Neither the color of the shell nor that of the yolk affects the egg's nutritive value.
- The average egg provides approximately 313 kilojoules of energy, of which 80% comes from the yolk.
- The nutritive content of an average large egg (containing 50 g of edible egg) includes:
  - 6.3 g protein
  - 0.6 g carbohydrates
  - 5.0 g fat (this includes 0.21 g cholesterol).
- Egg protein is of high quality and is easily digestible.
- Almost all of the fat in the egg is found in the yolk and is easily digested.

Vitamins

- Eggs contain every vitamin except vitamin C.
- They are particularly high in vitamins A, D, and B12, and also contain B1 and riboflavin.

Minerals

- Eggs are a good source of iron and phosphorus and also supply calcium, copper, iodine, magnesium, manganese, potassium, sodium, zinc, chloride and sulphur.
- All these minerals are present as organic chelates, highly bioavailable, in the edible part of the egg.

Factors affecting egg size

1. Breed

- Type of breed is one of the factors that affect egg size.
- Some breeds of chickens are known to produce small eggs due to their small body sizes and genetic makeup, while some chicken breeds produce medium to large eggs.
- So the breed of chickens being raised determines the size of eggs that will be produced or laid.

2. Ambient Temperature

- The chickens bred in the hot season usually lay small eggs after the start of production.
- First, the daily hours of sunlight are increased in the hot season or summer, and this always results in early sexual maturity and early onset of egg production.
- However, the eggs produced by the chickens are often small.
- Secondly, in the hot season or summer, the feed intake or consumption of birds is often low, and their body size is also small. As a result of that, they lay small eggs.
- When the temperature of the chicken house exceeds 27^{o}C, the eggs produced by the laying hens are smaller.
- The higher the ambient temperature, the smaller the egg production and egg size.

3. Lighting Programs

- Egg size is influenced by lighting programs adopted in the growing period.
- Lighting programs can delay or accelerate sexual maturity.
- The age at which chickens begin to produce and lay eggs has a significant influence on the egg size.
- The younger the hen, the smaller the eggs produced in the first year of life.
- The extension of daily hours of light in the growing period to 11 hours (or more) will accelerate sexual maturity and onset of egg production, and the eggs produced will be very small.

- The shortening of daily hours of light in the growing period to 10 hours from the 10-18 weeks of age will delay sexual maturity and onset of egg production, but the eggs produced later would be big.
- Eggs are big when the production starts late.

4. Age of Hen

- The younger the laying hens, the smaller the eggs are, and as the laying hens grow older, the eggs gradually increase in size.
- The eggs produced by old layers (about 1½ – 2 years) are often large and can reach more than 70 grams.
- Birds at 20 – 26 weeks of age will lay smaller eggs than at 40 – 50 weeks.
- Maximum egg size can be expected when the birds reach about one year old. Egg size tends to get smaller just before birds stop laying.

5. Feed Intake

- Provided that all required nutrients are available in the correct level in the feed, the higher the feed intake, the larger the eggs, and the lower the intake, the smaller the eggs.
- This is simply because eggs are also derived from feed through digestion, absorption and metabolism.

6. Water Consumption

- Water contributes significantly to the size of an egg.
- When the water consumed by a hen is low or inadequate, it affects the egg size and production.
- The quality of water is also vital.
- Avoid serving hot, too cold or dirty water to chickens. It has adverse effects on the production and welfare of chickens.
- Keep the water fresh and clean.

7. Body Weight and Physique

- Chickens with higher body weights lay larger eggs, and chickens with smaller body weights also lay smaller eggs.
- The size of body weight is related to variety, availability of required nutrient, light and feed intake.
- Therefore, the size of the egg can be controlled by controlling the weight and body size.

8. Nutrition

- Nutrition is the "raw material" of eggs, and normal-sized eggs can be produced with full price feed formulated according to the growth and development of chickens and production.
- The loss or unavailability of one or several nutrients affects the egg production rate and egg size.

9. Diseases

- Diseases are stressors to chickens.
- They affect the feed intake of chickens to varying degrees and directly affect the egg production rate and egg size of chickens.
- Therefore, prevention and control of diseases is a critical task in production.
- Proper hygiene and management will reduce the risk of infections.
- Preventing and controlling diseases is not only to enhance the quality of eggs but also a major element in the success or failure of chicken production.

10. Egg Cooling and Storage Condition

- It is important to cool eggs as quickly as possible after they are laid and to store them at a temperature of 50°F to 55°F; otherwise, they will lose weight by evaporation. This may result in poorer grading results, and so a poor economic return.

Breeds of fowl *-Exotic breeds*

Rhode Island Red

- The **Rhode Island Red** is an American breed of domestic chicken.
- It is the state bird of Rhode Island.
- It was developed there and in Massachusetts in the late nineteenth century, by cross-breeding birds of Oriental origin such as the Malay with brown Leghorn birds from Italy.
- It was a dual-purpose breed, raised both for meat and for eggs; modern strains have been bred for their egg-laying abilities.

Plymouth Rock

- The **Plymouth Rock** is an American breed of domestic chicken.
- It was first seen in Massachusetts in the nineteenth century, and for much of the early twentieth century was the most popular chicken breed in the United States.
- It is a dual-purpose breed, raised both for its meat and for its brown eggs.
- It is resistant to cold, easy to manage, and a good sitter

NewHampshire

- The New Hampshire Red has a deep, broad body.
- This bird grows feathers very rapidly and is prone to go broody and make good mothers.
- Most pin feathers are a reddish buff in color and, therefore, do not detract from the carcass appearance very much.
- The color is a medium to light red and often fades in the sunshine.
- The comb is single and medium to large in size; in the females it often lops over a bit.
- These good, medium sized meat chickens have fair egg laying ability.
- Some strains lay eggs of a dark brown shell color.
- New Hampshires are competitive and aggressive.

Indigenous breeds

Chittagong

- Indian breed named Malay
- The Malay is a breed of game chicken.
- It is among the tallest breeds of chicken, and may stand over 90 cm (36 inches) high.
- The Malay was the first chicken breed to be bantamised; a dwarf version of the standard-sized breed was created at the turn of the twentieth century.
- The Malay has an upright stance, a well muscled form and a large skull.
- Nowadays they are selected to be better egg-layers than in the 1970s with 70 to 120 eggs annually for a young hen and older hens laying only 30 to 55 eggs.
- Today, in the West the Malay is mainly kept for participation in poultry shows by breeders.
- It is considered a hard-feathered, gamefowl breed.
- Malay chickens have been used in Brazil for the creation of the Indio Gigante Chicken.

Ghagus

- The variety is mainly found in Andhra Pradesh and Karnataka.
- It has red, black, gray, brown and bay color plumage
- Pea shaped and small comb, small wattles, bagy throat and light yellow color and long legs.

Poultry Housing and Equipment

- The poultry farming business has occupied a leading role in the agriculture industry worldwide in recent years.
- A comfortable or good housing area directly affects the optimum growth and production in poultry farming
- The poultry farming business is one of the profitable business it gives maximum profit when we do extra care in the construction of the house.
- A better poultry housing construction maximizes the performance of the flock and ensuring better health.
- A high production poultry breed needs comfortable housing.

- The house should face the south to assure maximum sunlight, a consideration which is important during short winter days.
- Protection from other climatic extremes like direct sun, wind, rain, and even against theft and attack from natural enemies of the birds like a fox, dog, cat, kite, and snake, etc.
- The birds also should be protected against external parasites like ticks, lice, and mice, etc.
- Comfort - To be comfortable, a house should provide adequate accommodation, be reasonably cool in the hot weather, free from drafts, and sufficiently warm during the cool weather.
- Convenience - The house must be located at a convenient place, and the equipment so arranged as to allow cleaning and other necessary operation as required.
- Provision of accessible food and clean water.

Poultry Housing Equipment

- Depending on the size and type of poultry house, various types of equipment are to be used in poultry farms.

Important poultry house equipment includes Perches, Feed hoppers, Fogger, Heaters, Watering devices, De beakers, Chick guards, Laying nests, and Brooding hovers, etc.

MODULE 5

ANIMAL HUSBANDRY

- Animal husbandry : controlled cultivation , management and production of domestic animals including improvement of the qualities considered desirable by humans by means of breeding
- Animals are bred and raised for utility (eg,food) , sport , pleasure and research
- Eg; dairy farming , beekeeping

Indigenous dairy breeds of cattle

1. **Gir**
   - This breed is otherwise known as Desan, Gujarati, Kathiawari, Sorthi, and Surati.
   - Originated in Gir forests of South Kathiawar in Gujarat.
   - Basic colours of skin are white with dark red or chocolate-brown patches or sometimes black or purely red.
   - Horns are peculiarly curved, giving a 'half moon' appearance.
   - Milk yield ranges from 1200-1800 kgs.
   - Age at first calving 45-54 months and inter calving period from 515 to 600 days.
2. **Red Sindhi**
   - This breed is otherwise called as Red Karachi and Sindhi.
   - This breed mostly found in Karachi and Hyderabad district of Pakistan.
   - Colour is red with shades varying from dark red to light, strips of white.
   - Milk yield ranges from 1100-2600 kgs.
   - Widely used in crossbreeding programmes.
   - Age at first calving 39-50 months and inter calving period from 425-540 days.

3. Sahiwal

- Originated in Montgomery district in present Pakistan.
- This breed otherwise known as Lola (loose skin), Lambi Bar, Montgomery, Multani, Teli.
- The colour is reddish dun or pale red, sometimes flashed with white patches.
- The average milk yield of this breed is between 2,725 and 3,175 kgs in lactation period of 300 days

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Indigenous Draught breeds of cattle

1. **Hallikar**
   - Originated from the former princely state of Vijayanagarm, presently part of Karnataka.
   - The colour is grey.
   - They are compact, muscular and medium size animal.
   - The breed is best known for its draught capacity and especially for its trotting ability.

4. Kangayam

- Originated in Kangayam, Dharapuram, Perundurai, Erode, Bhavani and part of Gobichettipalayam taluk of Erode and Coimbatore district.

- The Kangayam breed was developed by the efforts of the late Pattogar of Palayakottai, Sri N. Nallathambi Sarkari Manradiar.
- Coat is red at birth, but changes to grey at about 6 months of age.
- Bulls are grey with dark colour in hump, fore and hind quarters.
- Bullocks are grey.
- Cows are grey or white. However, animals with red, black, fawn and broken colours are also observed.
- The eyes are dark and prominent with black rings around them.

5. Bargur

- Found around Bargur hills in Bhavani taluk of Erode district.
- Bargur cattle are of brown colour with white markings. Some white or dark brown animal are also seen.
- Animals are well built, compact and medium in size."

Indigenous Dual purpose breeds of Cattle

1. Tharparkar

- Originated in Tharparkar district of southeast Sind in Pakistan.
- Otherwise known as White Sindhi, Gray Sindhi and Thari.
- Body colour is white or light grey.
- The bullocks are quite suitable for ploughing and casting and the cows are good milch animals (1,800 – 2600 kgs).
- Age at first calving ranges from 38-42 months and inter calving period from 430 to 460 days.

2. Hariana

- It was originated from Rohtak, Hisar, Jind and Gurgaon districts of Haryana.
- Horns are small.
- The bullocks are good workers.
- Hariana cows are good milkers yielding on an average 1.5 kg/cow/day in a lactation period of 300 days.
- Average milk yield is 600 to 800 kgs per lactation. The age at first calving is 40-60 months."

FARM ANIMAL BREEDING

Artificial Insemination

- Artificial insemination (A.I.) is deposition of semen into the female genital tract by means of instruments.
- Artificial insemination is the technique in which semen with living sperms is collected from the male and introduced into female reproductive tract at proper time with the help of instruments.

- This has been found to result in a normal offspring. In this process, the semen is inseminated into the female by placing a portion of it either in a collected or diluted form into the cervix or uterus by mechanical methods at the proper time and under most hygienic conditions.
- it is a powerful tool mostly employed for livestock improvement.
- In artificial insemination the germplasm of the bulls of superior quality can be effectively utilized with the least regard for their location in far away places.
- By adoption of artificial insemination, there would be considerable reduction in both genital and non-genital diseases in the farm stock.

- Advantages

1. There is no need of maintenance of breeding bull for a herd; hence the cost of maintenance of breeding bull is saved.
2. It prevents the spread of certain diseases and sterility due to genital diseases.
   a. Eg: contagious abortion, vibriosis.
3. By regular examination of semen after collection and frequent checking on fertility make early detection of interior males and better breeding efficiency is ensured.
4. The progeny testing can be done at an early age.
5. The semen of a desired size can be used even after the death of that particular sire.
6. The semen collected can be taken to the urban areas or rural areas for insemination.
7. 7 It makes possible the mating of animals with great differences in size without injury to either of the animal.
8. It is helpful to inseminate the animals that are refuse to stands or accept the male at the time of oestrum.
9. It helps in maintaining the accurate breeding and cawing records.
10. It increases the rate of conception.
11. It helps in better record keeping.
12. Old, heavy and injured sires can be used.

- Disadvantages of A.I:

1. Requires well-trained operations and special equipment.
2. Requires more time than natural services.
3. Necessitates the knowledge of the structure and function of reproduction on the part of operator.
4. Improper cleaning of instruments and in sanitary conditions may lead to lower fertility.
5. If the bull is not properly tested, the spreading of genital diseases will be increased.
6. Market for bulls will be reduced, while that for superior bull is increased."

Embryo transfer

- Embryo Transfer involves the recovery of embryos, usually from an elite female (donor) and the subsequent transfer to recipient females.
- The recovery of embryos includes the induction of multiple ovulation by hormonal treatment.
- Embryo Transfer is used to disseminate desirable genes from superior female animals from various species (horses, cattle, sheep, goats, and pigs).

- Main advantages Embryo Transfer:

1. Increase in the number of offspring per female
2. Easier and more rapid exchange of genetic material between countries
3. Less transport of live animals, thereby reducing risks of disease transmission
4. Storage and expansion of rare genetic stock.

- The main disadvantage is the high cost of the technique. "

DISEASES

1. Anthrax

- Caused by : Serious illness caused by spore4-forming bacterium : *Bacillus anthracis*
- Affects livestock
- Humans can become infected through direct / indirect contact with sick animals
- Mode of entry : Bacterium enter body through wound in skin Or contaminated meat or inhaling spores
- Symptoms : skin sores, vomiting and shock , skin ulcer , respiratory distress

2. Foot & Mouth Disease

- Severe , highly contagious viral disease of livestock
- Caused by : entero virus
- Symptoms : smacking lips , shivering, tender & sore feet , reduced milk yield , sore and blisters on feet
- Raised temperature
- It spread in cough , sneezes ,and the fluid of blisters

3. Rinderpest

- Cattle plague
- Caused by : rinderpest virus
- Infects cattle & buffalo
- Symptoms : fever , wpunds in the mouth , diarrhoea,discharge form nose & eyes and eventually death
- Not known to infect human
- Is spread between animals by direct contact

2. Brucellosis

- Infection spread from animals people , mostly by unpasteurized dairy products
- Bacterial infection
- Symptoms : joint & muscle pain ,fever , weight loss & fatigue , stomach pain and cough
- In severe condition : central nervous system and lining of heart may be affected
- Treatment : antibiotics

6. Peste Des Petits Ruminants (PPR)

- Sheep and goat plague
- Highly contagious animal disease affecting small ruminants
- Caused by : virus : Morbillivirus genus
- Symptoms : sudden onset of depression , fever , discharges from nose and eyes , sores in mouth , disturbed breathing and cough , foul-smelling diarrhoea and death

MODULE 6

PARASITOLOGY

Commensalism

- **Commensalism** is a long-term biological interaction (symbiosis) in which members of one species gain benefits while those of the other species neither benefit nor are harmed.
- The commensal (the species that benefits from the association) may obtain nutrients, shelter, support, or locomotion from the host species, which is substantially unaffected.
- The commensal relation is often between a larger host and a smaller commensal
- Eg:- Remoras feed on their hosts' fecal matter
    - Pilot Fish feed on the leftovers of their hosts' meals.
    - Numerous birds perch on bodies of large mammal herbivores or feed on the insects turned up by grazing mammals.

Phoresis

- **Phoresis** or **phoresy** is a non-permanent, commensalistic interaction in which one organism (a phoront or phoretic) attaches itself to another (the host) solely for the purpose of travel.
- The largest mammalian example of phoresis is human beings directly riding on horses or other animals or using them to pull vehicles with humans in them
- Examples of phoresis are the numerous sedentary protozoans, algae, and fungi that attach to the bodies of aquatic arthropods, turtles, etc.

Parasitism

- **Parasitism**, relationship between two species of plants or animals in which one benefits at the expense of the other, sometimes without killing the host organism.
- Parasites may be characterized as ***ectoparasites***—including ticks, fleas, leeches, and lice—which live on the body surface of the host and do not themselves commonly cause disease in the host; or ***endoparasites***, which may be either intercellular or intracellular
- Intracellular parasites—such as bacteria or viruses—often rely on a third organism, known as the carrier, or vector, to transmit them to the host
- A different form of parasitism called brood parasitism is practiced by most species of cuckoos and all cowbirds.
- Those birds do not build nests of their own but deposit their eggs in the nests of other species and abandon them there, with the hope that adult birds of other species will raise the abandoned young as their own.
- The cowbird's parasitism does not necessarily harm the host or the host's brood; however, the cuckoo may remove one or more host eggs to reduce the suspicion surrounding the presence of its egg, and the young cuckoo may heave the host's eggs and nestlings from the nest.

Symbiosis

- Symbiosis is any type of a close and long-term biological interaction between two different biological organisms, be it mutualistic, commensalistic, or parasitic.
- The organisms, each termed a **symbiont**, must be of different species.
- When one organism lives on the surface of another, such as head lice on humans, it is called ***ectosymbiosis***
- When one partner lives inside the tissues of another, such as *Symbiodinium* within coral, it is termed ***endosymbiosis***.

Host-parasite Relationship

- Host-Parasite relationship is the **extreme case of animal association**, in which both partners influence each others life by affecting each others metabolism and behaviour using different adaptive mechanisms in order to ensure their survival.
- Host-parasite associations usually give rise to **four main** relationships namely parasitism, mutualism, commensalism and phoresis
- A parasitic relationship is one in which one organism, the parasite, lives off of another organism, the host, harming it and possibly causing death.
- The parasite lives on or in the body of the host.
- A few examples of parasites are tapeworms, fleas, and barnacles.

Physiology of parasitism

- The osmotic pressure of the body fluids of a parasite becomes the same as that of the host to prevent a disturbing exchange of water.
- Parasites living in blood or tissues find an abundance of oxygen, but those found in alimentary canal or bile duct have a considerable tolerance to an absence of oxygen, they become modified to obtain oxygen by anaerobic respiration
- Cestodes stimulate the gut of the host to secrete mucus which forms a protective envelope around the tapeworms.
- Gut parasites secrete anti-enzymes to neutralize the digestive juices of the host.

Immunology of parasitism

- An immune response to parasites, specifically worms, **triggers an IgE response.**
- IgE elicits an immune response by binding to Fc receptors on mast cells, eosinophils, and basophils, causing degranulation and cytokine release.
- The principal innate immune response to protozoa is **phagocytosis**, but many of these parasites are resistant to phagocytic killing and may even replicate within macrophages.

Biochemistry of parasitism

- All parasites still require a supply of energy for biosynthesis of macromolecules, growth, mechanical activity, reproduction etc.
- Major nutritional requirements are supplied by the host

Definitive (primary) host

- The host which harbours the adult parasite, or the host in which the parasite undergoes sexual reproduction.
- For most human parasites (e.g., Taenia, Wuchereria,.), man is the definitive host.
- But for Plasmodium, female Anopheles is the definitive host and man is the intermediate host in the sense that sexual reproduction occurs in the mosquito.

Intermediate (secondary) host

- The host in which the parasite spends its larval or asexual phase of life.
- Pig is the intermediate host of Taeniasolium, Culex mosquito is the intermediate host of Wuchereria.
- For some parasites, there may be more than one intermediate hosts.

Reservoir (reserve) host

- A host which first gets infected with a parasite and then serves as a source of infection of other organisms.
- Dog, in some parts of the world (e.g., China), is supposed to serve as the reserve host of *Entamoebahistolytica*. Mammals, such as monkeys, apes, deers, etc., serve as the reserve hosts of *Trypanosoma.*

Zoonoses

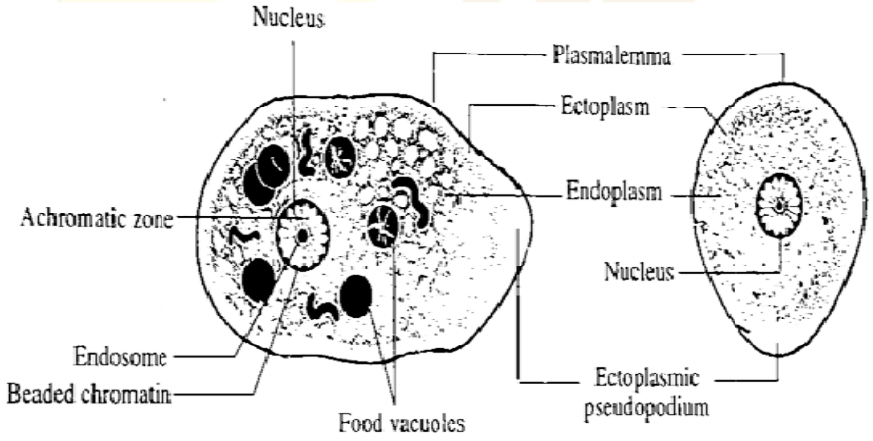
- Zoonoses are the diseases or infections, naturally transmitted from vertebrate animals to man.
- There are more than 150 known zoonotic infections of domestic & wild vertebrates that are

- transmitted to man
- Eg:- Bovine tuberculosis, ring worm, rabies,…

Human Parasites: Mention the habits, habitat, life cycle, mode of infection, controlmeasures of the following parasites

Entamoebahistolytica

- Commonly called ***dysentery amoeba***
- Lives in large intestine of man
- Causes ***intestinal amoebiasis***
- **Life cycle**–completed in one host
- It occurs in three forms – ***trophozoite, pre cystic & cystic form***
- ***Trophozoite*** – large & irregularly shaped
  Fully mature feeding & growing vegetative form
  Two forms – *magna &minuta*



Entamoeba histolytica - trophozoite

- *Pre cystic – transitory stage*
  Intermediate between trophozoite& cystic form
  Smaller & rounder in shape with large nucleus
  Blunt pseudopodium projecting to one side
- *Cystic form – encysted stage*
- Endoplasm contains a mass of glycogen & 1 or 2 refractile rods called ***chromatoid bodies***
- *E. histolytica* invades the intestinal wall, multiplies & causes the destruction & necrosis of intestinal tissues with the help of *histolysin*enzyme

- *Chronic amoebiasis* is characterized by nutritional disorders, amoebic granuloma, passage of blood & mucus in stools,..
- *Acute amoebiasis*is accompanied by deep ulceration, adhesion & perforation of intestinal wall, haemorrhage…
- **Mode of infection** – through contaminated food & water
- House fly & other insects contaminate food
- **Control measures** - personal hygiene& proper cleanliness & sanitation of surroundings

Giardia lamblia

- Is a flagellated protozoan parasite that colonizes and reproduces in the small intestines causing Giardiasis.
- The Giardia parasite attaches to the epithelium by a ventral adhesive disc.
- Reproduces via Binary fission.
- Does not spread via bloodstream nor does it spread to other parts of the Gastrointestinal tract, but remains confined to the lumen of the small intestines.
- Life cycle – cyst→trophozoite→adult
- **Cyst -** Infective form
- Oval, 4 nuclei
- Thick cyst wall
- Resistant to adverse environmental conditions
- **Trophozoite** vegetative active motile form
- Pear shaped, 2 nuclei
- 4 pairs of flagellae
- Attaches to mucosa by ventral adhesive (suction) disk
- Does not survive in external environment
- Trophozoitesabsorb their nutrient from the lumen of the small intestines and are anaerobes.
- If the organism is split and stained, it has a very characteristic pattern that resembles a familiar "***Smiley face***"symbol
- Affects humans but is also one of the most common parasites infecting Cats, Dogs and birds
- The mammalian hosts include: Cows, Beavers, Deer & Sheep
- **Mode of infection** - Ingestion of dormant cysts in contaminated water, food or by the faecal - oral route
- Through poor hygiene practices
- **Control measures** - personal hygiene & proper cleanliness & sanitation of surroundings

Leishmaniadonovani

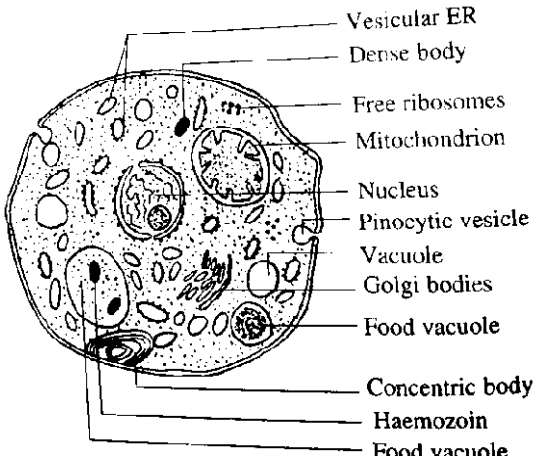
- Causes the disease - ***Kala azar***, also known as ***visceral leishmaniasis*** or dum-dum fever

- It is an intracellular endoparasite living in the spleen, liver, intestinal mucosa, lymph glands, bonemarrow. etc. of man.
- **Life cycle** - Leishmaniadonovani exists in two morphologically different stages, namely amastigote stage or leishmania form and promastigote stage or leptomonad form.
- Amastigote lives in man and some mammalian reserve hosts, and promastigote in the gut of sandfly
- The life cycle of L. donovani is completed in two hosts, man and Sandfly
- In the reticuloendothetial (R.E.) cells of man, the amastigote forms undergo continuous multiplication by repeated binary fission.
- When the host cells become packed with parasites, they rupture and release the parasites into the blood circulation.
- **Mode of infection**- is mostly inoculative and it occurs when the female sandfly bites human beings for its blood meal.
- Other modes of transmission include
- (i) congenital infection of a child in utero
- (ii) transmission through blood transfusion
- (iii) direct transmission through coituş, etc.

Control measures

- Destruction of intermediate hosts by mechanical and chemical methods
- Killing of infected reserve hosts, such as dogs and cats.
- Isolation of patients to prevent the spreading of the disease.

Plasmodium vivax

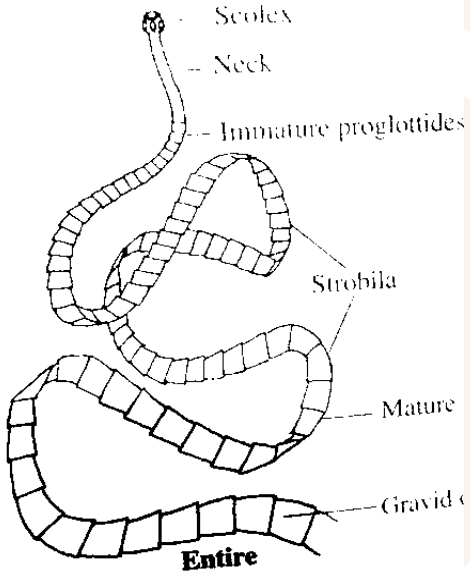


Plasmodium - Trophozoite

- Malarial parasite.
- **Life cycle** - Two host
  1. Female Anopheles mosquito – primary host – extracellular endoparasite in the gut cavity, salivary apparatus &haemocoel – undergo sexual phase.
  2. Man – secondary host – intracellular endoparasite in side RBC &parenchymatous liver cells – undergo asexual phase.

- ***Trophozoite*** – mature feeding & growing intracellular parasite in man.
- Amoeboid &uninucleate.
- Enveloped by ***plasmalemma***
- Cytoplasm is granular & vacuolated.
- Cytoplasm contains ER, golgi bodies, ribosomes, vacuoles, pinosomes,..
- ***Haemozoin*** – food vacuole contains dark residual pigment formed during the digestion of haemoglobin by parasite.
- **Mode of infection**–mosquito bite
- **Control measures** – destruction of mosquitoes & their larvae

Taeniasolium

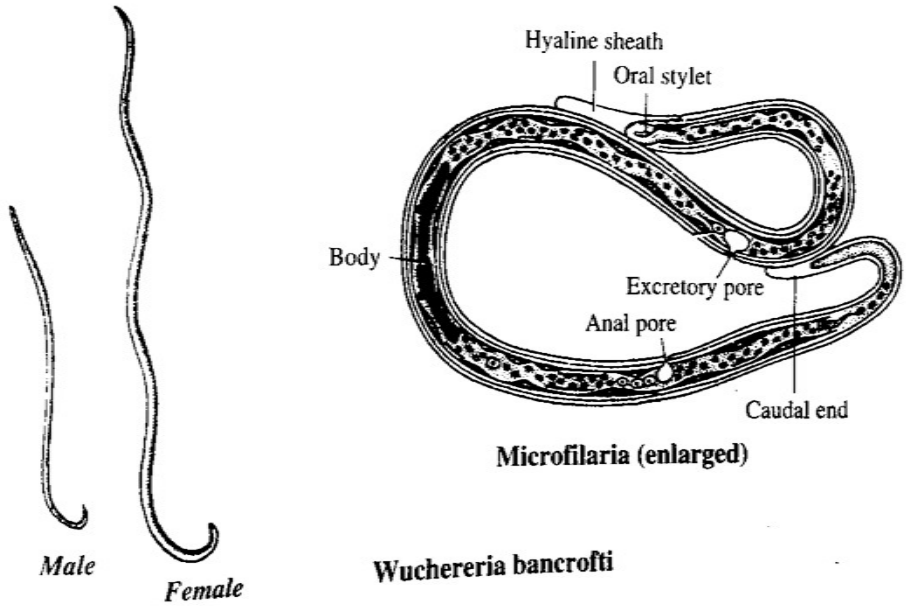


- Pork tape worm
- Endoparasiticcestode in the small intestine of man.
- Thin, flat & tape like
- Exhibits pseudosegmentation
- Body has three regions :scolex, neck & strobili.
- ***Scolex*** – small, pin head like anterior part
- Four suckers & a rostellum – terminal retractile cone – armed with chitinous hooks
- ***Neck*** – short unsegmented region – budding zone
- ***Strobila*** – long, ribbon like, segmented posterior part
- Segments called proglottids – immature, mature & ripe
- Infection causes, adult – taeniasis, cysticerci – cysticercosis
- **Mode of infection** - by eating improperly cooked measly pork
  Control measures -
- Steam-cooking or deep-freezing of pig's meat to kill cysticerci.

- Scientific inspection of pig's meat in slaughter houses to ascertain that it is free from cysticerci.
- Avoidance of improperly cooked pork.
- Sanitary control of sewage disposal and effective treatment of infected individuals.

Wuchereriabancrofti

- ***Filarial worm***
- Causes ***lymphatic filariasis*** in man.
- Endoparasitic nematode, inhabiting the lymphatic system of man.
- Adult worms are long, slender, creamy white and translucent.
- Their body is covered by a smooth & transversely striated cuticle.



- Male and female exhibit some degree of sexual dimorphism.
- Male is much shorter than female.
- ***Elephantiasis*** is the late complication of filariasis
- ***Life cycle*** – completed in two hosts
- Man & female mosquito
- **Mode of infection –** mosquito bite

Control measures

- Chemotherapy of infected persons
- Isolation of infected persons from mosquitoes
- Destruction of mosquitoes using insecticides