S Y B Sc Zoology

Paper II Sem I

(2) Agricultural Pests and their control:

By

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- Contents…
- An introduction to Agricultural Pests, types of pests (agricultural, store grain, veterinary).
- Major insect pests of agricultural importance (Marks of identification, life cycle, nature of damage and control measures).
- a) Jowar stem borer, b) Red cotton bug, c) Brinjal fruit borer, d) Mango stem borer, e) Blister beetle, f) Rice weevil, g) Pulse beetle, h) Tick.
- Non insect pests: Rats, Crabs, Snails, and Squirrels
- Pest control practices in brief: Cultural control, Physical control, Mechanical control, Chemical control, Biological control, Pheromonal control, Autocidal control and Concept of IPM in brief.
- Plant protection appliances: Shoulder type Rotary duster, Knapsack sprayer, Cynogas Pump.

Introduction :

- In modern India scientific study of insects was 18th Century.
- In 1898 the historical announcement was made *Anopheles* mosquitoes were the carriers of the malaria.
- Indian Council of Agricultural Research (ICAR) was established in 1929.
- Insect pests cause huge losses ranging from 5 to 80% of even up to 100%.
- The insects in storage 4 million tonnes of grains every year.

Losses due to insect pests in Indian agriculture are 23.3 per cent Economic Injury Level (EIL) i)The market value of the crop(ii)The yield loss attributable to a unit number of insects.(iii) The effectiveness of the ontrol.(iv) Cost of control

- **Definition of pest:**
  - **The word 'Pest' derived from French ward 'Peste' and Latin term 'Pestis' meaning plague or contagious disease.**

- ***Pest is any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products (FAO, 1990; revised FAO, 1995; IPPC, 1997).***
- **'Pest' is defined as insect or other organism that causes any damage to crops, stored produce and animals.**
- **Pest is an animal that causes harm to humans, their crops, livestock or possessions.**
- **The term 'pests' virtually covers all harmful insects and related terrestrial arthropods.**
- **Pests are organisms which impose burdens on human population by causing**
- **(i) Injury to crop plants, forests and ornamentals**

- (ii) Annoyance, injury and death to humans and domesticated animals
- (iii) Destruction or value depreciation of stored products.

Different Categories of Insect Pests

Depending upon the importance, pests may be

a) Agricultural crop pest,
b) Stored grain pest,
c) Veterinary or Medical pest
d) Structural pest,
e) House hold or Domestic pest,
f) Forestry and Nursery pest or aesthetic

a) Agricultural Crop Pests:

- Pest comprises a large number of insects attacking the various crop plants.
- These insects bear chewing and sucking type of mouth parts.
- The cabbage worms, semiloopers, potato beetles, etc., possess chewing type mouth parts.
- The important cereal and cash crops like jowar, bajara, wheat, cotton, sugarcane, etc. are attacked by pests like stem borer, shoot fly, Deccan wingless grasshopper, armyworms, flea beetles, aphids, leafhoppers mites, jowar midge fly, etc.

- **Rhinoceros beetle, mango stem borer, brinjal fruit borer, as well as in the storage.**
- **Thrips, Aphids, flea beetles, etc. damage grapes,**

Shoot & Fruit Borer of Brinjal

Introduction

Scientific classification

- Kingdom : Animalia
- Phylum : Arthropoda
- Class : Insecta
- Order : Lepidoptera
- Faimly : Pyralidae
- Genus : *Luecinodes*
- Species : *orbanalis*

- **Sugarcane stem borer, shoot borer moth, root borer, pyrilla, mealy bug, scale insects etc**
- **The cutworms, leafhoppers, potato tuber moth, epilachna beetles, mites, aphids and thrips.**

Agricultural Pests :

a)Direct effect

- **Leaf eaters *Zonocerus,* affect the plant growth.**
- **Stem borers make tunnels in the stem ex. *Antherigona* in Maize, *Disphya* in coffee.**


pyrilla,

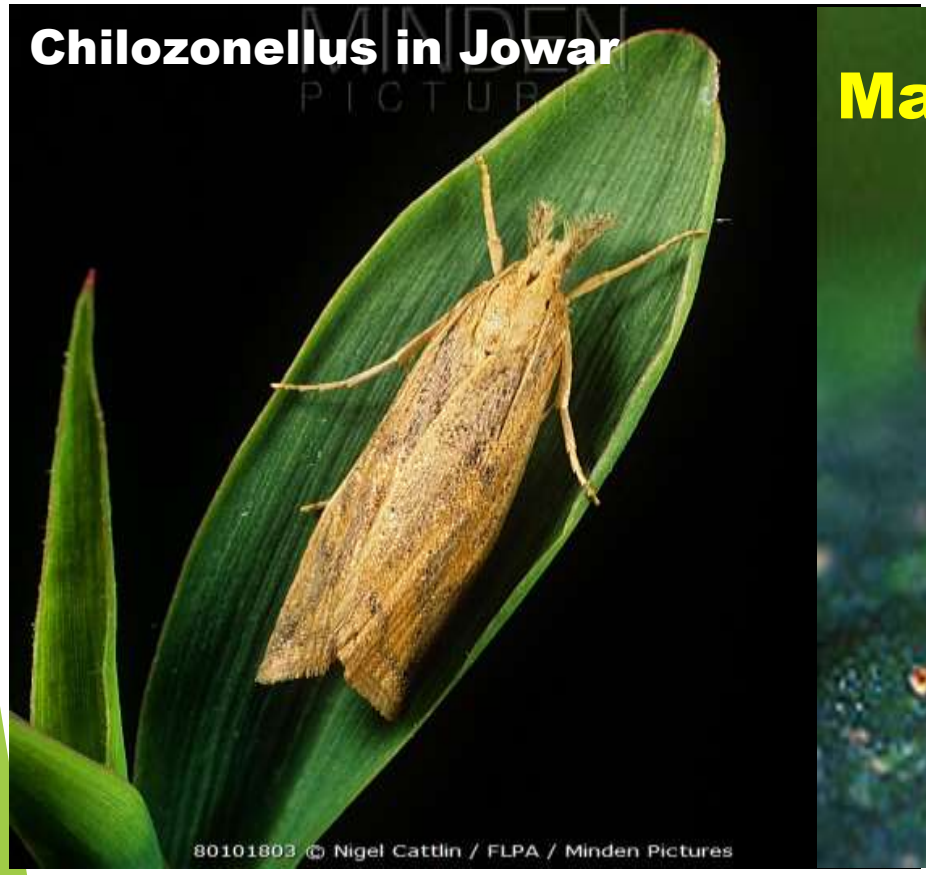

mealy bug


mite


Zonocerus

- **pests prevent the branching and growth of the stem. i.e. *Chilozonellus* in Jowar and *Earias* in cotton.**
- **pests causes the immature fruit fall i.e. Mango fruit fly, ridge fly.**
- **Pests attack the flowers and damage the crop e.g. *Tassel* beetle of Maize.;**
- **Insects consume stored food, underground tubers, etc. affect growth i.e. potato beetle.**

- **Sucking insects sucks cell sap results in loss of vigour of the plant. For example, Bemisia (white fly) on cotton, *Aphids* on many vegetable plants.**
- **Sucks sap from flower and reduces the seed setting i.e. *coffee Lygus bugs.***



Agricultural Pests :

(b) Indirect Effects:

(i) Agricultural pests effects, delay the crop maturity and harvest. These pests not only cause loss of production but also cause *decline of* qualify, nutritional value, discolouration and market value.

(ii) The insects cause damage also act as transmission agents to transfer the pathogenic fungi, bacteria or viruses which leads secondary effects on the crop plants. For example *Platygasteri* wasp transmit coffee leaf rust, viral diseases like mosaic virus disease and curling leaf of cotton.

b) Stored grain pest:

- About 30 species of insect commonly infest food aid grain and grain products.
- Most insect pests are either beetles or moths.
- In addition to insects, only mites.
- Organisms like insects, mites, rodents, fungi and bacteria are directly responsible for causing loss in stored products.
- Any stored or transported food commodity can be subject to attack by pests: Insects, Rodents and Birds.

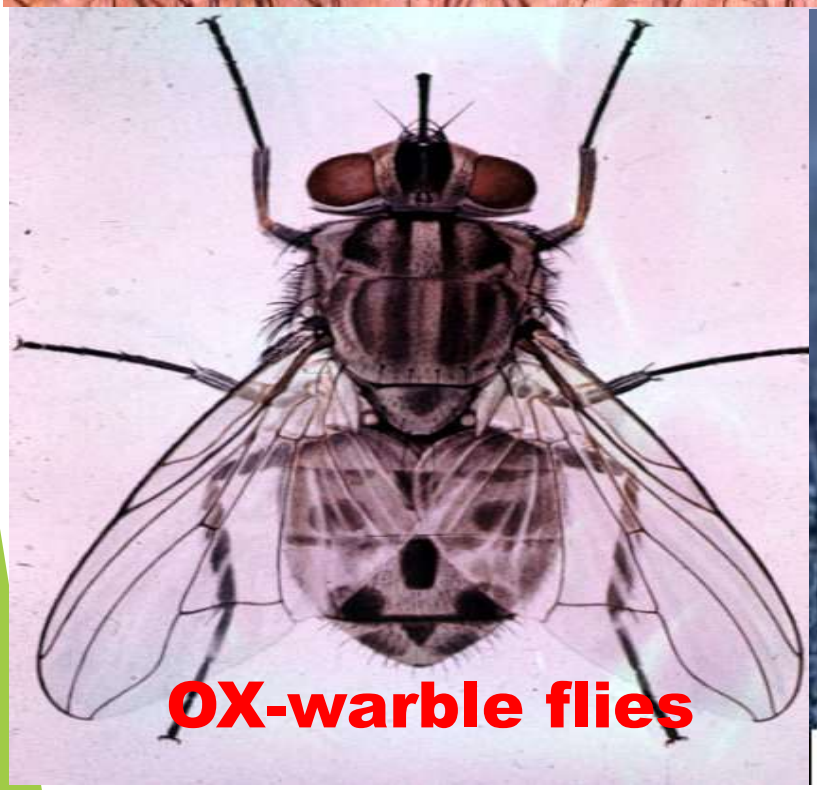
- **Primary pests: attack and breed in previously undamaged cereal grains and pulses.**
- **Secondary pests are able to attack only materials that have been previously damaged either by other pests (primary pests) or by poor threshing, drying and handling.**
- **transmission of zoonotic diseases, damage packaging materials (holes, gnawing, chewing) damages at the warehouse premises.**

(C) Veterinary pest : (Domestic Animal Pests)

- The insects which cause damage to domestic animals like goats, chicken, horses, cattle, etc.
- And blood sucking insects like fleas, lice, bugs, mosquitoes, stable flies as ectoparasite are the examples of domestic animal pests.


Tabanid flies
UF


horn flies

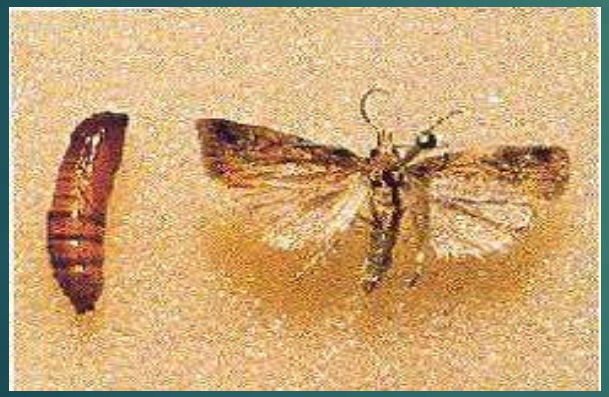

OX-warble flies


Mallophaga lice
shutterstock.com · 1362817910

- ***Tabanid flies, horn flies*** **suck the blood from cattle and horses.**
- **Both flies cause serious stomach disturbances in horses. Grubs of *OX-warble* flies cause loss of flesh in cattle and can cause damage to the leather by cutting holes in the skin.**
- **A biting lice like *Mallophaga* cause irritation and loss of flesh in poultry farms.**
- **Thanks…**

Major insect pests of agricultural importance

(Marks of identification, life cycle, nature of damage and control measures).



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Marks of identification, life cycle, nature of damage and control measures).

a) Jowar stem borer,
b) Red cotton bug,
c) Brinjal fruit borer,
d) Mango stem borer,
e) Blister beetle,
f) Rice weevil,
g) Pulse beetle, h) Tick.

Non insect pests: Rats, Crabs, Snails, and Squirrels

a) JOWAR STEM BORER

Scientific Name: Chilo partellus S.
Class — Insecta
Order – Lepidoptera
Family - Pyralidae
Genus - Chilo
Species — zonellus = partellus (Swinhoe)

- Jowar is the most important stable food crop of the Maharashtra state.
- Besides being stable food crop of the people, it also supplies very good fodder for the cattle. It is cultivated in Kharif, Rabi and also in hot weatherDistribution:
- It occurs throughout India. The jowar stem borer is commonly called as pink borer or spotted stalk borer because of dark spots on the body of larva.

Marks of Identification:

The Moths - medium sized with 3 cm wing span, its forewings are straw or light brown or yellowish grey in colour with numerous shining brown spots on the margin and hind wings are white and papery.

The hind wings are whitish. Caterpillar or (Larvae) - dirty white, brown head with mandibulate type of mouthparts, many dark spots on the body, 12- 20 mm in length and shows four broad and patchy strips on the body.

Life history:

a) Eggs - A female moth after matting lays about 50-300 eggs in clusters arranged in two rows on the under surface of the leaves during April-May. The eggs are oval creamy white in colour.

b) Caterpillar- Larvae- The eggs hatch into the young caterpillar in about six days of incubation period. The young caterpillar feeds on tender leaves for a day or two and bores into the central shoot. The larval period last for about 3-4 weeks and have normally five moults. Before pupation larva prepare a hole on stem at ground level for the moth to escape / come out.

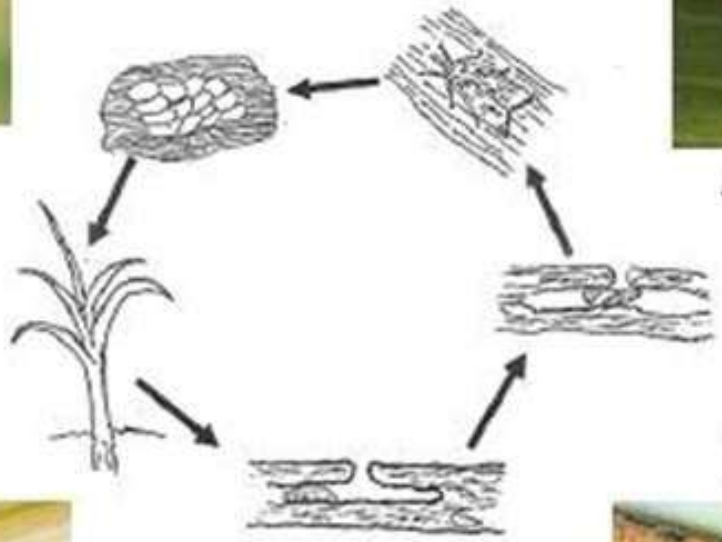
c) Pupa: Pupation takes place inside the stem and it last for about 7-10 days.

d) The adult lives for 2-4 days. Adult longevity is 2-4 days.

Life cycle of *Chilo partellus*

Egg batch

Adult Moth



Larvae

Pupae

Nature of damage:

- On hatching from the eggs, the larvae initially feed on the tender leaf whorls causing series of small holes in the leaf lamina and attack all parts of jowar plant except the roots.
- The larvae on entering the leaf, whorl and cut the leaves, which on emergence manifest characteristic pin holes, shoot holes and longitudinal streaks.
- At times the growing point is cut which results in drying of the central shoot, causing the death of central shoot and commonly known as “dead-hearts”.

Nature and symptoms of damage

Larva is damaging stage

- The infestation starts 20 days after seedling emergence and continued till maturity

- **In the early stage –** hatching larvae feed on the surface of leaf sheath and leaf whorls causing pin holes / shot holes on the whorls of newly opened leaves

- As the severity of leaf damage increases , blend of feeding punctures and scratches appears on leaves

- The larvae bores into mid rib and the shoot and feeds on the internal tissues and causes typical **'dead heart'** formation, thus killing young plants

Larval stage
inside the stem

Adult

Fig. : Jowar Stem Borer

Control Measures:

Preventive:

- Collection and destruction of stubbles after the harvest of crop to kill hibernating larvae
- Increase the seed rate to compensate the loss.
- Follow proper crop rotation (with non host crop).
- Use of light traps.

Curative: Cultural Practices:

- Removal & destruction of affected shoots along with the larvae.
- Hand picking or light trapping of adult moths and collection of their eggs for destruction.
- Burning of stubbles and trash which harbour borers and act as source of infestation for the next crop.

Changing the sowing and harvesting timing reduces infestation.

- Crop rotation is another cultural practice that does not allow the pest of one crop to survive next year for lack of its host.
- Growing resistant varieties of jowar like CHS-7, CHS-8, Indian sorghum types IS-5285, 5566, and 5613.
- Chemical Method:
- 1. For the Chilo on jowar a spray of 0.05% linden or 0.1% endosulfan on 15 days old plants has been found.
- 2. If the crop infestation is noticed, dusting of crop in the early stage with 10% BHC at the rate of 25 kg per hectare or spraying the crop with 350-400 ml of aldrin or dieldrin in 200 litre of water helps to control the pest.

- **Biological Method:**
- **1.Only the egg hymenopteran parasitoid, *Trichogramma minutum* is employed as egg parasite.**
- **2. If the caterpillars are outside the stem particularly on leaves then *Apanteles flavipes* and *Bracon brevicornis* as larval parasites can be used to control.**
- **3. The lady beetles, *Coccinellaseptempunctata* and *Menochilus* . *Sexmaculata* have been recorded predating on early stages of the larvae of this pest.**

Thanks…

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Major insect pests of agricultural importance

(Marks of identification, life cycle, nature of damage and control measures).

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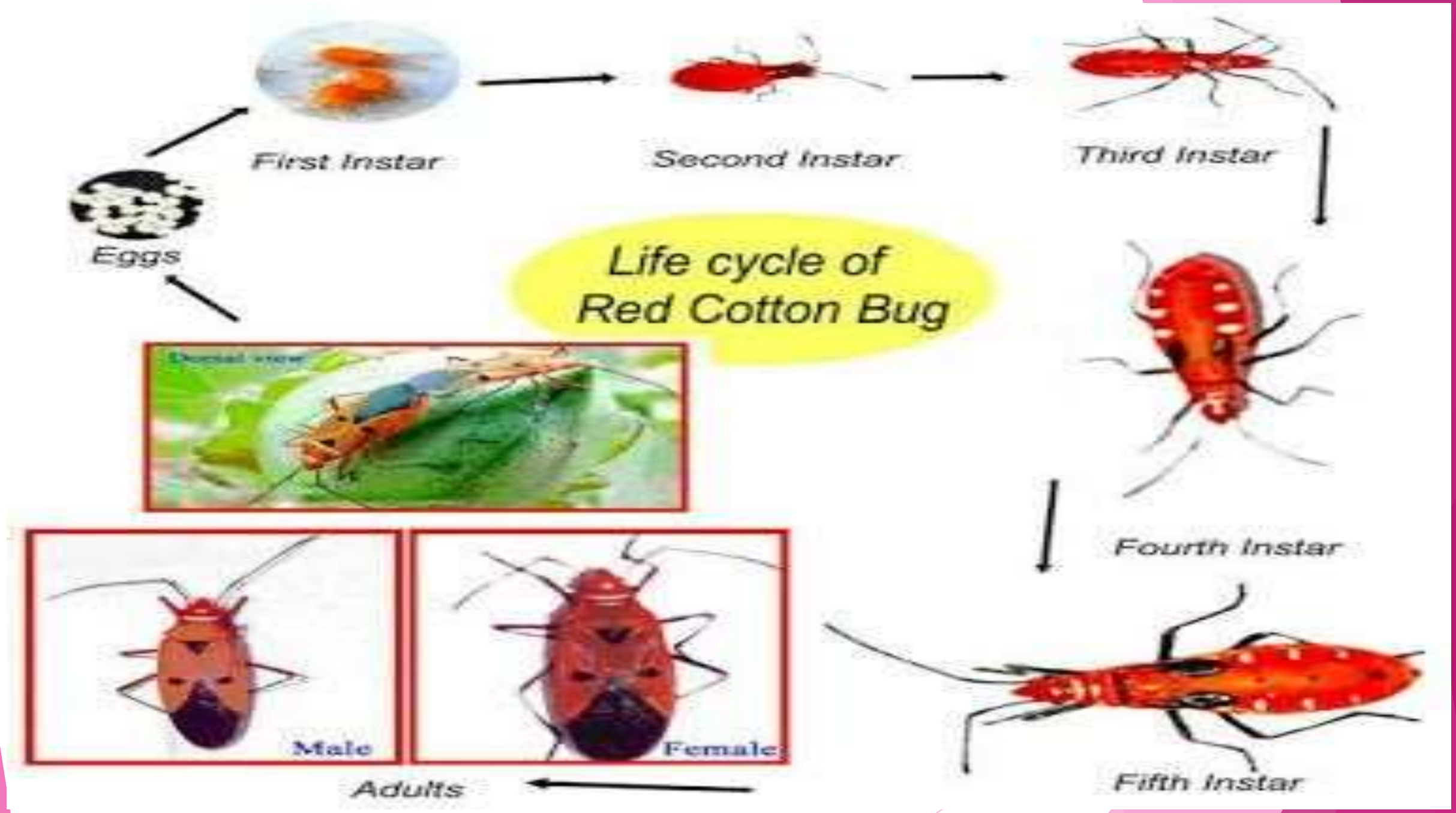
- Jowar stem borer,
- Red cotton bug,
- Brinjal fruit borer,
- Mango stem borer,
- Blister beetle,
- Rice weevil,
- Pulse beetle,

- h) Tick

Red cotton bug,

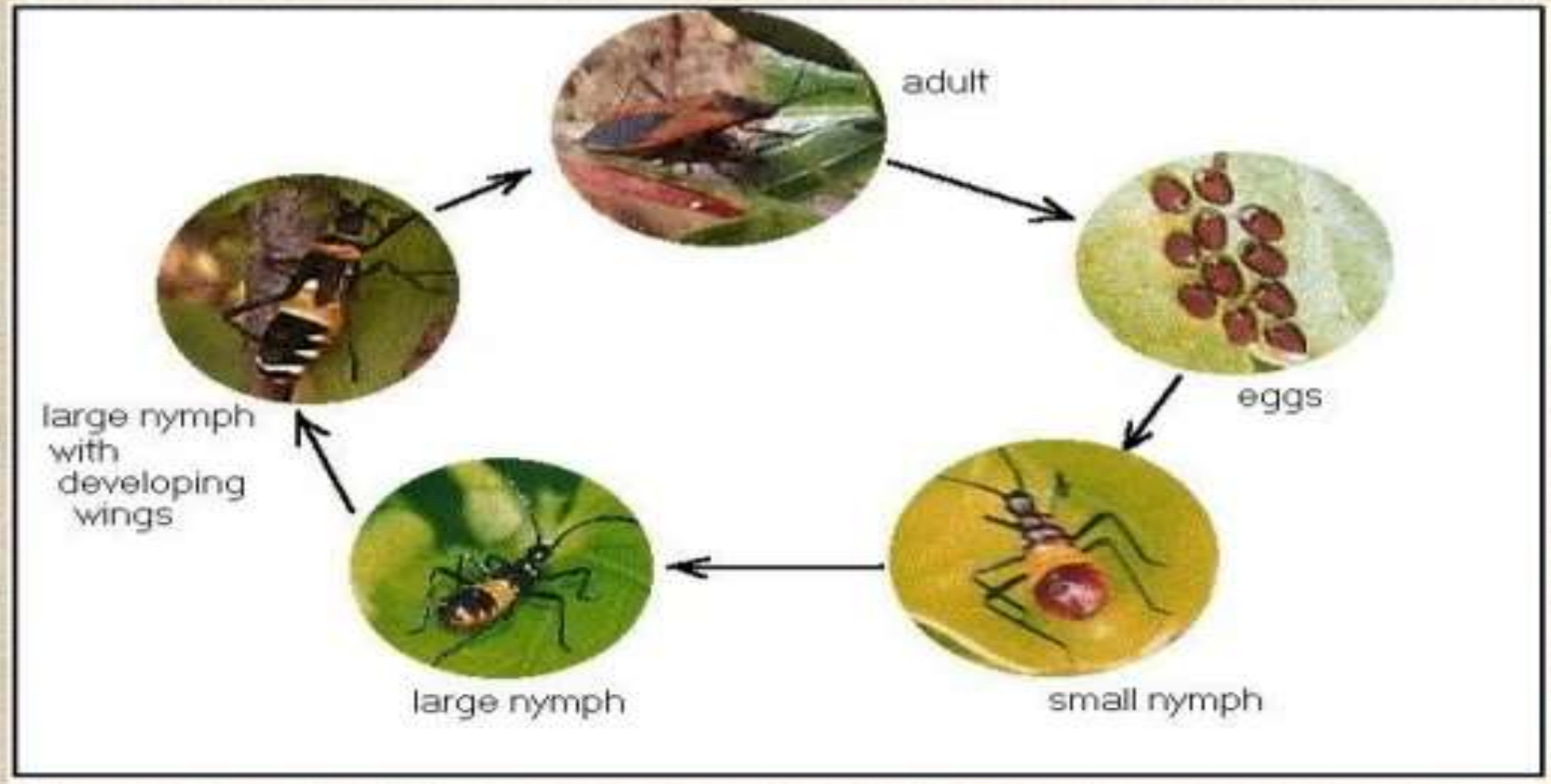
Host Plants : Cotton, bhendi, ambadi, hollyhock and several other malvaceous plants.


First Instar
Second Instar
Third Instar
Eggs
Life cycle of
Red Cotton Bug
Fourth Instar
Male
Female
Adults
Fifth Instar

Life History :

- i)The eggs are laid by the female under the soil in cracks and are covered with loose earth or with small dry leaves. Eggs are round and light yellowish about 1.2 mm in length. Each female is capable of laying between 100-130 eggs. Egg period lasts 7-8 days.
- ii Eggs are hatched in to active 1mm long red coloured nymphs. They resemble the adult with the adult except size and absence of wings.

LIFE CYCLE


adult
eggs
small nymph
large nymph
large nymph with developing wings

- Nymphs after hatching are wingless with their abdomen red with central row of black spots and row of white spots on either side.
- Nymphal period lastsfor5-7days. Nymphs pass through five moults with wings developing from the third instars and attaining full form after the fifth.

- iii) The development is completed in 50- 90 days. Males are smaller than the females and the swollen abdomen can differentiate females from males. In winter the longevity of the adult is about 3-months but in summer it is varied.

- iv) Pest breeds on cotton from August- November; takes shelter under leaves or debris from December-middle of March and feeds on bhendi from April-July.
- v) Life cycle: completed within six to eight weeks.
- Carry over: Pest breeds on cotton from August- November; takes shelter under leaves or debris from December-middle of March and feeds on bhendi from April-July. Red cotton bug appearance on cotton is after the commencement of the first open boll in the cotton fields.

Identification Marks

- The adult bug measures about 12-15 mm in length.

- The females are Longer (15 mm) than the males (12 mm).

- It is blood red in colour except eyes, scutellum, anal style, and antennae which are black coloured.
- Besides, there is a black spot on each of the membranous forewings.

Nature of Damage:

- Adults and nymphs suck the sap from leaves, green bolls and seeds of partially opened bolls. Vitality of the pl ant is lowered, in general.
- Affected bolls open badly with their lint stained with the excreta or body juices. Quality of the lint is affected and the attacked seeds be come unfit for either sowing or oil extraction.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- Boll rot is caused by the secondary infection due to bacteria wherein rotting of the entire contents of the boll occur following the initial discolouration of the lint to yellow or brown.
- The lint is stained by the excreta of bugs or by their body juice as they are crushed in the ginning factories, so named cotton stainer.

Fire ant

Ladybird beetle

Spider

Reduviid bug

Praying mantis

Common mynah

- **Control Measures:**
- **Cultural Practices**
- 1. Cotton field should be ploughed to expose eggs to sunlight.
- 2. Insects should be handpicked and killed in kerosene water.
- 3. The crops of bhendi should be sown as trap crop and pests collected there, should be destroyed.

- 4. Moistened cotton seeds should be hanged up at different places in the field where bugs congregate, they may get killed in the kerosene water.

- Chemical control

1. Spraying of Malathion 0.05% is effective to control the pest.

2.Spraying of 1 liter endosulfan 35% EC, 0.25 liter phosphamidon = 100% EC or 1 liter Fenitrothion 100% EC per hectare is very effective or reduce pest population.

BRINJAL FRUIT BORER:

Scientific name: *Lucinodes orbonalis Guen*

Class: - Insecta

Order: - Lepidoptera

Family: - Pyralidae

Genus: - *Lucinodes*

Species: - orbonalis

Distribution:

India, Bangladesh, Malaysia, Thailand, Burma, Srilanka, Laos, South Africa, Congo. It is a major and regular pest of brinjal causing damage to even 30 -50% of fruits or more.

Most destructive pest of brinjal, found throughout the country. It is active throughout the year, except in severe cold weather in North India.

Marks of Identification

- The moths are medium sized. Wings expanse 22-26mm. Full grown larva is light pink measuring about 12mm long.
- Fore wings are white having conspicuous black and brown patches and dots
- Hind wings are opalescent with black dots.
- Eggs are flattened, elliptical, laid singly on leaves, shoots, flower buds and occasionally on fruits.
- Full grown caterpillars are light pink in colour.

- **Host plants**
- **Besides brinjal, the pest is also known to infest potato, bitter gourd, pea pods, cucurbits etc. and other solanaceous crops.**
- **Life history**
- **a) A female lays on an average 250 eggs on leaves, shoots or sometimes on fruits. Incubation period is 3-5 days, larva become full grown in 7-15 days.**

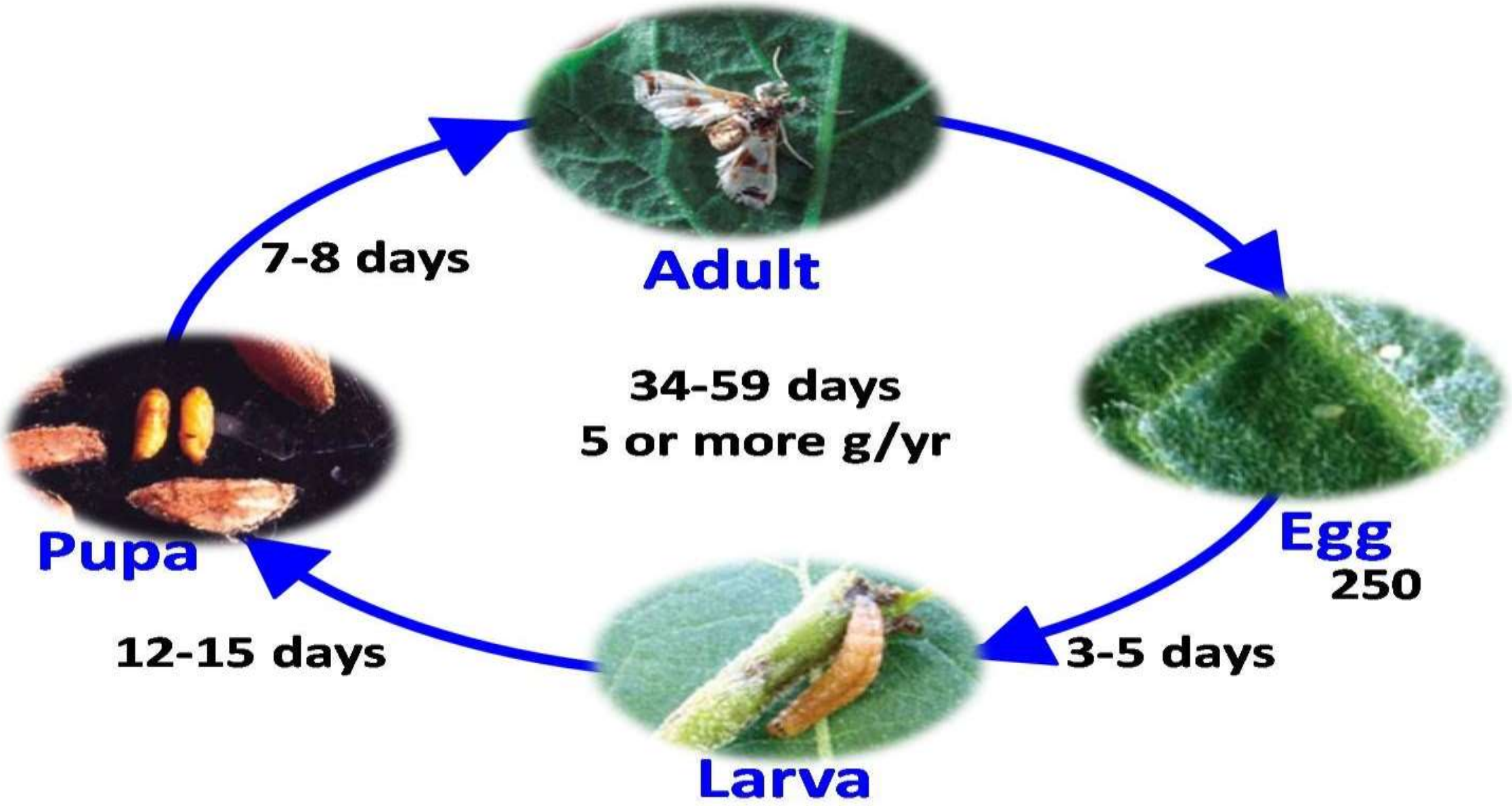

Fig. Life cycle of brinjal shoot and fruit borer

- b) The full grown larva comes out and pupation takes place in boat shaped cocoons on the plant itself. The pupal period lasts about 7-10 days. Adults live for 2-3 days.
- c) Life cycle is completed in 25-40 days. The duration of development of life stages depend on temperature, in winter when there is low temperature it requires more days and in summer when there is increase in temperature there is decrease in duration of developmental period.

Nature of damage

- Infestation starts after few weeks of transplantation. In young plants caterpillars bore into petioles and midribs of large leaves and young tender shoots and feed on internal tissue.
- Faecal pellets are seen at entrance hole.
- When the infestation is on shoots, they bend down and whither, affected leaves and shoot wither and dry.

Destructive larva

Adult moth

Shoot damage

Stem damage

Exterior fruit damage

Fruit flesh damage

Nature of damage

- Damage is caused by caterpillar.
- Larva is a internal feeder it immediately bore into the nearest tender shoot or flower or fruit just after hatching.
- Larval feeding, inside shoots, result in wilting of the young shoot.

- . The larvae also attack the fruits making their entry under the calyx when they are young, leaving no visible signs of infestation.
- **The pinkish larvae make zigzag tunnels in the fruits which are holed.**
- At later stage of growth, caterpillars bore into flower buds and fruits, sometimes from under the calyx, when no visible symptoms are apparent.
- **Damaged flower buds are shed and fruits show circular holes.**
- The large holes seen on fruits are usually the exit holes of the caterpillars.
- The content of vitamin C in the fruits of the brinjal is found to be reduced.

- **Control measures**
- **Cultural practices**
- **Continuous cropping of brinjal and potato should be avoided and resistant varieties if available should be cultivated,**
- **Continuous cropping of the brinjal leads to more infestation and hence should not be indulged in.**

CONTROL OF FRUIT AND SHOOT BORER IN BRINJAL

- Brinjal with long, narrow fruits are less susceptible to attack and, therefore, this variety should be preferred than other varieties. Use of Resistant/Tolerant varieties in endemic zones.
- Removal and destructof withered and dried shoots help in arresting the spread of the pest.
- ion The use of light traps containing killing solution like kerosene at the base of container during night times can be used to kill adult moth of pest insect.

- **Chemical Control**
- **Spraying with 0.05% monocrotophos 36 WSC or 0.2% carbaryl or dusting with 10% carbaryl 3-4 weeks after transplantation subsequent application 15 days thereafter controls the pest effectively.**
- **Endosulfans, Fenvalerate, Cypermethrin or Deltamethrin are also recommended.**

- Synthetic pyrethroids in hot weather are less effective.
- One or two of the following insecticide can be used with proper care and counselling with agricultural expertise for control of brinjal fruit borer.

Name of the Insecticide	Quantity in one liter of water
Carbaryl 50 w/p	4.0 g
Endosulfan 35EC	3.0 ml
Malathion 50 EC	2.0 ml
Phosalone- Zolone 35 EC	2.1 ml
EC = Emulsifiable Concentrates; w/p = Wettable Powders	


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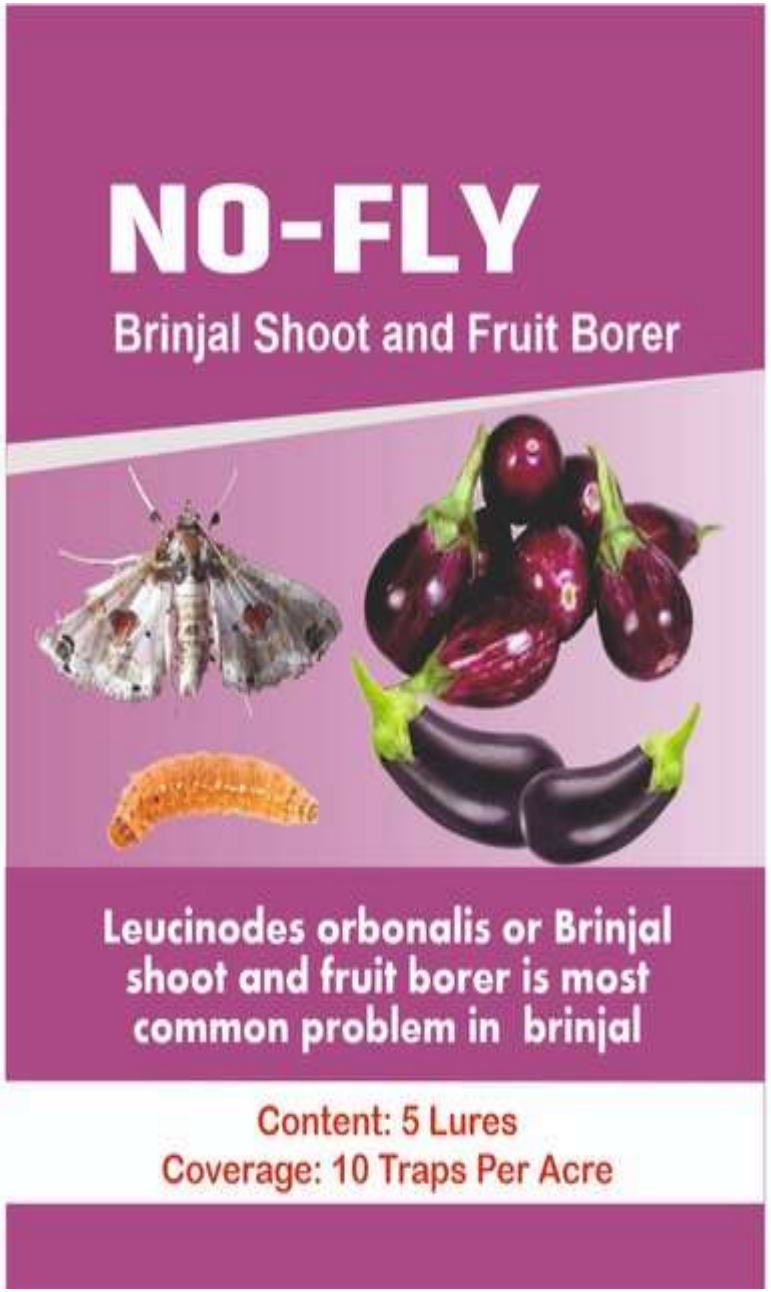
THE ANTI FEEDANT


NO-FLY
Brinjal Shoot and Fruit Borer
Leucinodes orbonalis or Brinjal shoot and fruit borer is most common problem in brinjal
Content: 5 Lures
Coverage: 10 Traps Per Acre


Brinjal Fruit Shoot Borer Pheromone Trap
(Leucinodes Orbonalis)
Chipku
INSECT TRAP

- **Biological control**
  - The Braconid wasps *(Bracois chinensis*) and Ichenumoid wasps (*Trathela flauoorbitais*) parasitize the caterpillars of brinjal fruit borer.
- **Carry over: The pest is active throughout the year.**

d) MANGO STEM BORER

Class — Insecta

Order — Coleoptera

Family — Cerambycidae

Genus — *Batocera*

Species — *rubus* (Linnaeus, 1758)

Synonyms: *Batocera albofasciata* De Geer, 1775; *Batocera albomaculatus* Retzius

Common names: rubber root borer; lateral-banded mango longhorn; mango longhorn beetle (en), asiatischer Kautschukbaumbohrer (de), panterboktor (nl)

Distribution:

- **In its native area in Asia *B. rubus* is seldom a serious pest. It is present in:America:no data Asia: Bangladesh, Brunei Darussalam, Cambodia, China, India, Indonesia, Lao, Malaysia, Myanmar, Pakistan, Philippines, Europe:intercepted in FTaiwan,Thailand,VietnamAfrica:nodatarance (2011, Nanterre on a single bonsai plant-*Ficus microcarpa*), incursion in Italy (2012).**
- **It is very common in Gujarat, Maharashtra, Andhra Pradesh**

- **Marks of Identification:**

- **The adult beetles are well built, large sized, measure about 4.5- 5 cm long in length and brownish yellow/grey coloured. It has orange yellow spots on thorax and has hard forewings (elytra); lateral spines on the prothorax and long antennae and legs. The grubs are large, yellowish white in colour, fleshy in appearance and measures about 100 x 18 mm. with black head bearing strong mandibles.**

- (Mango stem borer- *Batocera rubus* L.) (Mango stem borer)
- Host Plants: *Batocera rubus* is known to attack broadleaf trees and woody plants. In Europe it was intercepted on bonsai trees. *B. rubus* is a large wood borer that has been recorded on rubber tree *Hevea brasiliensis* in Thailand, particularly on trees damaged by other causes such as fire and lightning. Larvae (6-8 cm) also feed on freshly felled timber. The other recorded major hosts: bread fruit trees *Artocarpus altilis*, *A. heterophyllus*, fig *Ficus carica*, mango *Mangifera indica* In India this pest is found on the planted plants like mango, fig, rubber and jack.

- **Life history :**
- **i.The female beetle deposits single egg under the loose bark or in a diseased part of trunk or in the crevices of stems.**
- **ii.After the completion of incubation period of 14 to 17 days the egg hatches out**
- **iii.The grubs on hatching penetrate into the stem or even the roots feeding on the woody tissue and make tunnels. The larval stage last for 3 to 6 months; then they pupate in the stem and remain in the pupal stage for 3 to 6 months over winter and the adults generally emerge during the monsoon.**
- **iv. The life cycle may extend for period of 1 – 2 years.**

- **Nature of damage:**
- The milky white grubs make zigzag galleries beneath the bark and tunnel into the trunks or main stems.
- As a result of feeding on the internal tissues, the attacked branches and stem die and wither away.
- Sometimes, frass and masses of refuse exude may be seen on the opening of the bored holes. In severe cases of attack, the branches may collapse and the tree may die.

Control Measures:

- To prevent infestation regular cleaning, checking and applying salt, lime or kerosene to the stem can reduce the chances of infestation.
- The population of grubs and pupae of stem borer can be reduced by cutting and destroying the infested branches.
- In tunnels or holes kerosene or other oil if injected can kill the grubs to some extent.

- The best way to control the grubs is to just inject borer solution (i.e. 2 parts of carbon disulphide + one part of chloroform and cresol) in the holes after which it should be closed by mud.
- Pest population can also be effectively reduced by injecting 0.05% spray liquid of the following insecticides into the borer holes of tree or branches.

Name of Insecticide	Quantity (ml.) / liter of water
Chiorpyriphos (Durshan) 20 EC	2.5
Endosulfan (Thiodan) 35 EC	1.5
DDVP (Dichlorvos) 76 EC	0.7
EC= Emulsifiable Concentrates	

e) PULSE BEETLE

Scientific name: *Callosbruchus chinesis* Linn.

Preferred Common Name- Chinese bruchid

Class : Insecta

Order: Coleoptera

Family:Bruchidae

Genus: *Bruchus or Callosbruchus (= Pachymerus)*

Species: *chinensis (Linn.)*

International Common Names English: adzuki bean weevil, oriental cowpea bruchid, southern cowpea weevil

- ***Callosobruchus chinensis*** **is major pest of pulses in Asia and other regions. It is a holometabolic insect with the egg and adult stage found on the grain and the larval and pupal stages living inside the grain.**
- **Distribution: The two most widespread species of bruchid beetle are *C. maculatus* and *C. chinensis*, which are distributed throughout the tropics and sub-tropics. *C. chinensis* originated in tropical Asia where it is still the dominant species.**

Marks of identification

- i. Adult beetles are 3-4 mm in length, oval in shape, chocolate/reddish brown in colour, and have long, erected antennae.
- ii.The adult beetle is more or less tapering at the anterior end.
- iii. There are two ivory coloured spots in the middle of the dorsal side of its body.
- iv The grub is white, cylindrical, and fleshy and wrinkled with brownish month-parts. It is always found inside the grain.

Host plants

- *C. chinensis* is a major pest of chickpeas (Pandey and Singh, 1997), lentils, green gram, broad beans, soybean (Srinivasacharyulu and Yadav, 1997; Yongxue et al., 1998a) adzuki bean and cowpeas in various tropical regions.
- It also attacks other pulses on occasions, but appears to be incapable of developing on common beans (*Phaseolus vulgaris*).

Life history

- i.Adult beetle is 3-4 mm long, female being larger, brownish in colour, broader at shoulders and rounded posteriorly. There are dark patches on elytra and thorax.
- ii.Adults show sexual dimorphism. Males possess deeply emarginated or indented eyes and prominently serrate antennae, while in female these characters are not distinctly marked. In females tip of abdomen is exposed while in males it is covered by elytra.

- iii.The female lays between 1-8 oval shaped and scale-like eggs/grain.
- The eggs are deposited mostly singly but sometimes in-groups on the surface of seeds and pods.
- In the fields, eggs are even laid on green pods, which carry infestation to the store. A female can lay from 60 to 95 eggs. Fecundity is about 100 eggs per female. Eggs are whitish, elongated and stuck on the grains or on pods and sometimes on the surface of the container. Egg stage lasts for 4-5 days.

- iv. On hatching, larva enters the grain and becomes full-grown in 2 to 3 weeks.
- Each larva completes the life cycle in a separate chamber.
- Grubs are scarabeiform or eruciform, plump and with short legs and yellowish in colour.
- First instars larvae bear functional legs and a pair of thoracic plates to facilitate boring into the seeds.
- They feed on the inner contents of the grain and may damage several grains during development.
-

- Larval period may vary between 12 and 20 days.
- v. Pupation takes place inside the grain and pupa is dark brown in colour. Occasionally pupation may take place outside the grain in a cocoon made of excretory matter.

vi. After 4 to 8 days the adults come out of the grain. It can fly and spread the infestation from store to the field. Adults live for 10 days or more. Completion of life cycle takes 4-5 weeks and there may be 6-7 overlapping generations in a year.

- In India the insect breeds freely from March to November and hibernates in the larval stage during the winter. The adult emergence takes place from January to April.
- Nature of damage
- It is a major pest of pulses in store.
- However, field infestation is also common.
- As the larva eats up the endosperm it is the most damaging stage of the life cycle.

- The young grubs burrow into the pod or grain and continue to develop inside the grain.
- The holes seen on pulses are the exit holes from where the adults have emerged.
- Such grains are unsuitable for sowing.
- The pest causes maximum damages during February to August, when all its developmental stages exist simultaneously. Cowpea varieties with resistance to this pest are under development (e.g. Soma et al., 2008).

Control measures: Prevention and Control

Chemical Control

- It is difficult to control the pest in the field.
- In storage however fumigation with carbon-di-sulphide at the rate of 1 lb/100 cu.ft.
- Or 2.5 1b EDCT/100 cu. ft. or methyl bromide at 1 lb/1000cu.ft. would control the pest.
- *Callosobruchus* spp. may be controlled by fumigation treatment with phosphine, although legislation in many regions now frequently prohibits or restricts the use of these products.

- Sealed or hermetic storage affords some protection against *C. chinensis* (Singh and Yadav, 1996; Shaw, 1998). Approved grain insecticides, especially organophosphates, will protect against infestation.
- When grain pulses are stored at farm level the admixture of vegetable oil or essential oils can give protection.
- Many of these products have been traditionally used by subsistence farmers, thereby reducing the need for, and risks associated with, the use of insecticides.
- The mode of action of these biological may be insecticidal or anti-ovipositional.

The list of plants and plant extracts shown to have insecticidal or anti-ovipositional effect against *C. chinensis* and other bruchid pests is very long, including for example: *Acacia nilotica, Crinum defixum, Achyranthus aspera, Lantana camara, Acorus calamus . Alpinia galangal, Amoora rohituk,a Cassia occidentalis, Cedrus deodara, Chamomilla recutita, Cymbopogon citratus*.

The most well known of anti-bruchid phytochemicals is azadirachtin which has been used alone, in 'botanical insecticides' or as a component of leaves or extracts (liquid or powder) of the neem tree, *Azadirachta indica*, particularly in the Indian subcontinent (Kumari and Singh, 1998; Ahmed et al., 1999).

- Cultural Control and Sanitary Methods
- Intercropping maize with cowpeas, and not harvesting crops late significantly reduced infestation by *C. chinensis*).
- Good store hygiene plays an important role in limiting infestation by these species. The removal of infested residues from last season's harvest is essential, as is general hygiene.
- Solarization (or drying and heating) can be used to control infestations of *C. chinensis* without affecting seed germination

- **Irradiation**
- **Irradiation by ionizing gamma radiation has the potential for being used for disinfestations in stores, although the practice is not widely allowed and may be costly (Bui-Cong-Hien et al., 1997).**

RICE WEEVIL/BLACK WEEVIL *(Sitophilus oryzae Linn.)*

- There are three types of rice weevil
- 1. Rice or black weevil
- 2. Maize weevil
- 3. Granary weevil
- Scientific name: ***Sitophilus oryzae Linn.***

- Common name: Rice weevil, Vernacular name- Sonde
- Class: Insecta
- Order: Coleoptera
- Family: Curculionidae
- Genus: ***Sitophilus***
- Species: ***oryzae***

- **Distribution: All over India and many other countries though not worldwide.**
- **Marks of Identification**

The insect can be identified easily by the following criteria:

- **Size is around 3 mm**
- **It possesses characteristic long slender beak or snout**
- **Antennae are elbowed and slightly clubbed**
- **Hind wings are present except in granary weevil**
- **The color ranges from reddish brown, chocolate to almost black**
- **The maize weevil is the largest amongst the three species.**
- **It has slender, hard-shelled bodies that appear pitted or scarred with tiny holes.**
- **Rice weevils have four faint red-brown spots on the back of the abdomen.**
- **They are able to fly and have small round pits on the surface of the thorax.**

Host plants: Rice weevil mainly affects stored food grains such as wheat, rice, maize and sorghum.

- **Life history**

The egg, larva, and pupa stages of these weevils occur in the grain kernels and are rarely seen. Feeding is done within the grain kernel, and adults cut exit holes to emerge. Emergence holes of Females drill a tiny hole in the grain kernel, deposit an egg in the cavity, then plug the hole with a gelatinous secretion. Females start laying eggs 5 days after emergence. The eggs are minute, white, translucent 0.7x0.3 mm in size. Female rice weevils lay between 300 to 400 eggs. From eggs after completion of incubation period of 5-8 days depending on temperature the egg hatches into a young larva or grub which bores toward the center of the kernel, feeds, grows, and pupates there. The larva shows four instars. The larval period lasts for 25-35 days.

- The grub is apodous i.e. without legs.
- The full grown larva pupates inside the grain.
- The pupa is curved and takes 3-6 days to emerge as an adult.
- New adults bore emergence holes from the inside, then leave to mate and begin a new generation.
- The adults live 3 to 6 months, infesting grain in the field.
- Two larvae can develop in one wheat kernel.
- The life cycle of the insect is completed in about 26 days at 30°C and 75% relative humidity (RH).
- The optimum climatic conditions particularly the temperature for development, ranges from 26°C to 30°C.

Nature of Damage

The damage to the grains is mainly caused by two stages of this insect

(1) Larvae

(2) Adults

- **Due to infestation by the above stages of the insect, the grains are hollowed out and in some cases the kernels are reduced to mere powder.**
- **Rice weevil and maize weevil are also known to cause infestation right from the field.**

Adult insects cut circular holes in the grains.

When the intensity of infestation increases it results in heating, referred to as dry heating.

Grains with less than 10% moisture are not attacked by the insect.

- **Control measures**

Cultural Practices

The simplest and most effective measure is to locate the source of infestation and quickly get rid of it. If practical and regulations allow, dispose of heavily infested foods in wrapped, heavy plastic bags or in sealed containers for garbage removal, or bury deep in the soil.

- If you detect an infestation early, disposal alone may solve the problem.
- Properly ventilate the storage area to discourage these moisture-loving stored product pests.
- Be sure to store only clean, dry grain with a moisture content of 12 percent or less to reduce weevil problems.

Chemical Control

Grain insects are declared under the Agriculture and Related Resources Protection Act.

- **Limited chemical controls are available to farmers and emphasis is placed on clean hygienic storage and cleaning of machinery.**
- **Farmers are encouraged to purchase and maintain sealed farm silos to increase the effectiveness of fumigation.**

Thanks...

S Y B Sc Zoology

Paper II Sem I

Major insect pests of agricultural importance:

- Rice weevil,
- Pulse beetle,
- Tick

(Marks of identification, life cycle, nature of damage and control measures).

by

Dr. Bhausaheb R Ghorpade

Shri Anand College Pathardi

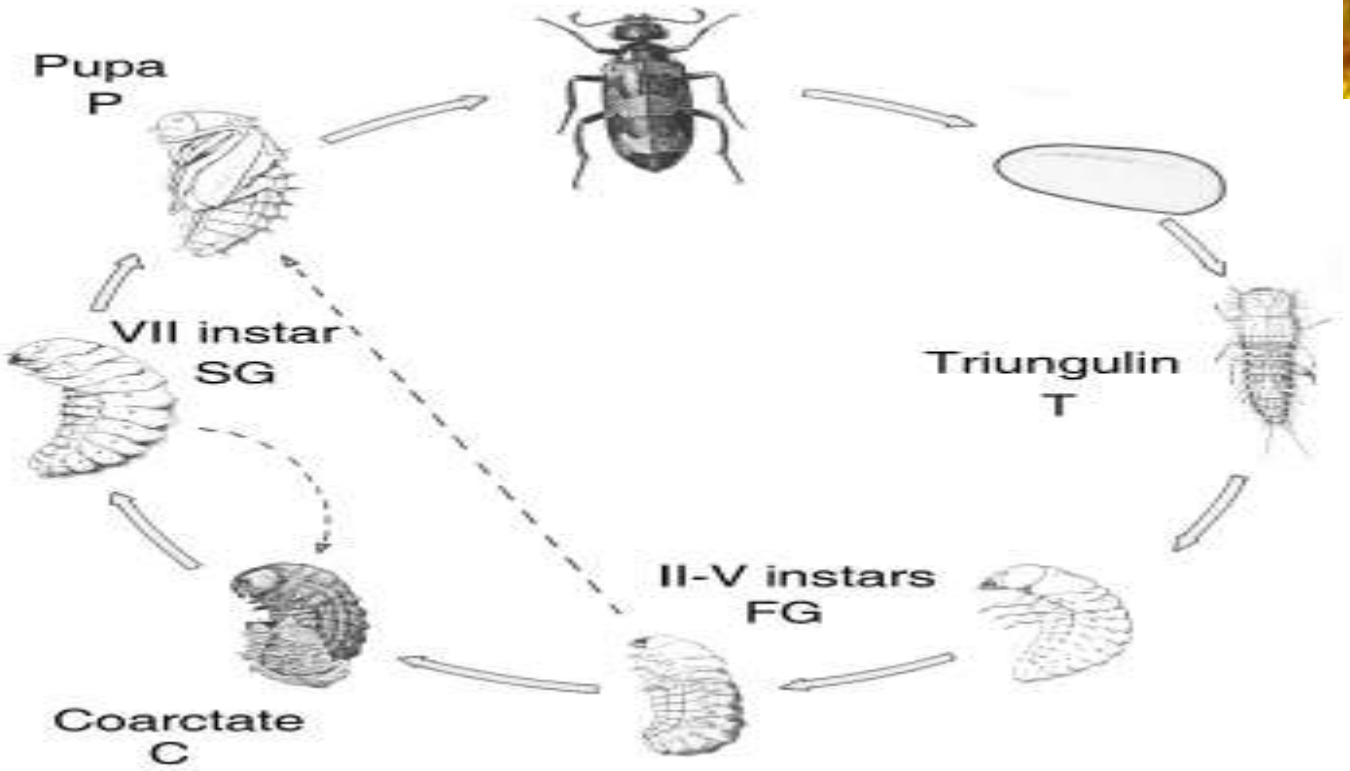
Online lecture on19/01/2022, 09:50 -10:40 am

- Jowar stem borer,
- Red cotton bug,
- Brinjal fruit borer,
- Mango stem borer,
- Blister beetle,
- Rice weevil,
- Pulse beetle,
- h) Tick


ADULT
EGGS
1ST INSTAR
2ND INSTAR
3RD INSTAR
4TH INSTAR
5TH INSTAR
6TH INSTAR
PUPA
Batocera rufomaculata
LIFE CYCLE

Mango stem borer,
Organic farming


Blister beetle,


Pupa
P
VII instar
SG
Triungulin
T
II-V instars
FG
Coarctate
C


UGA1435048


REPELLENTS TO PREVENT
BLISTER BEETLE
(2018)

Pulse beetle,

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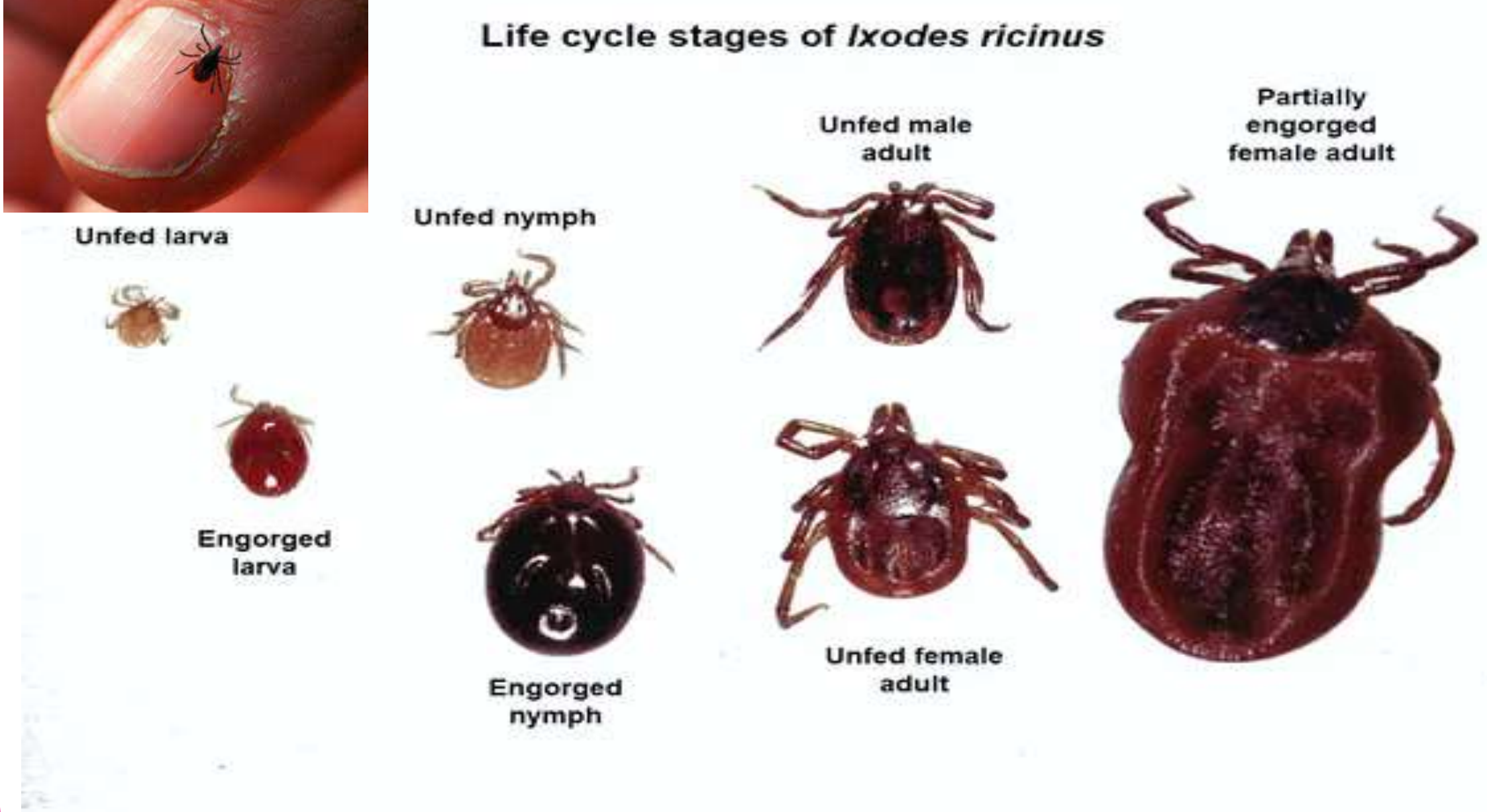
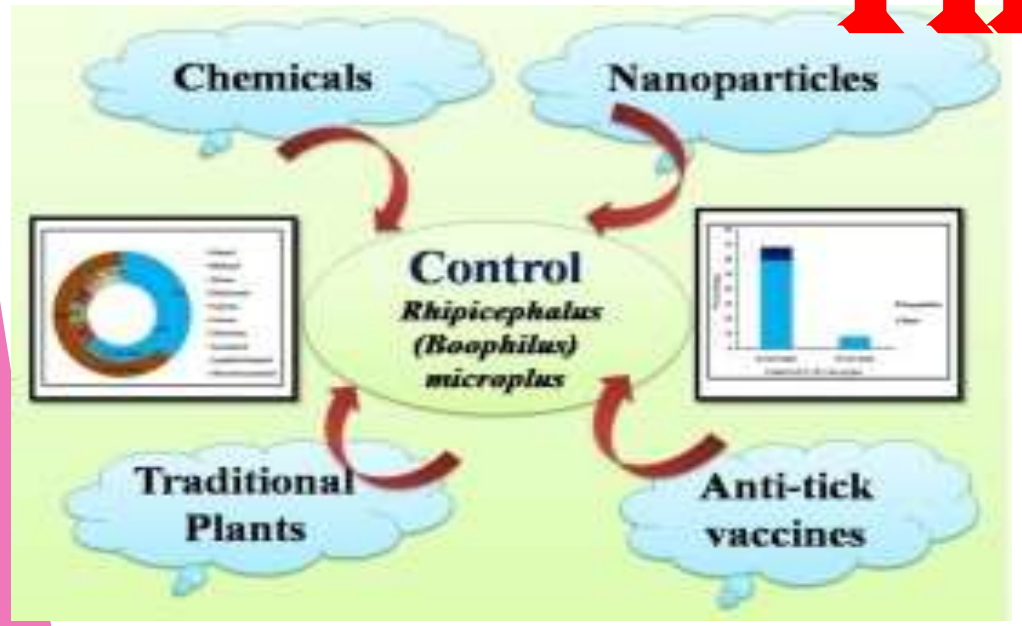
Tick


Life cycle stages of *Ixodes ricinus*
Unfed larva
Unfed nymph
Unfed male adult
Partially engorged female adult
Engorged larva
Engorged nymph
Unfed female adult

Weak and anemic animal

THANKS…



S Y B Sc Zoology

Applied Zoology II

(ZO -242)

Paper II Sem II

(1) Apiculture

By

Dr Bhausaheb R Ghorpade

Dept Of Zoology

Shri Anand College Pathardi

Dist Ahmednagar (MS)

Date24th April 2023

Introduction :

- Usually insects are considered harmful to man but hardly 1 per cent of insect species fall in the pest category.
- Benefits of insects in maintaining economy outweigh the injury inflicted.
- Honey bees are one of the few insects directly beneficial to man
- Apiculture is the commercial production of Honey.
- Honey is mentioned in ancient books like Vedas, purana and epics like Mahabharata and Ramayana.
- It has been an important element in the sweet diet of man.
- Apiculture is scientific method of rearing honey bees .
- Bees are bred commercially in apiaries .
- The word ‘apiculture’ comes from the Latin word ‘apis’ meaning bee.

.1.1 Systematic position:

Phylum-Arthropoda,

Class- Insecta,

Order-Hymenoptera,

Superfamily-Apoidea

Family-Apidae.

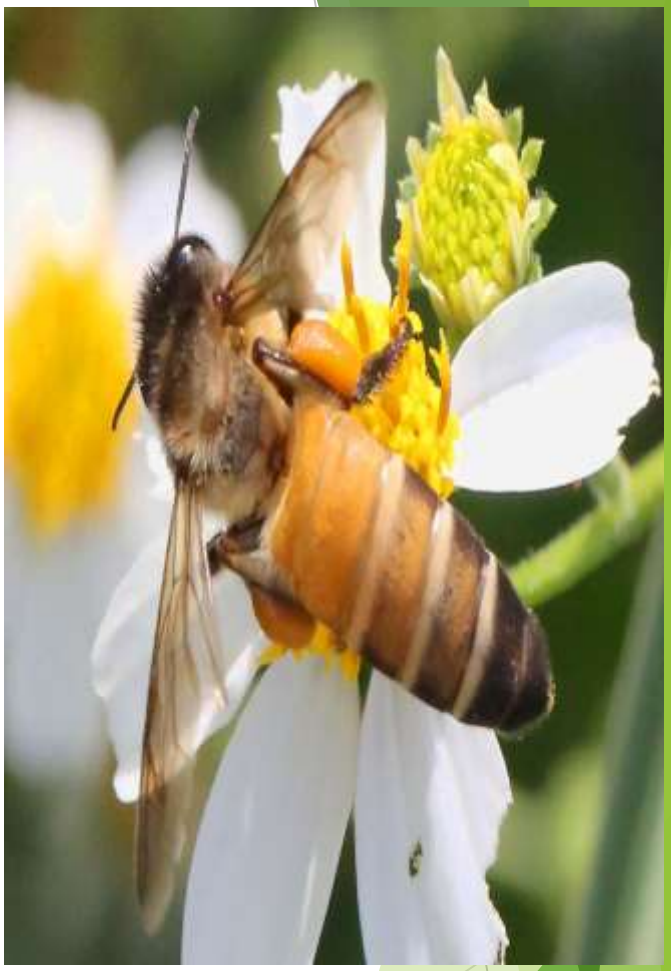
Genus- *Apis*

- **Sps- *dorsata* , *florea*, *cerana* indica and *mellifera***

	Apis dorsata	*Apis florea*	*Apis cerana*	*Apis mellifera*
Distribution in India	Found in plains as well as hills up to 1600 metres above sea level. Highly migratory.	Found in plains up to 300 metres above sea level. Highly migratory.	Found throughout India having 3 subspecies	Exotic bee to India. Introduced successfully in 1962. It has many subspecies (more than 3)throughout world
Size	Biggest honey bee (16-18mm)	Smallest Apis bee (9- 10mm)	Medium size (14-15mm)	Medium size (14- 16mm)
Average honey yield per colony/year	40 kg	500 g	5 kg	15 kg
	(wild bees; cannot be domesticated)	(wild bees; cannot be domesticated)	(Hive bees; can be domesticated)	Hive bees; can be domesticated)
Method of honey extraction	By squeezing (unhygienic)	By squeezing (unhygienic)	By centrifugal honey extractor from the hived bees (hygienic).	By centrifugal honey extractor from the hived bees (hygienic).
Number of cells/10cm comb (worker cells)	18-19	32-36	21-25	17-19

- **Kinds of Honey Bees:**
- **1. *Apis dorsata* (The rock-bee or Giant honey-bee)**
- **This is the largest honeybee.**
- **Builds single large open comb on high branches of trees and rocks.**
- **Produces large quantity of honey, but this bee is difficult to domesticate.**
- **This bee is ferocious, stings severely causing fever and sometimes even death.**

- 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.
- 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).
- The honey gathered from Apis dorsata contributes 2/3 of the total production of honey in India 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



Apis dorsata

Dr Bhausaheb R Ghorpade

2) *Apis cerana indica:*

- Medium – sized Hive consists of several parallel combs in dark places such as cavities of tree Trunks, mud walls, earthen posts, etc.
- This bee is not so ferocious and can be domesticated
- 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.

Apis florea (The little bee)

3. *Apis florea* (The little bee)

- small - sized Builds single small combs in bushes, hedges, etc. Honey yield is poor.
- 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.
- 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.**

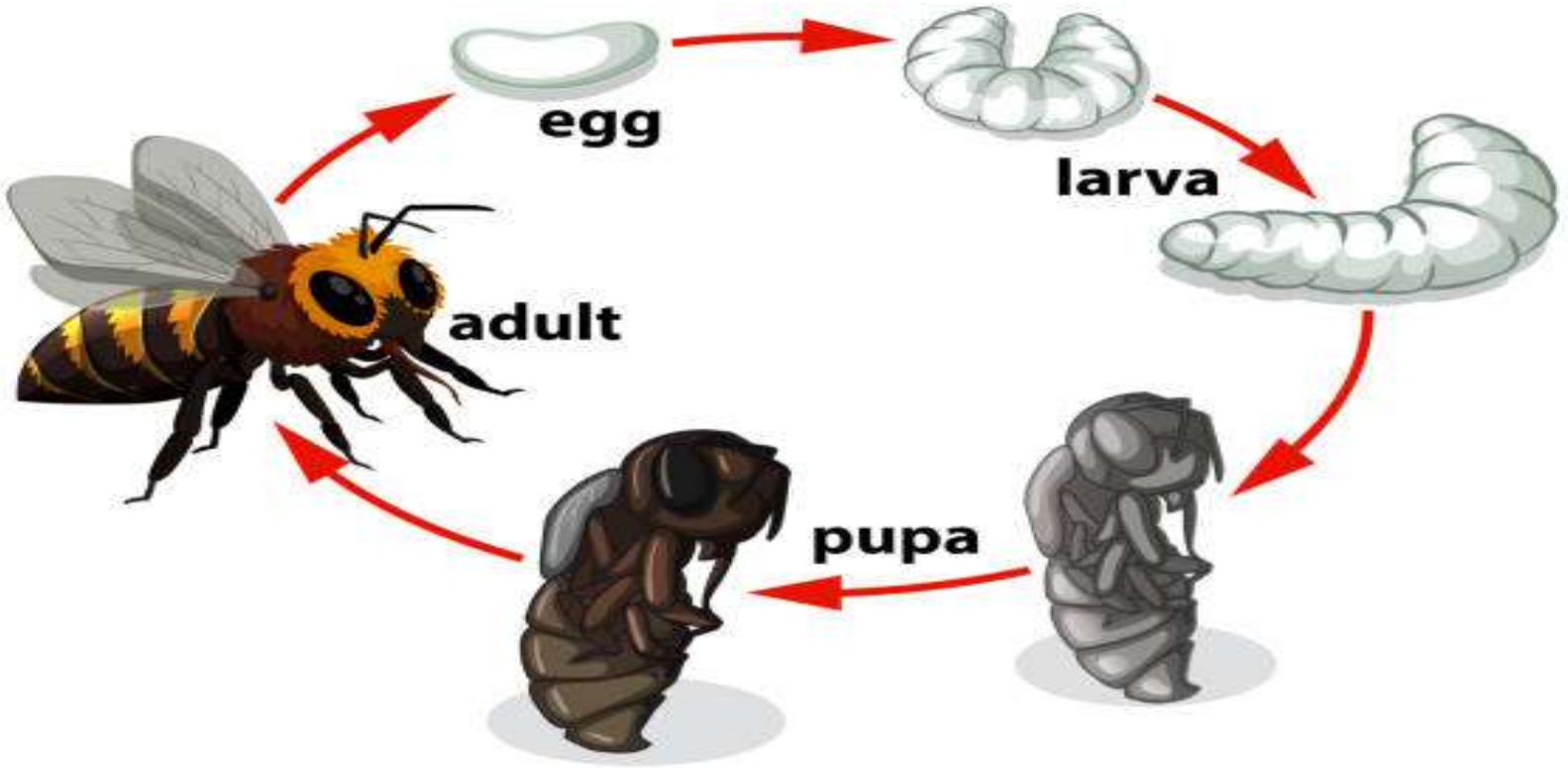
4. *Apis mellifera* (The European bee)

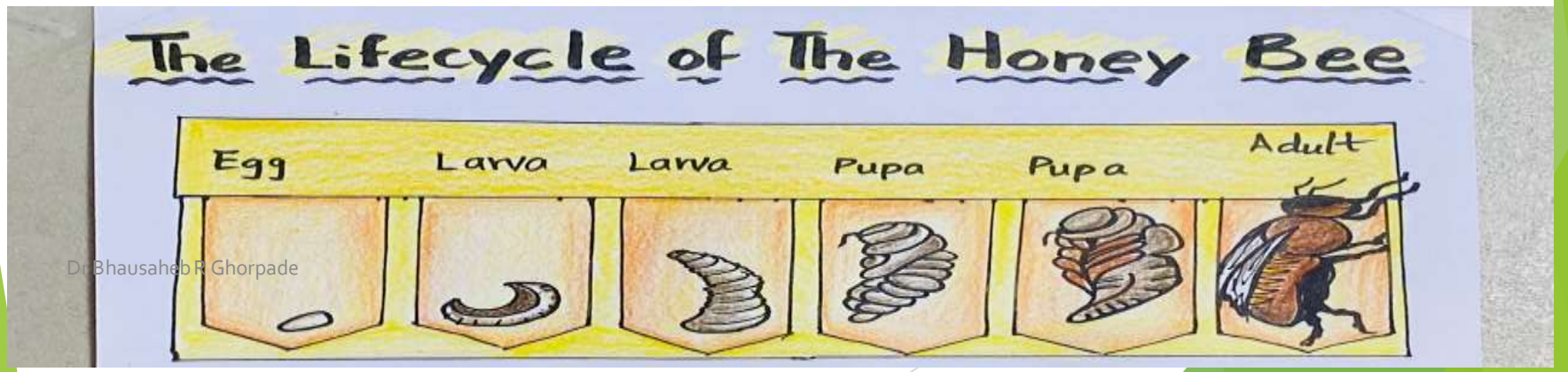
- **European races of *Apis mellifera* have been spread extensively beyond its natural range. Presently, European honey bees are naturalized on all continents except Antarctica.**
- **It is easily domesticated. Like all honey bee species, the western honey bee is eusocial, creating colonies with a single fertile female (or "queen"), many normally non-reproductive females or "workers", and a small proportion of fertile males or "drones".**
- **Individual colonies can house tens of thousands of bees. Colony activities are organized by complex communication between individuals, through both pheromones and the dance language.**
- **The western honey bee was one of the first domesticated insects, and it is the primary species maintained by beekeepers to this day for both its honey production nd pollination activities.**

	Apis dorsata	*Apis florea*	*Apis cerana*	*Apis mellifera*
Nesting	Open nesting. Builds single large comb (ca 1m^2) attached to branches of trees or rocks etc.	Open nesting. Builds single small comb (ca size of palm of hand) fixed to branches of bushes.	Cavity nesting. Builds many parallel combs in cavities of tree trunks, hollows of rocks, poles and other covered places	Cavity nesting and similar in habits to Apiscerana and builds parallel combs.

- **Life Cycle:**
- **Queen deposits egg at the base of cell and fastens with mucilaginous secretion.**
- **After 3 days egg hatches and workers provide pearly white food in which "C" shaped larva floats. Cell is sealed when larva is fully grown. In the sealed cell it turns into pupa from which adult emerges.**
- **Larva sheds skin five times during development.**
- **The sealed cells containing worker and drone brood and honey can be differentiated on the basis of appearance**
- **Development:**
- **The developmental stages of honey bees are: egg, larva, pupa and the adult.**

Life Cycle of a Honeybee



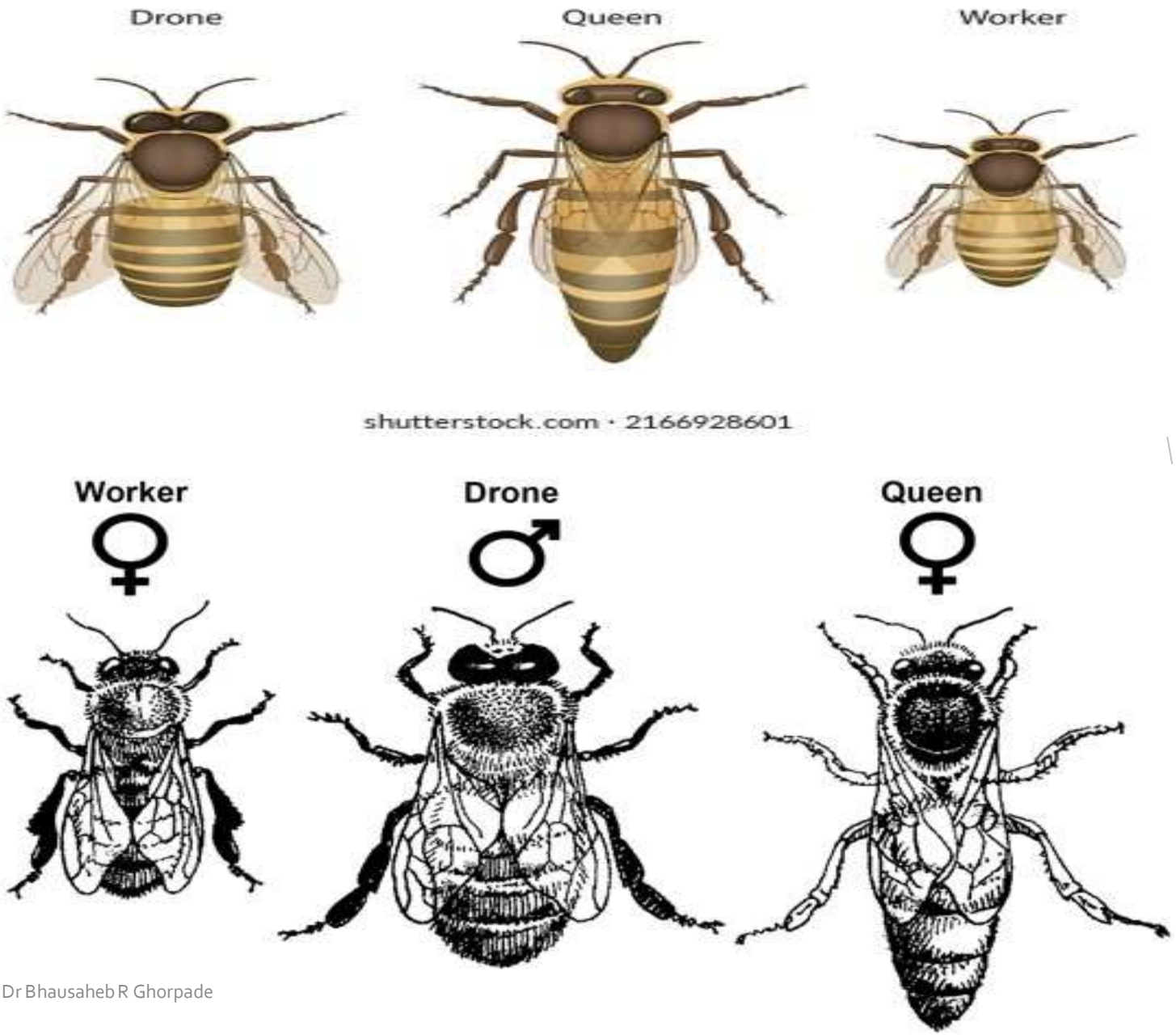


Caste	Egg period (days)		Larval Stage(days)		Pupal Stage (days)		Total (days)	
	A. Cerana	*A. mellifera*	*A. cerana*	*A. mellifera*	*A. cerana*	*A. mellifera*	*A. cerana*	*A. Mellifera*
Queen	3	3	5	5	7-8	8	15-16	16
Worker	3	3	4 -5	5	11- 12	12-13	18-20	21
Drone	3	3	7	7	14	14	24	24

Hive:

- The nest of the honey bee is known as the bee-hive.
- The population of an average sized colony consists of 30 to 50 thousand individuals.
- A colony is termed ‘weak’ or ‘strong’ according to the number of worker bees it possesses.
- There are three types of individuals in a colony, namely the Queen, worker and drone.
- Due to the existence of several morphological forms, bees are said to be a polymorphic species.

- **The Queen bee**
- **It is a diploid, fertile female.**
- **The presence of queen is a must in a colony**
- **The size of the body of queen is much larger than other castes of bees of the colony**
- **Her legs are strong as she always has to walk about on the comb**
- **The queen has a sting, curved like a sword at the tip of the abdomen, which is a modification of the egg-laying organ known as ovipositor.**
- **The sting serves as an organ of defense. She never uses it against anybody except her own caste**
- **The queen is responsible for laying eggs for a colony.**
- **She lays about 1000 to 1500 eggs every day and lives for about two to three years.**
- **She lays both fertilized eggs (from which females develop) and unfertilized eggs (from which males develop).**


Drone
Queen
Worker
shutterstock.com · 2166928601
Worker
♀
Drone
♂
Queen
♀

- **The Worker bee**
- **It is a diploid, sterile female.**
- **The size of a worker is the smallest among all the other castes but they constitute majority population of the bees in a colony.**
- **Collection of honey,**
- **Producing royal jelly for feeding the community,**
- **Raising larvae and young ones,**
- **Cleaning the comb,**
- **Making wax,**
- **Constructing the beehive,**
- **Defending and protecting the hive,**
- **Clearing the debris and dead bees,**
- **Maintaining the temperature of the hive**

- **Worker bees are again of different types depending on the type of work they do,**
- **Laying worker: These worker bees lay unfertilized eggs in the absence of the queen bee.**
- **Nurse workers: They serve the queen with royal jelly, larvae and drones with honey and beebread.**
- **House workers: They perform house cleaning, comb building, accepting nectar and pollen for foragers and finally guard the hive.**
- **Field workers: They travel to distant places to collect the nectar, pollen grains and resin from the flowers.**

- **The Drone bee**
- **The drones are born out of unfertilized eggs in the brood chamber.**
- **The males are larger than workers and are quite noisy.**
- **They have large wings, robust body and reduced mouthparts.**
- **They are unable to gather food, but they voraciously eat the food fed to them by the worker bees.**
- **They are stingless and their sole function is to fertilize the queen during the nuptial flight after which they are starved to death.**
- **The number of drones in a colony varies from 200-300.**
- **The drone develops parthenogenetically from unfertilized eggs.**
- **Drones live only for a short period of time.**

BEHAVIOUR OF HONEY BEES

- Among different insect orders, only 8 have been recognized by insect taxonomists which have some communal life.
- Out of these 8 orders only two orders viz. Isoptera and Hymenoptera have well developed social organization.
- Even in Hymenoptera, only two families namely Halictidae and Apidae of superfamily Apoidea contain fully social species.
- Most of other bees live solitary life.
- Honey bees are among the fully social insects having overlap of many generations in the same nest.
- The colony is a well organized social group having division of labour in terms of laying of eggs, nursing, comb building, guarding, food collection and its storage.
- They have well developed communication system through different types of dances as well as trophallaxis.

❖ Biological communication

- ❖ **It can be defined as an action on the part of one organism that alters the probability pattern of behavior in another organism in an adaptive fashion.**
- ❖ **Adaptive means that the signaling or the response or both which have been genetically programmed to some extent by natural selection.**
- ❖ **Trophallaxis is food transmission (exchange of food) which is common between workers and also from workers to queen and drones.**
- ❖ **It is a sort of communication regarding availability of food and water and also a medium for transfer of pheromone.**
- ❖ **In honey bees, recruit communication is very important mode of communication which is defined as a communication that brings nest mates to some point in space where work is required.**
- ❖ **Dances of honey bees are important recruit communication.**

DANCES OF HONEY BEES

It was Father Spitzner in 1788 who for the first time described bee dances as method of communication among inmates of the hive about volume of honey flow and place of source of nectar.

These observations remained unnoticed till Frisch (1920) published his observations. Karl von Frisch got noble prize in 1973 (under physiology & medicine, who shared it with two other animal behaviourists) on the basis of his work published in 1946.

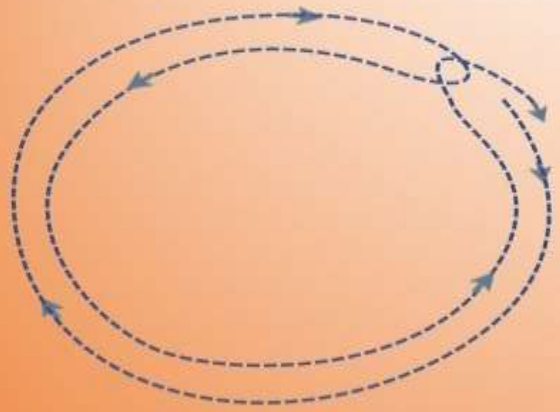
Round dance

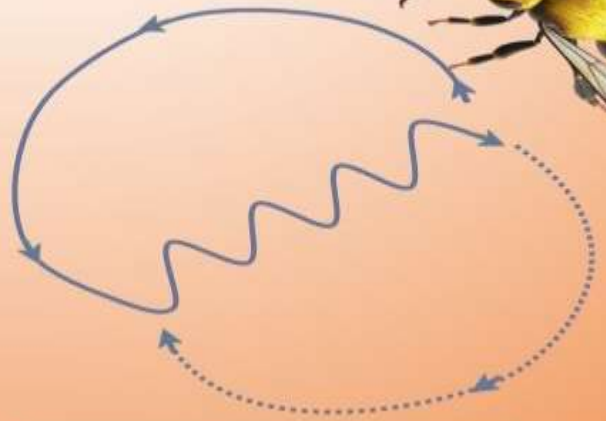
Wag-tail dance

ROUND DANCE

- **This type of dance is performed if food source is nearby (within100 metres in case of *A. mellifera* and 10 metres in *A. cerana*).**
- **The performing bee takes quick short steps and runs around in narrow circles on the comb; once to right and then left and then repeating for several seconds**
- **The dance excites the bees and they touch the performer with their antennae and then leave the hive in search of source of food.**
- **In this dance there is no indication of direction of food and the foragers search within 100 metres in all direction using floral odour clinging to hairy body of scout bee as cue as well as from the sips of nectar which they receive from the dancing bee.**

Dance of Honey Bee





Round Dance

Waggle Dance

DANCE OF HONEY BEE

Round dance

Waggle dance

WAG-TAIL DANCE

- This dance is performed when the distance of food source is more than 100 metres from the hive.
- In this dance the bee starts dancing on the comb making a half circle to one side and then takes a sharp turn and runs in a straight line to starting point.
- Thereafter takes another half circle on the opposite direction to complete one full circle
- Again the bee runs in a straight line to the starting point. In the straight run the dancing bee makes wiggling motion with her body that is why this dance is known as wag-tail dance.
- Location of food is indicated by direction of straight run in relation to line of gravity.
- If the food is in line with the sun, bee wag-tails upwards and if away from the sun, it performs downwards
- . If the food source is to the left of the sun the bees dance at an angle counterclockwise to the line of gravity .
- whereas, if it is to the right of the sun the bees dance to the right of the line of gravity.

Thanks....

S Y B Sc Zoology Paper II

Course Title: Applied ZoologyII

Course Code: ZO – 242

Semester - II (2 credits – 30 Hours)

1.4 Bee Keeping Equipments

1.6 Bee Products

1.7 Bee diseases and enemies

1.8 Bee pollination & Management

By

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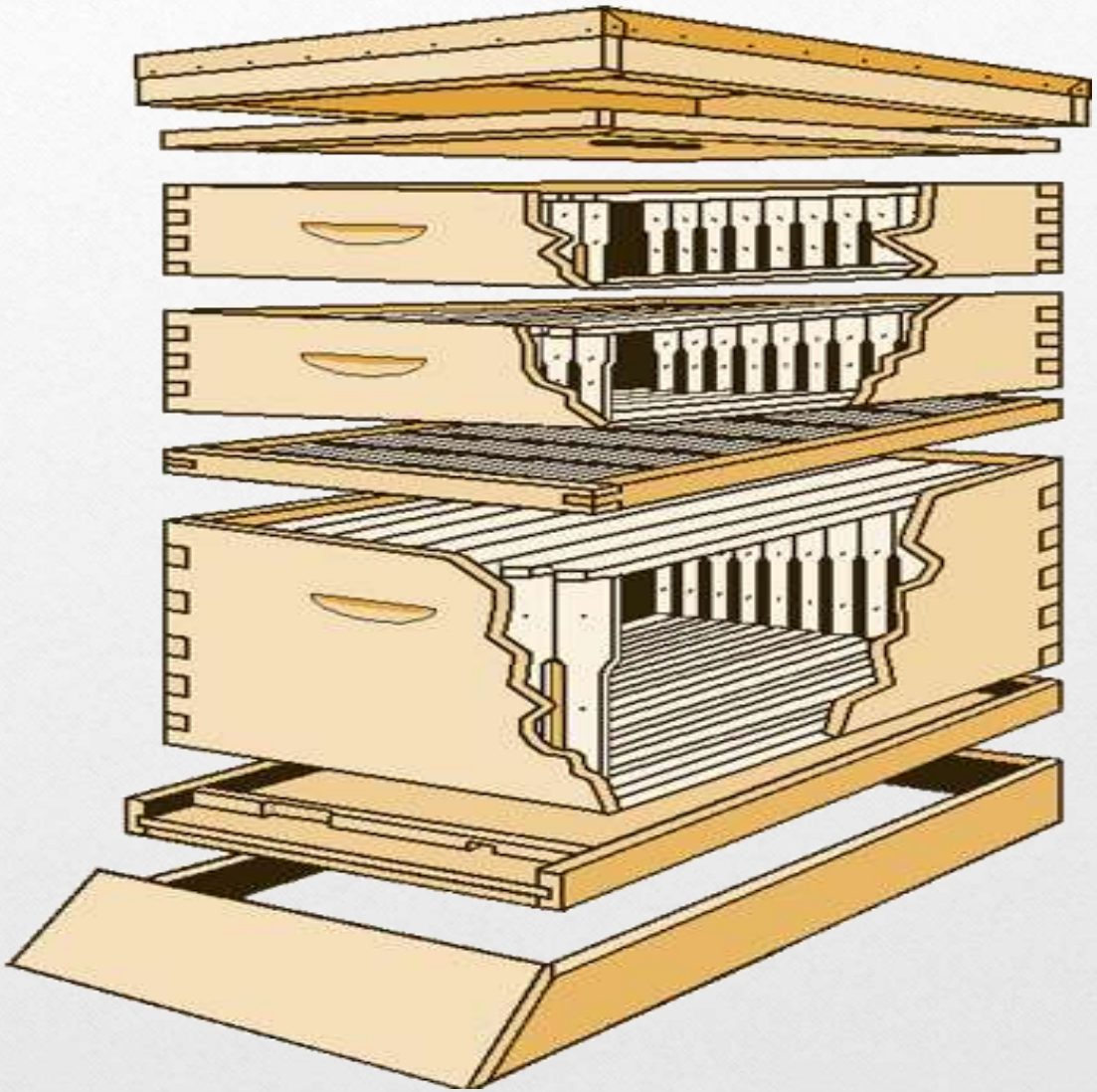
A)BEE HIVES/ Bee Box(Langstroth type):

- In modern apiculture several types of hives are used.
- The hive is a wooden structure, consisting of several parts.
- Primative and rustic hives like hallowed logs and wood, baskets, claypots and clay cavities fixed in the walls of mud houses have been in use for keeping bees in India till about the close of 19th century.
- The hive developed on the principle of bee space by L. langstroth (USA) revolutionized the whole concept of bee keeping from 1851 onwards.
- In India beginning was made to keep the bees in movable from hives in 1880's after the widespread adoption ;of Langstroth hive in west.
- These movable frames which could be taken out of the hive, observed and replaced by shifting them suitably.
- The standard Longstroth hives made of light strong wood is now in use in most of the country for A. mellifera.

Complete Beehive

Bee Box(Langstroth type):

Outer Cover
Inner Cover
Honey supers
Queen Excluder
Deep Super
Bottom Board
Stand



- **Stand:** To support bottom board.
- **Bottom board:** It is floor of the hive having an entrance for bees.
- On this board brood chamber rests.
- **Brood chamber:** Chamber used for rearing of brood.
- Frames are placed in this chamber on which bees raise combs.
- The dimensions and number of frames vary with the type of hive. A wooden dummy board is used to limit the size of brood chamber and is placed at the end of brood frames.
- **Frame:** Each frame consists of a top bar, two side and a bottom bar.
- Inner aspect of the top bar has a groove fo fixing comb foundation sheet.
- Side bar has 4 holes for wiring the frame. The frame holds a comb.

- **Super:** Dimensions may be same as that of brood chamber or half of it (depending on tThis is the chamber where bees store surplus honey. ype of bee hive).

- **Inner cover:** A board which acts as a partition between brood/super chamber and the roof .
- **Top cover:** A type of lid acting as roof placed over inner cover.

B) Honey extractor

- This instrument is used for extracting pure honey from the frames without any destruction to the comb.
- It is a drum made up of metal, having several pockets around a rotating wheel.

- The frames are made to hang from these pockets and the pockets are made to rotate round a central axis.
- This rotation creates a centrifugal force which separates the honey from the comb.
- The collected honey is taken out from the drum through a hole at the bottom.
- After extraction of the honey, the combs and frames are utilized again.

Honey extractor

❖Smoker

❖C) Smoker

- ❖A bellows type smoker is used to drive the bees out of uperous or from brood box after lifting top cover for easy handling.
- ❖It consists of a tin can provided with a spout for directing smoke from smoouldering material inside it with the help of leather, bellow attachment.
- ❖The smoke should be without heat and flame.
- ❖Bees ;should be smoked gently and not blasted.

❖ D) Bee veil

- ❖ It is worn over the face for protection against bee stings.
- ❖ It should be made black colour mosquito nylon netting, top and botton portion with cloth.
- ❖ The bottom cloth should have a rim with an elastic to make it stick to the neck.

❖**Bee veil**

The uncapping knife

Overall

Overall

- It is a protective garment worn over the clothes, so that the bees cannot get under them to sting.
- It should be made ;of white cloth.
- Blue or black cloth should be avoided as the bees are attracted to them.

The uncapping knife

It is a flat sharp long edged knife used for cutting the wax capping of ;sealed honey cells at time of honey extraction then the frames are placed in the extractor.

The knife is heated by steam or electric heated knife with thermostatically controlled temperature are used for the purpose.

The Queen's cage

- Various types of queen cages viz. rectangular and conical are used in bee keeping.
- Rectangular queen cage :- It is a small rectangular cage made of wire gauge (Zinc sheet) closed at one end and open at the other .
- It is used when a new queen is required to be introduced into a queenless ;clolonmy.
- The aperature in the wire gauage should be as large as possible but not so large as to allow entry of worker bees.
- A laying queen with 5-6 workers is confined to this cage, along with a little candy (dry sugar) and the opened end is closed withbn a piece of wood.
- The cage is then suspended along side a frame in the colony.
- Within 24 -48 hours when the queen has acquired the odour of the colony or the workers of the colony have adopted to the queens' odour.

Queen cell protector

- It is a cone shaped structure made of up of a piece of wire would spirally.
- It fits around a queen cell giving protection to the developing queen inside.

The Queen's cage

Queen cell protector

Comb foundation sheet

It is a sheet of bees wax on both sides of which are depressions or marks of the exact shape and pattern of workers brood cell.

As bees build cells of various sizes in comb in different parts of the country, the use of several types of comb foundation sheets are required.

Number of cells : 20-24 per 100 mm in A. c. indica

Number of cells: 19 per 100 mm in A. mellifera

Division board feeder:

It is a wooden trough of regular frame dimension with its shoulders so made that it may hang in the hive just like any other frame and with a wooden strip to serve as a float.

Sugar syrup or other liquid food is poured into it for the bees to feed on at the time of scarcity of food.

Plastic bottle: - Plastic bottle of 500 ml capacity is used for feeding sugar syrup solution to the bees.

Queen gate (Wire entrance guard)

This wire gate is placed in front to the hive entrance so as to confine the queen inside and thus helps to prevent swarming.

Division board feeder

Comb foundation sheet

Gloves

Hive tool

❖ E) Gloves

- ❖ **They are usually made of heavy canvas or supple leather or rubberized cloth and are useful for beginners to develop confidence.**
- ❖ **There is arrangement of elastic in the wrist which will protect the ;hands from the bee stings.**

F) Hive tool

- It is a piece of flattened iron Spatula like sharpened at one end for inserting between hive boxes to separate them and the other end bent at 90o to separate the frames.
- It is also used to scrape off the bee glue (Propolis) and superfluous pieces of comb or debrishes from various part of the hive.
- It is a perforated (2.3-3.5mm) zinc sheet placed on the top of frames, then separating brood chamber from super.
- The workers can pass through spaces, whereas the queen and drones can't.
- The queen will be obliged to stay with the brood box and spare the supers of the eggs and brood.

G) Bee brush

- A bee brush or soft broom is employed to brush off the bees from a honey comb before it is taken out for extraction mostly in colonies of Apis mellifera. .

- It can also be used to bring together the scattered bees at the time of hiving a swarm.

Bee brush

Queen Excluder

H) Queen Excluder:

- **This consists of a frame fitted with metallic wire net assembled together 0. 150 inches apart. It is utilized for preventing the queen's entrance from the brood chamber to the super chamber.**
- **The holes in the net do not cause any inconvenience to the workers to pass through it.**

Bee products

- Bees and their pollination services contribute to maintaining biological balance in nature and enable various animal and plant species, including humans, to thrive.
- They also provide bee products that are an entirely natural food source.
- People have used them since time immemorial, and they are a particularly suitable source of food in today's increasingly faster pace of life.
- Alongside honey, which is certainly the most widespread bee product, bees also provide us with pollen, propolis, royal jelly and wax.
- Bee venom is another product from which people can benefit.
- Bee products are listed below

Honey, Pollen Propolis, Royal jelly ,Wax and Bee venom

a). Honey:

- For millennia, honey was only considered a sweetener, whereas today we know that it contains many other substances that are beneficial for people.
- It is an excellent nutrient and calmative. Owing to its antibacterial and antioxidant properties, it is widely used in folk medicine.
- We can mix honey into different drinks or foods, for example tea,milk, cakes, yoghurt, sour milk or natural juices.
- We can also sweeten Turkish coffee with it instead of using sugar. Honey can fully replace consumer sugar in our diet.
- Surprisingly, many of the conditions that honey is used to treat are far more serious than the simple sore throat.
- Burns. Honey has been used as a salve to heal burns and prevent infections .Memory .Herpes .Diabetes .Cancer .

b). Wax :

- For softer and younger looking skin Wax is produced by the glands of worker bees, which they need to build the honeycomb and to seal the top of honey-filled cells.
- Chewing vitamin-fortified candy from honey and wax is a fabulous substitute for chewing gum!
- Beeswax contains over 300 natural compounds, among which the main component is fatty-acid esters. Fresh wax is almost pure white, whereas later it turns a yellowish brown colour.
- It has a pleasant scent reminiscent of honey, propolis and pollen.
- The cosmetics industry loves it Wax is often added to creams because it makes skin soft and supple and has antibiotic properties.
- The chewing of capping, i.e. the wax covering over honey, is well known, while thermal therapies using beeswax, which are usually carried taken straight after a massage or physiotherapy, are also becoming popular of late.

Honey

Wax

Bee products

Bee venom

Propolis

C. Bee venom:

- An indispensable ingredient used to desensitise against bee stings
- Bees, however, need a very good reason to sting.
- If you encounter bees in nature, they will only sting if their life is seriously threatened.
- There, guard bees diligently perform their duty of guarding the ntrance to their home, which not only hosts larvae but also plentiful reserves of honey and pollen.
- In medicine, bee venom is used to desensitise people allergic to bee venom.
- Around the world, bee venom is also used to heal various conditions and illnesses, but such treatment is only possible under medical supervision.
- Lately, bee venom is becoming increasingly popular in cosmetics industry.
- It is added to creams and serums, since it is supposed to be a natural substitute for Botox.

d). Propolis : Natural antibiotic

- **Propolis in particular is the beehive's very special treasure, because it is a natural antibiotic .**
- **Bees collect resin from a variety of trees and shrubs and blend it with pollen pellets while feeding larvae.**
- **Over 360 substances have already been found in it.**
- **Bees coat the inside of the hive with propolis, thus protecting itfrom moisture, wind and microbes.**
- **We can use it in the form of alcohol- or water-based solutions or mix it with honey or other drinks (yoghurt, sour milk, tea etc.).**
- **We know of various pharmaceutical preparations made with propolis, such as ointments, tablets, injections and solutions that can be used topically.**

e). Royal jelly :

- An excellent dietary supplement for the elderly Royal jelly is secreted by the glands of young worker bees.
- Nurse bees feed the jelly to the larvae, which are up to three days old, whereas queen bees live exclusively on it. It is this distinctive food that decides
- whether a worker or a queen bee will hatch from the larva.
- When the honeycomb cells contain the largest amounts of royal jelly, beekeepers harvest it.
- Production of xtensive amounts of royal jelly is, however, very demanding.
- Royal jelly improves general wellbeing and brain function
- Because it alleviates conditions and inconveniences related to ageing, which, it has proven to be an excellent dietary supplement particularly for the elderly.
- Royal jelly improves general wellbeing and brain function and promotes the healthy functioning of glands.
- We ingest it in small quantities, either fresh or in natural form, or in the form of various preparations.

Royal jelly

f. Pollen

A good source of proteins and vitamins.

Pollen is extremely rich in protein.

It contains all the essential amino acids, various fatty acids, vitamins B, C, D, E and K, and provitamin A.

Bees get covered in pollen as they collect nectar from plants, then they enrich it with different ferments, hormones and antibiotic substances,and deposit it in honeycomb cells.

If we extract these balls of pollen out from inside a honeycomb cell, we get extracted honeycomb pollen or bee bread.

If we install a pollen trap at the entrance to the hive, we get trapped fresh pollen. When bees try to squeeze through the wire of a pollen trap, pollen loads fall off their hind legs.

Pollen can cause allergies in some people. If you are not sure whether pollen is harmful to you, just ingest a very small amount, i.e. equal to a knife tip the first time out.

	Nosema disease
Causative Organism	Nosemaapis(protozoan)
Symptoms	Infected bees collect in front of hive, sluggish, crawlers on leaf blades, distended abdomen, dysentric (Fig. 17.4)
Control	Feed fumigillin 200 mg in sugar syrup to each colony or 0.5-3.0 mg in 100ml sugar syrup. or Two feedings at weekly intervalof Dependel-M @0.5g/litre/colony

Figure 17.4 Symptoms of nosema disease in *A. cerana*
(Photograph by Dr B S Rana)

	American Foul Brood
Causative Organism	Paenibacillus larvae (bacteria)
Time of death	Late larval or earlypupal stage
Cappings	Sunken and punctured
Colour of dead brood	Off white to light cream to brown; coffee brown to dark brown or almost black
Position of dead Brood	Lying flat on cell base
Consistency of dead brood	Sticky to ropy
Odour of dead brood	Glue pot, putrid faint
Type of brood affected	Worker, rarely drone or queen
Control	Terramycin @ 0.250 – 0.400g in 5lt sugar syrup feeding

Figure 17.1 Healthy worker brood of *A. mellifera*
(Photograph by Dr B S Rana)

Figure 17.2 European foul brood disease in *A. mellifera*
(Photograph by Dr B S Rana)

	European Foul Brood	Sac Brood/Thai sac brood
Causative Organism	Melissococcus pluton (bacteria)	Virus (sac brood in A. mellifera and Thai sac brood in A. cerana
Time of death	Coiled larvae in unsealed cell (usually young unsealed larvae sometime older sealed larvae)	Late larval stage; (usually older sealed larvae sometimes young unsealed larvae)
Cappings	Dead brood in uncapped stage	Capping removed or punctured often with two holes.
Colour of dead brood	Yellowish white to grey or dark brown, dark brown or almost black (Fig. 17.2) as compared to glittering white in case of normal brood (Fig. 17.1)	Straw coloured, starts darkening from head
Position of dead brood	Coiled, twisted or collapsed	Extended with head curled upright in cells (Fig. 17.3)
Consistency of dead brood	Soft and gummy ; rarely sticky or ropy, granular	Sac like with watery content
Odour of dead brood	Slightly sour to penetratingly sour, Putrid fish	None to slightly sour; faint sour
Type of brood affected	Worker, drone and queen	Worker only
Control	Feed Terramycin @ 0.2g in 500ml conc. Sugar syrup	No effective cure

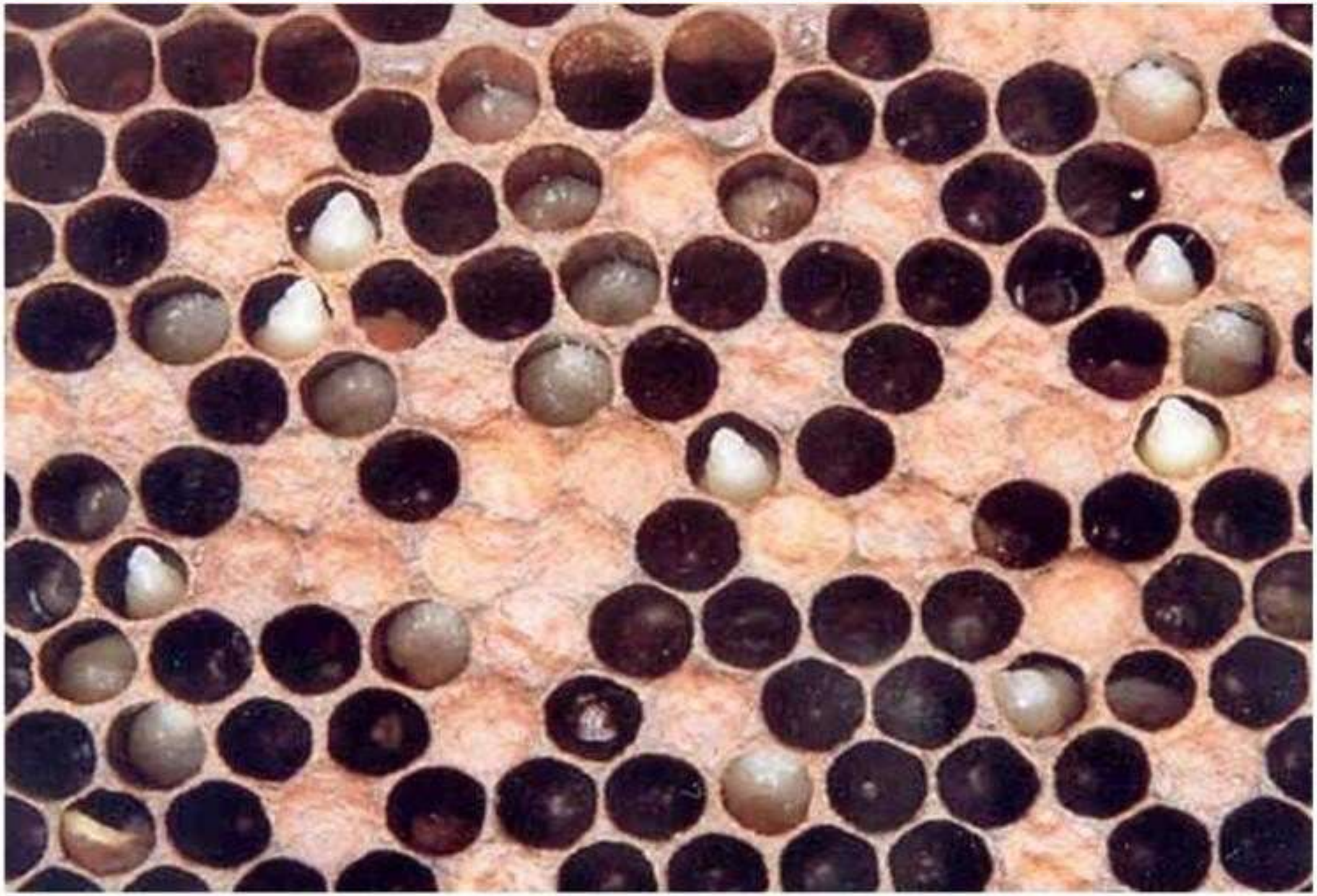


Figure 17.3 Sac brood disease in *A. mellifera* (Photograph by Dr B S Rana)

- **3. Chalk brood disease and stone brood disease**

  The fungus *Ascosphaera apis* that causes chalk brood only attacks larvae.

- When the spores are ingested, they germinate and mycelia grow through the body penetrating the epidermis and covering the pre-pupa in a short time-span.
- They cause mummification of the diseased larvae.

Bee Pests:

- **Wax moth (*Galleria mellonella*) Nature and extent of damage:**
- **The attack is more prevalent during monsoon**
- **The wax moth larvae tunnel through the mid ribs of the comb and there is presence of small mass of minute wax particles outside the tunnels In case of severe infestation, further brood rearing is stopped; bees stop field work and colony may abscond.**
- **Prevention and control:**
- **Close cracks and crevices in the hive. Reduce hive entrance**
- **Remove combs not covered by bees. Keep the bottom board clean.**
- **Control in storage: Keep spare combs in empty hive bodies in tiers and close both at bottom and top. Disinfect the stack by burning sulphur @ 180 g/ cubic metre (fumigation by sulphur fumes). After fumigation, put naphthalene flakes in moth proof stacks.**

WAX MOTH

Figure 16.4 Larvae of *Galleria mellonella* exposed from the galleries

Figure 16.5 Damage of comb by larvae of wax moth

- **2. Wax Beetle:** The small hive beetle (SHB) is a native of Africa where it occurs in tropical, subtropical and warm temperate zones – mostly affecting weak honey bee colonies.
- **Damage caused**
- Larvae burrow and tunnel through comb, piercing and damaging the wax comb and cell caps.
- **Larvae eat honey, pollen and live honey bee brood (eggs, larvae and pupae).**
- Larvae defecate in the honey causing it to ferment, froth and weep from the cells.
- **Combs of honey removed from hives and put aside for extracting at a later time may be ruined.**

Bee predators:

1.) The Green bee-eater- It is a small bird that lives in parts of Asia and Africa.

It is a tiny exquisite bird that has bright emerald green plumage.

It has a narrow black stripe known as a 'gorget' on its throat, and a black 'mask' running through its crimson eyes.

Its two central, narrow, long black tail streamers are also distinctive and are only present in mature birds.

Male and female birds look the same.

2.) King Crow:

- ***Dicrurus macrocercus*** **(King Crow) occasionally visit apiaries on cloudy days and prey upon bees.**
- **The Black drongo is a small Asian drongo and is a common resident breeder in the tropical southern Asia.**
- **This species is found in open countries and usually perches and hunts close to the ground.**
- **It is an aerial predator of insects and prey upon grasshoppers, cicadas, wasps, dragonflies and honeybees.**
- **The nesting of the black drongo is done during April to August.**

3.) Wasps:

The yellow banded hornet, *Vespa cincta* F., is a large wasp with a broad transverse yield band on the abdomen. It is a social insect constructing papery nests in hollow spaces. It waits area the entrance of the hive, catches bees as they come out, macerates them for feeding the juice to its young. It captures bee in the field also. By reducing the width of the alighting board of the hive, the wasps can be prevented from sitting near the entrance Wasp nests should be destroyed by burning them. *V. tropica* vat, *haemotoides* B. is also known to attack bees in India.

The bee hunter wasp, *Palarus orientalis* Kohl., is black in colour with transverse yellow lines on the abdomen. It catches bees while they are on flight. A wasp can collect about 20 bees a day, stings and carries them to its underground nest and places one in each of the compartments of the nest before laying an egg on the back of each bee. The grub on hatching feeds on the bee.

4.) Lizards:

Arboreal reptiles such as many geckos and skinks, can attack bees either near the hive entrance or on the limbs of flowering trees visited by forager bees. Smaller lizards, such as the gecko, Hemidactylus frenatus, often hide in the empty space between the outer and inner covers of the hive.

Bee pollination:

All plants want to be pollinated, as only then can they reproduce.

The bee's senses are adapted to signals that are emitted by flowers.

On the one hand by their colour and on the other by their scent. Bees can see colours.

They prefer to fly to-wards the colours yellow and blue. They cannot see red. For example, they only see the poppy as a dark spot.

However, bees can see ultraviolet light, and the flowering plants "know" this.

They have pigments that reflect ultraviolet light. This means the bees know where the nectar sources are and therefore the optimum places to land.

It is fascinating that bees can only see colours at a maximum flight speed of 5 km/h.

At higher speeds they see their environment in black and white.

- Bees smell with their antennae.
- The bees suck up the nectar, the basis for honey, using their proboscis and store it in their honey stomach. Pollen, which contains a lot of protein and is primarily used to rear the brood, is picked up by the bees almost as they fly past.
- It sticks to the hairs on the bees, and when they visit the next plant of the same species it is transferred in adequate quantities to their stigma.
- A bee visits around 100 flowers per foraging flight, with a maximum speed of up to 30 kilometres per hour. With ten foraging flights per day, this equates to 1,000 flowers.
- With a maximum of 40 flights per day, however, considerably more is possible.
- If 20,000 bees swarm out of a hive several times a day, 20 million flowers or more are pollinated each day.

Management of bees for pollination.

Place hives very near the field source to save bee's energy
Migrate colonies near field at 10 per cent flowering
Place colonies at 3/ha for Italian bee and 5/ha for Indian honey bee
The colonies should have 5 to 6 frame strength of bees, with sealed brood and young mated queen
Allow sufficient space for pollen and honey storage

1. Sunflower: It is a cross-pollinated crop.
The pollen of the plant cannot fertilize ovary of same plant. Pollen source should be from different plant. Hence, honey bees acts as important agents for pollination in sunflower. In sunflower, yield increases even up to 600 per cent due to bee pollination.
Mostly irrigated crop is preferred by bees.

2. Cucurbitaceous vegetables: Cucurbits are monoecious with staminate and pistillate flowers in same plant. Due to bee pollination fruit set increases up to 30 to 100 per cent.

3. Alfalfa or lucerne: When bee sits on a keel petal, stamina column strikes against standard petal resulting in shattering of pollen. This is called *tripping.* Seed set occurs only if bee sits to trips the flowers.

4. Coriander: In coriander yield increases up to 187 per cent due to pollination.

5. Cardamom: It is an important commercial crop depending on bees for pollination. Here yield increases up to 21 to 37 per cent.

6. Gingelly: Another oilseed crop where bee pollination causes 25 per cent increase in yield.

7. Apple: In apple seed set occurs only if it is pollinated by bees. Fruit is formed only around the seeds. If improper seed set occurs fruit shape is lopsided resulting in decreased market value.

Other fruit Trees

All kinds of citrus, litchi, peach, apple, guava, *jamun*, date palm, apricot, quince, pear, almond, plum, loquat, phalsa, and cashew.

Thanks...

S Y B Sc Zoology Paper II

Course Title: Applied ZoologyII

Course Code: ZO – 242

Semester - II (2 credits – 30 Hours)

Chapter_2 Fisheries

By

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Note: This material is only for educational purpose and is non –commercial (27-04-2023)

- **Module-2: FISHERIES**
- **2.1-TYPES OF FISHERIES**
- **2.1-a- Inland (freshwater) fisheries**
- **Definition:-**
- **Fisheries is a branch of applied zoology which deals with the cultivation and management of fishes , prawn , pearl oysters in a commercially viable way so as to harvest them as good quality fishes , prawn for human consumption and obtaining pearls from oysters**

- **Inland fisheries – Harvesting of fishes from small tanks , ponds , canals, lakes rivers is called inland fisheries.**
  - **Riverine Fisheries – Harvesting of fishes from rivers is called riverine fisheries.**
  - **Pond culture – culturing of certain types of fishes (specially carps) in wells , garden ponds or domestic and temple tanks is called pond culture.**

Wallago attu

Silonia silondia

Mystus seenghala- Giant catfish

Clarius batrachus- walking fish

Channa punctatus

Anguilla bengalensis


Murrels-Garfish


Half banded Spiny Eels

Stocking pond (Spawners and Milters)

Breeding pool (8-10 Hrs)

Incubation pool (hatchlings 18-24 Hrs + spawn 72 Hrs

Nursery pond (fry 15-20 days)

Rearing pond (fingerling three months

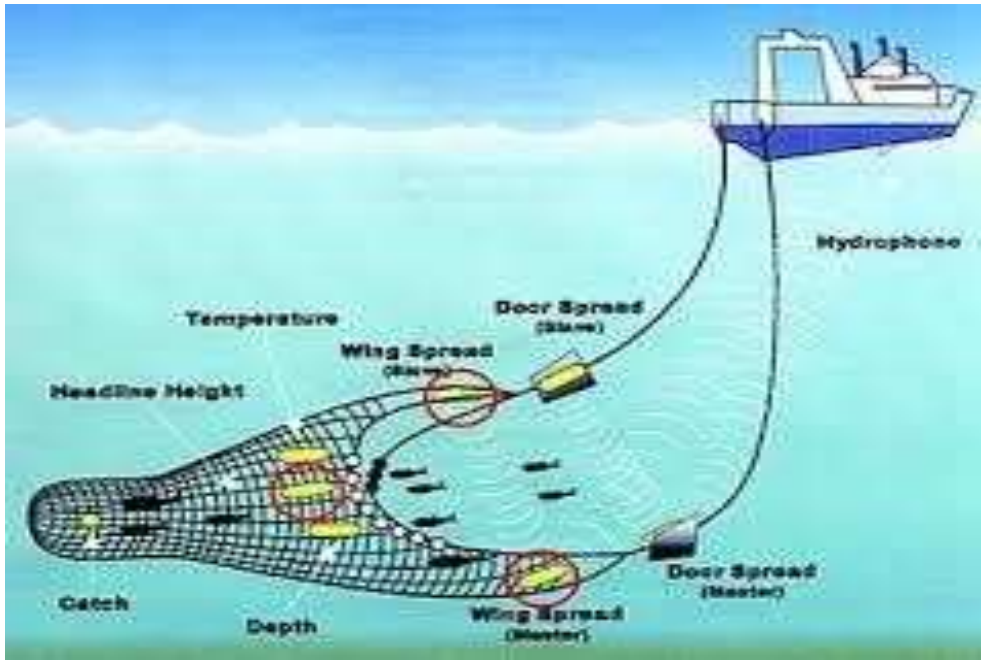
Yield (3000-10,000 kg/ha/year

2.1Marine Fishery

b-OFFSHORE AND DEEP SEA FISHERY

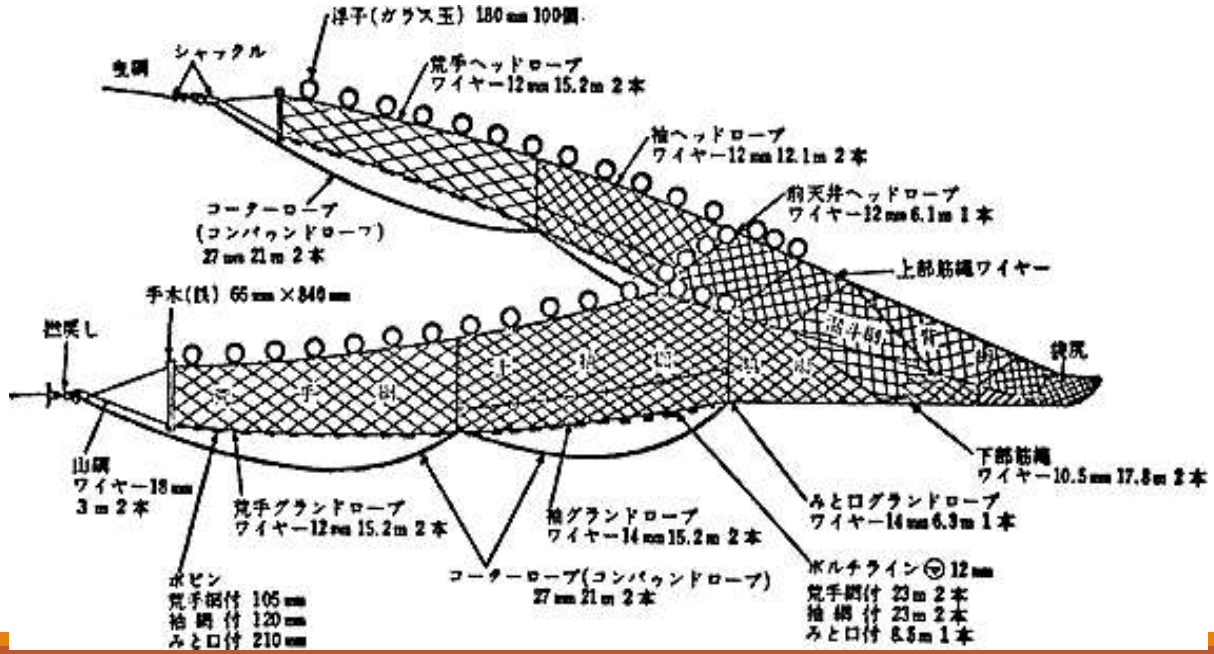
- Not given much importance due to lack of mechanized boats and capital
- 1946- Govt. of India started Deep sea Fishery station at Mumbai
- Later State Govt. set up in Kerala and WB
- 1958- Central Govt. added 2 more at Cochin and Vishakhapatnam

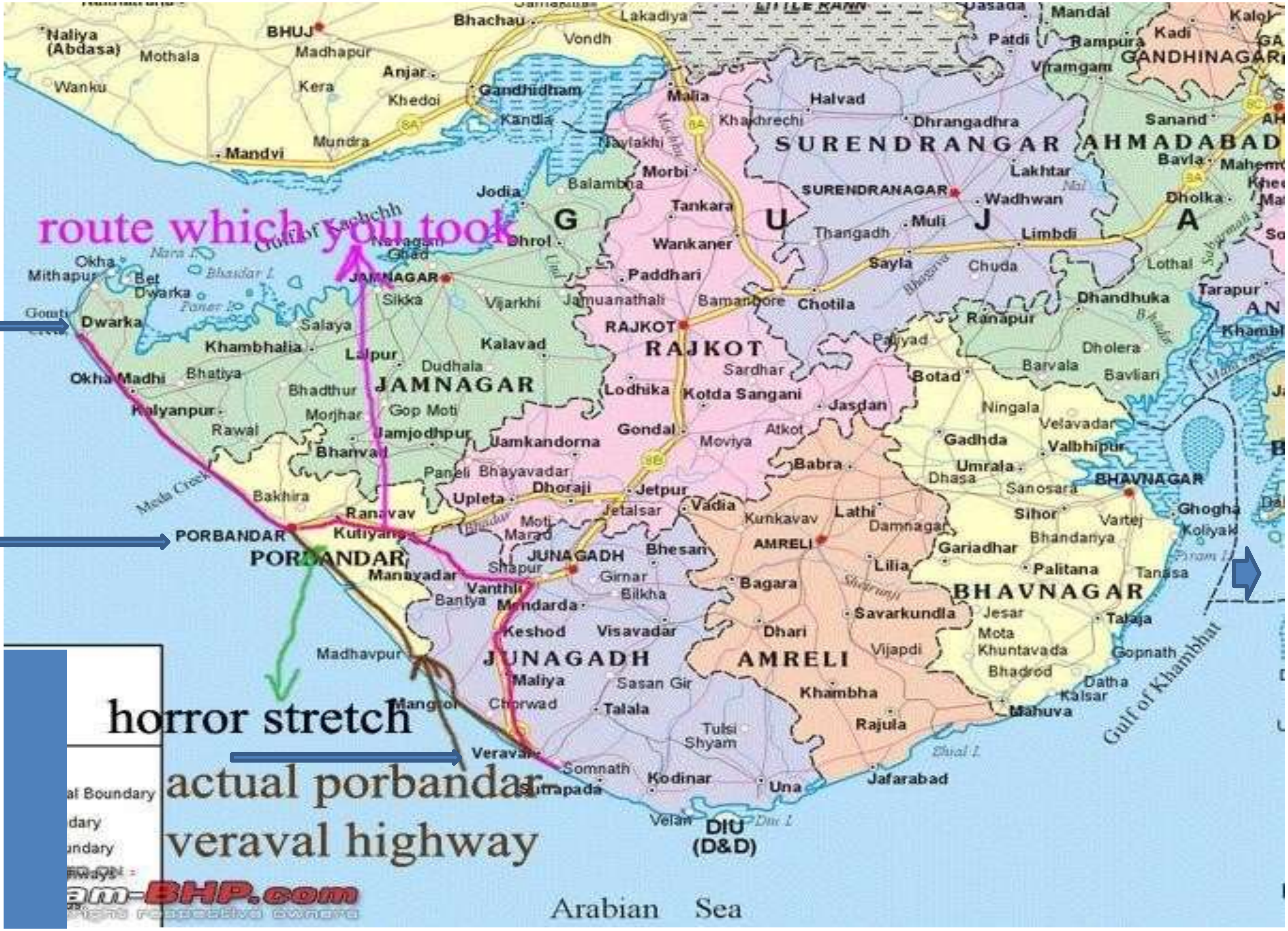
- TRAWLING GROUND
  5 trawling grounds of India are Mumbai, Cambay, Veraval, Porbunder, and Dwarka
- Experimental trawling centers in Kerala and Gujarat
- Oldest trawling net- Otter type
- Bull trawling (Japanese) more effective and used in Mumbai and Saurastra
- Kerala- Dori fishing



Otter trawling

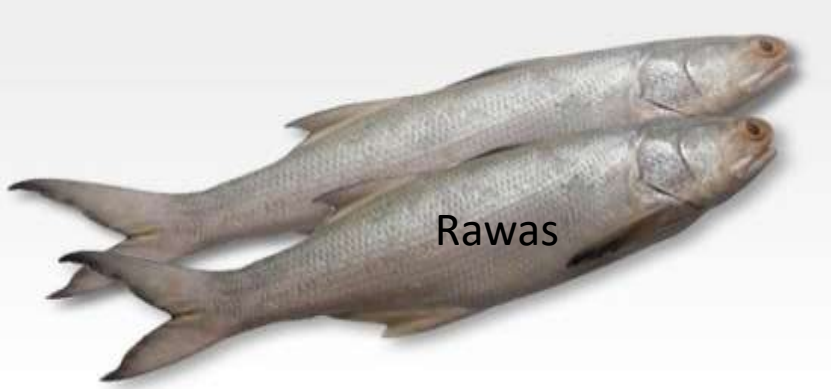
Bull trawling

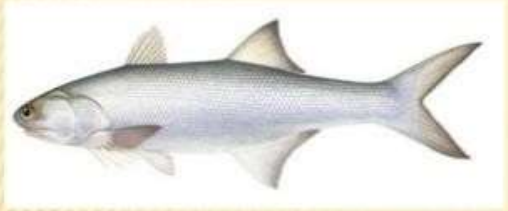




1 Dwarka 2 Porbunder 3veraval

- **Important commercial offshore fishes**
- **1 Rawas (Indian Salmon- *Eleutheroneina tetradactylus)***
- **2 Dara (Giant headfin- *Polydactylus indices*)**
- **3.Ghol (Jew fish- *Pseudosciaena diacanthus*)**
- **4.Koth (large Sciaenid- *Otolithoides brunneus*)**
- **5.Wam (Sea eel- *Anguilina furaenosox*)**
- **6.Karkara (Grunters, Jew fishes)**
- **7 Pomfrets**
- **8 Cat fishes, rays, small sciaenids, silver bellies At 20 fathoms (37m)**
- **catch is maximum**
- **Catch better during day**





Etheronema tertradactylum
(Indian salmon)
Marathi name - Rawas

Polynemus indicus
Marathi name - Dara

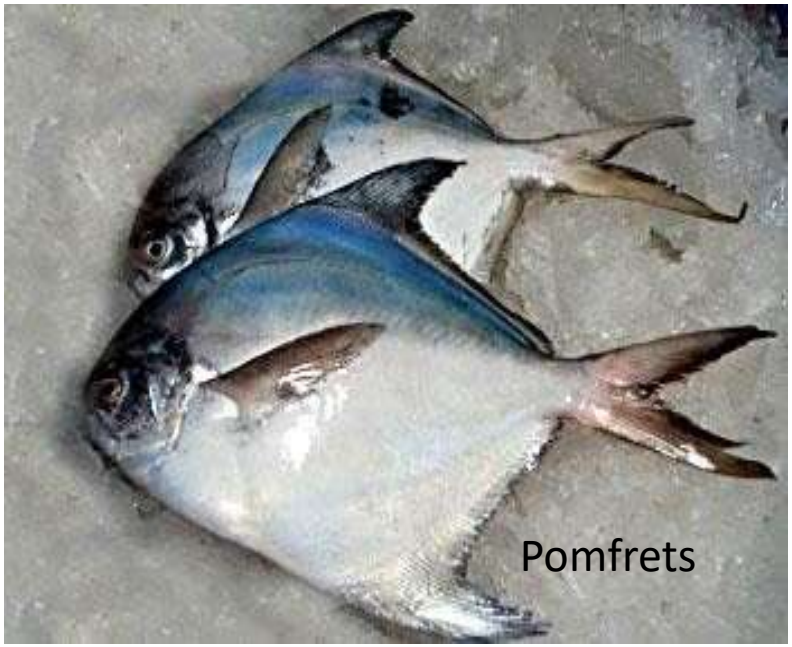
JewFish/ Croaker

Malayalam: Kora, Manham, pallikora, Maham
Tamil: Kathalai, Panna, kopayen, Vari Kathalai,vanakathal,vellai kathalai, Kora
Telugu: pullipanna,gorasa,tella,katchelu,goraka
Kannada: Ghoti
Others: Bara Poa, Lambu(bengali)dodyaro(konkani)Poma, Goli, Balvi, Dodi, Dantya,B
corvine, vella jaltelle,karoos katlellr,bola
Arabic: Nagroor,shimahi
Mushka, chan, boro, tont(in Pakistan)

Grunt/Grunter bream/Silver Grunt

Grunter

Malayalam:Karukaruppan, Kurukuruppan
Kannada:Thondakappe,Thondo
Tamil: Cheri, Ghorakan, Kadichani, Kakan, Korukkai, Seraiah, Kalianthalai, komkee,Kalianthalai, Komkee, Kurumutti, Mullankra, Pullikurimeen
Telugu:Gorakka,Karuppi
Other:Karkara(marathi)
Arabic:Nagroor, Nagrur, Nakroor

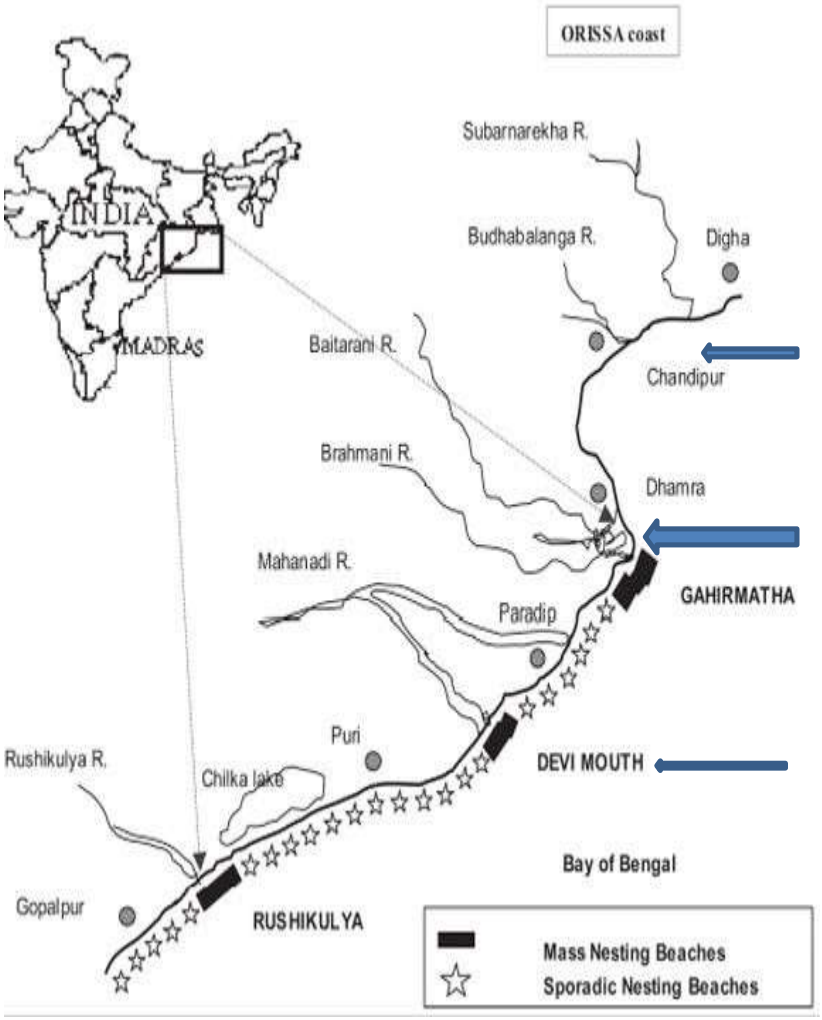

Pomfrets


Cat fishes


Rays

DEEP SEA FISHING STATIONS IN BAY OF BENGAL

- Black Pagoda
- Sand Head Tiger Point
  False Bay Point
- Off Devi River mouth
  Off Prachi River mouth
- Off Baitarani River mouth



- **Fishery A Success**
- **Good harbor and anchorage facilities**
- **Transportation from landing place to distribution center**
- **Marketing and storage facilities**
- **Scientifically trained men**

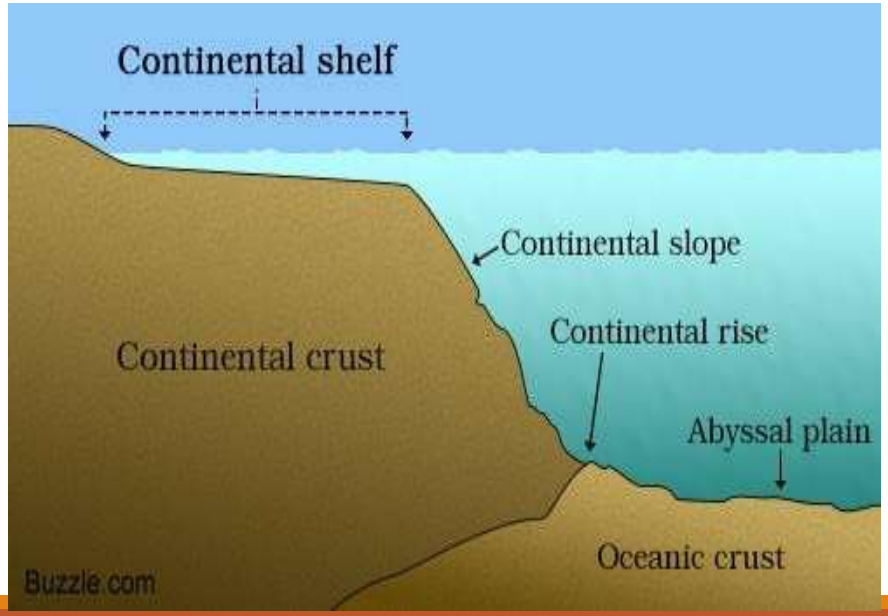
❖ 2.1-b-Marine fisheries- Coastal fisheries

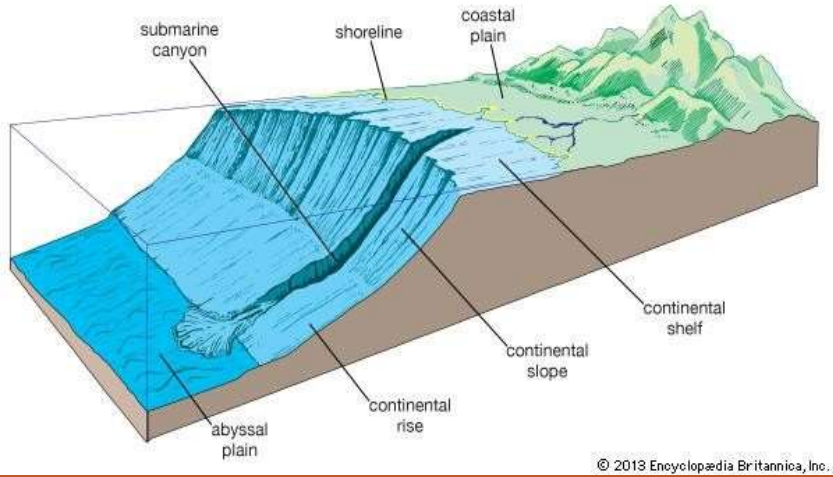
- ❖ **Harvesting of fishes in marine water i.e. Seas and oceans is called marine fisheries**
- ❖ **Coastal fisheries – harvesting of fishes in coastal waters of continental shelf is called coastal fisheries.**
- ❖ **Off- shore and deep sea fisheries – harvesting of fish fauna beyond the area of continental shelf in the expansive seas and oceans constitutes deep sea fisheries.**

Coastal fisheries

- **Narrow continental shelf**
- **Plankton production low**
- **Water circulation is less**
- **Bay of Bengal**

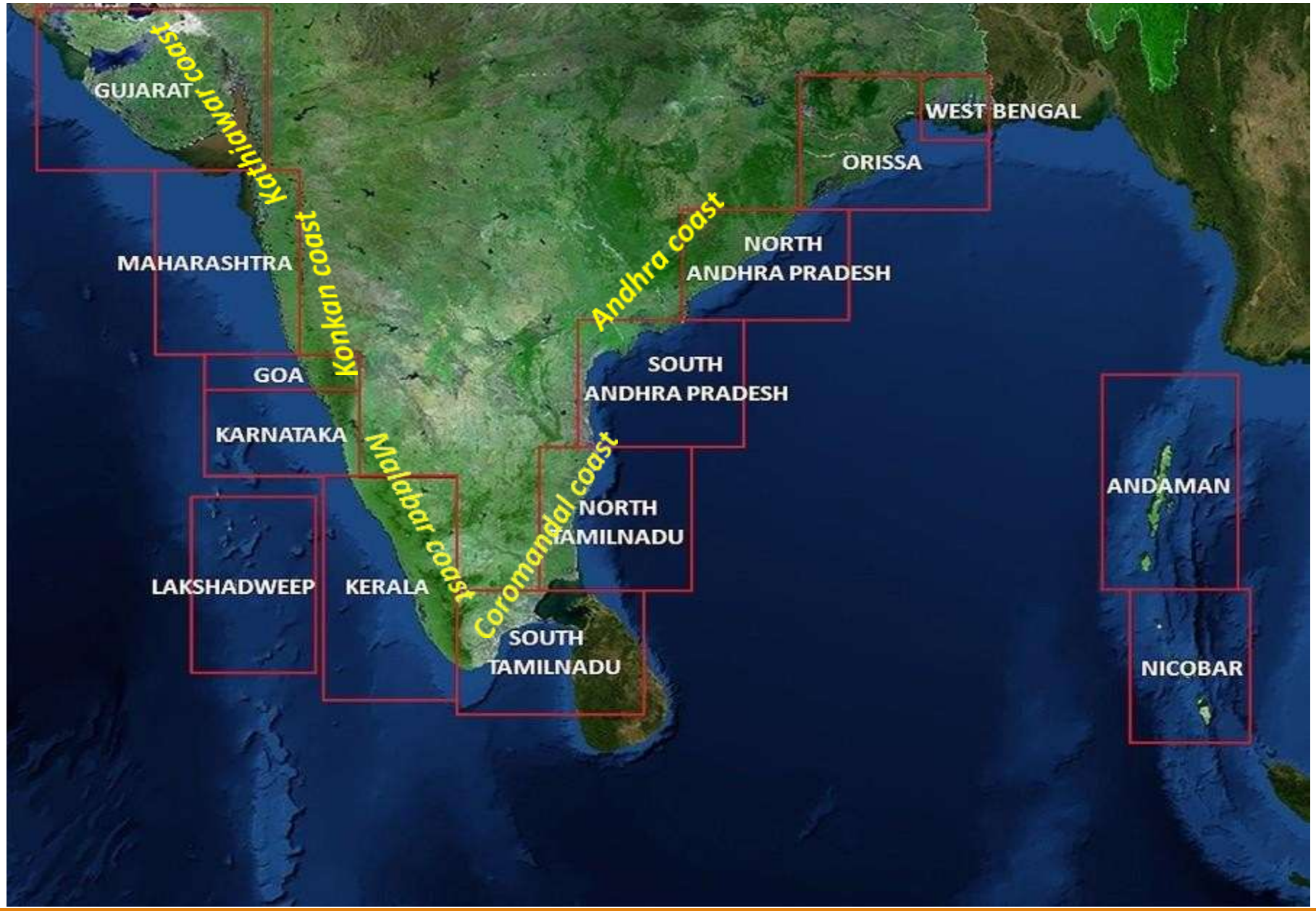
Broad continental shelf Abundant plankton growth Water circulation is more Arabian sea, Indian ocean

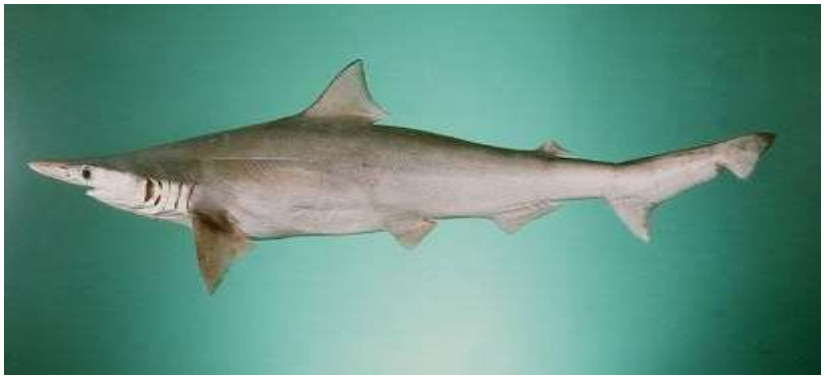




Fishing zones

- West Bengal and Orissa
- Andhra coast
- Andhra coast
- Andhra coast
- Coramandel coast
- Coramandel coast
- Palk Bay and Gulf of Mannar
- Kerala and south Malabar
- Malabar and south Kapara
- Konkan coast from north Mangalore to south Ratnagiri
- Maharashtra and Gujarat
- Kathiawar coast


GUJARAT
Kathiawar coast
MAHARASHTRA
Konkan coast
GOA
KARNATAKA
Malabar coast
LAKSHADWEEP
KERALA
SOUTH TAMILNADU
Coromandal coast
NORTH TAMILNADU
SOUTH ANDHRA PRADESH
Andhra coast
NORTH ANDHRA PRADESH
ORISSA
WEST BENGAL
ANDAMAN
NICOBAR



Fishes found in coastal waters

Elasmobranches – sharks (*Scoliodon*)

Sep to March –west coast ; May to Jan – east coast

Sardines – only 50 m from coast

Hilsa - mouth of river

Bombay duck – Gujrat, MH, WB, AP, Orissa coastMackerel – western coast ; Eastern coast – little pockets of TN, AP and Orissa

- **Estuarine fishery-(Brackish water Fishery)**
- **Rearing and harvesting of fishes in brackish water/ estuarine water is called as estuarine fishery**
- **Estuarine/ Brackish water Fishery**
- **Chilka Lake**
- **Pulicate lake**
- **Mouth of all major rivers**
- **Coastal bays and Tidal marshes**

- **Chilka Lake**
- **Largest estuarine lake- Orissa**
- **23 km channel connects with Bay of Bengal**
- **Daya river (tributary of Mahanadi)**
- **Marine Fishes- *Gerres, Xenentodon, Therapon, Sillage***
- **Fresh water fishes- Carps, catfishes, Murrels**
- **Annual production- 3000 MT**
- **90% exported**
- **10% local market**

Embanked brackish water Lakes

- Protected by artificial walls of barriers
- Developed in Java and Phillipines
- In WB- Bhasabandha/Bherls fisheries. Bunds to keep away floods and tidal waters. Fresh water is introduced
- Vempanand kayal of Malabar (Paddy- Jul-Sep) Then sea water-Prawns (80%)and Mullets, Etropus (20%)


Etroplus


Mullets

2.3-Harvesting Methods of following marine forms

a) Harpodon Mackerel Pearl oyster

a) HARPODON NEHEREUS

- **Also called bummalo, Bombay Duck is a marine lizardfish**
- **Body is soft, gelatinous, elongated and slender**
- **Phosphorescent n fresh condition**
- **Lower jaw is prominent with wide mouth**
- **Caudal fin is trilobed**
- **Lateral line tubules can be seen**
- **DISTRIBUTION**
  - **98% catch is from Gujrat and Maharashtra**
  - **90% of total catch is from Mumbai coastline**
  - **Landing areas on west coast are**
- **Gujrat - Rajpara, Jaffanabad, Navabunder, Porbunder, Veraval.**
- **Maharashtra- Versoa, Satpati, Vasai, Dhanu, Kolaba, Thane and Konkan coast upto Ratnagiri**
  - **Landing areas on east coast are West Bengal to Orissa and Andhra coast**

- ✓ ***Harpodon*** **breeds throughout the year. However fish catch is maximum during September- January**
- ✓ **3-4 decades ago fishermen used sailing boats and fishing done upto 7-10 fathoms**
- ✓ **Now a days mechanized boats go upto 25 fathoms**

- **HARVESTING OF MACKEREL**
- **GENERAL CHARACTERS**
- **Body laterally compressed**
- **Head longer than wide**
- **Teeth present in both jaws**
- **Two dorsal fin**
- **Caudal fin homocercal with deep notch and prominent labels**
- **Surface feeder, feeding on planktons**
- ***HARVESTING METHOD***
- **Distribution:**
- **A single species of *Rastrilliger kanagurta* found along both east and west coast of India**
- **Maximum catch is on west coast from Ratnagiri in Maharashtra to Quilon in Kerala**

- **Important fishing centers on west coast**
- **Ratnagiri, Malvan, Goa, Karwar, Kozikode, Cochin and Alleppey**
- **Important fishing centers on east coast**
  - **irregular and less catch is observed**
  - **Parts of West Bengal, Orissa, Andhra Pradesh (Vishakhapatnam and Kakinada) and Tamil nadu (Chennai, Nagapattinam)**
    - **Mackerel migrate in shoals which can be seen from a distance during day**
- **They enter the inshore waters in post-monsoon months**

- **Harvesting Method of Pearl Oyster**
- **Economically important as they produce high quality pearl**
- **It is called moti or muktaphal**
- ***Pinctada fucata, Pinctada margaritifera* and *Pinctada vulgaris***
- **General characters**
- **Pearl oysters are marine bivalves**
- **One shell is attached to substratum while other is free**
- **Beneath the shell is present a thin membrane called mantle which covers the visceral mass**
- **Mantle secretes nacreous material of pearl**
- **Genus *Pinctada* produces best quality pearl**
- ***Pinctada vulgaris* is commonly found in Indian waters**

❖ Oyster Culture-Pearl producing sites

- ❖ They are present on ridges of rocks or dead corals in the
- ❖ Gulf of Munnar.
- ❖ These are called “Pearl banks” or “Paars”
- ❖ “Tholairam paars” neat Tuticorn is the most productive pearl bank of India.
- ❖ Pearl banks are 20-24 m deep (10-12 fathoms) and 15-20 km away from shore
- ❖ Rann of Kutch near Jamnagar has only few thousand oysters which are exposed during low tides and can be handpicked
- ❖ In Pak Bay oysters are found on the muddy bottom
- ❖ Japan is major pearl producing country

- **Natural Pearl formation**
- **According to "Pearl sac theory" Accidental entry of foreign material like sand and grain, sea weed or insect in the mantle cavity acts as nucleus.**
- **Mantle epithelium closes it like a sac to avoid irritation and starts secreting nacre (calcium carbonate in an organic matrix) around it**
- **Crystals are arranged in lamellae, giving it lustrous white appearance**
- **Over years (3-4 years) it forms natural pearl**

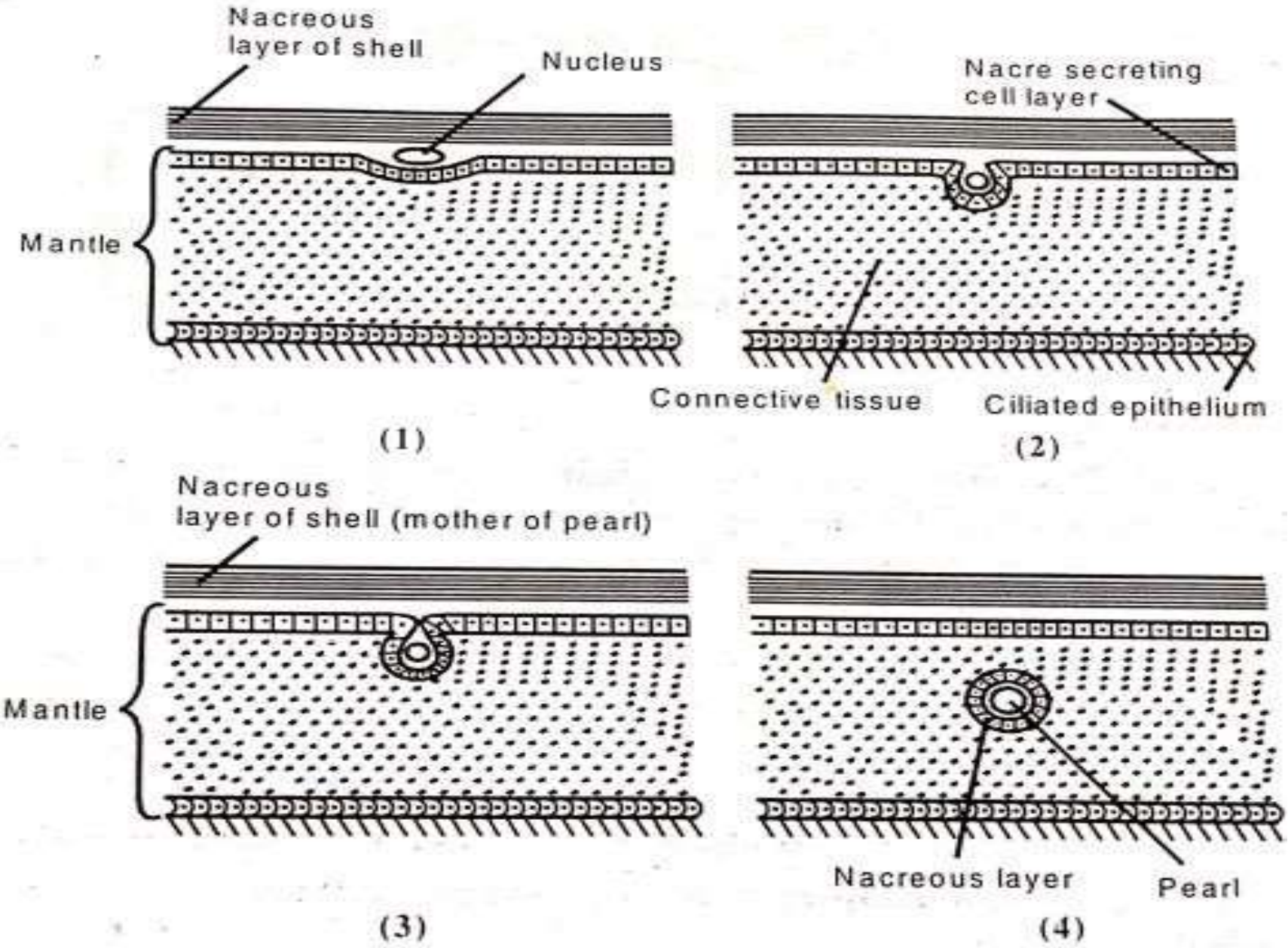


Fig. 3.6(b) : Process of Formation of Pearl

- **Artificial Pearl formation**
- **Central Marine Fisheries Research Institute at Tuticorn offers training in pearl culture**
- **Pearl oysters are collected from oyster beds and reared in cages**
- **The shell is opened slightly and foreign particles (nucleus/ shell bead) is inserted surgically between shell and mantle**
- **The operated and treated oysters are kept in cages and suspended from floating rafts in shallow sea water**

- **The nacreous material is secreted by the mantle and deposited on the nucleus forming pearl**
- **After 3-4 years oysters are collected and pearl is obtained from them**
- **Gonadal insertion and mantle tissue insertion of foreign particle (nucleus) is also done**

➢ Harvesting of pearl

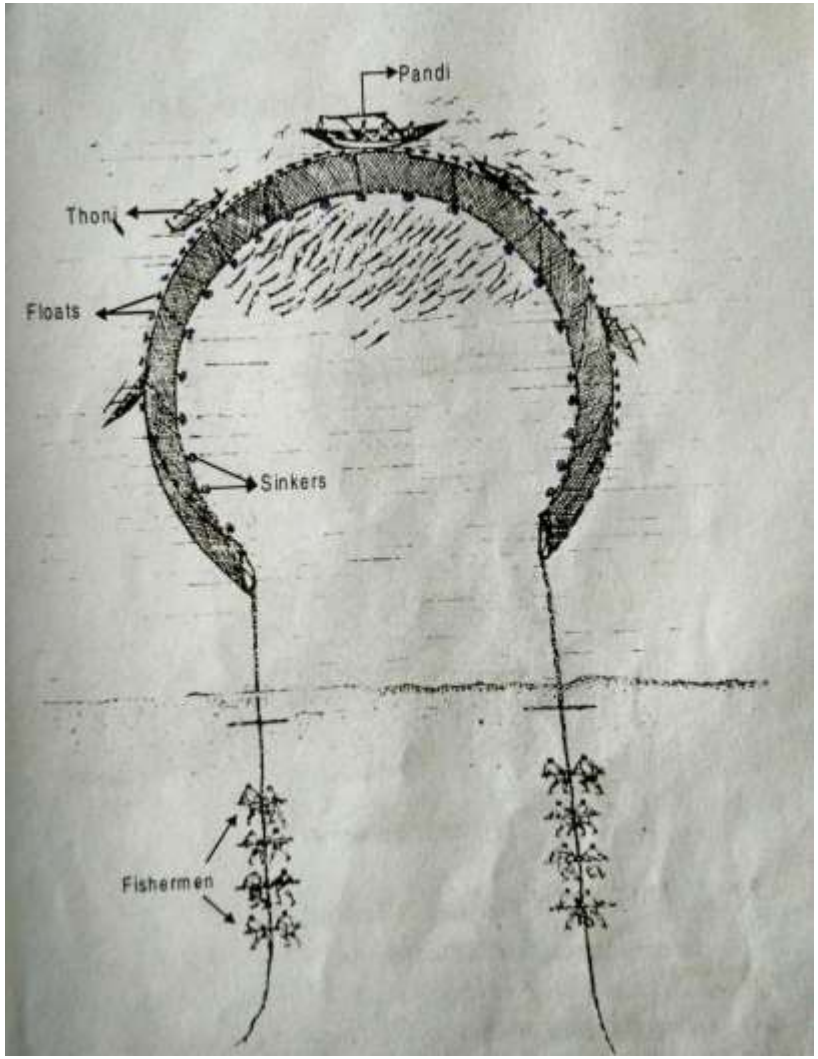
- Harvested in the month of December to February by divers from sea bed
- It is done by divers from the boat from morning till evening
- Now a days scuba diving divers can stay in water for longer time to collect the oysters
- Harvesting is done 3 years after insertion of foreign material (nucleus)
- They are auctioned in lots of 1000
- Allowed to rot for few days
- Opened, washed and pearl is collect Natural pearls fetch high price

a)Nets/ Gears:

i) Rampani net:

Description

- Rampani nets are very large drag nets
- Each net contains 100-500 small nets.
- The central 100 pieces are called Chikkambale and the side portions of 200 piece each is called Allibale.
- The net is kept in position by wooden floats and stone sinkers held in the head and foot ropes.
- Operation of this net is carried out by 60-80 fishermen.
- The biggest shore seines used in India is Rampani of Konkan and Malabar coasts are largely used for mackerel fishing.



❖ **ii) Other nets**

❖ **Besides Rampani net, boat seines, beach seines (Beja jal/ drag net), Purse seines, gill nets, drift nets and cast nets are also used**

❖ **a)Boats/ Crafts**

- **Dug out canoes (Pandi and Thoni, Rampani boat), canoe boats, plank boats and catamaran**
- **Four types of nets are used**

➢ **'Dol' Nets**

➢ **Gill Nets**

➢ **Boat Seines (Filter Nets)**

➢ **Fixed Bag Nets (Behundi Jal)**

- **In south and southeast coast of Saurastra**
  - **operate 'Dol' nets 6-12 miles from the coasts in water of 10-15 fathoms deep..**
- **Gujrat coast**
  - **Use gill nets along a stretch of 10 miles of coast line in inshore water during the months of June to September.**
  - **These gill nets are 30 feet long and 3 feet high with a mesh of one inch from knot to knot.**
- **Konkan coast**
  - **operate 'Dol' nets of various sizes in waters ranging in depths from 6-10 fathoms.**
- **Andhra-Orissa coast**
- **Fishermen use boat seines (filter nets) and fixed bag nets (behundi jal) operated by two catamarans**

❖ 2.5 FISHERY BYPRODUCTS

- ❖ Fishes important part of diet.
- ❖ They are valuable as well as easily accessible
- ❖ Source of rich protein, carbohydrates, vitamins A and D, iron, calcium and other mineral salts.
- ❖ Food value of fish is 300 to 600 calories in one pound depending upon its oil contents.
- ❖ Fishes unsuitable for human consumption are important raw material for a fishery byproduct industry.
- ❖ Byproducts from fish are derived from marine and fresh water prawns, mussels,
- ❖ cephalopods, lobsters and others.
- ❖ The non edible parts like fins, scales, chitinous parts, shells, bones and skeleton - for the manufacture of fertilizer, lime, leather, gelatin, glue etc.
- ❖ Byproducts of fish industry are fish meal, fish liver oil, fish body oil, fish

Production site-

A-Fish meal :Fish meal is produced in Chennai, Mumbai, Orissa and West Bengal coast.

Definition-

❖**It is cleaned, cooked, dried tissue of undecomposed fish.**

Raw material-

❖**The species like Sardines, mackerels, ribbon fish, silver belly, sharks, and ray form the raw material for the fish meal.**

❖**A-FISH MEAL- MANUFACTURING PROCESS**

❖**The big sized fishes are cut into pieces while the small ones are treated as a whole.**

❖**The process of manufacture involves the boiling in sufficient water in large pots to extract oil.**

❖**The cooked mass is then pressed in canvas or coir bags in screw presses to remove water.**

❖**The resulting cake is then dried in the sun. The solid mass is packed and marketed**

FISH MEAL- COMPOSITION

Proteins	55-70%
Fats (oils)	2- 15%
Minerals	10-12 %
Water	6-12%

- **Contains small quantities of iron, calcium and phosphorus and traces of vitamins A, D, B and K.**
- **It is estimated that India produce each year about 1.5 lakhs Pounds of fish meal.**
- **Manufacture of fish meal can be taken up as a cottage industry as it needs cheap equipment.**

A-FISH MEAL- USES

- Waste products of fish are utilized for preparing feed for poultry, pigs and cattle.
- High quality fish meal is used on animal farms to supplement the daily dietIt is particularly useful for chicken and other young animals as it contains amino acids, proteins in a readily digestible state.
- Fish meal can be stored in air tight sterilized containers for long period.

B-Fish flour

Definition

Fish flour is the fine, superior quality of fish meal .

Manufacturing process

It is prepared on a large scale by the solvent extraction method

Raw material

Fresh good quality fish

Uses-

- **Fish meal used for human consumption is fish flour**
- **It is rich in protein content and poor in fatty acid ingredient .**
- **It can be mixed with wheat flour or maize flour (10%fish flour and 90% wheat flour).**
- **It is used as an enriching component in bread, biscuits, cakes, sweets, soups and gruels .**
- **And it is also a good source of fish protein for skin and infants ice- cream; pharmaceuticals due to its high nutritive value**

D- Fish Manure: a- Fish manure

- It is prepared by drying fish in the sun on the sea beach.
- **Raw material**
- When there is abundant supply of fish or spoiled fish brought to the shore which are unfit for human consumption.
- The fishes which are mainly used to prepare manure are mackerels, sardine and etc.
- **Uses**
- The dried fish mixed with ash forms an ideal manure
- Fish manure contain 5-7% nitrogen and phosphate .
- **Raw material**
- It is composed of head, tail and body shell of prawn.
- These are separated during the preparation of prawn pulp and form the waste.
- **Composition**
- Prawn manure contains 5-6% nitrogen, 3-4 % phosphate and some lime.

Fish Manure : c- Fish Guano

Raw material

Fish guano is prepared from sardines on the Malabar coast.

The solid matter left after fishes are cooked and pressed for oil in fish oil factories forms the fish Guano.

Composition

- **It contains 8-10% nitrogen and phosphates along with calcium.**
- **It is also called fish cake.**

Use

- **Fish guano mixed up with the soil is utilized by the plants quickly.**
- **protein, nitrogen contents along with calcium and phosphorus.**

2.5-c-FISH LIVER OIL

COMPOSITION

- Fats-55-75%
- Protiens-5-10%
- Water-20-36%
- Vitamins-A and D
- Cod liver oil is poor in Vit-A content while shark liver oil has highest Vit-A
- To obtain good quality oil the processing to be done immediately

Extraction of fish liver oil

Boiling method - cut- boiled in water at 85-90^{0}C- skim oil- fishes with high oil content

- **Steaming method- heated with steam under pressure- (2kg/sq)- 85-90^{0}C- oil collected through pipe and residue diverted to centrifuge for further processing**
- **Floatation-liver pieces- crushed- dehydrated with sodium sulphate for few days –extracted with organic solvent like ethylene- di- chloride--distillation- oil-costly**
- **Alkali enzyme method- liver- grind- treated with caustic soda (1-2 ays) or with Sodium carbonate (2-5%) constant stirring for an hour – centrifugal machine- oil seperates**
- **USES OF FISH LIVER OIL**
  - ✓ **High medicinal value**
  - ✓ **Natural source of Vit A, D and C**
  - ✓ **Used to cure rickets, tuberculosis, and xeropthalmia**

- **2.5-e-FISH FIN SOUP**
- **Shark fin soup is a traditional soup or stewed dish found in Chinese cuisine and Vietnamese cuisine.**
- **The shark fins provide texture, while the taste comes from the other soup ingredients.**
- **In the late twentieth century, shark fin soup was a popular delicacy in China, and was eaten in Chinese restaurants around the world.**
- **It is commonly served at special occasions such as weddings and banquets, or as a luxury item in Chinese culture**

❖ PREPARATION

- ❖ Raw fins are cut near the root, processed by first removing the skin and denticles, then trimming them to shape.
- ❖ Washed in sea water, dusted with a mixture of wood ashes and lime and bleaching to a more-desirable colour or dried in sun or smoked.
- ❖ The cured product is crisp and brittle
- ❖ Sharks' fins are sold dried, cooked, wet, and frozen. Ready-to-eat shark fin soup is also available in Asian markets

❖ Uses

- ❖ Shark fins are believed in Chinese culture to have properties of boosting sexual potency, enhancing skin quality, increasing *qi* or energy, preventing heart disease, and lowering cholesterol.
- ❖ There is no scientific base, in fact it causes poisoning and Alzeimer

Ethical issues

- These are regularly harvested by a process known as shark finning, which takes only the fins and discards the carcass, alive or dead. Overfishing poses a major threat to the world's shark populations.
- The movement against shark fin soup began in 2006, when WildAid enlisted Chinese basketball star Yao Ming as spokesperson for a public relations campaign against the dish

FISH PRESERVATION

- Fish is a valuable source of food.
- Contains proteins, fats, minerals, iodine, phosphorus.
- Easy to digest due to low connective tissue.
- Spoilage is more infectious than cattle, sheep and chicken.
- Live fish carry bacteria on it's body, gills, gut and that start the process of decomposition after death.

Causes of spoilage

- Bacterial action
- Bacteria present in and on the body, gills and gut start reproducing due to high moisture content(75-80%).
- Handling, body-cut or hemorrhage enhance this activity.

Enzymatic activity

- Digestive enzymes- Autolysis
- Chemical action
- Oil of fatty fish is oxidized by atm. O_2 causing discoloration.
- Tri methyl amine oxide – tri methyl amine


Photo: Naser
www.bdfish.org

Difference – Fresh and Spoiled Fish

Sr. No	Fresh Fish	Spoiled Fish
1	Flesh stiff	**Soft and flabby**
2	Eyes glistening	**Eyes opaque**
3	Fingerprints not left on body	**Fingerprints left on body**
4	Gills bright red	**Gills violet red**
5	**Smell of slime and gills is fishy.**	**Typical smell of slime of fish**

Principals of Preservation
Cleanliness and Sanitation.

- **Washed to remove bacteria, slime, blood, faeces, mud and sand.**
- **Must be gutted immediately – prevent spoilage by digestive enzymes and gut bacteria.**
- **Handled and stored under sanitary conditions.**
- **Stored at low temperature.**
- **Method of Fish Preservation**

Chilling
Freezing
Salting
Drying
Canning

- ✓ **Chilling**
  - ✓ **Cheapest method**
  - ✓ **Temperature 0°C**
  - ✓ **Can be preserved for 3-15 days**
  - ✓ **Ratio of fish and ice is 1:1**
  - ✓ **Flake ice or crushed ice is used (to leave small air pockets- prevents growth of anaerobic bacteria)**
  - ✓ **Kept in large tanks between layers of ice Or packed with ice in fisholds or iceboxes**
  - ✓ **Antibiotics like aureomycin or terramycin**
- ✓ **Anti-fungals (maximum 5 ppm.) also used**

Freezing

More effective than chilling, achieved by using ice and salt mix or refrigeration.

- **Temperature of raw fish reduced to -16°C to -18°C , therefore, most of the fluids in it are converted to ice.**
- **Method only for live and perfectly fresh fish.**
- **In modern freezers, fish are frozen very quickly to temperature upto -20°C to -30°C.**
- **In cold air**
  - **Fishes kept in cabinets having freezer coils or pipes below the trays.**
- **In liquefied gas**
  - **Liquefied gases like nitrogen (B.P. 195°C). CO_2 (B.P. 78°C) . Air (B.P. 194°C).**
  - **Air cargo – solid CO2.**
- **Deep Freezing**

– **Used for large period of preservation**

– **Before freezing, fishes are washed properly and kept at -18°C for a long period**

– **Product is wholesome and fresh looking in appearance, flavor, colour and quality.**

- **Freeze drying**
  - **Complicated, laborious and expensive method, used only for preservation of good quality fishes**
  - **Fish first frozen, then dried by sublimation**
  - **Fish frozen to -20°C in freezing chamber**
  - **Fishes kept in trays and transferred to heating plates for drying conditions in vacuum, then placed in air conditioned chamber.**
  - **Flavour, colour and nutritive value is fully preserved**

Salting

✓Two methods are used

✓Dry Salting

✓Proportion of salt to fish depends on season size of fish, type of fish and local practice(1:3 to 1:10)

✓Oil fishes require more salt

✓Fishes are rolled/rubbed/sprinkled/covered with salt powder

✓Stocked in tanks with sufficient amount of salt for 10-20 hr

✓

Removed and washed

✓Sun dried for 2-3 days

✓Sea salts unsuitable as contain impurities of Ca and Mg resulting in stiff and brittle fish with bitter taste. Protein decomposition also sets in early

✓Pure salt with high NaCl content to be used

✓Colour, odour and taste affected

Drawback of Salting methodSalty taste

- Nutrients are drained along with water
- Has to be done in hygienic condition and expert supervision

Drying/Dehydration

- Drying in the sun or under shade
- Traditional, simplest and best method
- In West Bengal and Assam done during winter
- In India- 40% catch is sun dried
- Removal of water prevents microbial and enzymatic spoilage
- Fishes are spread on sandy beach over coir mats, palm leaves, bamboo thattis, palmura leaves etc.

Small and thin fishes like Bombay duck, ribbon fish, prawns, silver bellies are dried whole

- Bombay ducks are hung on wooden rods or ropes stretched horizontally between poles 1 to 1.2m high for 3-4 days.
- Large fishes are gutted washed and spread on mat
- Few products like shark fins, fish maw's prawns are sun dried only
- Gujrat- except jaw fishes all are sun dried
- Assam "sutki" prepared from Labeo, catla by sun drying

•Thanks...