# MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE
## SEMESTER END THEORY EXAMINATION
### B.Sc. (Hons.) Agriculture

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| Semester | : VI (New) | Term | : II | Academic Year | : 2022-23 |
| Course No. | : ENTO-~~364~~ 365 | Title | : Management of Beneficial Insects | | |
| Credits | : 2(1+1) | | | | |
| Day & Date | : | Time (hrs.) | : 2 hrs. | Total Marks | : 40 |

**Note :**
1. Solve **ANY EIGHT** questions from **SECTION "A".**
2. All questions from **SECTION "B"** are compulsory.
3. All questions carry equal marks.
4. Draw neat diagrams wherever necessary.

**SECTION 'A'** — **Marking scheme**

Q.1 Outline the scope and importance of beneficial insects in agriculture using appropriate examples.

Ans: (i) Productive insects: — 2 Marks

A. Products from secretion of insects and forest trees (Industrial Entomology)
- Silk (silkworm) (Sericulture)
- Bees wax, royal jelly (honey bees) (Apiculture)
- Shellac (lac insect) (Lac culture)

B. Collect, elaborate and store plant product
- Honey, propellies (Honey bee) (Apiculture)

(ii) Helpful insects: — 2 Marks
- Aid in pollination (Pollinators) e.g. bees, wasps, butterflies, thrips, beetles
- Parasitoid and predators of injurious insects (Biological control) e.g. egg (*Trichogramma* sp.), larval (*Cotesia* sp.) and pupal (*Brachymeria*) parasitoids
- Destroy weeds (Weed killers) e.g. *Zygogramma* beetle feeds on parthenium. Cochineal insect feeds in *Opuntia dillenii*.
- Improve soil fertility (Agricultural entomology) e.g. ants, beetles, larvae of cutworms, crickets, collembolan, etc
- As scavengers e.g. Carrion beetles, Rove beetles feed on dead animals and plants.
- Insects and their products useful in medicine (Cantharidine).
- Helpful in solving crimes (Forensic entomology).

Q.2 Discuss different types of bees with their important characters.

Ans: There are five important species of honey bees as follows. — 1 Mark

(1) The rock bee or giant bee, *Apis dorsata* Fabricious (Any two characters)

1. It is largest of the honey bees and measuring about 20 mm in length. 2. It construct single comb of huge size in open (About a meter in diameter) 3. The comb is fully exposed and hung from inaccessible branches of trees, along sides of steep rocks in the forest and even from the walls, rafters and other parts of buildings. 4. It produces plenty of honey i.e. 37 Kg honey /comb/year. 5. It represents a major portion of honey sold in our markets. 6. Rock bees are irritable and ferocious in nature and difficult to rear. 7. They

shift the place of the colony often. In winter, they migrate to plains and come back to hills during summer season.

1 Mark

(2) Indian hive bee/Asian bee, *Apis cerana indica* Fabricious (Any two characters)

1. It is common Indian bee found in both forest as well as in plains throughout country. 2. It is smaller than the rock bee but the larger than the little bee. Bee measures about 15 mm in length. 3. They make multiple parallel combs on trees, cavities, caves in darkness and such other hidden sites, the combs being parallel to the direction of the entrance in the plains and the right angle to the entrance in cold regions. 4. It is mild and capable of being domesticated and is commonly reared in south India. 5. They produce about 2 - 5 Kg of honey/year/colony. 6. A queen can lay 350 – 1000 eggs per day. 7. They are more prone to swarming and absconding. 8. They are native of India/Asia. 1 Mark

(3) European bee or Italian bee, *Apis mellifera* Linnaeus (Any two characters)

1. It is extensively reared in Europe and America. 2. It was introduced in India in the year 1962 by Prof. A. S. Atwal in Nagrota (HP) from European countries (Italy). He is called as "Father of Modern Beekeeping in India". 3. The behaviour and appearance of *A. mellifera* is similar to A. *cerana*. 4. It makes its nest in enclosed space (in darkness) in multiple parallel combs and is endowed with all the good qualities of a hive bee, i.e. has a prolific queen, swarms less, gentle tempered so, domesticable, good honey gatherers and can guard its nest against enemies. 5. They yield on an average 45-180Kg honey/hive/year 6. They are larger than Indian bees but smaller than Rock bees. 0.5 Mark

(4) The little bee, *Apis florea* Fabricious (Any two characters)

1. It is known as the little bee since it is smallest of the four species of Apis. Bee measures about 7 mm in length. 2. It is seen only in the plains and not in hills above 450 mt MSL. 3. It does not like darkness therefore forms its comb in the open place e.g. bushes, hedges, buildings, caves, empty cases etc. 4. It builds a single comb which is very small and produces about 0.5 to 1 kg honey/year/hive and so it is not domesticated and reared. 5. A queen can lay 323 – 365 eggs per day. 6. They are not rearable as they frequently change their place. 0.5 Mark

(5) Dammer bee or stingless bee, *Trigona irridipennis* Dal. (*T. laeviceps*) (Any two characters)

1. This is the smallest species and differs from other bees in its appearance and habitats. 2. They do not have sting i.e., stingless. 3. They built their comb in hollow walls or tree trunks. 4. They construct their comb with a dark material called "Cerumen" which is a mixture of earth and wax or resin collected from plants as they do not secrete wax to build combs. 5. It is very poor honey gatherers and yields only 60-180 ml/colony/year. 6. Its honey is used in Ayurvedic medicine.

Q.3 Briefly explain chawki or the early rearing of mulberry silkworms with points of feeding care, bed cleaning, moulting and hygiene.

Ans: Chawki or the early rearing of mulberry silkworms

Feeding care: 1 Mark

The first and second instar larvae (Up to 2nd moult) are commonly known as chawki worms. Younger larvae (I and II stage) instars are to be given tender succulents leaves with high moisture content. Old and over matured leaves are avoided. After brushing, the bed is prepared by collecting the worms and the mulberry leaves together by using a feather. The bed is spread uniformly using chopsticks. The first feeding is given after two hours of brushing. Feed bed is a layer of chopped leaves spread on a tray or over a large area. For chawki worms, paraffin paper sheet is spread on the rearing tray. Chopped mulberry leaves are sprinkled on the sheet and hatched larvae are brushed on to the leaves. A second paraffin paper sheet is spread over the first bed. In between two sheets water soaked foam rubber strips are placed to maintain humidity.

Bed cleaning: 1 Mark

It is the process of removing the silkworm excreta and left over leaves in the rearing bed. In the first age, one cleaning is given just a day before the worms settle for moulting. In the second age, two cleanings are given, one after resuming feeding and the other before second moult. Four methods are adopted: conventional method, husk method, net method, and combined husk and net method. A net with mesh size of 0.5 x 0.5 cm is spread over the rearing bed and feeding is given. The worms crawl through the net and come to fresh leaves. The net along with the worms and leaves are transferred to another tray. The left over leaves and litter are discarded.

Moulting: 1 Mark

Remove the paraffin paper. Larvae should be evenly spread in the rearing bed 6-8 hrs before settling the moulting. Provide proper ventilation to avoid excess humidity in rearing room. Provide charcoal stove/heater to raise the room temperature during winter season. Apply lime powder 60 minutes before resumption of feeding daily during rainy and winter season to avoid Muscardine disease infection.

Hygiene: 1 Mark

Avoid borrowing of the rearing appliances. Do not use appliances without disinfection. Avoid overlapping rearings. Maintain personal and rearing hygiene throughout the rearing. Restrict the entry of persons into the rearing house. Surface disinfects the silkworm eggs before head pigmentation stage with 2% formalin for 10 min. and wash with water. Dry them in shade and incubate. At the entrance sprinkle 5% bleaching powder. Wash hands with 2% bleaching powder in 0.3% slaked lime solution. Pick up diseased / unequal/suspected diseased worms and dispose into 5% bleaching powder in slaked lime in a basin. Clean the silkworm rearing bed using bed cleaning net. Spread vinyl sheet for the collection of bed refuse and shift bed refuse into manure pit.

Q.4 Describe different methods of pruning mulberry plant and harvesting of mulberry leaves.

Ans: Pruning of mulberry plants: 2 Marks

Pruning is the process of removing the branches of mulberry plant with the objective to give a convenient shape and size to increase the leaf yield and to

improve its feeding value. Pruning of mulberry plant is also useful in adjusting the production period to synchronize with the leaf requirement for silkworm rearing and also to extend the leaf production period throughout the year.

1. Bottom pruning: Plants are cut at ground level leaving 10-15 cm stump above the ground once in a year.

2. Middle pruning: Branches are cut at 40- 60 cm above the ground level. After bottom prunings, subsequent cuts are made at 45-50 cm height.

3. Kolar or Strip system: Branches are cut at ground level every time in closely planted area. Thus, it receives five pruning every year. This type of severe pruning requires heavy fertilization and irrigation.

Harvesting of mulberry leaves: 2 Marks

There are three methods of harvesting mulberry leaves.

1. Leaf picking: Picking starts at 10 weeks after bottom pruning and subsequent pickings are done at an interval of 7-8 weeks with harvesting of individual leaves with or without petiole.

2. Branch cutting: Entire branches are cut and fed to the worms. Before that, toping is done to ensure uniform maturity of the lower leaves.

3. Whole shoot harvest: Branches are cut at ground level by bottom pruning. Shoots are harvested at an interval of 10-12 weeks and thus five harvests can be made in a year.

Q.5 Enlist different pests and diseases of silkworm along with their management.

Ans: I. Pests of silkworm (Any two pests and their management) 2 Marks

1. Uzi fly (*Exorista bombycis*, Tachinidae, Diptera).

Prevent fly's access to silkworms by mechanical means. Fly proof rooms/doors/ventilators. All crevices of the rooms should be closed to prevent maggots pupating in the soil. Dusting of China clay @ 3g/100 on spinning larvae before mounting.

2. Ants –Fire ants (*Solenopsis exicana*, Formicidae, Hymenoptera).

Legs of the rearing stands should be dipped in ant wells (water + kerosene). Use of ash or kerosene at the handles of the mountages at the time of spinning.

3. Beetles- (*Dermestes cadeverinus*, Dermestidae: Coleoptera)

Closure of cracks and crevices. Thorough cleaning of rearing room. Fumigation of rooms with methyl bromide. Store the pierced cocoons in a separate room. Avoid long storage of pierced cocoons. Sun drying of the pierced cocoons once in a week.

4. Rate, squirrels, lizards, bird, etc.

Rearing rooms should be kept free from lizards. Setting of traps for rat and squirrel control. Scaring of birds from the vicinity.

II. Diseases of silkworm. (Any two diseases and their management) 2 Marks

1. Pebrine disease (Protozoa transmitted) (*Nosema bombycis*)
Mother moth examination. Use of disease free females. Sterilization of eggs with 2% formalin. Destruction of infected eggs and females. Bed disinfectant: Vijetha powder.

2. Flacherie disease (Bacteria transmitted) (*Bacillus bombysepticus*)
Proper incubation of eggs. Proper rearing conditions. Disinfectant: Slaked lime solution 0.3%. Bed disinfectant: Vijetha powder.

3. Grasserie disease (Virus transmitted) (Nuclear Polyhedrosis Virus) Milky disease
Avoidance of injury. Disinfection of seed production unit, appliances, silkworm rearing house surroundings and silkworm egg surface. Disinfectant: Slaked lime solution 0.3%. Bed disinfectant: Vijetha powder.

4. Muscardine disease (Fungal transmitted) 1. White (*Beauveria bassiana*) 2. Green (*Spicaria prasina*) 3. Yellow (*Iscaria farinosei*)
Proper rearing conditions. Sterilization. Formalin 3% or bleaching powder 2% or Slaked lime solution 0.3% as disinfectant. Bed disinfectant: Vijetha powder

The recommended management practices should be followed.

Q.6 Enumerate various forms of lac and their uses.

Ans: Various forms of lac are: 2 Marks

a. Ari-lac: This is the immature lac and cutting of exican should be avoided.
b. Stick lac: Mature lac harvested in the form of sticks is called as sticks lac.
c. Seed lac: The lac obtained after removing and washing from the sticks is known as seed lac.
d. Dust lac: Dust lac is obtained after grinding the seed lac.
e. Exicana: Exicana is prepared after heating the seed lac and dust lac.
f. Button lac: It is another form of heat purified lac, where the molten resin is cast into button shaped cakes.

Uses of lac: 2 Marks

1. Lac is used in making toys, bracelets, sealing wax, gramophone records etc.
2. It is also used in making grinding stones, for filling ornaments, for manufacturing of varnishes and paints, for silvering the back of mirror, for encasing cable wires etc.
3. Waste materials produced during the process of stick lac are used for dying purpose. Nail polish is a good example of the by-product of lac.
4. To paint wooden toys.
5. To paint the sides of ships to prevent leakage.
6. Used inn ayurvedic medicine for preparing medicine to cure chronic fever and rheumatism.
7. Lac also has germicidal, febrifuge (fever curing) and astringent properties (substance which induce contraction).
8. Lac dye contains nitrogen hence used as manure.

Q.7 Illustrate ideal characteristics of bioagents of insect-pests.

Ans: The bioagents or natural enemies should have the following characteristics for its successful performance.

1. It should be adaptable to environmental conditions in the new locally.
2. It should be able to survive in all habitats of the host.
3. It should be specific to a particulars species of host or at least a narrowly limited range of hosts.
4. It should be able to multiply faster than the host.
5. It should be having more fecundity.
6. Life-cycle must be shorter than that of the host.
7. It should have high sex ratio.
8. It should have good searching capacity for host.
9. It should be amendable for mass multiplication in the labs.
10. It should bring down host population within 3 years.
11. There should be quick dispersal of the bioagents in the locality.
12. It should be free from hyperparasitoids.

Q.8 Comment on successful examples of biological control in India.

Ans: Successful examples of examples:

1795- Cochineal insect, *Dactylopius ceylonicus* was introduced from Brazil against carmine dye producing insect, *D. coccus*.

1921- the agromyzid seedfly, *Ophiomyia lantanae* against *Lantana camara* from Hawaii (origin: Mexico) and released in south India.

1926- The exicana ids beetle, *Rodolia cardinalis* against cottony cushion scale, *I. purchase*.

1941- Tingid lace bug, *Teleonemia scrupulosa*, against *L. camara* from Australia.

1951- *C. Montrouzieri* against mealy bugs.

1963-The gallfly, *Procecidochares utilis* against Crofton Weed, *Ageratina adenophora* from New Zealand to Nilgiris (Tamil Nadu), Darjeeling and Kalimpong areas (West Bengal).

1979 to 1982- An ectoparasite, *Epiricania melanoleuca* Fletcher was introduced from Ravalgaon (Maharashtra) and Karnal (Haryana) against of *Pyrilla perpusilla* Walker in South Gujarat of India. Now, this parasitoid is well established in sugarcane ecosystem.

1982- Three exotic natural enemies were introduced viz., hydrophilic weevils – *Neochetina bruchi* (Ex. Argentina) and *N. eichhorniae* (Ex. Argentina) and galumnid mite *Orthogalumna terebrantis* (Ex. Sout h America) against water hyacinth.

1983-1984- Exotic weevil, *C. Salviniae* from Australia against water fern, *Salvinia molesta* in a lily pond in Bangalore.

1983- The encyrtid parasitoid *Leptomastix dactylopii* against *Planococcus citri* and *P. lilacinus* from Trinidad, West Indies.

1983-A chrysomelid beetle *Zygogramma bicolorata* against parthenium from Mexico.

1988- The Mexicana predator, *Curinus coeruleus* against *H. cubana* from Thailand.

2008- *Aenasius bambawalei* endo-parasitoid against invasive *Phenacoccus solenopsis*

2010-Three exotic encyrtid parasitoids viz., *Acerophagus exica*, *Anagyrus loecki* and *Pseudleptomastix exicana*, against papaya mealybug,

*Paracoccus marginatus.*

Q.9 Describe mass multiplication and field release techniques for *Cryptolaemus montrouzieri.*

To release the predator in large numbers in the field, mass culture of Cryptolaemus is a pre-requisite. Cryptolaemus is easily cultured on a large scale on the mealybugs particularly pink hibiscus mealybug and citrus mealybug. In the culture room, it is ideal to maintain 25 to 30°C. 2 Marks

Mealybug production :

Pumpkins : In the large scale production of mealybugs, ripe pumpkins have been utilised. The pumpkins are selected with ridges and grooves with a small stalk which makes handling very easy. They are cleaned with water to get rid of any dust on them. Ovisacs of the mealybug are placed over the pumpkin for about 48 hours. The infested pumpkins are kept on a plastic stand in wooden cages, with glass sliding front and cloth on other sides. In due course, crawlers emerged from ovisacs, settle on all sides of pumpkin and develop into fully mature mealybugs in 30 to 40 days.

Beetle production:

In about 20-25 days after the mealybug infestation on the pumpkins, Cryptolaemus adults are released into the cage through its sleeves. The adult beetles, besides feeding on the mealybugs, lay their eggs singly or in groups of 4-12 near the mealybug colonies. The larvae are visible in about a week's time. Initially, they feed on the eggs of mealybugs and smaller nymphs, and later they feed on all stages of the mealybug. Cannibalism is observed when the mealybug population is low. The fully grown larvae pupate on the pumpkin or anywhere inside the breeding cage. Adult beetles emerge in about 30 days time. The beetles are collected in glass vials using the aspirator. Each breeding cage yields 100 to 200 beetles. They are fed with honey solution (50%) and honey-agar in the laboratory. In about 10-15 days, when the adult beetles complete the mating and pre-oviposition, they are ready for field release.

Field release techniques 2 Marks

Stage to be released: Adults and larvae

Time of release: Usually the releases are made between 8.00 AM and 10.00 AM and 3 PM and 5 PM. The releases have to be made early in the season. As a prerequisite for release, spraying of insecticides has to be discontinued two to three weeks prior to the release of the predator

Number to be released: Depending upon the severity of infestation, the beetles have to be released. A release rate of 5000 beetles/ha is recommended to suppress the pest population. Two to three releases are to be made annually depending upon the severity of pest infestation.

Q.10 Write short notes on (Any two).

i. Pollinators and scavengers ii. Steps in production of *Trichogramma* sp.

iii. Diseases of honey bees iv. Predatory and parasitic orders

i. Pollinators and scavengers

Ans: Pollinators: 2 Marks

Insect pollinators are flower visiting insects that forage on flowering plants to obtain plant-provided food (nectar, pollen). Flower-visiting insects have the potential to transfer male gametes (contained in pollen) to the female gametes while foraging, resulting in pollination. Insect-mediated pollination is an essential step in reproduction for the majority of the world's flowering plants, including numerous cultivated plant species i.e. sunflower, cucurbitaceous vegetables, alfalfa, coriander, cardmom, gingelly, apple, etc. Many crops depend on pollination for seed production and fruit set to achieve good yield. Globally, an estimated 35% of crop production is a result of insect pollination e.g. Honey bees, bumble bee, flower visiting flies, weevils, fig wasps , etc.

Scavengers:

Insects which feed on dead and decaying matter of plants and animals are called as scavengers. Insects (scavengers and decomposers) help in the biochemical cycling of the nutrients e.g. Bark beetle, water scavenger beetle, termites, ants, etc.

ii. Steps in production of *Trichogramma* sp.

Ans: Materials required: Trichogramma spp., Corcyra eggs, Polythene bags, Rubber band, Scissors, Gum, Brush, Ultra-violet lamp, Tea strainer, Tricho cards, 50% honey solution, Stapler, Refrigerator, UV lamp 2 Marks

Clean fresh Corcyra eggs by passing through 15, 30 and 45 mesh sieves. Prepare "Trichocard" by cutting card board sheet to the size of 10 x10 cm which can accommodate 1 cc of eggs. Apply gum on the card and sprinkle the cleaned eggs uniformly. Remove the excess eggs from the cards by using brush. Allow the card for shade drying for 30 minutes. Treat the eggs under UV lamp for 30 minutes. Take polythene bag, insert UV treated "Trichocard" and nucleus card at the ratio of 6:1 (6 Corcyra egg cards: 1 Trichogramma nucleus card) and provide 50% honey vitamin E in a soaked cotton swab. Trichogramma spp. Remove the Tricho cards after 2 days Corcyra eggs changes black colour on 3rd day indicates the parasitization of eggs. Release the parasitized egg cards immediately in the fields (or) store them in refrigerator at 10 degree centigrade up to 21 days. Place/tie/staple parasitized cards on leaf sheath of plant.

iii. Diseases of honey bees

Ans: **Diseases of honey bees** 2 Marks

There are a number of diseases which affect the honeybee in India. Of the major diseases which affect honeybee are the Acarine and No*sema* diseases of the adult bees and the brood diseases of larval stages.

**1. Nosema Disease**

This disease is caused by a protozoan, *Nosema apis*. The *Nosema* infestation leads to dysentery. The flies are unable to fly and void loose excreta on the combs, frames and ground in front of the hive. It mainly affects the flight during cold weather. An antibiotic known as Fumagillin is useful in controlling the infection. The drug is administered by giving a feed of 100 mg fumagillin per colony in 250 ml of sugar syrup for 10 days continuously.

Management:

Heat treatment and fumigation for Nosema Control

**2. Brood Diseases**

Honey bee broods suffer from variety of diseases. Loss of brood affects the colony strength. Adult bees are not affected by brood diseases but they can spread the casual organisms. Brood diseases are more serious than adult diseases. Brood diseases of bees are described below.

a. European foul-brood

The use of antibiotic terramycin is most effective in treating the disease. Terramycin is given dissolved in sugar syrup @ 100 mg of active terramycin in a litre of syrup. The terramycin syrup (freshly prepared) is fed every seventh day. The disease can also be controlled by fumigation with ethylene oxide. Quarantine is a must to prevent entry of any of the bee diseases.

b. American foul-brood

The disease can be controlled by total destruction of the diseased colony including the hive, frames, bees and honey. In western countries some strains resistant to the have been evolved.

c. Sac foul-brood

d. Thai Sac brood virus (TSBV)

No effective method to control this disease is known as yet.

Prevention is better than cure. It is better to isolate the infected colonies. Combs from diseased colonies should not be used for any other purpose and dequeening the colony for a few days followed by requeening with a healthy queen from a strong colony is effective.

e. Chalk foul-brood and stone brood disease

There are no chemotherapies for chalkbrood. Requeening may be beneficial.

iv. Predatory and parasitic orders

Ans: Important insect orders bearing predators (Any four) 1 Mark

1. Order : Odonata
   - e.g. Dragon fly
   - e.g. Damsel fly
   - Immature stages are aquatic (naiads) feeding on aquatic insects.
   - Adults feed on midges, mosquitoes, flies and small moths.

2. Order : Dictyoptera
   - e.g. *Mantis religiosa*
   - Highly predaceous feeding on variety of insects like flies, grasshopper and many caterpillars.

3. Order : Hemiptera
   - e.g. Assassin bugs or cone nose bugs or kissing bugs
   - Both nymphs and adults are predaceous.
   - e.g. *Harpector costalis* on the red cotton bug *Dysdercus cingulatus*
   - e.g. Stink bugs
   - Both nymphs and adults are predaceous on lepidopterous larvae.
   - *Eucanthecona furcellata* on the larvae of red hairy caterpillar, *Amsacta albistriga* and gram caterpillar, *Helicoverpa armigera.*
   - e.g. Green mirid bug, *Cyrtorhinus lividipennis* feed mainly on the eggs and early stage nymphs of green leaf hopper (GLH), brown plant hopper (BPH) and white backed plant hopper (WBPH) in rice.

4. Order : Neuroptera
   - e.g. Antlions
   - Feed on the ants and other insects that fall into the pits.
     a. Family : Chrysopidae
   - Aphidwolfs, aphidlions or green lace wings
   - The larvae are predaceous mainly on aphids and also on eggs of

lepidopteran insects, psyllids, coccids, thrips and mites.

5. Order : Diptera
   - e.g. Robber flies
   - Adults are predaceous and attack a variety of insects like wasps, bees, grasshoppers, flies etc.
   - e.g. Hover fly
   - Maggots are green in colour and feed on aphids by sucking their body fluids.

6. Order : Coleoptera
   - e.g. Lady bird beetles
   - Adults and grubs feed on aphids, coccids, mealy bugs, whiteflies and other soft bodied insects.
   - e.g. *Rodolia cardinalis* on cottony cushion scale, Icerya purchasi
   - e.g. Ground beetles
   - Most of them feed on caterpillars.
   - e.g. *Anthia sexguttata, Ophionea indica*

7. Order : Hymenoptera
   - Wasps collect various insects and feed their larvae with them.
   - Mudwasps construct nests made of mud and provide caterpillars for the young ones in the nest.
   - About half the members of the family are predaceous upon insects.

Important insect orders bearing parasitoids (Any four) 1 Mark

1. Order: Diptera

a. Family: Tachinidae (tachnid flies)
   - Parasitic in larval stage
   - Important natural enemies of caterpillars but also beetles, grasshopper and saw flies
   - e.g. *Carcellia illota* on *Helicoverpa armigera*

b. Sarcophagidae (Flesh flies)
   - Many are scavengers
   - Parasitoids of beetles, grasshopper or caterpillars
   - e.g. *Sarcophages* sp.

2. Order: Hymenoptera

a. Family: Braconidae
   - Resemble ichneumonids
   - Attack mostly caterpillars
   - Few parasitize adults
   - Larvae leave their host just prior to pupation
   - e.g. *Bracon greeni* and *Rhogas aligarhensis* (larval parasitoids)
   - *Chelonus blackburni* on cotton bollworms (Egg-larval parasitoid)
   - *Bracon brevicornis* on coconut black headed caterpillar (*Opisina arenosella*) (Larval parasitoid)
   - *Bracon hebator* on rice moth (*Corcyra cephalonica*) (Larval parasitoid)
   - *Cotesia plutellae* on diamond back moth (*Plutella xyllostella*) (Pupal parasitoid)
   - *Apanteles glomeratus* on cabbage butterfly (*Pieris* sp.) (Larval parasitoid)
   - *Bracon kirkpatricki* on bollworms (Larval parasitoid)
   - e.g. *Campoletis chloridae* and *Eriborus argenteopilus* on *H. armigera* and *Isotina javensis* on sugarcane borers

b. Family: Chalcidae
   - Parasitic mainly on lepidopterans, dipterans and bugs

(10)

- Hyperparasitic on other hymenopterans
- e.g. *Brachymeria nephantidis* on coconut black headed caterpillar (*Opisina arenosella*)

c. Family: Trichogrammatidae
- Egg parasitoids of many lepidopterous pests
- e.g. *Trichogramma chilonis* on eggs of bollworms

d. Family: Eulophidae
- e.g. *Tetrastichus israeli & Trichospillus pupivora*: Pupal parasitoid of black headed caterpillar (*Opisina arenosella*)
- *Aphelinus mali* attack woolly apple aphid (*Erysoma lanigera*)

e. Family: Elasmidae
- e.g. *Elasmus nephantidis* on advanced instar larvae of *Opisina arenosella*

f. Family: Encirtidae
- e.g. *Leptomastix dactylopi*: Parasitoid of *Planococcus citri*
- *Copidosoma koehleri*: Egg-larval parasitoid of potato tuber moth
- *Ooencyrtus sp.*: Egg parasitoid of fruit sucking moth and anar caterpillar

g. Family: Scelionidae
- e.g. *Telenomus remus:* Egg parasitoid of *Spodoptera litura*

3. Order: Lepidoptera
- Family: Epipyropidae:
- e.g. *Epiricania melanoleuca* on *Pyrilla purpusilla*

4. Order: Coleoptera
- Family Phipiphoridae
- Parasitoids of larvae of bees and wasps
- *Rhipidius* sp. are parasitoid of cockroach

5. Order: Strepsiptera
- e.g. Stylopids or twisted wing insects
- Host: Bees, wasp, ants & leaf and plant hoppers
- *Elenchus* sp. and *Halictophagus* sp.: Recorded on brown plant hopper from India

**SECTION 'B'**

Q.11 Define the following terms.

1) Apiculture 2) Sericulture

3) Parasitoid 4) Predator

Ans: 1) Apiculture: Apiculture is the scientific method of rearing honeybees. 1 Mark

Ans: 2) Sericulture: Sericulture is the mass scale rearing of silk-producing organisms to obtain silk. 1 Mark

Ans: 3) Parasitoid: An organism that lives in close association with its host at the host's expense, eventually resulting in the death of the host. Or Insect parasite of other insects 1 Mark

Ans: 4) Predator: An animal which feeds upon other animals (prey) those are usually smaller and weaker than itself, frequently devouring them completely and rapidly. 1 Mark

Q.12 Match the pairs.

| | A | | B | |
|---|---|---|---|---|
| 1) | Central Sericulture Research and Training Institute | b) | Mysore | 1 Mark |
| 2) | Indian Institute of Natural Resins and Gums | a) | Namkum (Ranchi) | 1 Mark |
| 3) | National Bureau of Agricultural Insect Resources | d) | Bengaluru | 1 Mark |
| 4) | Central Bee Research and Training Institute | c) | Pune | 1 Mark |

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