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PRACTICAL MANUAL
on
Management of Beneficial Insects

(ENT 321) 2(1+1)
For B.Sc. (Hons.) Agriculture VI Semester

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Syllabus:

Honey bee species, castes of bees. Beekeeping appliances and seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication. Types of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Species of lac insect, host plant identification. Identification of other important pollinators, weed killers and scavengers. Visit to research and training institutions devoted to beekeeping, sericulture, lac culture and natural enemies. Identification and techniques for mass multiplication of natural enemies.

Name of Student _____

ID. No. _____

Batch _____

Session _____

Semester _____

Course Name: _____

Course No. : _____

Credit _____

CERTIFICATE

This is to certify that Shri./Km. ----------ID No----------has completed the practical of course----------course No. ---------- as per the syllabus of B.Sc. (Hons.) Agriculture ---------- semester in the year ----------in the respective lab/field of College.

Date: Course Instructor

CONTENTS

EXERCISE NO. 1

Objective: To study and identify the different types of honey bees

Exercise: Go to the field, observed the different species of honeybees and note down their character.

Materials required: _____

_____

Observation to be recorded:

Species	Characters
i. _____	_____ _____ _____ _____ _____
ii. _____	_____ _____ _____ _____ _____
iii. _____	_____ _____ _____ _____ _____
iv. _____	_____ _____ _____ _____ _____
v. _____	_____ _____ _____ _____ _____

EXERCISE NO. 2

Objective: To study and identify the different castes of honey bee

Exercise: Draw the diagram of different castes of honey bee and write down their morphological character of honeybee provided to you.

Materials required: _____

_____

Observation to be recorded:

Characters	Diagram
Queen: _____	
Drones: _____	
Workers: _____	

EXERCISE NO. 3

Objective: To study and get familiarize with different body regions of honeybee

Exercise: Observe the honeybee specimen carefully in the lab using magnifying lens and write down the morphological features of honey bee.

Observation to be recorded:

Head:

_____

_____

_____

_____

_____

Thorax:

_____

_____

_____

_____

_____

_____

Abdomen:

_____

_____

_____

_____

_____

Draw a well labeled diagram of the general morphology of the honey bee.

EXERCISE NO. 4

Objective: To study the bee hive and various beekeeping equipments

Exercise: Draw the diagram of the bee hive and write down the details of its different parts. Illustrate the beekeeping appliances that you observe in the Apiary unit.

Observation to be recorded:

Hive stand: _____

Bottom board: _____

Brood chamber: _____

Supers: _____

Covers:

Frames: _____

Other Bee-keeping Appliances

	Appliances	Uses	Diagram
1.			
2.			
3.			
4.			
5.			

6.			
7.			
8.			
9.			
10.			

11.			
12.			
13.			
14.			
15.			

EXERCISE NO. 5

Objective: To study about the diseases of honey bee and their symptoms

Exercise: Identify and collect the infected honey bees in plate from the hives. Carefully observe the symptoms cause by the pathogen and identify the causal organism.

Materials required: _____

_____

Observation to be recorded:

Disease Name	Causal Organism	Site of Infection	Stage Infected	Symptoms
Protozoan diseases:				
Fungal diseases:				
Bacterial diseases:				

Viral disease:				

EXERCISE NO. 6

Objective: To study about the enemies of honey bee

Exercise: Visit to the nearby field, inspect and identify the enemies present in bee hive. Write down their nature of damage (symptoms) and management for the pest.

Materials required:_____

_____

Observation to be recorded:

	Common name	Scientific name	Nature of damage	Management
1.	_____ _____ _____	_____ _____	_____ _____ _____ _____	……. ……. ……. ……. …….
2.	_____ _____ _____	_____ _____	_____ _____ _____ _____	……. ……. ……. ……. …….
3.	_____ _____	_____ _____	_____ _____ _____ _____	……. ……. ……. ……. …….
4.	_____ _____	_____ _____	_____ _____ _____ _____	……. ……. ……. ……. …….
5.	_____ _____	_____ _____	_____ _____ _____ _____	……. ……. ……. …….

EXERCISE NO. 7

Objective: To study and understand the communication in honeybee

Exercise: Draw the dances perform by the bee in the hive as a means of communication.

Observation to be recorded:

Round dance: _____

_____

_____

_____

_____

_____

_____

Wag-tail dance: _____

_____

_____

……..…

When food is in the direction of sun

When food is away from direction of sun

When food is to the left of the sun

When food is to the right of the sun

EXERCISE NO. 8

Objective: To study about the seasonal management of honey bee boxes

Materials required: _____

_____

Exercise: Make a trip to Inspect the hive. Write down the different management scheduled at different season.

Spring season management: _____

_____

_____

_____

_____

Monsoon season management: _____

_____

_____

_____

_____

Summer season management:_____

_____

_____

_____

_____

_____

Autumn/ fall season management: _____

_____

_____

_____

_____

Winter season management: _____

_____

_____

_____

_____

EXERCISE NO. 9

Objective: To study about bee pasturage and bee foraging

Exercise: Write down the bee flora available in the campus and record the bee foraging behavior by visiting the nearby crop field and orchard.

Observation to be recorded:

Bee flora/ Pasturage	
Good nectar source	_____ _____
Good pollen source	_____ _____
Both source of pollen and nectar	_____ _____

Procedures for recording bee behavior

_____

_____

_____

_____

_____

_____

Results on foraging activity:

EXERCISE NO. 10

Objective: To study the different types of silkworm

Exercise: Identify the specimen. Draw the diagram and write its distinguishing characters.

Observation to be recorded:

Tasar Silkworm: _____ _____ _____ _____ _____ _____	
Mulberry silkworm: _____ _____ _____ _____ _____ _____	
Eri silkworm: _____ _____ _____ _____ _____ _____	
Muga silkworm: _____ _____ _____ _____ _____ _____	

EXERCISE NO. 11

Objective: To study the method of cultivation of mulberry, mulberry varieties and method of harvesting and preservation of mulberry leaves

Exercise: Evaluate the survivability of mulberry plants by different methods of propagation. Write down the name of mulberry varieties grown. Write down about methods of harvesting and preservation of mulberry leaves.

Materials required: _____

_____

PROCEDURE:

Cuttings: _____

_____

_____

_____

_____

_____

Grafts: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Mulberry Varieties: _____

_____

Methods of Harvesting:

Leaf picking: _____

_____

_____

Branch cutting: _____

_____

_____

Whole shoot harvest: _____

_____

_____

Preservation of Leaves: _____

_____

_____

_____

Plant ten cuttings each from upper, middle and lower portions of shoot. Find out the difference in their survivability

Cuttings	No. of cutting planted	Survival %
Upper		
Lower		
Middle		

Prepare a graft leaving more space and less space between stock and scion at the place of union

Method of Preparation of Grafts	No. of Grafts Planted	Survival %

EXERCISE NO. 12

Objective: To study the biology of mulberry silkworm, *Bombyx mori*

Exercise: Observe and evaluate the biology of mulberry silkworm.

Materials required: _____

_____

Procedure: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Observation to be recorded:

Observation	Duration	Description
Incubation period		_____ _____ _____
Larval period		_____ _____ _____
Pupal period		_____ _____ _____
Adult longevity		_____ _____ _____
Fecundity		_____ _____

EXERCISE NO. 13

Objective: To study the cultivation and host plant identification of lac insect

Exercise: Enlist the host plant of lac insect grown in your university and Inoculate the brood lac on specific host plants.

Materials required: _____

_____

Procedure: _____

_____

_____

_____

_____

_____

Precautions: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Host plant of lac insect: _____

_____

_____

_____

_____

_____

EXERCISE NO. 14

Objective: To Identify the important weed killers and scavengers

Exercise: Identify the weed killer/ Scavenger using magnifying lens/microscope by collecting the specimen from the field

Materials required: _____

Observation to be recorded:

Specimen Name	Role
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

EXERCISE NO. 15

Objective: **To Identify the important pollinators**

Exercise: Observed and identify pollinators. Write and draw their characteristic features

Observation to be recorded:

Pollinators observed:

EXERCISE NO. 16

Objective: To Identify the important parasitoids and predators

Exercise: Collect and identify the predators from the crop field. Identify the parasitoid under microscope and write their difference in characters.

Materials required: _____

_____

Observation to be Recorded:

PARASITOIDS	FAMILY	IDENTIFYING CHARACTER
_____	_____	.....
		.....
_____	_____	.....
		.....
_____	_____	.....
		.....
_____	_____	.....
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_____	_____	.....
		.....
_____	_____	.....
		.....
_____	_____	.....
		.....
PREDATORS	**FAMILY**	**IDENTIFYING CHARACTER**

_____	_____	…….
_____	_____	…….
_____	_____	…… ……
_____	_____	…… ……
_____	_____	…… ……
_____	_____	…… ……
_____	_____	…… ……
_____	_____	…… ……
_____	_____	…… ……
_____	_____	
_____	_____	…….
_____	_____	…… ……
_____	_____	…… ……
_____	_____	…… ……
_____	_____	…… ……
_____	_____	…… ……
_____	_____	…… ……
_____	_____	…… ……
_____	_____	…… ……

EXERCISE NO. 17

Objective: To study about mass multiplication technique of *Chrysoperla carnea*

Exercise: Write down procedure for the mass multiplication of *Chrysoperla carnea* (Flow chart)

Materials required: _____

_____

_____

Procedure:

PRECAUTIONS: _____

_____

_____

EXERCISE NO. 18

Objective: To study about mass multiplication technique *Trichogramma sp*

Exercise: Follow the mass rearing technique of *Cocyra cephalonica* and *Trichogramma spp.*

Materials required: _____

_____

Flow Chart (Elaborate steps involved in mass multiplication):
Mass culture of the laboratory hosts (*Corcyra cephalonica*) of the *Trichogramma:*

Mass multiplication of *Trichogramma spp.* (egg parasitoid)*:*

EXERCISE NO. 19

Objective: To visit research and training institutions devoted to beekeeping, sericulture, lac culture and natural enemies

Exercise: Visit to the lac culture, apiculture unit, sericulture unit and make a report

Report: _____

SPECIES OF HONEY BEE

Rock-bee (*Apis dorsata)*

- They are giant bees found all over India in sub-mountainous regions up to an altitude of 2700 m.
- Largest honeybee; builds single open comb on high branches of tree, building and rocks.
- Produces large quantity of honey, but very difficult to domesticate. Rock-bee produce about 36-40 Kg honey per comb per year.
- This bee is ferocious, stings severely causing fever and sometimes even death of affected ones.

Little bee (*Apis florea)*

- They build single vertical combs.
- Small sized; builds single small combs in bushes, hedges, etc.
- Honey yield is poor approx. half a kilo of honey per year per hive.
- They can't be domesticated as they frequently change their place.
- They distribute only in plains and not in hills above 450 MSL.

Indian bee: *Apis cerana indica*

- Medium sized, larger than *Apis florae* but smaller than *Apis mellifera*; several parallel combs in dark places.
- Not so ferocious and can be domesticated.
- They are native of India/Asia.
- The average honey yield of 6-8 kg per colony per year.
- More prone to swarming and absconding.

European bee / Italian bee (*Apis mellifera*)

- Similar in habits to Indian bees which build parallel combs but bigger
- The average production per colony is 25-40 kg.
- Less prone to swarming and absconding.
- They have been imported from Italy.

CASTES OF HONEY BEE

Queen	Workers	Drones
• It is a fertile female with long elongated abdomen, strong legs and short wings. • Their main role is reproduction with drone and lay egg. • Fed with royal jelly throughout their larval period than the larva developed into queen. • Lays about 1500 to 200 eggs per day and lives for 2-3 years.	• Smallest member of the colony; ovipositor modified into stinging organ • They are the sterile female produced from the fertilized eggs laid by queen. • Their function is to collect honey, looking after their young ones, cleaning the comb, to defend the hive and to maintain the temperature of the hive (heating and cooling).	• Larger than worker with blunt abdomen • These are fertile male bee develops parthenogenetically from unfertilized eggs laid by queen. • They are stingless and their sole function is to mate with queen and fertilize.

Precautions:

- Before handling bee colonies, it is better to wear a bee veil and gloves.
- Do not wear black or dark cloth as bees are furious to black colour.
- Do not use any kind of perfume or strong-smelling hair oils or metals like ring, watch etc which would induce bees to sting, should be removed before handling the bees.
- Take care and avoid quick and jerking movem
- If a bee stings, do not get nervous. Gently pull out the sting with the sharp edge of hive tool or finger nail from the base and not from the top without squeezing the venom out of it. Rub some grass on the stung area to mask the smell of alarm pheromone which otherwise induces other workers to sting in that area.
- Hive should not be opened on a windy, chilly day or the period when bees are not working outside the hive.

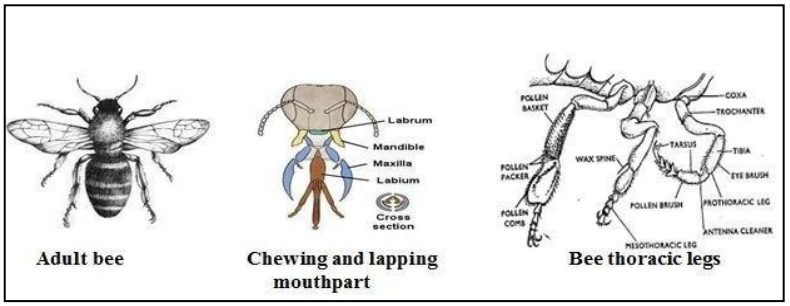
HONEYBEE: GENERAL MORPHOLOGICAL CHARACTERS

Head:

- Chewing and lapping mouthpart
- 3 ocelli and a pair of compound eye which can distinguish different colour
- A pair of geniculate antennae

Thorax

- Two pair of membranous wings and hamulate type of wing coupling mechanism found
- Three pairs of legs densely covered with hairs.
- Foreleg - eye brush and an antenna cleaner.
- Middle leg - bushy tarsi for cleaning of thorax. Spur like spine at end of tibia for loosening pellets of pollen from pollen basket and wax from the abdomen.
- Hind leg - pollen basket or corbicula.



Abdomen

- First abdominal segment fused with metathorax forming propodeum
- wax secreted from 3 to 6 abdominal sternite (wax gland) and scent glands (on last two terga)
- Ovipositor is modified into stinging organ in case of worker but queen uses ovipositor for egg laying and for stinging rival queen.

BEEKEEPING APPLIANCES

Hive stand: It can be a few bricks/ concrete blocks stacked under each hive corner, or it might be a wood frame with an alighting board. Keeps the hive off the ground reducing dampness in the hive, prolong the life of the bottom board and helps the hive entrance free from weeds.

Bottom board: It forms the floor of the hive made up of a single piece of wood or two pieces of wood joined together. Wooden beading are fixed on to the lateral sides and back side. There is a removableentrance rod in the front side with two entrance slits to alter the size of the hive entrance based on need.

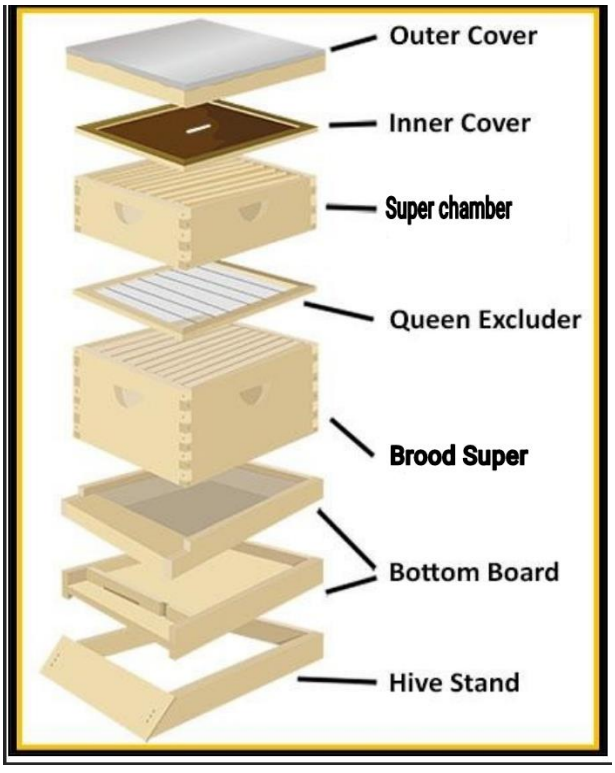
Brood chamber: It is a rectangular wooden box without atop and bottom which rest on the floorboard. Notches are made on the outer surface of the side wall for lifting. In brood frames, bees develop comb to rear brood.

Supers: It is kept over the brood chamber and its construction is similar to that of brood chamber. Super frames are hung inside. Surplus honey is stored in super chamber.

Covers: It insulates the inner portion of the hive. There are two covers:

Inner cover - flat cover with an oblong hole in the center for the exit of the bee.

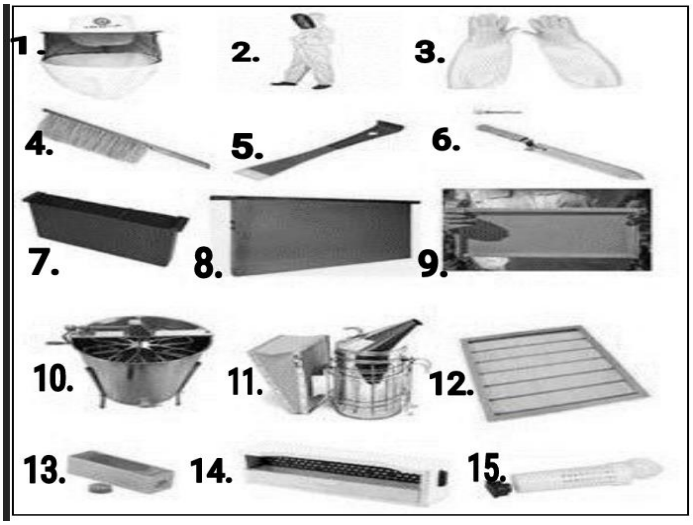
Outer cover - waterproof lid made of metallic sheet that rests on the edges of the top super. It protects the hive against rain and sun.



Frames: The frames are so constructed that a series of them may be placed in a vertical position in the brood chamber or the super chamber so as to leave space in between them for bees to move. Each frame consists of a top bar, two side bars and a bottom bar nailed together. Both the ends of the top-bar protrude so that the frame can rest on the rabbet.

Other beekeeping appliances

1.	Bee veil
2.	Overall
3.	Bee gloves
4.	Bee brush
5.	Hive tool
6.	Uncapping knife
7.	Feeder
8.	Dummy division board
9.	Comb foundation sheet
10.	Honey extractor
11.	Smoker
12.	Queen excluder
13.	Queen cage
14.	Pollen trap
15.	Queen cell protector



DISEASES OF HONEY BEE

DISEASE NAME	CAUSAL ORGANISM	PLACE & STAGE INFECTED	SYMPTOMS
Protozoan diseases: **a.** Amoebic disease	*Malpighamoeba mellificae*	Malpighian tubules; Adult	• The bees get infected by ingesting the cysts which accumulate in the posterior end of the midgut or in the rectum. • The cysts get loose, swollen and enter the glassy malpighian tubules entering intestine and show faecal matter at that place.
b. Nosemosis	*Nosema apis* *Nosema ceranae*	Intestinal tract of adult	• Dysenteric with distened abdomen with faeces, shining and swollen abdomen. • On dissection of the infested bees, the mid intestine is seen swollen & dull greyish-white in colour as it is full of spores.
Fungal diseases: **a.** Chalk brood disease	*Ascosphaera apis*	Gut; Larvae	• The pathogen mainly infects drone brood and less often to worker brood of the honey bee • White and chalky appearance
b. Stone brood disease	*Aspergillus flavus* *A. fumigates* *A. niger*	Alimentary canal; Larvae and adults	Dead larvae turn black and become difficult to crush, hard like mummies Fungus erupts from the integument of the larva and forms a false skin and larvae are covered with powdery fungal spores.
Bacterial diseases: **a.** American foul brood (AFB)	*Bacillus larvae*	Late larval or early pupal stage	• Sunken and punctured capping • Infected larvae normally die after their cell is sealed, turn dark brown and later changes into sticky mass-producing foul smell (Infected larvae darken and die).
b. European foul brood disease	*Melissococcus plutonius,* *Streptococcus pluton*	Gut; Mid-gut; usually young larvae uncapped stage	• Larvae turns watery, yellow and then brown and black the tracheal system becomes visible. • Larvae die in a coiled stage causing foul smell.
Viral disease: **a.** Thai sac brood disease	*Morator aetatulus* (Thai strain)	Skin; Larvae	• Dead larvae dry up in brood cell forming loose scale or sac like
Colony collapse Disorder (CCD)	stresses, malnutrition, pathogens andGM crops	colony; worker bees	Worker bees disappear from bee colony.

COMMON ENEMIES OF HONEY BEE AND BEE HIVES

Common name	Scientific name	Nature of damage
A. Wax moths Greater wax moth Lesser wax moth	*Galleria mellonella* *Achroia grisella*	• Eggs laid in cracks between hive parts in weak colonies. • Larva tunnel into wax combs and feeds on wax, honey and pollen in comb by making silken tunnels. • Cocoons attached to the wooden parts of equipment, their silk trails, and damaged combs all throughout the hive.
B. Predatory wasp	*Vespa orientalis,* *Vespa magnifera,* *Palarus orientalis*	• Wasps prefer the thorax portion of adult bees and discard the head and abdomen of the bees. • Some species wait on the back of the hive and capture bees coming out of crevices and macerates the bees and feed the juice to grubs. • Sometimes the wasp killed the guard bee and feed on the brood and young bees.
C. Small hive beetle	*Aethina tumida*	• Small reddish brown or black beetle covered in fine hair. • Feed pollen, wax, honey, bee eggs and larvae. • Excrete in the honey, causing it to ferment.
D. Ants	*Dorylus labiatus,* *Componotus compressus*	• Take away honey and brood • Attacks on weaken and destroy the colony
E. Mites	*Varroa destructor* *Tropilaelaps clareae* (Ectoparasitic mites)	Disfigured or stunted bees or pale and dark reddish-brown spots.
	Acarapis woodi (Tracheal)– (Endoparasitic mites)	Lives inside the breathing organs of bees. Deformed winged/ K winged condition.

COMMUNICATION IN HONEYBEE

Types of dances: The scout bees perform two types of dances

Round dance

- Communicates the distance and direction of the supply, not the distance.
- 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.

Wag-tail dance (Waggle dance)

- 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.

SEASONAL MANAGEMENT OF BEE HIVE

Spring management:

- On the onset of spring, provide sugar syrup solution.
- Provide raised comb or frames with comb foundation sheet
- Prevent swarming
- Divide the colony if colony multiplication is needed (manually)
- Follow queen rearing technique to produce new queens for new colonies (if it is required)

Monsoon management:

- Inspect the bees and make sure that the queen is there in the hive.
- Remove and destroy the diseased comb.
- Introduce queen to queenless colony.
- Unite the weak queenless colony to colony with queen.
- Provide supplement like sugar syrup, candy by artificial feeding.
- Keep the hives in tilted position so as to drain out the accumulated water inside the hive.

Summer management:

- Place the hive behind artificial or tree cover.
- To lessen the severe heat, sprinkle water on the gunny sack or rice straw that is included with the hive.
- Provide timely pollen alternatives, adequate ventilation, and sugar syrup.
- Freshwater, liquids, shelter, and windbreak provision become essentials for the colony.

Autumn/ fall management:

- During this time, management strategies are based on the meteorological and floral conditions of the beekeeping area. The hive is winterized with the help of fall management.
- Check the hives for pests, diseases, and the presence of the queen.
- If the local bee flora is scarce, offer a sugar syrup solution.
- Decrease the amount of comb space by getting rid of superfluous frames and adding a dummy division board.

Winter management:

- Shrink the hive entrance to protect it from the cold.
- Plugging all cracks and crevices in the hive
- Protecting the colonies from direct chilly winds.
- Provide artificial nutrition
- Provide queen to the queenless colony.
- In colder climates, follow winter packing.

BEE PASTURAGE AND FORAGING

Important bee pasturage

- Good nectar source: tamarind, moringa, neem, *Prosopis juliflora, Soapnut tree, Glyricidia maculata, eucalyptus, Tribulus terrestris* and pungam.
- Good pollen source: sorghum, sweet potato, maize, and tobacco, millets like cumbu, tenai, varagu, ragi, coconut, roses, castor, pomegranate and date palm.
- Both source of pollen and nectar: banana, peach, citrus, guava, apple, Sunflower, berries, safflower, pear, mango and plum.

Recording bee behavior

- Select a particular crop and 2 m^2 are (preferably rapeseed mustard)
- Count the no. of bee visiting in that particular area per 5 min
- Number of bee visiting in the same flower per 2 min
- Time duration of the bee landing on the flower
- Take the observation in morning, afternoon and evening

SPECIES OF SILKWORM

Silkworm species	**Colour of cocoon**	
1. Mulberry silkworm (*Bombyx mori)*	Creamy white	
2. Tasar silkworms- Tropical tasar (*Antheraea mylitta)* Temperate tasar (*Antheraea proylei)* Chinese tasar (*Antheraea pernyi)* Japanese tasar (*Antheraea yamamai)*	Coppery	
3. Eri silkworm - *Samia ricini*	White	

4.Muga silkworm (*Antheraea assamensis)*	Golden yellow	

CULTIVATION OF MULBERRY

Cuttings: Harvest the shoots (well grown for 6-8 months) from a mulberry garden (seed garden) with a secateurs / pruning saw. Cover the shoots with wet gunny cloth. Avoid thin upper portion and thick lower portion of the shoots. After selecting the shoots, prepare the cuttings by a secateur without damaging the bark. Cuttings can also be prepared with the help of cutting machine. Prepare cuttings of 12-15 cm length and 10-15 mm diameter with 3-4 active buds.

Grafts: Make a slanting cut to the stem which is to be used as scion. Take a seedling and prepare the stock out of it. Scion should be of lesser diameter than the stock to facilitate union of the two. The stock can be prepared by giving a slanting cut out of the roots of the seedling. The stock is mostly prepared from a well-adapted variety to the local conditions. Insert the scion into stock carefully in between the bark and woody portion of the stem. Ensure that a minimum gap is left while inserting a scion into a stock. Bandage the portion of the newly prepared graft at the place of union of stock and scion. Plan the graft in the well-prepared nursery bed. Irrigate the nursery immediately and as and when required. Uproot the grafts same as of saplings raised through stem cuttings.

Mulberry varieties

Irrigated	:	Kanva 2, MR 2, S 30, S 36, S 54, DD (Viswa), V1
Semi irrigated	:	Kanva 2, MR 2
Rainfed	:	S 13, S 34, RFS 135, RFS 175, S 1635

Method of Harvesting:

Leaf picking: Harvest individual leaves with or without petiole. Starts leaf picking 10 weeks after bottom pruning and follow subsequent pickings at an interval of 7 - 8 weeks.

Branch cutting: Cut the entire branches for feeding the worms. Ensure topping before that for uniform maturity of the lower leaves.

Whole shoot harvest: Cut the branches at ground level by bottom pruning. Harvest shoots at an interval of 10-12 weeks and thus 5 to 6 harvests are made in a year.

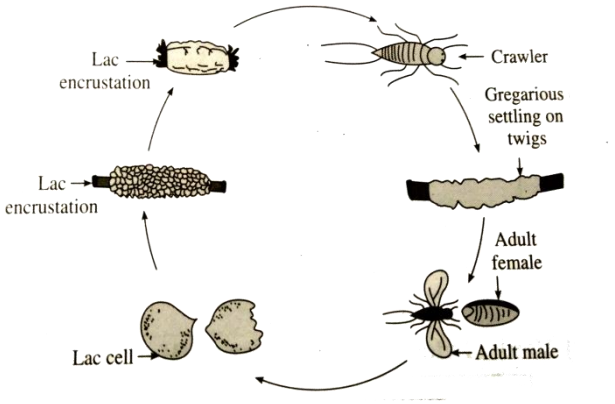
Preservation of leaves: Use leaf preservation chamber or wet gunny bags to store the leaves or cover the bamboo basket with wet gunny bags to keep it cool and fresh.

BIOLOGY OF MULBERRY SILKWORM

Procedure: Collect eggs after mating pairs of silk moth. When the incubation period completed, transfer the hatched egg to rearing tray with the help of feather. Sprinkle the chopped pieces of mulberry leaves over the newly hatched young larva. Spread the larva on the bed with the help of chopstick. The food, spacing and cleaning to be carried out as per the stages of the larvae and requirements. Four feedings of chopped mulberry leaves to be given in a day. The size of the chopped leaves is to regulate according to conditions and size of the larvae. During moulting don't provide any food to the larva and not disturbed. The quantity of food should increase as per the growth of the silkworm. When the larva ceases to eat and become translucent with creamy colour, transfer them to the mountage for spinning the cocoon. Allow the larva to spin the cocoon and note for the emergence of adults.

CULTIVATION OF LAC INSECT

Inoculation: Prune the host plants in Jan or June. Only light pruning should be carried out. Cut the brood twigs in of size 20 - 30 cm in length. Tie the cut pieces of brood twig to fresh tree twigs in such a way that each stick touches the tender branches of trees at several places. After swarming, remove the brood twigs from the host plant



Precautions

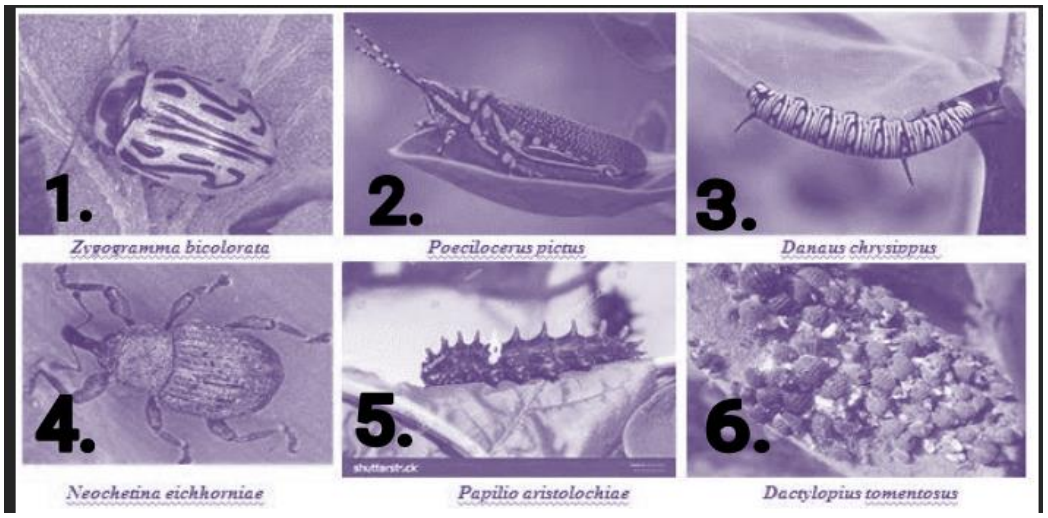
- Fully mature and healthy brood free from pest infestations should be taken.
- Brood meant for inoculation should not be kept for long and used immediately after crop cutting.
- Tying of the brood lac stick should be done securely on the upper surface of branches. This will prevent falling of twigs and provide full contact for quick and easy crawling of the nymphs. One should keep a watch on the brood lac dropping down.
- Sometime due to bad weather, swarming of nymphs from brood is prevented. Hence, the room storing brood lac sticks is moderately heated to 200°C to induce swarming, and then sticks are tied.
- Generally, cultivation of kusumi in rangeeni area and vice versa should be avoided. Brood lac from a particular host used year after year is likely to deteriorate in quality. Therefore, alternation of brood and host give production of a better quality of brood lac.

Host plant of Lac insect includes:

Butea monosperma (Palas)	*Zizyphus* spp (Ber)	*Cajanus cajan* (Pigeon-pea)
Schleichera oleosa (Kusum)	*Acacia catechu* (Khair),	*Grewia teliaefolia* (Dhaman)
Acacia arabica (Babul)	*Acacia auriculiformis* (Akashmani)	*Albizzia lebbek* (Siris)
Flemingia macrophylla (Bholia)	*Shorea talura* (Sal)	*Ficus religiosa* (Peepal)

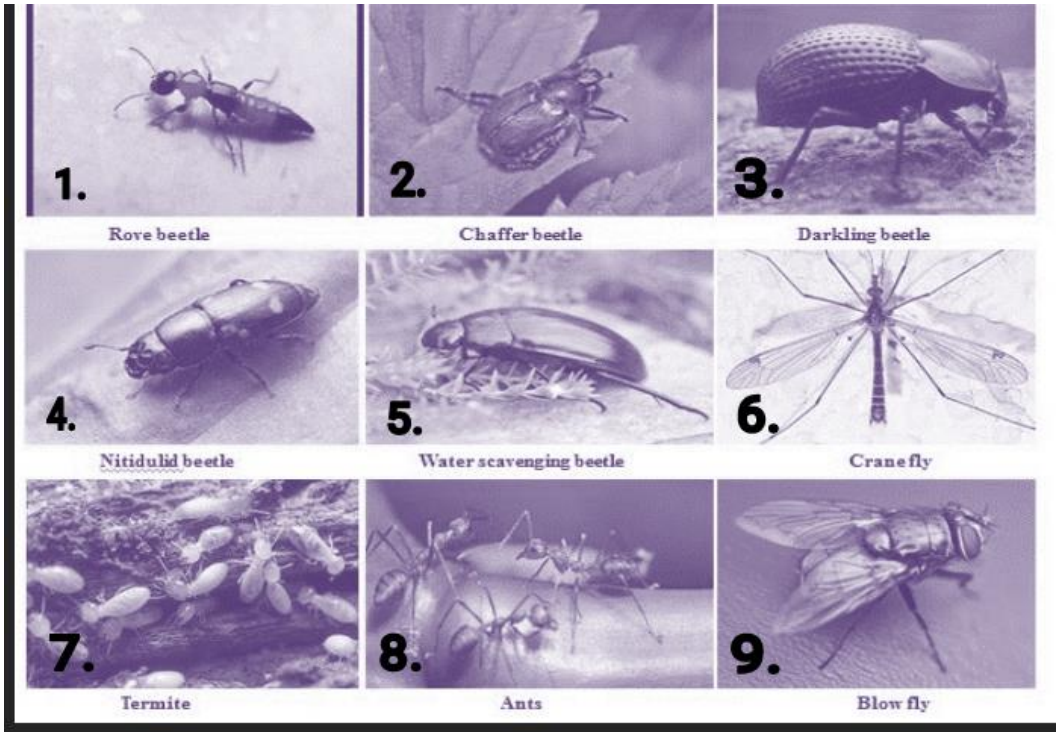
WEED KILLERS AND SCAVENGERS

Some important weed killers:



1. *Zygogramma bicolorata* feed on carrot grass
2. *Poecilocerus pictus* feeds on milk weed
3. *Danaus chrysippus* feeds on milk weed
4. *Neochetina eichhorniae* feeds on water hyacinths
5. *Papilio aristolochiae* feeds on *Arista lochia*
6. *Dactylopius tomentosus* feeds on prickly pear

Scavengers



1. Rove Beetle- *Neobisnius ludicrus*
2. Chaffer beetle- *Amphimallon majale*
3. Darkling beetle- *Ecnolagria tomentosa*
4. Nitidulid beetle- *Glichrochilus quadrisignatus*
5. Water scavenging beetle- *Hydrophilus triangularis*
6. Crane fly- *Tipula paludosa*
7. Termite- *Odontotermes obesus*
8. Ants- *Camponotus spp.*
9. Blow fly- *Chrysomya rufifacies*

INSECT POLLINATORS

Important insect pollinators includes Honey bees, Carpenter bee, Digger bees wasp, Hoverflies, Butterflies, Moths, Ants, flies, stingless bees, beetles etc.

i. Bees (honey bees, solitary species, bumblebees):

Body covered with hairs and have structural adaptation for carrying nectar and pollen.

ii. Hoverflies *Syrphus* sp.

Brightly coloured flies

Body is striped or banded with yellow or blue

Resemble bees and wasps

Larval stage predatory, adults are pollinators

iii. Carpenter bee, *Xylocopa* sp.

Robust dark bluish bees with hairy body

Dorsum of abdomen bare, pollen basket absent

Adults are good pollinators

Construct galleries in wood and store honey and pollen

iv. Digger bees, *Anthophora* sp.

pollen collecting bees

ith black and blue bands

v.* Fig wasp *Blastophaga psenes

Fig is pollinated by fig wasp only. There is no other mode of pollination.

PARASITOIDS AND PREDATORS

Parasitoids:

Trichogrammatidae: Very minute insect with three segmented tarsi. Forewings-broad, stubby and paddle shaped with a long fringe of seta around the outer margin.

Ichneumonidae: Size 5-10mm; long antennae, long ovipositor and extruded permanently. Distinct pterostigma and narrow costal cell on forewing; two distinct recurrent cross veins.

Braconidae: Tiny wasp upto 5mm, only one recurrent vein, cross vein m-Cu is absent in forewing

Chalcididae: Among the smallest metallic coloured insects (<3 mm). Hind femur stout with rows of short teeth; Ovipositor short and straight.

Other parasitoid families: Evaniidae, Scelionidae, Platydasteridae, Bethylidae, Encyrtidae, Tachinidae, etc

Predators:

Coccinellidae: Adult-small, oval or spherical, convex, brightly covered with coloured spots. Larvae campadeiform usually covered with minute tubercles or spines

Chrysopidae: Bright green body with wing veins and iridescent eyes. Eggs with long pedicel

Syrphidae: Wasp or bees like, brightly coloured with yellow stripes or bands. These are distinguished from other flies by a spurious vein, located parallel to the fourth longitudinal wing vein.

Mantispidae: Pronotum elongated and doesn't cover the head. Forelegs are raptorial

Other Predatory families: Reduviidae, Gerridae, Anthocoridae, Carabidae, Meloidae, Staphylinidae, Asilidae etc

MASS MULTIPLICATION OF PREDATOR-*Chrysoperla carnea*

Mass production of *Chrysoperla carnea* (green lace wing)

Release adult *Chrysoperla* (approximately 200 in numbers) into an oviposition cage with sliding top cover fitted with black cloth for depositing the eggs. Provide protein diet (water + honey + protinex mixture + castor pollen) for the adults. Replace the eggs on the black cloth of sliding top cover on alternate days starting from 5th day onwards. Keep the eggs on the black cloth for 24 h to facilitate hardening of the chorion and later dislodge by gently rubbing with piece of sponge. Collect the eggs for larval rearing. Mix 3 days old chrysopid eggs (approx. 120 in no.) with 1.0 cc of inactivated *Corcyra* eggs in plastic containers. On 3rd day, transfer the *Chrysoperla* larva to 2.5 cm cubic cells of plastic louvers for individual rearing (to prevent cannibalism). The total amount of *Corcyra* eggs required for 100 *Chrysopid* larvae is 5.0 cc. Collect cocoons after 24 hrs of formation and place in the oviposition cages for adult emergence and egg laying. The eggs that are laid can be used for field release or used for further culturing.

Precautions: *Chrysopid* eggs should always packed in container with saw dust and paper strips in order to reduce the contact and cannibalism. Releases should be made early in the morning. Don't release them as eggs as they can be eaten by other predators. Do not use pesticides in the field where the predators are released.

MASS MULTIPLICATION PARASITOID

***Trichogramma* spMass culture of the laboratory hosts (*Corcyra cephalonica*) of the**

Trichogramma:

Sterilized 500g of maize grind in oven at 100 °C for 30 minutes. Spray the cool sterilized grains with 0.2% formalin and air dry the grains. Pour the grains into rearing boxes @ 2.5 kg / box. Inoculated each box with 0.5cc *Corcyra* eggs and close by placing the lid. Collect the emerged moths daily starting from 40 days after inoculation and transfer to oviposition cages. Place the oviposition cage over a plate for egg laying. Cover the upper and lower side of the cage with fine GI wire net with a circular window hole on its upper side. The eggs were collected every day, cleaned and the scales were removed by blowing by a fan.

Mass multiplication of *Trichogramma* (egg parasitoid)*:*

Sterilize fresh eggs of *Corcyra* by exposing to UV light to kill embryo. Glue the sterilized eggs to Trichocard in a uniformly thin layer (1 cc to each Trichocard). Divide the card into six strips and insert into another glass tube having newly emerged adults of the *Trichogramma* sp. Apply honey on the inner sides of the tube bands to feed the adult parasitoid and cover with muslin cloth and rubber. Change the card after 24 hours (for 3-4 days or till the female remains productive) and replace with fresh card. After 3 days of parasitization on the host egg, the parasitized eggs can be used for field release or stored at 10°C for fortnight.