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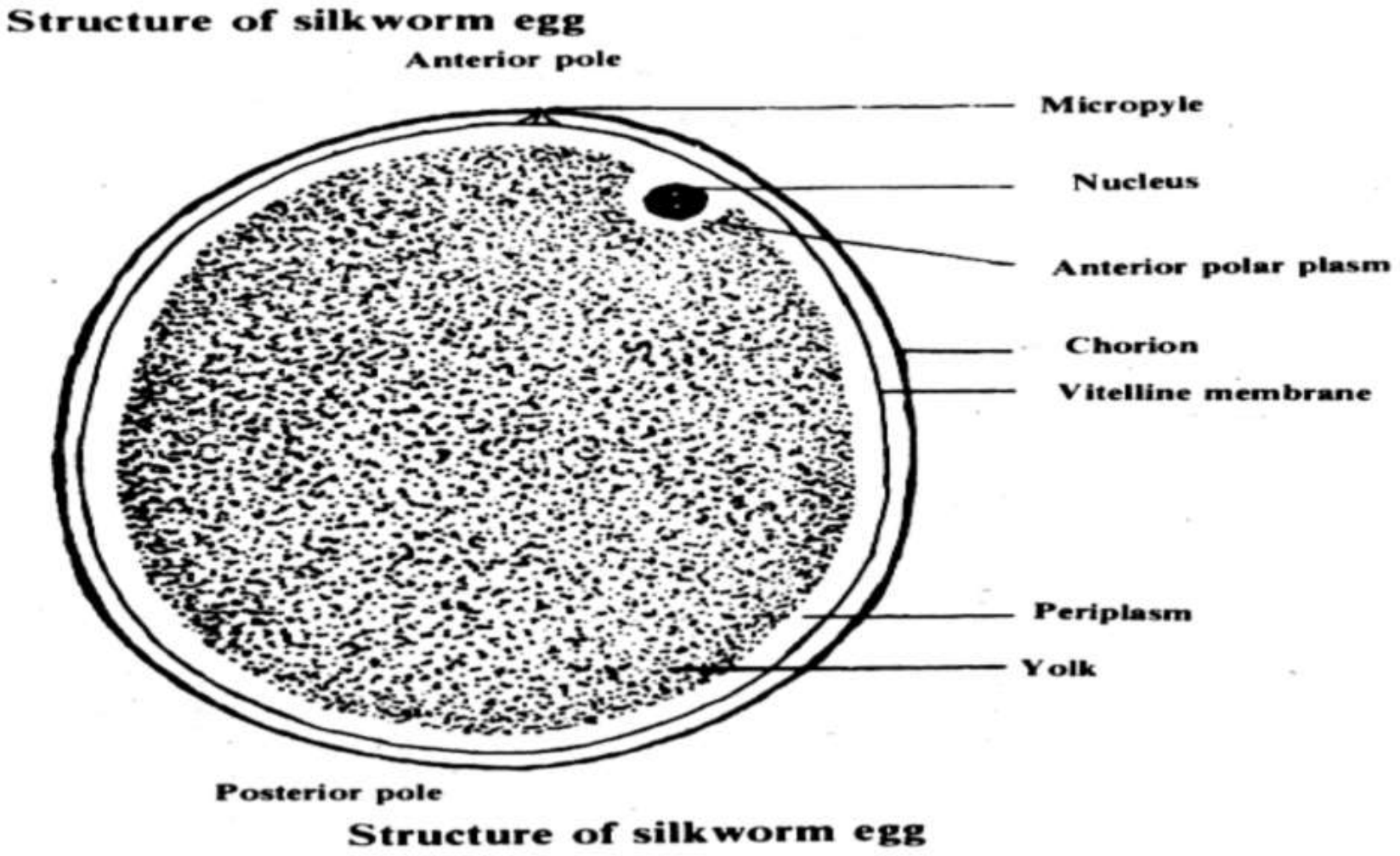
Unit – 2
Biology of silk moth

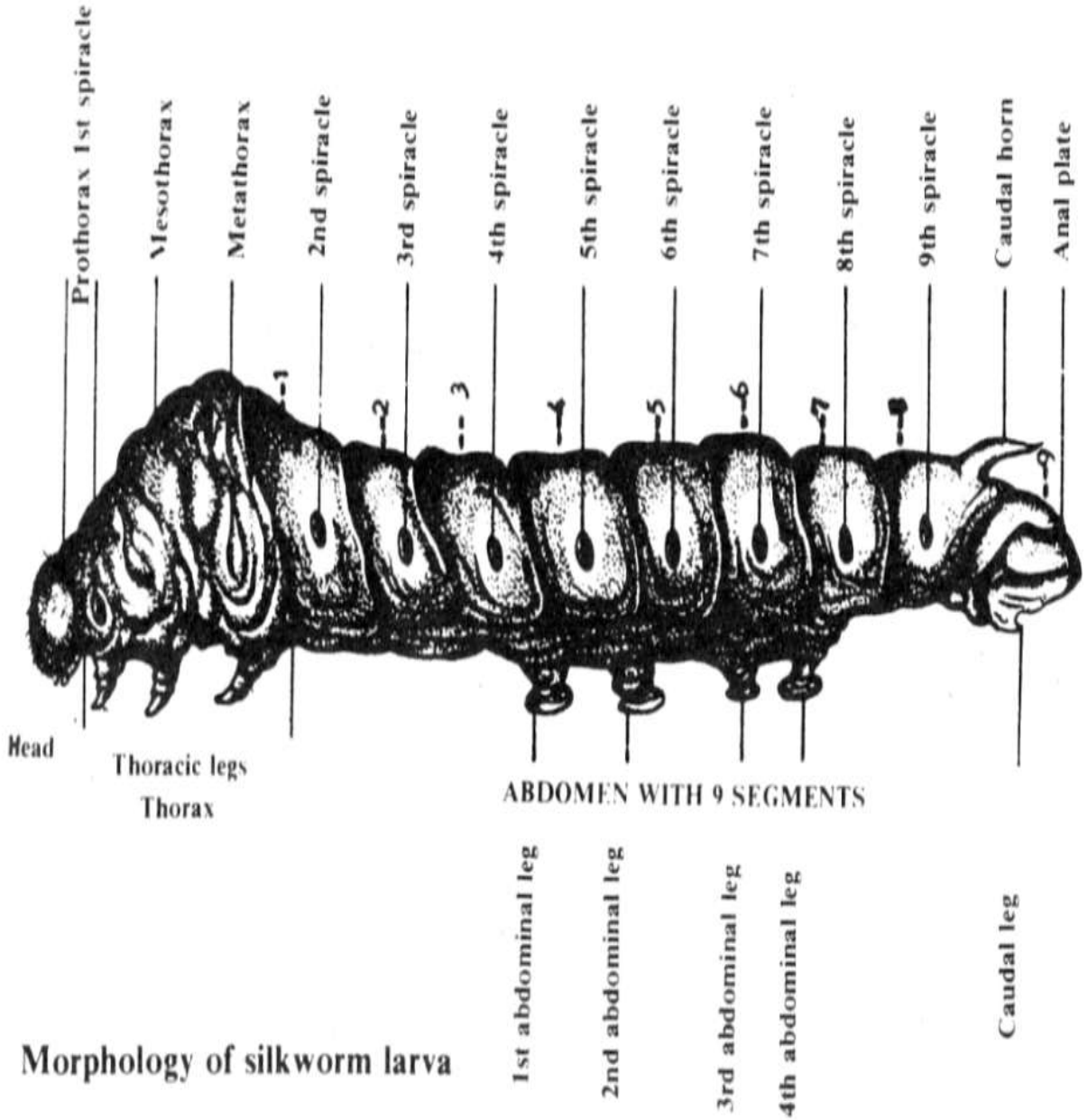
Synopsis

Anatomy of silk worm – Digestive system including mouth parts, reproductive system, life cycle including moulting and metamorphosis, silk glands spinning of silk threads, disease and pests of mulberry silk worm.

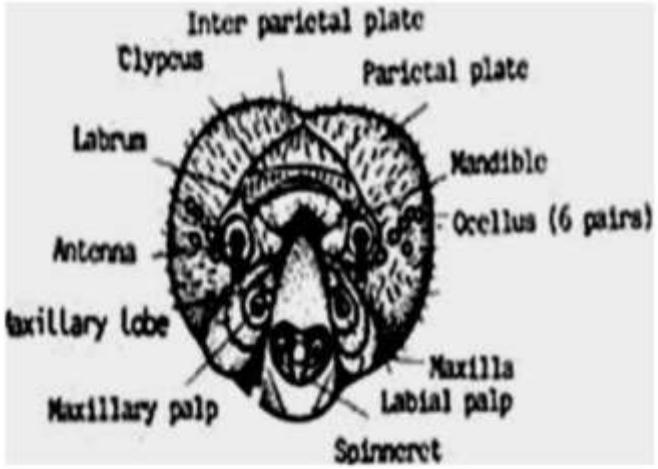
Morphology of silk worm



Structure of silkworm egg



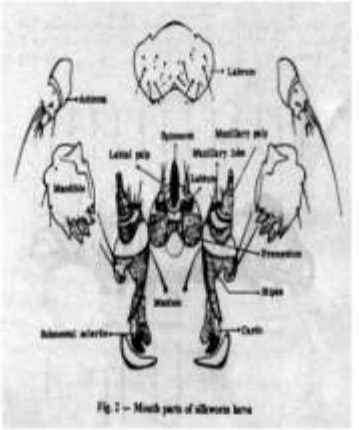
Morphology of silkworm larva

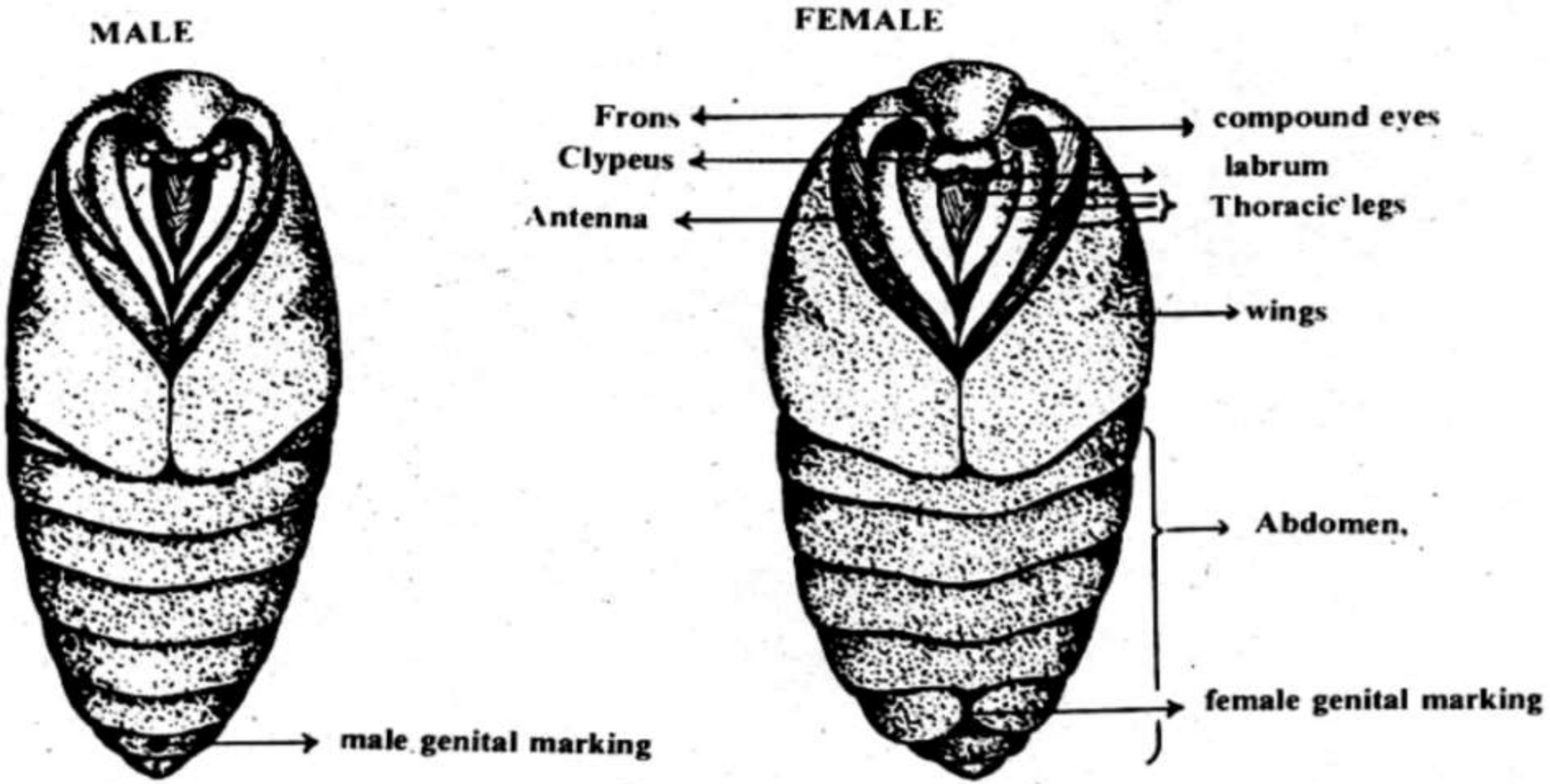


Magnified Head od the silkworm

Coloured scanning electron micrograph

(SEM) of the head of a silkworm

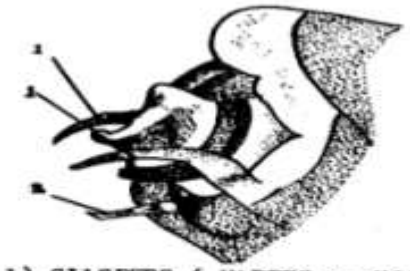




Drawing of male and female pupa

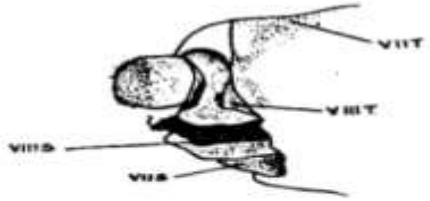
Bombyx mori

Female and Male Moths



1) CLASPERS (HARPES or HOOKS)
2) AEDEAGUS

Abdominal end of male moth



(lateral view)

VII T ▲ VIII T-7 ▲ 8 Abdominal tergite

VII ▲ VIII S — 7 ▲ 8 Abdominal sternites

Abdominal end of female moth

Anatomy of silk worm

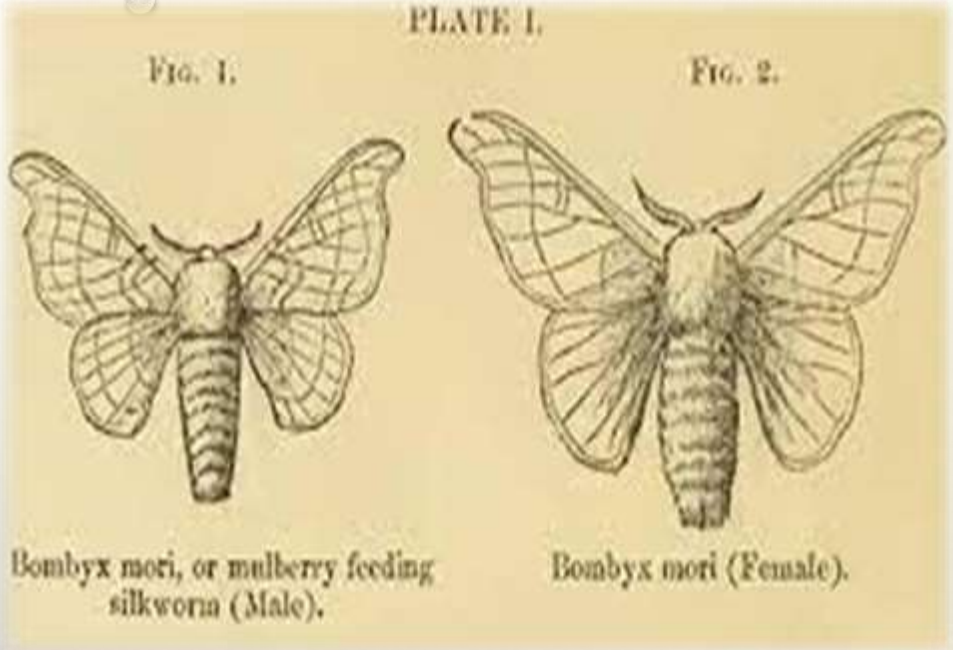
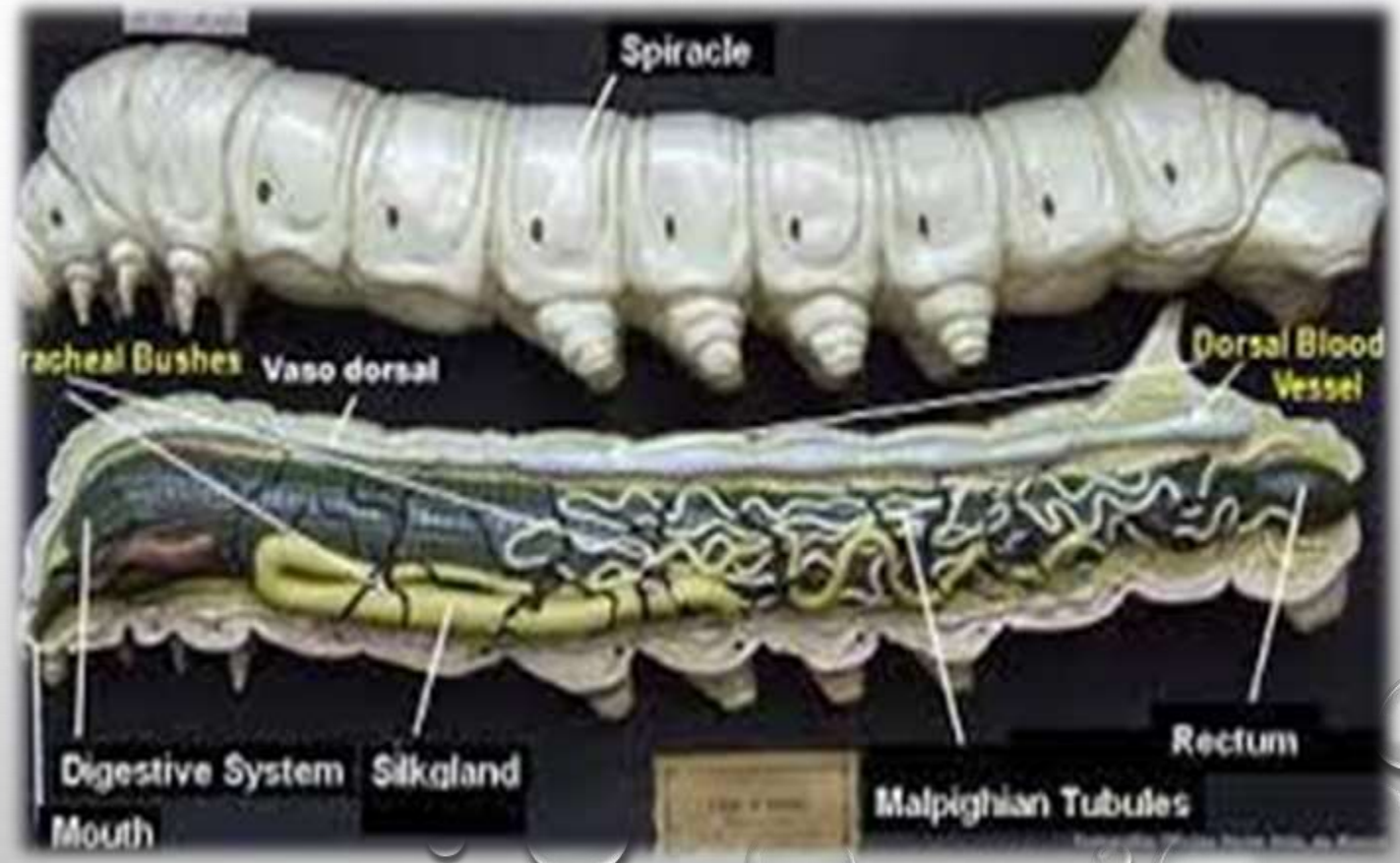


PLATE I.

Fig. 1. Fig. 2.

Bombyx mori, or mulberry feeding silkworm (Male).

Bombyx mori (Female).

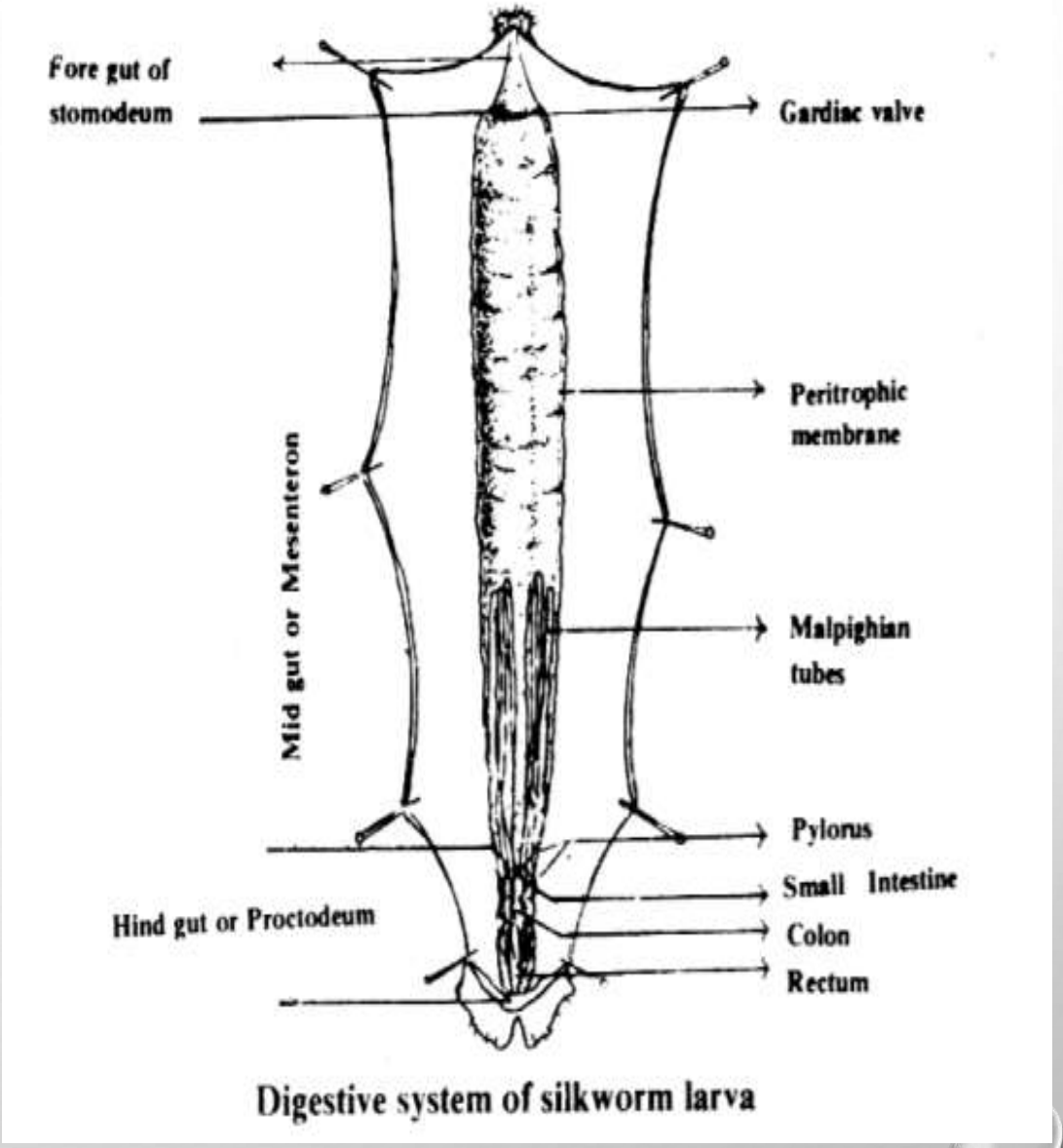


Digestive system of silk worm

- In the silkworm larva the digestive system is more or less a straight tube from the mouth to the anus divided into three main parts-

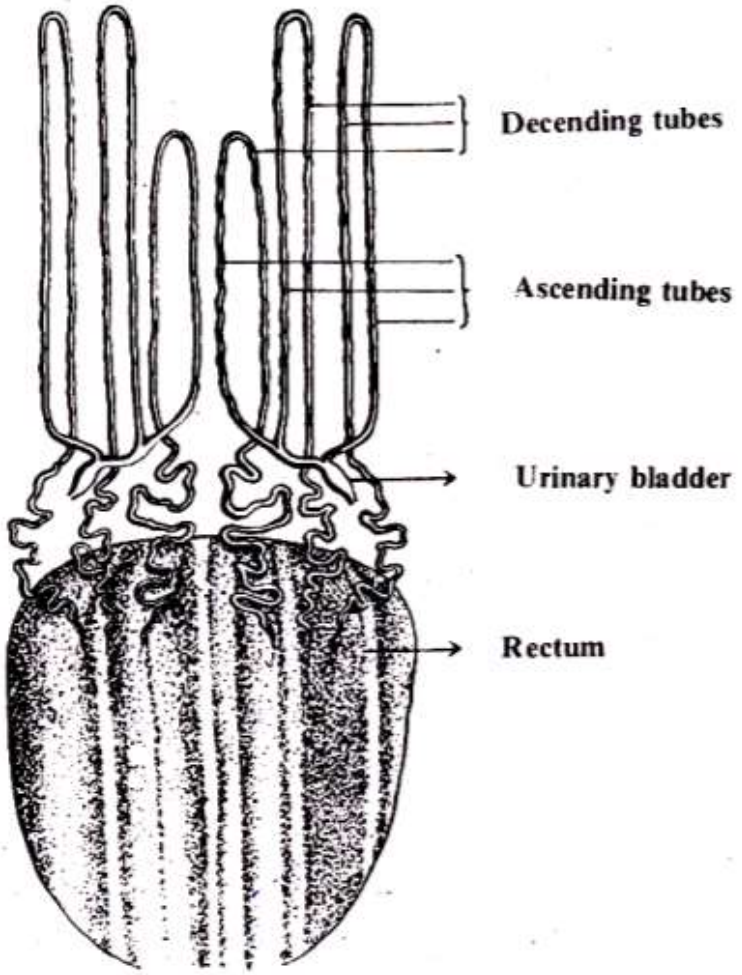
1. Fore gut or stomodeum
2. Mid gut or mesenteron
3. Hind gut or proctodeum

- The oral aperture opens into the mouth cavity which is followed by a narrow pharynx and oesophagus.
- Oesophagus is narrow at the anterior end and gradually widens towards the posterior end.
- There is a cardiac or stomodeal valve at the end of the fore gut that retains the chewed mulberry leaf bits in the oesophagus for some time and also prevents the regurgitation (backward flow) of food from mid gut to fore gut.
- The fore and hind gut have a chitinous lining.
- The hind gut consists of the small intestine, colon and rectum and a pylorus valve near the anterior end of the small intestine, which guards and regulates the passage of digested food.



Digestive system of silkworm larva

EXCRETORY SYSTEM OF SILKWORM LARVA:



Excretory system of silkworm larva

Reproductive system of silk worm

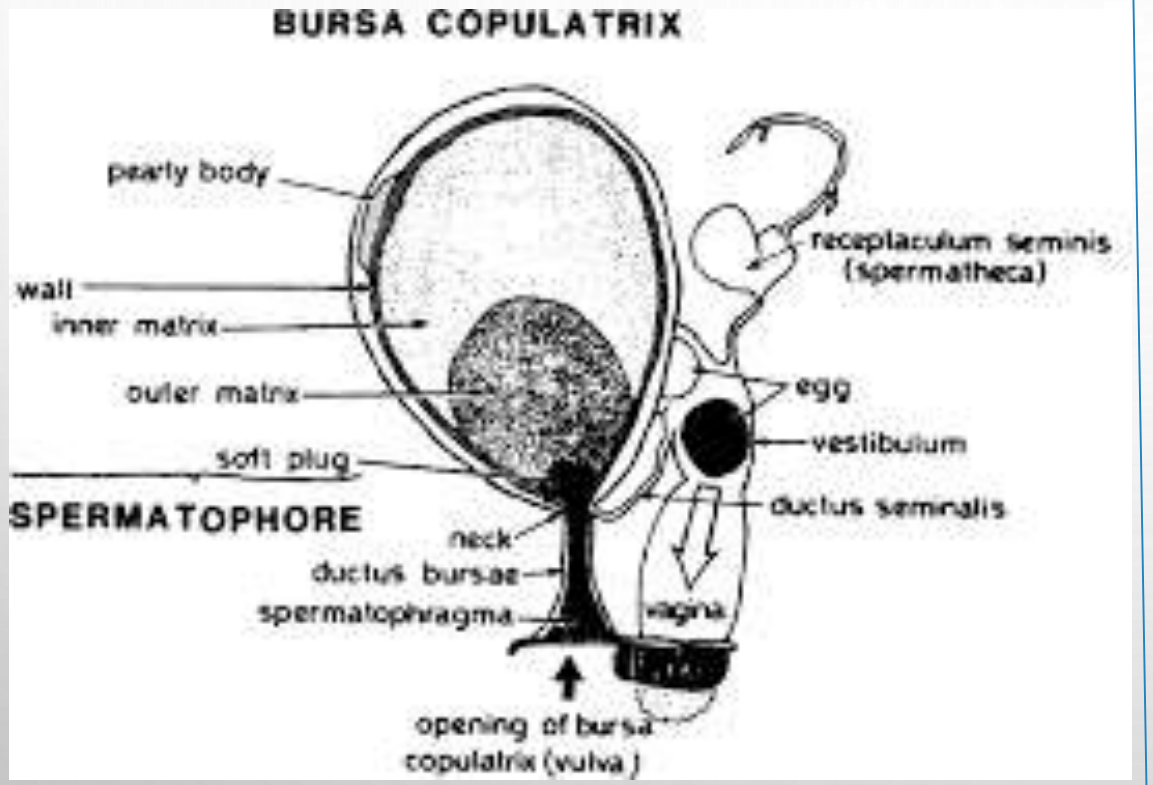


Fig. Female reproductive system

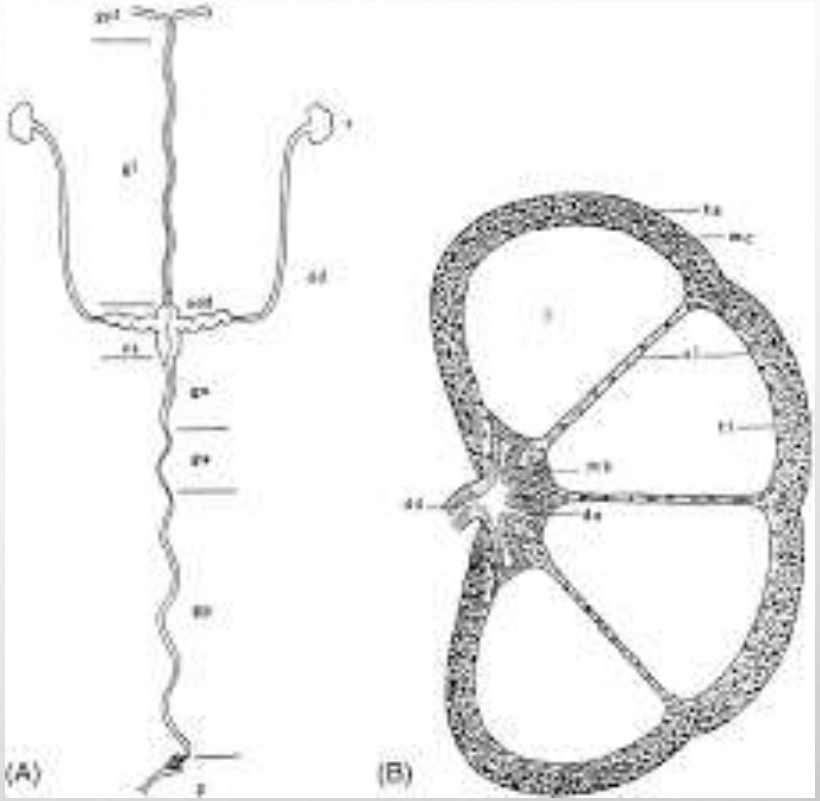


Fig. male reproductive system

REPRODUCTIVE SYSTEM

In the larva, the sexual phase develops in the late instars when it may be possible to note in the female, a pair of triangular ovaries (gonads) situated on the dorsal side of the sixth abdominal segment; from each of which a blind tube arises and terminates at the eighth abdominal segment. The pair of translucent spots seen ventrally on the eighth abdominal segment is the Ishiwata's foreglands and the pair on the ninth abdominal segment is the Ishiwata's hind-glands. These four ventral spots are prominent in the fifth instar and are used to identify the female larva.

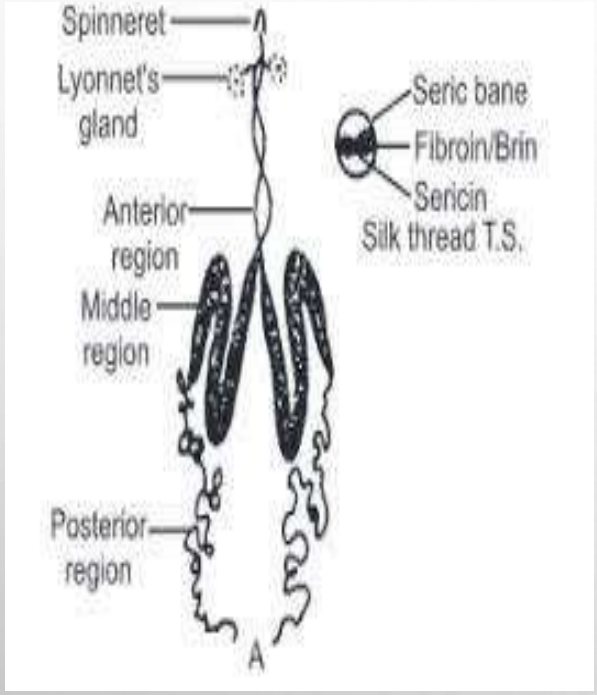
The male larva consists of a pair of kidney-shaped testes (gonads) on the dorsal side of the fifth abdominal segment and a blind tube which is connected with the Herold's gland - a milky white body-at the centre of the ventral side between the eighth and ninth abdominal segments.

In the female moth, paired ovaries occupy most of the abdominal space.

Female Reproductive System (Enlarged)

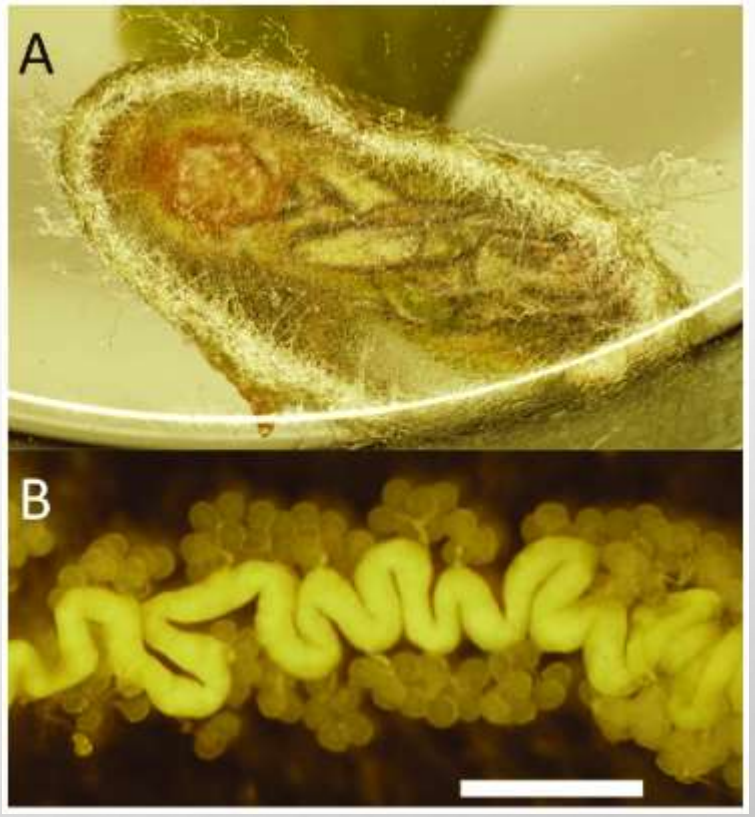
A pair of lateral oviducts arises from the ovaries and unites to form a single, wide common oviduct that ends in the ovipositor at the posterior end of the body. Each of the ovaries carries four egg tubes or ovarioles where the eggs are formed. The ovarioles are polytrophic and an alternating succession of nurse cells and oocytes (developing eggs) are found in the egg chambers particularly in the pupal stage. In the adult stage, the four pairs of ovarioles look like coiled strings of beads containing eggs. The *bursa copulatrix* is a sac-like structure situated ventrally to the common oviduct and continues as a tube to the outside posteriorly on the eighth abdominal segment. At the time of mating, the *aedeagus* is received by the opening, *ostium bursae,* of this tube. The *bursa copulatrix* also opens into the common oviduct by a narrow tube known as the seminal duct. Paired accessory glands occur dorsally to the common oviduct. The accessory glands produce an adhesive material which coats the eggs when they pass down the common oviduct and glues them to the substratum when they are laid. The spermatheca is a sac-like structure for the reception and storage of spermatozoa and opens into the common oviduct anterior to the accessory glands opening.

Silk Gland


Spinneret
Lyonnet's gland
Anterior region
Middle region
Posterior region
A
Seric bane
Fibroin/Brin
Sericin
Silk thread T.S.

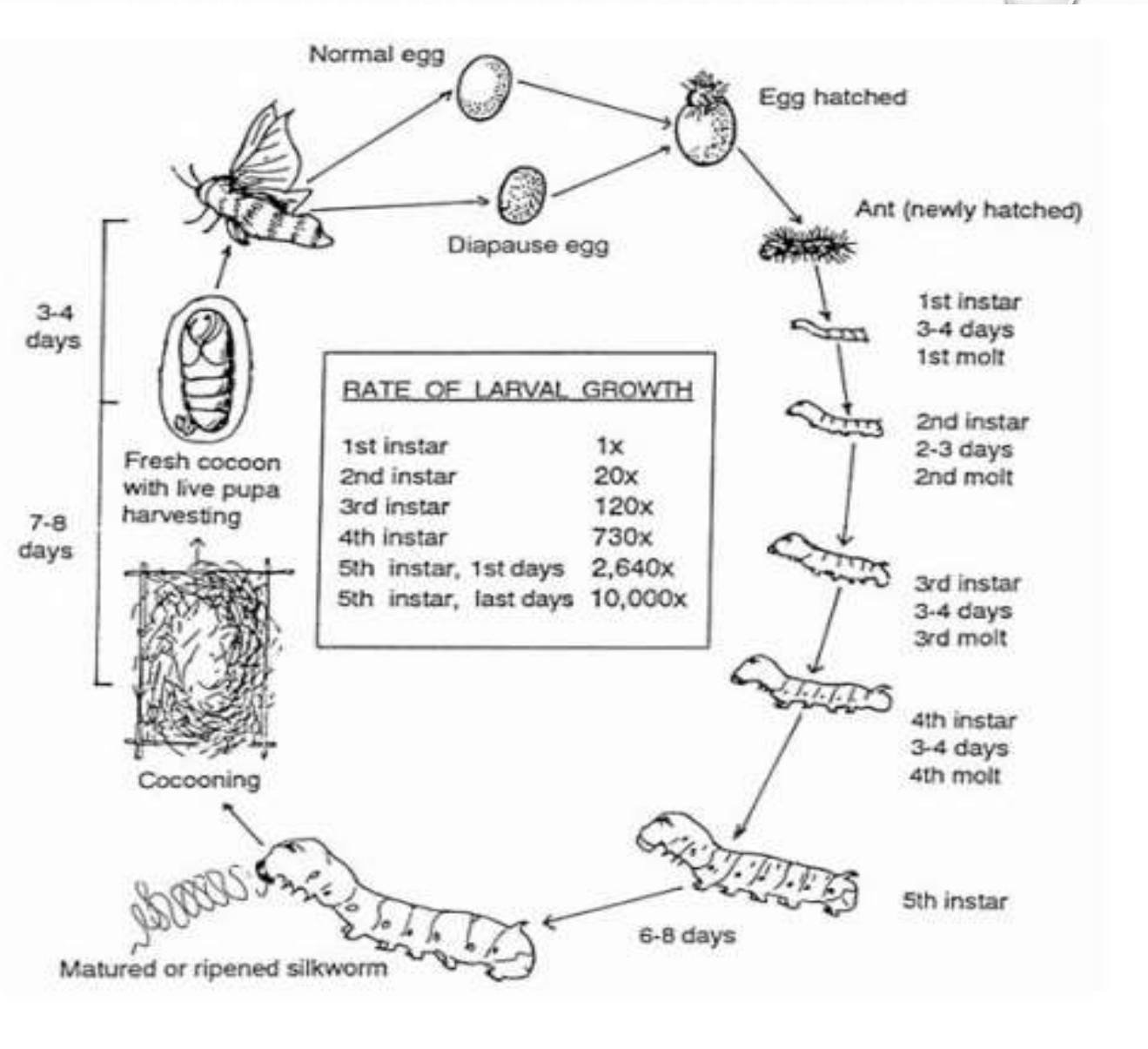

Fibroin
Sericins

Spinneret
Fillipi's gland
Anterior silk gland
Middle silk gland
ser-2
ser-1
Posterior silk gland
H-fib
L-fib
fhx


A
B

The life cycle of silkworm

- The life cycle of silk moth starts when a female silk moth lays eggs.
- The caterpillar or larvae are hatched from the eggs of the silk moth. The silkworms feed on mulberry leaves and give rise to pupa.
- In the pupa stage, a weave is netted around by the silkworm to hold itself. After that it swings its head, spinning a fibre made of a protein and becomes a silk fibre.
- Several caterpillars form a protective layer around pupa and this covering is known as the cocoon. The silk thread (yarn) is obtained from the silk moth's cocoon.



Moulting

- Moulting is the process when silkworms seized feeding, becomes immobile and prepare themselves for shedding their old skin to accommodate the fast growth. Four moults takes place during the entire larval period
- Moulting period **lasts for about 24 hrs** and care should be taken not to disturb silkworms during this period.

Complete Metamorphosis

- A silkworm moth has a complex life cycle in which the immature animal—the larva—grows and molts (sheds its exoskeleton) several times in succession.
- These larval stages are called instars. The last larval instar then becomes a **pupa**, a stage in which the animal transforms, or metamorphoses, into an adult.

DISEASES OF MULBERRY SILKWORM

1. Viral Disese

Symptom:

•The larvae will be sluggish with swollen inter-segmantal region
•The integument of diseases larvae will be fragile and brakes easily
•On infury milky fluid containing many polyhedral inclusion bodies oozes out from the larval body
•The diseases larvae do not settle for moult and showshining integument
•The larvae appear to be restless
•The dead larvae hand by hind legs head downward

Management

1.Sun drying of rearing appliances for one/two days
2.Disinfection of rearing room and appliances with 5% bleaching powder
3.Disinfection of worms, trays and discarding of diseased worms
4.Ensure proper ventilation and air circulation
5.Provide proper bed spacing
6.Feed the larvae with nutritious mulberry leaves
7.Collect and burn infected larvae, faecal matter and bed refuses
8.Early diagnosis and rejection of infected lots
9.Dust the bed disinfectant, Vijetha (or) Resham Keet Oushadh on the larvae, after each moult and ½ hr. before resumption of feeding (3 kg/100 dfl).
10.Spray 1% of extract of *Psoralea coryleifolia* on mulberry leaves, shade dry and feed worms once during third instars.

2. Bacterial Diseases

Bacteria and viruses cause the disease individually or in combination. Fluctuating temperature and humidity and poor quality mulberry predispose the disease development.

- The diseased larvae will be stunted in growth, dill lethargic soft and appear flaccid
- The cephalothoracic region may be translucent
- The larvae vomit gut juice, develop dysentery and excrete chain type fecus.
- The larvae on death putrefy, develop different and emit foul smell

Management

1. Maintenance of hygienic condition
2. Disinfection of rearing room and appliances
3. Disinfection of worms, trace and discarding of sick worms
4. Avoid injury to the worms, overcrowding of trays and accumulation of faeces in the rearing bed
5. Sound management, improving the rearing environment and feed stuff
6. Feeding the larvae with healthy nutritious leaves.
7. Early diagnosis and rejection of infected lots
8. Avoid spraying commercial ***B. t.*** insecticides in nearby mulberry field.
9. Apply antibiotics like Streptomycin/Tetracyclin/Ampicillin

3. Fungal Diseases

White muscadine is caused by a fungus *Beauveria bassiana* and the green muscadine is caused by a fungus *Spicaria prasina*. Aspergillosis is common in young age silkworms and the infected larvae will be lustrous and die. Dark green (*Aspergillus flavus*) or rusty brown (*Aspergillus tamari*)mycelial cluster are seen on the dead body.

- The diseases larvae prior to death will be lethargic and on death are flaccid
- oil specks may be seen on the surface of larvae
- They gradually be fome hard, dry and mummify into a white or green coloured structure
- The diseases pupae will be hard, lighter and mummifies

Magagement

1. Sundry the rearing appliances.
2. Disinfect the rearing room and utensils with 5 per cent bleaching powder
3. Avoid low temperature and high humidity in the rearing room
4. Keep the rearing bed thin and dry
5. Early diagnosis and rejection of infected lots
6. Apply Dithane M45 (3 kg/100 dfls) / Vijetha supplement as disinfectant on the larvae
7. Disinfect rearing rooms and trays with 4 per cent pentachlorophenol to control Aspergillosis.

Diseases of mulberry silkworm

I. DISEASES

1. GRASSERIE:

Causative agent: *Bombyx mori* Nuclear Polyhedrosis Virus

Occurrence: The disease prevails all through the year but its severity is more during Summer and Rainy seasons.

Source of infection: Silkworm gets infected when it feed on contaminated mulberry leaves. The milky white fluid released by the grasserie larvae, contaminated silkworm rearing house and appliances are the sources of infection.

Predisposing factors: High temperature, low humidity and poor quality mulberry leaves.

Symptoms:

•The skin of infected larvae becomes shining before moult and fails to moult.

• Inter segmental swelling appears and the colour of the body becomes yellowish.

•The infected larvae move restlessly in the rearing bed/ along the rim of the trays.

•Infected larval body ruptures easily and turbid white haemolymph oozes out.

Management:

•Practice thorough disinfection of rearing house, its surroundings and appliances with any recommended disinfectant.

•Conduct an optional disinfection with 0.3% slaked lime solution when high incidence of disease noticed in the previous crop.

•Practice personal and rearing hygiene.

•Collect the diseased larvae and ensure its proper disposal.

•Maintain optimum temperature and humidity in the rearing house.

•Feed quality mulberry leaf and avoid overcrowding.

•Apply recommended bed disinfectant as per schedule and quantity.

•Feed Amruth as per schedule to control grasserie disease.

2. FLACHERIE:

Causative agent: *Bombyx mori* Infectious *flacherie* virus/*Bombyx mori Densonucleosis* virus or different pathogenic bacteria viz., *Streptococcus* sp./Staphylococcus sp./*Bacillus thuringiensis*/*Serratia marscesence* individually or in combination of bacteria and viruses.

Occurrence: The disease is common during Summer and Rainy seasons.

Source Infection: Silkworm gets infected by eating contaminated mulberry leaf. Dead diseased silkworm, its faecal matter, gut juice, body fluid are the sources of pathogen contamination. The infection can also takes place through injuries/cuts/wounds.

Predisposing factors: Fluctuation in temperature, high humidity and poor quality of leaves.

Symptoms:

The larvae become soft and flaccid.

The growth of infected larvae retarded, becomes inactive and vomit gut juice. The faeces become soft with high moisture content. Sometimes chain type excreta and rectal protrusion also observed.

Larval head and thorax become translucent.

When infected with Bacillus thuringiensis symptoms of toxicity such as paralysis and sudden death are observed. After death, larvae turn black in color and gives foul smell.

Some times, the dead larvae turn red when infected with Serratia sp.

Management:

Disinfect the rearing house, its surroundings and equipments with recommended disinfectant mentioned above.

Pick up diseased larvae and dispose them by burning.

Provide good quality leaf grown under good Sunlight and recommended inputs. Do not provide over matured/over stored /dirty leaf to the silkworms

Avoid starvation, overcrowding and accumulation of faeces in the rearing bed.

Rear silkworms under optimum temperature and humidity.

Avoid injury to the larvae.

Apply recommended bed disinfectant as per schedule and quantity.

Feed Amruth as per schedule to control flacherie disease.

3. MUSCARDINE:

Causative agent : Among fungal diseases, White Muscardine is common. The disease is caused by Beauveria bassiana.

Occurrence: The disease is common during Rainy and winter seasons.

Source of Infection: The infection starts when conidia come in contact with silkworm body. Mummified silkworms / alternate hosts (most are lepidopteron pests), contaminated rearing house and appliances are sources of infection.

Predisposing factors : Low temperature with high humidity.

Symptoms:

•The larvae loose appetite and become inactive.
•Presence of moist specks on the skin.
•The larva vomits and turns flaccid.
•After death, larva gradually becomes hard followed by mummification due to growth of aerial mycelia and conidia over the body and body turns chalky white.

Management:

•Disinfect the rearing house, its surroundings and equipments with recommended disinfectant as mentioned above.
•Control mulberry pests in the mulberry garden.
•Pick up diseased larvae before mummification and dispose them by burning
•Avoid Low temperature and high humidity in the rearing house. If required use heater/stove to raise the temperature.
•Regulate bed humidity during rainy season by dusting slaked lime powder during moult.
•Apply bed disinfectant, Vijetha and Vijetha supplement/Ankush/any recommended bed disinfectant as per schedule and quantity.

4. PEBRINE:

Causative agent: Nosema bombycis / different strains of microsporidia.

Occurrence: Non-seasonal

Sources of Infection: Silkworm gets infected through eggs (Transovarian/Transovum transmission) or by eating contaminated mulberry leaf. Infected silkworms, faecal matter, contaminated rearing house and appliances and alternate hosts (mulberry pest) are the sources of infection.

Symptoms:

•Irregular hatching of silkworm eggs.
•Irregular size of the larval body and moulting.
•The infected larva looses its appetite and becomes inactive with wrinkled skin.
•Black pepper-like spots appear on the body of the infected worms.
•White postules appear on the silkgland when examined under microscope with presence of shining oval spores.

Management:

•Disinfect the rearing house, surroundings and with recommended disinfectant as mentioned above.
•Conduct strict mother moth examination and surface disinfection of silkworm eggs to produce and rear disease free layings.
•Follow strict hygiene maintenance during rearing.
•Control mulberry pests in and around the mulberry garden.
•Apply recommended bed disinfectant, Vijetha/Ankush as per schedule and quantity.
•Monitor seed crops constantly to eliminate the microspodian infection.

Disinfection of rearing house, its surroundings and appliances:

Select any recommended disinfectant for disinfection purpose. CSR&TI, Mysore has recommended the following disinfectants:

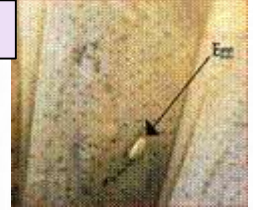
•0.05% Asthra solution (Add 50g Asthra powder in 100 liters of water and stir thoroughly and keep for 2 hours for dissolution of the powder).
•2.5 % Sanitech/Serichlor in 0.5% Slaked lime solution (To prepare 100 liters of solution, take 250g of activator in to a basin/bucket and add 2.5 liters of Sanitech/Serichlor solution. Keep it for 10 minutes. Add activated solution to the rest of water. To this solution, add 500 g slaked lime powder and mix thoroughly). 2% Bleaching powder in 0.3% slaked lime solution (To prepare 100 liters of solution, add little water to 2 kg bleaching powder and 300g slaked lime powder and make a paste. Add this paste to the rest of water and stir thoroughly. Keep for 10 minutes and use the supernatant).
•0.3 % Slaked lime solution (optional disinfection if viral diseases noticed in previous crop – Add 300g of slaked lime to 100 liters of water and stir thoroughly. Keep for 10 minutes and use supernatant).
•The total requirement of disinfectant solution for disinfection is estimated based on the rearing house floor area (Length × Breadth of floor).
•The quantity of disinfectant solution required is 1.5 lt./sq. m or 140 ml/sq. ft. floor area of rearing house (height 3 m /10 ft.) + 10% of total quantity of disinfectant solution. Disinfect the rearing house, appliances and surroundings by spraying the solution with power sprayer. Two times disinfection recommended for each crop (once 3days before initiation of rearing and after completion of rearing).

PESTS

1. Uzi fly

Uzi fly

Egg of uzi fly



Black scar

Damage to cocoons

Occurrence & Symptom:

The uzi fly, Exorista bombycis is a serious endo-larval parasitoid of the silkworm, Bombyx mori, inflicting 10-15% damage to the silkworm cocoon crop in the premier silk producing states of Karnataka, Andhra Pradesh and Tamil Nadu.

Uzi fly occurs throughout the year, but severe during rainy season. Presences of eggs or black scar on the silkworm body and maggot emergence hole at the tip of the cocoon are the typical symptoms of uzi fly attack.

As soon as the uzi fly enters into rearing house, it lays one or two eggs on each silkworm larva. After 2-3 days, egg hatches, enters inside the larva and feed on internal contents for 5-7 days, after which it comes out by rupturing the larva. The maggot pupates in a dark corner or cracks & crevices in about 18-24 hours. The pupal stage lasts for 10-12 days. If the uzi fly infests at last instar, the uzi maggots come out after cocoon formation by making a circular hole.

Control measures

Exclusion Method

Provide wire mesh/nylon net on all windows/doors.

Provide doors with automatic closing mechanism.

Provide anteroom at the entrance of the rearing house.

Keep the leaf in the verandah of the rearing house and observe for the uzi fly before shifting leaf into the rearing house.

Physical (using uzi trap)

Dissolve one table in 1 litre of water and keep the solution in white trays both inside and out side the rearing house at window base from 3rd instar onwards up to spinning.

Place uzi traps inside the rearing house/mounting hall after spinning up to 20 days under close-door condition to trap uzi flies emerging inside.

Biological

Release Nesolynx thymus (a pupal parasitoid of the uzi fly) inside rearing house on 2nd day of V instar.

After mounting of all spinning worms transfer the same pouches near the chandrikes.

After harvesting of cocoons keep the same pouches near the manure pit.

Two pouches are required for 100 dfls.

Proper disposal of silkworm litter after cocoon harvest

Separate the silkworm litter from mulberry twigs.

Do not throw silkworm litter in open space/litter pit, as it contains hundreds of

Uzi fly pupae. Instead, pack it in plastic bags and keep for 15 to 20 days to prevent the emergence of uzi fly from litter. Alternatively, it can be buried in soil or burnt immediately.

Availability of Nesolynx thymus:

Available at Pest Management Lab., CSRTI, Mysore. Place indents on the day of brushing, indicating the number of pouches required and brushing date of silkworms. Supply is made by courier on receipt of advance payment @ Rs 25 per pouch.

2. Dermestid beetles

Occurrence & Symptom:
Dermestid beetles, Dermestis ater are known to attack pierced cocoons in cocoon storage rooms. The female beetles lay about 150-250 eggs in the floss of cocoons. The beetles migrate from cocoon storage room to grainage and attack green cocoons as well as moths also. Generally they attack the abdominal region of the moth. The damage is estimated to be 16.62% on cocoons and 3.57% on moths.

Management of Dermestid beetles:

Preventive measures

Storage of rejected cocoons and perished eggs for long period should be avoided.
Rearing house & cocoon storage rooms should be cleaned periodically.
Grainage premises should be cleaned before & after moth emergence.
Provide wire mesh to door & windows in pierced cocoon (PC) storage rooms.
Wooden articles of storage room & grainage should be dipped in 0.2% malathion solution for 2-3 minutes.
Trays etc., should be thoroughly washed & sun dried for 2-3 days before reusing.

Mechanical control: Collect the grubs and adults by sweeping or by using a vacuum cleaner, destroy by burning or dipping in soap water.

Chemical control:

Store pierced cocoons in Deltamethrin treated bags ie., soak the bags in 0.028% Deltamethrin solution (1 ltr : 100 ltr water) and dry in shade.
Spray 0.028% Deltamethrin solution on walls and floor of PC room once in 3 months.
Sprinkle bleaching powder (200 gm/sq.mt) all around inner wall of PC room to prevent crawling of grubs from PC room.

Thankyou