

SERICULTURE

Diseases and Pests

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Bacterial Disease

- **Flacherie**
 - Bacterial disease of digestive system
 - Septicemia
 - Sotto disease

Flacherie

- The word "flacherie" was used to describe the flaccid condition seen in the silkworm, *Bombyx mori*, ailing from all sorts of dysenteries. Even now this term is widely used to describe many different diseases.
- Louis Pasteur separated flacherie from other silkworm diseases and attributed the disease microbial or infectious causes.
- According to him, owing to the extremely rapid multiplication of a large number of certain kinds of bacteria in the intestine the digestive functions of the gut were adversely giving rise to the symptoms typifying the disease.
- Other attributed causes are:
 - (i) high temperature, high humidity and bad ventilation;
 - (ii) bad leaves, i.e. dirty coarse leaf, leaf not suitable to the age of the larvae, wet and fermented leaf, etc;
 - (iii) over feeding;
 - (iv) decreased alkalinity of the gut; and
 - (v) over-crowding, etc.
- Of late flacherie is classified into five types depending on causal agent and symptoms:
 - 1. bacterial disease of digestive organs;
 - 2. septicemia;
 - 3. sotto disease;
 - 4. cytoplasmic polyhedrosis, and
 - 5. infectious flacherie.

Bacterial disease of digestive system

- **Causal Agent and Infection:**
 - a widely accepted theory states that silkworms become weak on and after hatching, then their metabolism becomes inactive, causing imbalance of functions.
 - As the sterilizing power of the digestive fluid weakens, the bacteria devoured together with mulberry leaf multiply in the digestive tract and take nutrition from the body of the silkworm, destroying the membranous tissue of the intestine.
 - The following major bacteria have been found to be associated with the progress of the disease:
 - (i) initial infection stage: *Streptococci*;
 - (ii) final stage (near death): *Coli* such as bacillus; and
 - (iii) moribund stage or corpse: *Proteus* such as *Bacillus*

Symptoms:

- not always uniform vary according to the
 - time of occurrence,
 - the kind of bacteria multiplying in the digestive organ,
 - the race of the silkworm and
 - other conditions.
- The general ones are:
 - loss of appetite,
 - sluggishness,
 - slow growth,
 - inelasticity of the skin,
 - softening of the body.

These are symptoms common to all flacherie but the time of infection of silkworms and the progress of the disease show symptoms characteristic of each type of the disease:

- (a) shrinking after moulting: the larvae does not feed after moulting and its body shrinks;
- (b) shrinking disease: the body of the larva shrinks since it does not feed;
- (c) diarrhoea: this suddenly afflicts the silkworms in the fourth and fifth instars, especially in the latter, causing soft excrements of irregular shape. In the latter case, the excrements come out in beads mingled with membrane of the intestine;
- (d) vomiting disease: diarrhoea and vomiting of fluid are observed. The body softens, putrefies and shrinks as time passes. In most cases the body becomes black but sometimes it turns red owing to the presence of *Bacillus prodigiosus* or green because of *Bacillus pyocyaneus*. Mixed propagation of a few bacteria may show some other colours.

Control:

- (1) Foremost requisite is to raise healthy and strong silkworms since the primary cause is the weakness of the silkworms.
- (2) Proper incubation of eggs; Temperature and humidity should be maintained at 22°-25°C and 80-85 percent respectively.
- (3) Selection of suitable race: it is essential to select a race that is sturdy and resistant to adverse conditions for summer and autumn rearing.
- (4) Feeding of good quality leaf; it is essential to feed plenty of high-quality mulberry leaves to avoid flacherie.

Septicemia

- **Causal agent:**
 - penetration and multiplication of certain kinds of bacteria in the haemolymph cause septicemia.
 - The principal pathogenic bacteria are large and small bacilli, streptococci, staphylococci, etc. Infection is through an injury or wound in the skin.
 - Pupae or moths which do not feed, are also affected with septicemia.
 - Even with bacterial diseases of the digestive organs, bacteria may sometimes penetrate into the body fluid through the membranous cells of the alimentary canal towards the final stage of the disease and cause septicemia.

- **Symptoms:** vary depending on the kind of bacteria.

- When a silkworm is infected with more than one kind of bacteria, the symptoms are determined by the predominantly propagated one.
- As the disease advances, the pro-legs lose the capacity to clasp and the worm dies.
- The body of a diseased larvae does not differ much in appearance to that of a healthy larva until it dies, but when the larvae vomit fluid, the body shrinks. Soft and liquid like excrements irregular in shape may be found.
- Towards death the excrements become brown or dark brown.
- Depending upon the kind of bacteria present, the colour of the dead body also varies. In many cases black or greyish black colour may be observed.
- But colours such as dark brown (*Proteus* such as *Bacillus*) red (*Bacillus prodigiosus*) green (*Bacillus pyocyaneus*) light yellow etc., are also to be observed.
- Occasionally, many small brown or dark brown spots appear on the skin.
- Depending on the kind of bacterial infections, the corpse may or may not emit a foul odour.
- In general, the fore-intestine part of the body may be swollen and the posterior part shrunken in dead larvae.
- The disease occurs in a similar manner as regards clour, progress and odour in pupae and moths.

- **Control:**

- irrespective of the health of the silkworm the disease is transmitted mainly through an injury or wound.
- Hence the infected silkworms should be treated as for any other infectious disease.
- The affected silkworms should be isolated from the healthy ones as soon as possible and destroyed by burning or burying deep in the soil.
- General disinfection of rearing rooms and rearing appliances with a 2 percent formalin must be carried out after rearing is over.

Sotto disease

- **Pathogen and infection:**

- *Bacillus sotto* (*Bacillus thuringiensis* var. *sotto*) or a large *Bacillus* is involved in this disease.
- It produces a toxic substance and the disease is a toxicosis.
- The toxin produced is dissolved in the alkaline digestive fluid and absorbed through the gastric wall.
- It affects the nervous centres, causing spasm and paralysis.

- **Symptoms:**

- the symptoms are
 - lack of appetite,
 - sluggishness,
 - lack of skin tension followed by shrinkage of the body,
 - diarrhoea,
 - complication of both shrinkage and diarrhoea,
 - constipation,
 - loss of clasping power of prolegs followed by death.
- The body of the insect becomes black shortly after death.
- The time from initial infection to death is shorter when temperature and humidity are high.
- The corpse becomes dark brown and the inner organs of the body liquified.
- If the skin is cracked, a black foul-smelling liquid oozes out.

- **Control:**

- *Bacillus sotto* is found in
 - silkworms killed by this bacteria,
 - in diseased larvae
 - in mulberry leaves and even in the
 - air and
 - water.
- Since this disease is a toxicosis caused by swallowing bacterial toxin, regardless of the health of larva, prevention of swallowing of the toxic substance by the larva is the primary step in controlling this disease.
- Diseased silkworms must be removed from the healthy ones and destroyed.
- As usual the rearing rooms and rearing equipment must be thoroughly disinfected before starting the next rearing.

Viral Diseases

Virus diseases

- Virus diseases found in silkworms are:
 - Grasserie or nuclear polyhedrosis
 - Cytoplasmic polyhedrosis
 - Infectious flacherie and
 - Gattine

Grasserie

- This disease is also known as jaundice or nuclear polyhedrosis. Jaundice indicates the yellowish colour of the diseased insect.
- Causal agent: *Borrelina* virus, which is a parasite principally in the nuclei of certain cells. It initiates the morbid process that ends in the elaboration of polyhedral bodies. It is contained in vast quantities in the supernatant haemolymph fluid and in the polyhedral bodies. Polyhedra vary from 0.5-15 microns in diameter. Their shape also varies, they usually have five or eight facets, although polyhedra of six facets are the more common. The virus constitutes only about 3-5 percent of the polyhedron. The virus may occur as bundles of small rod-shaped particles which at times may be seen to separate from each other. They are about 30-40 millimicrons in diameter (including the development membrane) and about 200-400 millimicrons in length and are incorporated within the structure of the polyhedron. The nucleic acid of the nuclear polyhedrosis virus in the silkworm is DNA.

- Infection: it is believed that the disease begins with the digestion of infectious material (polyhedra or free virus) into the alimentary tract of the insect. It has been assumed that the alkaline reaction of the silkworm gut, as well as certain enzymes present there, dissolve the polyhedra, releasing the virus which then passes through the intestinal wall into the body cavity of the insect, and invades the cells of the susceptible tissues.
- The polyhedral bodies are formed in the nuclei of adipose tissue, tracheal membranes, dermal cells and blood cells, but generally polyhedra are not formed in glands of nerves. However, the formation of polyhedra in the middle and posterior portions of the silk glands has been noticed.
- There is a close relationship between the atmospheric temperature and the occurrence of this disease. The disease may be induced when low temperature (5C for 24 hours) or high temperature (50 C for 10 minutes) treatment is applied to the larvae immediately after moulting. Surface contamination of the silkworm eggs is possible and can be a source of infection. It has been shown that the grasserie virus reproduces very actively when the silkworm is weak through vitamin deficiency.

- Symptoms: As the disease advances, appetite decreases and skin tension is lost. Usually five to seven days after infection, the intersegmental membranes of the body becomes swollen and the skin becomes shiny. The diseased larva in the final stages of attack shows pronounced swellings at the intersegments giving the larva the appearance of a bamboo cane with distinct nodes.
- The larva becomes restless and impatient. The colour changes to light yellow and the normally clear haemolymph becomes turbid. The integument becomes fragile and when ruptured, a milky haemolymph flows out. In the haemolymph of infected larva numerous polyhedral bodies are observed. The adipose tissue which disintegrates as a result of the attack is released as a milky fluid which mixes with the haemolymph. If the disease occurs just before moulting, the period when it is most likely to occur in the earlier stages, the larva does not go into moult earlier.
- In fact many victims do not moult at all. As the disease advances, the larvae are excited, crawl aimlessly and fall off the rearing tray onto the floor where they crawl in a circle and die. The period from the swelling of the intersegmental membranes to death is relatively short, from several hours to less than a day. A ripe larva attacked with grasserie may waste its silk or it may spin a flimsy cocoon and die before or after pupa formation.
- During the greater part of incubation period of the virus, no external change is observed in the pupa. But toward the end, the skin is easily ruptured on handling as the pupal body is almost homogenized by that time. Sometimes black markings are observed on the body about the time of death.

- Control: rearing the larva under hygienic conditions, avoiding unsuitable leaves, proper ventilation and spacing, timely picking out of and destroying of affected worms, are some of the precautionary measures that can be followed. The virus can also infect the silkworm through wounds and so the silkworms should be handled carefully so as not to cause any injuries. Another cause of the disease is reported to be physiological disturbance under unfavourable conditions. So extremely low or high temperatures in rearing room must be avoided during the rearing period. Great care should be taken in removing the sick and dead caterpillars, as their skin is so fragile that rough handling will cause it to break and liberate the infectious material. The diseased ones may be easily separated by using a net as they are left behind with litter and can be easily destroyed.
- Polyhedral bodies retain their infectivity for a long time under dry conditions, but this infectivity is lost in 30 minutes at 70C, and three minutes at 100C. Therefore rearing tools and appliances should be sterilised with steam or hot water. The rearing room and rearing appliances can also be disinfected with formalin or high-power bleaching powder in order to inactivate the polyhedral bodies.
- A 1 percent caustic soda solution or a 2 percent formalin solution can be used for dipping the egg boards for 2 minutes for surface sterilisation. The egg cards should then be rinsed in running water for a few minutes.