

Mulberry Silkworm

The insect producing mulberry silk is a domesticated variety of silkworms, which has been exploited for over 4000 years. All the strains reared at present belong to the species *Bombyx mori* that is believed to be derived from the original Mandarina silkworm, *Bombyx mandarina* Moore. China is the native place of this silk worm, but now it has been introduced in all the silk producing countries like Japan, India, Korea, Italy, France and Russia.

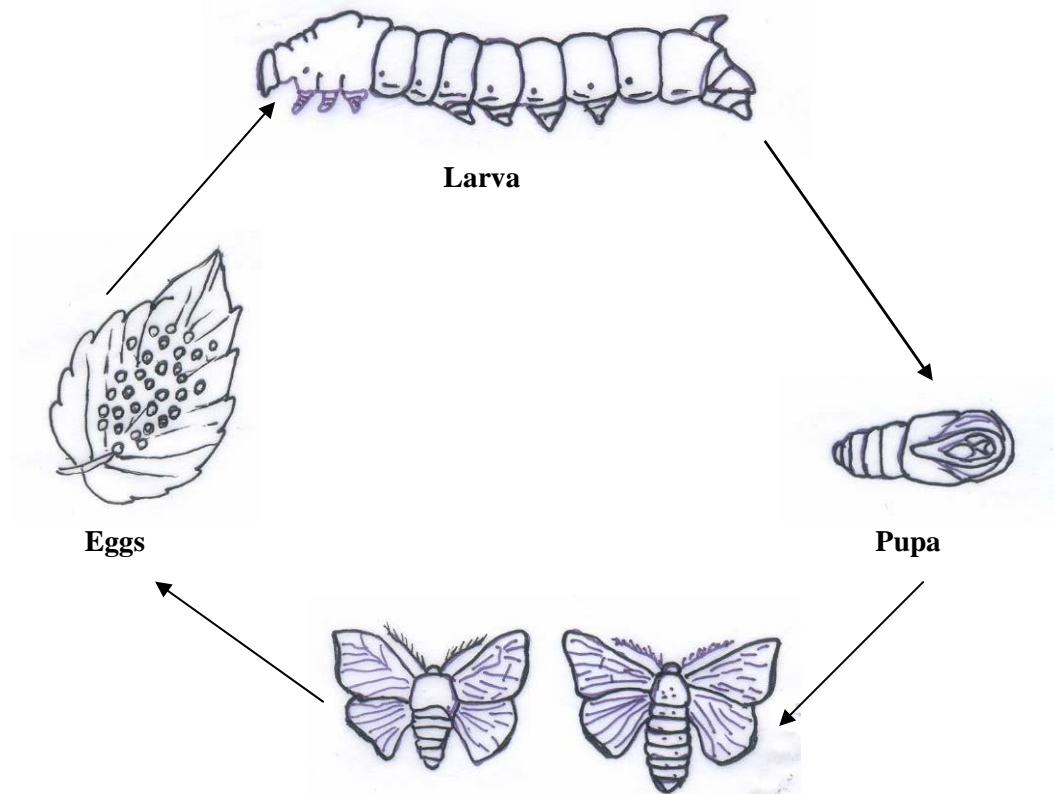
The races of mulberry silk worm may be identified on the basis of geographical distribution as Japanese, Chinese, European or Indian origin; or as Uni-, Bi- or Multivoltine depending upon the number of generations produced in a year under natural conditions; or as Tri-, Tetra- and Penta-moulters according to the number of moults that occur during larval growth; or as pure strain and hybrid variety according to genetic recombination.

Life Cycle

Life cycle of the silkworm consists of four stages i.e. adult, egg, larva, and pupa. The duration of life cycle is six to eight weeks depending upon racial characteristics and climatic conditions. Multi-voltine races found in tropical areas have the shortest life cycle with the egg, larval, pupal and adult stages lasting for 9-12 days, 20-24 days, 10-12 days and 3-6 days, respectively. Seven to eight generations are produced in multi-voltine races.

In uni-voltine races, the egg period of activated egg may last for 11-14 days; the larval period, 24-28 days; the pupal period, 12-15 days and the adult stage, 6-10 days. In nature, uni-voltine races produce only one generation during the spring and the second generation of eggs goes through a period of rest or hibernation till the next spring. In case of bivoltine races, however, the second generation eggs do not hibernate and hatch within 11-12 days and produce second generation normally during summer and it is the third generation eggs which

undergo hibernation and hatches in the next spring, and thus producing two generations in one year.



Egg

Egg is round and white. The weight of newly laid 2,000 eggs is about 1 g. It measures 1-1.3 mm in length and 0.9-1.2 mm in width. With time, eggs become darker and darker. Races producing white cocoons lay pale yellow eggs; while races producing yellow cocoons lay deep yellow eggs. In case of hibernating eggs laid by bi-voltine and univoltine races, the egg colour changes to dark brown or purple with the deepening of colour of the serosal pigments.

The eggs may be of diapause or non-diapause type. The diapause type of eggs are laid by the silkworms inhabiting in temperate regions; whereas silkworms belonging to subtropical regions like India lay non-diapause type of eggs. During diapause all vital activities of the eggs cease.

Larva

After 10 days of incubation, the eggs hatch into larva called caterpillar. After hatching caterpillars need continuous supply of food, because they are voracious feeders. Newly hatched caterpillar is about 0.3 cm in



length and pale yellowish white. The larval body is densely covered with bristles. As the larva grows, it becomes smoother and lighter in colour due to rapid stretching of the cuticular skin during different instars of the larval stage. The skin consists of cuticle and hypodermis. Cuticle is made up of chitin as well as protein and is covered with a thin layer of wax, which is capable of being extended considerably to permit rapid growth of the larva during each instar. Nodules are found all over the surface of the body, and the distribution pattern differs according to the variety of silkworm. Larva bears four pairs of tubercles: sub-dorsal, supra-spiracular, infra spiracular and basal tubercle. Each tubercle carries 3-6 setae.

The larval body is composed of head, thorax and abdomen. The head consists of six fused segments. It carries the appendages: antennae, mandibles, maxillae and labium. Median epicranial suture, clypeus and labrum are well developed and prominent. Six pairs of larval eyes or ocelli are located a little above the base of antennae. Five segmented antennae are used as sensory organs. The mandibles are well developed, powerful and adapted for mastication. The

maxillary lobe and palpi help in discriminating the taste of food. The prementum is also chitinized, and its distal part carries a median process known as spinneret through which silk is extruded out from the silk gland. The sensory labial palpi are found on both sides of the spinneret.

The thorax has three segments: prothorax, mesothorax and metathorax. Each of the thoracic segments carries ventrally one pair of true legs, which are conical in shape and carry sharp distal claws. These claws are not used for crawling but they help in holding the leaves while feeding.

Abdomen consists of eleven segments, though only nine can be distinguished, as the last three are fused together to form the apparent ninth segment. Third to sixth and last abdominal segment bear a pair of abdominal legs, which are fleshy, unjointed muscular protuberance. Eighth abdominal segment bears caudal horn on the dorsal side.

The abdominal segments carry the sexual markings on ventral side, which are developed distinctly during fourth and fifth instars in the eighth and ninth segments. In females, the sexual marking appear as a pair of milky white spot in each of the eighth and ninth segments and are referred to as Ishiwata's Fore Gland and Ishiwata's Hind Gland respectively. In males a small milky white body known as Herold's Gland appears ventrally in the centre between eighth and ninth segments. Nine pairs of spiracles are present: one pair on the first thoracic segment and eight pairs one on each side of the first to eighth abdominal segments, respectively.

The larval growth is marked by four moultings and five instar stages. The full-grown caterpillar develops a pair of sericteries or silk glands. Sericteries or silk glands are modified labial glands. These glands are cylindrical and divided into three segments: Anterior-, middle- and posterior-segments. The inner lining cells are characterized by the presence of large and branched nucleus. These

glands secrete silk which consists of an inner tough protein, fibroin, enclosed by a water soluble gelatinous protein, sericin. In *Bombyx*, the fibrinogen which on extrusion is denatured to fibroin is secreted in the posterior segment of the gland and form the core of the silk filament in the form of two very thin fibres called brins. The sericin, a hot water soluble protein, secreted by middle segment of the gland, holds the brins together and covers them. The duct from another small gland called Lyonnet's gland, that lubricates the tube through which the silk passes, joins the ducts of the silk glands. Finally, the silk is moulded to a thread as it passes through the silk press or spinneret.

Pupa

Pupa is the inactive resting stage of silkworm. It is a transitional period during which definite changes take place. During this period, biological activity of larval body and its internal organs undergo a complete change and assume the new form of adult moth. The mature silkworm passes through a short transitory stage of pre-pupa before becoming a pupa. During the pre-



pupal stage, dissolution of the larval organs takes place which is followed by formation of adult organs. Soon after pupation the pupa is white and soft but gradually turns brown to dark brown, and the pupal skin becomes harder.

A pair of large compound eyes, a pair of antennae, fore and hind-wings, and the legs are visible. Ten segments can be seen on the ventral side, but only nine are visible on the dorsal side. Seven pairs of spiracles are present in abdominal region, the last pair being non-functional. Sex markings are prominent and it is much easier to determine the sex of pupa. The female has a fine longitudinal line on the eighth abdominal segment, where as such marking is absent in case of male. The pupa is covered within a thick, oval, white or yellow

silken case called cocoon. The pupal period may last for 8-14 days after which the adult moth emerges slitting through the pupal skin and piercing the fibrous cocoon shell with the aid of the alkaline salivary secretion that softens the tough cocoon shell.

Adult

The adult of *Bombyx mori* is about 2.5 cm in length and pale creamy white. After emergence the adult is incapable of flight because of its feeble wings and heavy body. It does not feed during its



short adult life. The body of moth has general plan of insect body organization. The ocelli are absent. The antennae are conspicuous, large and bipectinate. The meso- and meta-thorax bear a pair of wings. The front pair overlap the hind pair when the moth is at rest.

The moth is unisexual and shows sexual dimorphism. In male eight abdominal segments are visible; while in female, seven. The female has comparatively smaller antennae. Its body and the abdomen are stouter and larger, and it is generally less active than male. The male moth possesses a pair of hooks known as harpes at its caudal end; while the female has a knob like projection with sensory hair. Just after emergence, male moths copulate with female for about 2-3 hours, and die after that. The female starts laying eggs just after copulation, which is completed within 24 hours. A female lays 400-500 eggs. The eggs are laid in clusters and are covered with gelatinous secretion of the female moth.