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| Name of Teacher | PROF (DR) VINAY KUMAR SINGH |
| Mob. Number | 9807110100 |
| E-mail | vinay.zool@ddugu.ac.in |
| Designation | Professor |
| University Name | Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur |
| Stream | BIO-GROUP |
| Faculty | SCIENCE |
| Department/ Subject | ZOOLOGY |
| Course | 304- Applied Zoology |
| Course Duration | Semester (CBCS) |
| Sub Topic | SERICULTURE |
| Content | Intoduction, Species of silk-worm, Life-cycle of mulberry silk-worm, Sericulture Industry and its potential in India, silk, Rearing of Silk-worm, Silk-worm pests & Disease, Silk Research Institutes |
| Search KeyWords | Silk, Silk-worm, Mulberry, Vanya Silk, Tasar, Munga, Eri, Disease |

Learning Outcomes

- Understanding about the sericulture in India.
- Information of various types of silk-moth their role in silk production and natural diversity.
- Identify the different types of silk in India.
- Suggest various methods for the sericulture.

Introduction-

Silk, the multifaceted wonder fibre has a well acknowledged religious dimension too. Across culture globally, silk occupies a special stature which renders it sacrosanct. Besides being mirrors of all civilizations, germinated through the legendary 'Silk Rout' the tiny silk fibre has also been accredited with the adjective such as the 'catalyst' for the Cultural Revolution in the word humanity. All major religious scriptures of Hindu, Christian, Muslim, Buddhism and many others find a mention about silk and connecting this holy fibre with their eschatology. Thus, it does not come as a surprise that silk should, through the ages, has come to be associated with the religious rituals and a symbol of spirituality across many continents.

As a kind of natural fibre, cotton is regarded as the "king of textile fibre" among the all natural fibres. It is one of the significant agricultural crops which provides lion share of textile fibre for industrial use, for production of clothing, home furnishing, etc. Products of cotton are not only comfortable to wear, but also quite durable. It is also resistant to abrasion and at the same time cotton is washable as well as relatively inexpensive. Improvement on textile technology has made cotton finished products crease resistant, shrink and stain resistant.

The silk industry, from sericulture to weaving, was well established in India during the Gupta era. The wealth of the well-known Mandasor silk weaving guild testifies to the prosperity of the trade. In the early seventh century when Hsuan-tsang visited India, he listed silk as one of the most popular material for clothing in the country.

The dictionary meaning of Sericulture is silk-worm breeding. The word 'Sericulture' is derived from the Greek word 'Sericos' meaning silk and the English word 'culture' meaning 'rearing'. Sericulture, therefore, refers to the "conscious mass-scale rearing of silk producing organization to obtain silk. But among all the natural textile fibres, silk is the most precious and beautiful textile fibre and is regarded as the 'Queen of Textile'. India continues to be the Second largest producer of silk in the World. India has the unique distinction of being the only country producing all the five kinds of silk – Mulberry, Eri, Muga, Tropical Tasar and Temperate Tasar. Sericulture is an important labour-intensive and agro-based cottage industry, providing gainful occupation to around 7.25 million persons in rural and semi-urban areas in India.

Although, all the known varieties of silk, viz. Mulberry, Eri, Muga and Tasar are produced in India, Mulberry silk is the most popular variety. Mulberry silk alone contributes more than 80% of the Country's silk production. Silk and silk goods are very good foreign exchange earners. Export potential of this sector is promising as silk production in Japan is declining and that of China, the largest silk producer the World, it is stagnant. The present global scenario clearly indicates the enormous opportunities for the Indian Silk Industry.

In India, because of the prevalence of favourable climatic conditions, mulberry is cultivated mainly in five states, viz., Karnataka, Andhra Pradesh, Tamil Nadu, West Bengal and Jammu and Kashmir. These five states collectively account for 97% of the total area under mulberry cultivation and 95% of raw silk production in the country. Now, as a result of growing realization, sericulture is gaining ground in non-traditional areas too.

Central Silk Board for the development of silk industry in India, the Central Silk Board, a statutory body, is functioning under the administrative control of the Ministry of Textiles, Govt. of India with its Headquarters at Bengaluru. The following are the important functions assigned to the Board. (a) Promoting the development of silk industry by such measures as it thinks fit. (b) Undertaking, assisting and encouraging scientific, technological and Economic Research. (c) Devising means for improved methods of mulberry cultivation, silkworm rearing, developing and distributing healthy silkworm seeds, improving methods of silk reeling, improving the quality and production of raw silk. (d) Improving the marketing of raw silk. (e) The collection and compilation of statistics relating to the sector. (f) Advising the Govt. of India on all matters relating to the development of silk industry including import and export of raw silk.

Species of Silk-worm

Mulberry Silk-worm- *Bombyx mori*. It belongs to the family Bombycidae. China is the native place of this silk-worm but now it has been introduced in all the silk producing countries like India, Japan, Korea, Italy, France and Russia etc. Since the natural food of this worm is mulberry leaf, it is called as mulberry silk-worm. The silk produced by this moth is white in colour.

Eri Silk-worm- *Attacus ricinii*. It belongs to the family Saturniidae and produces silk in East-Asia. Also known as endi or errandi, this silk is produced by the **eri** silk-worm (Philosamiaricini). These worms feed mainly on Castor and Kessuru. As eri cocoons are open ended, the yarn is spun. Interestingly, in many parts of the North-East, eri cocoons are produced for their edible pupae and silk is the by-product. Elegantly designed eri shawls and

chaddars are quite popular because of their thermal properties. It is also called Non-Violent silk as the pupa is allowed to develop and come out as moth because eri is spun and not reeled. Its life history resemble with that of mulberry worms.

Tasar silk-worm- *Antheraea paphia*. It belongs to the family Saturniidae and common in India, China and Sri Lanka. Tasar silk is produced by tasar silkworms (*Antheraea mylitta* and *Antheraea proylei*) that feed mainly on the leaves of ber, sal, fig, Asan, Arjun and Oak. India is the second largest producer of tasar silk and the exclusive producer of Indian tasar (also known as tropical tasar) which is largely tended by tribals in the Gondwana belt. Oak tasar (also known as temperate tasar) is mainly used for furnishing, dress materials and sarees. Bomkai, Paithani, Ikkat (tie & dye) and Katki are some popular fabrics produced using tasar silks. Bafta is a popular blend of tasar and cotton. The moths do not easily breed in captivity. Since breeding is not well controlled, the tasar silk industry has not reached up to mark as the mulberry silk-worm industry.

Muga Silk-worm- *Antheraea assama*. It belongs to the family Saturniidae and semi-domesticated in nature. The pride of India, muga silk is known for its natural shimmering golden colour. Its production is confined to Assam, border areas of neighboring Northeastern states and Cooch Bihar in West Bengal. It is produced by the muga silk-worms (*Antheraea assamensis*), which feed on Som and Sualu. The most expensive of silks, muga is intrinsically woven into the cultural traditions of the people of Assam. The vibrant Sualkuchisarees and mekhla-chaddars are the traditional items made from muga silk. In recent times, fashion designers have found exciting prospects in using muga silk for developing new products and designs. Use of muga yarn as a substitute for 'zari' in sarees is finding favor with reputed weavers.



Tasar



Munga



Eri



Mulberry

Life-cycle of Mulberry Silk-worm-

The bulk of the commercial silk produced in the world comes from this variety and often silk generally refers to mulberry silk. These silk-worms are completely domesticated and reared indoors in India. Various varieties of silk-worm are produced by genetic crossing and they are producing 2-7 generations in India but in some countries like Europe and Russia where the duration of winter is more than the summers only one generation is produced per year. The race of silk-worm by which only one crop is taken in one year is called Uni-Voltine, producing two crops in a year is called Bi-Voltine and producing more than two crops in a year is called Multi-Voltine races.

The adult of *Bombyx mori* is about 2.5 cm in length and pale creamy white in colour. The moth is unisexual in nature and does not feed during its very short life period. Of 2-3 days.

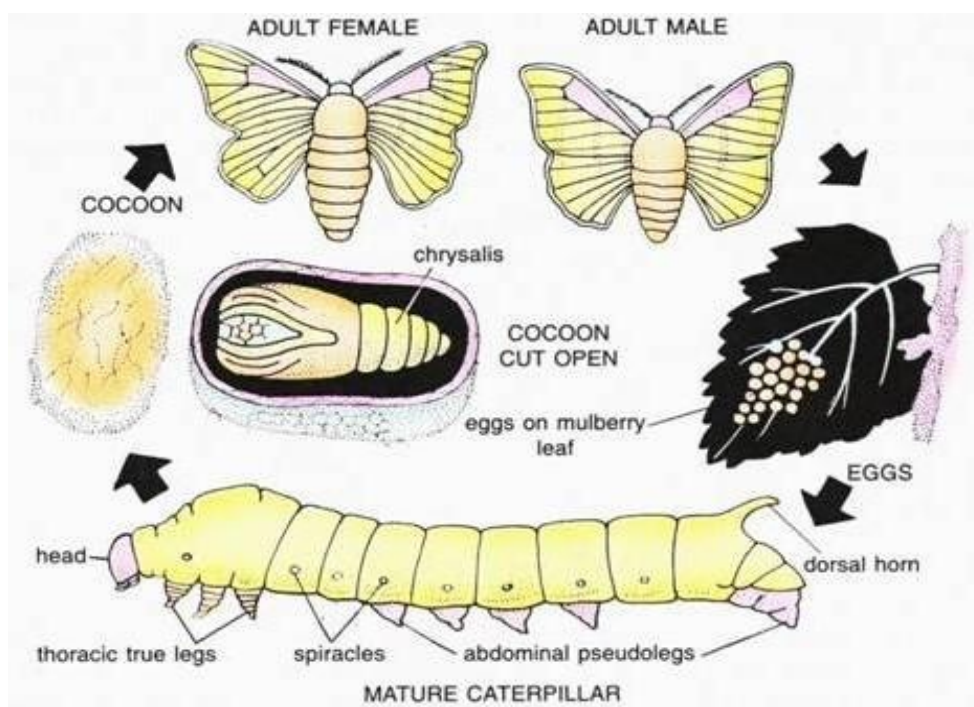
Fertilization- is internal preceded by copulation. Just after emergence, male moth copulates with female for about 2-4 hours and if not separated they may die after few hours of copulating with female.

Egg Laying- just after copulation female starts egg laying which is completed in 1-24 hours. Single moth lays 400-500 eggs depending upon the climatic conditions and supply of the food material to the caterpillar from which the female moth is obtained. The egg laying is always in form of clusters and covered with gelatinous secretion of the female which helps them in proper attachments.

Eggs- laid by the female's moth are rounded and white in colour. With the increase in time after egg laying, eggs become darker and darker day-by-day. Two types of eggs are generally found viz. Dipause and Non-dipause type. The diapauses type of eggs are laid by the silk-worm inhabiting in temperate regions, whereas, silk-worms belonging to subtropical regions like India lay Non-dipause type of eggs.

Hatching- The eggs after ten days of incubation hatch into a larva called as caterpillar. Hatching is the most important phase of silk-moth's life. They are voracious eater so that food supply is continuous.

Caterpillar- The newly hatched caterpillar is about 0.3 cm in length and is pale, yellowish-white in colour. The caterpillars are provided with well developed mandibulate type of mouth parts adopted to feed easily on the mulberry leaves. The caterpillar is twelve segmented and the abdominal region has ten segments having 5-pairs of pseudo-legs. It is also provided with a small dorsal horn on the anal segment because of its being very much tender, the 1st instar larva can feed only on very soft leaves of mulberry plants. As they are voracious feeders, they grow rapidly which is marked by four moultings. After 1st, 2nd, 3rd and 4th moultings caterpillars get changed in to 2nd, 3rd, 4th and 5th instars, respectively. It takes 20-25 days after hatching. Full grown caterpillar develops salivary glands, stops feeding and undergoes pupation.



Life-history of *Bombyx mori*

Pupa- the caterpillar stops feeding and move towards corner among the leaves and secrete a sticky fluid through silk gland. The secreted fluid comes out through spinneret (a narrow pore situated on the hypopharynx) and takes the form of long fine thread of silk which hardens on exposure to the air and wrapped around the body of the caterpillar in the form of a covering called as Cocoon.

Cocoon- is the white coloured bed of the pupa whose outer threads are irregular while the inner threads are regular. The length of continuous thread secreted by a caterpillar for the formation of cocoon is about 1000-2000 metres which requires 3 days to complete. The threads is wound around the cocoon in concentric manner. The binding of threads round the cocoon is very interesting and quick going phenomenon achieved by the constant round motion of the head of the caterpillar from one side to the other at the rate of 65 times per minute. Now the silk-worm pupa is covered within a thick, oval white or yellow silken cocoon. It is estimated from the data obtained by practical application that one pound of silk can be obtained from 2500 cocoons. The weight of one cocoon is about 1.8-2.2 gm and the weight of the cocoon shell only is 0.45 gm. The size of the thread is 2.0-2.8 denier. Freshly harvest and un-stifled cocoons with live pupae inside are termed as ‘**Green Cocoon**’.

Composition of Cocoon Shell- about 76% of the weight of the cocoon shell contains **fibroin**, 22% **sericin** and the rest wax and other substances.

Denier- The denier is the indication of the degree of fineness of silk yarn. Weight in grams of silk yarn of 9000 meters is known as the denier.

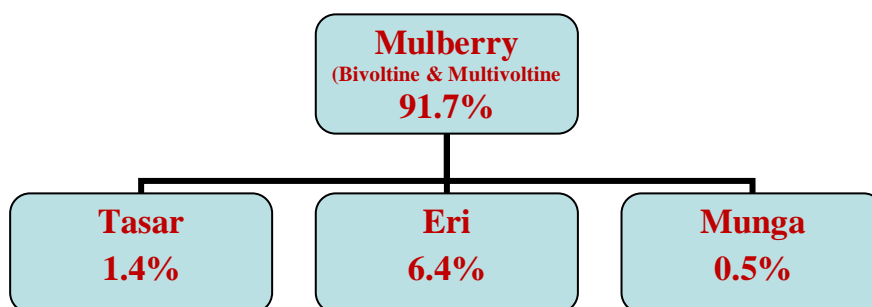
$$\text{Denier} = \text{weight of silk (gm)} / \text{length of silk (mtrs)} \times 9000$$

Emergence of Pupae- Due to active metamorphic changes during pupal period the abdominal pseudo-legs disappear and two pairs of wings develop. The silk-worm within the cocoon secretes an alkaline fluid to moisten its one of the ends. As a result of this the moistened end becomes soft where the threads are cut open (hydrolysed) by the silk-worm. Finally a hole is formed through which a feeble adult moth squeezes out of the cocoon.

Sericulture Industry and its potential in India-

Sericulture, the technique of silk production, is an agro-industry, playing an eminent role in the rural economy of India. Silk-fibre is a protein produced from the silk glands of silk-worms. Historians and antiquarians the world over are unanimous in their findings that silk was originated in China sometime in 2640 BC and the legend also has it, that the Chinese Princess Xi Ling Shi was the first to reel a cocoon of silk from a tea cup. Discovering the life cycle of silk-worm, the Chinese kept it as a closely guarded secret from the rest of the world. Later, it was introduced into Europe and Japan as well. According to reports, sericulture was introduced into India about 400 years back and the industry flourished as an agro-industry till 1857.

The government of India has allocated Rs. 2161.68 crores for three years i.e. 2017-2020 to its central sector scheme ‘**Silk Samagra**’ for the development of sericulture in the country. The scheme is being implemented by the Central Silk Board (CSB). Except mulberry, other non-mulberry varieties of silks are wild silks, known as vanya silks. The Indian sericulture market was worth Rs. 266 billion in 2019. India is currently the world’s second largest producer of raw silk and largest consumer of raw silk and silk fibre. India has the distinction of producing all the four types of silk i.e. Mulberry silk (91.7%); Tasar silk (1.4%); Eri silk (6.4%) and Munga silk (0.5%) which are produced by different species of silk-worms. Central Silk Board has developed latest technology packages, improved farm machineries, indigenous automatic reeling units and vanya silk reeling and spinning units to reduce drudgery and improve quality and productivity of vanya silk.



High employment potential-

- 60 lakh persons are engaged in various sericulture activities in the country.
- It is estimated that Sericulture can generate employment @ 11 man days per kg of raw silk production (in on-farm and off-farm activities) throughout the year. This potential is par-excellence and no other industry generates this kind of employment, especially in rural areas, hence, sericulture is used as a tool for rural reconstruction.

Women friendly occupation-

- Women constitute over 60 % of those employed in down-stream activities of sericulture in the country. This is possible because sericulture activities starting from mulberry garden management, leaf harvesting and silkworm rearing is more effectively taken up by the women folk. Even silk reeling industry including weaving is largely supported by them.

Eco-friendly activity-

- As a perennial crop with good foliage and root-spread, mulberry contributes to soil conservation and provides green cover.
- Waste from silkworm rearing can be recycled as inputs to garden.
- Dried mulberry twigs and branches are used as fuel in place of firewood and therefore reduce the pressure on vegetation/forest.
- Being a labour intensive and predominantly agro-based activity, involvement of smoke-emitting machinery is minimal.
- Developmental programmes initiated for mulberry plantation are mainly in upland areas where un-used cultivable land is made productive.
- Mulberry can also be cultivated as intercrop with numerous plantations.
- Mulberry being a deep-rooted perennial plant can be raised in vacant lands, hill slopes and watershed areas.
- Currently, only about 0.1 % of the arable land in the country is under mulberry cultivation.

Sericulture involves growing of host plants, rearing of silkworms, reeling, twisting, weaving and marketing of various value added products and services. In order to meet this new varieties of mulberry silkworm, to suit various agro climatic conditions and to increase productivity, quality and profitability of sericulture, number of products, methodologies, package of practices, etc., have to be developed and released.

Silk - Chemically speaking, silk is made of proteins secreted in the fluid state by a caterpillar, popularly known as 'silk-worm'. These silk-worms feed on the selected food plants and spin cocoons as a 'protective shell' to perpetuate the life. Silk-worm has four stages in its life cycle viz., egg, caterpillar, pupa and moth. Man interferes this life cycle at the cocoon stage to obtain the silk, a continuous filament of commercial importance, used in weaving of the dream fabric.

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| 2019-2020 | Mulberry Plant | 239967 hectare | Plantation |
| | Cocoon | 185143 MT | Production |
| | Silk Total | 25239 MT | |
| | Vanya Silk Mulberry | 10581 MT | |

| | | | |
|-----------|---------------|------------|------------|
| 2019-2020 | Mulberry Silk | 25239 Silk | Production |
| | Tasar Silk | 3136 MT | |
| | Eri Silk | 7204 MT | |
| | Munga Silk | 241 MT | |

Rearing of Silk-worm

The word rearing does not mean only the feeding of caterpillars as often understood but a continuous care from egg laying through aestivation, hibernation, incubation, early stage larval care, late stage larval care to the production of cocoon. It should be proceed by

Grainage Management-

The process of silk-worm egg making in lay mans term is called *grainage*. It involves storage of eggs, facilitating of male female coupling, washing cleaning of eggs and disease checking. After the first crop the pupa inside the cocoon goes into diapause that is hibernation till next cycle. Good quality of cocoon are selected and stored in the grainage houses where temperature and humidity are maintained and controlled.

With the onset of monsoon the moths start coming out of cocoon. The moth immediately start coupling with opposite sex and within 3 days of coupling start laying eggs. These eggs are collected washed with soap and other chemicals and are examined under a microscope for diseases primarily for Pebrine which is a protozoan disease capable of destroying whole crop.

Once the samples are certified as disease free they are labeled as DFL and are sent to the fields where they are supposed to be reared. Each DFL has a fixed date for hatching hence each DFL group is labeled properly with the date of hatching so that they reach the site and inoculated before hatching.

- A- **Emergence of moth and fertilization-** when kept for emergence at room temperature, mass emergence of adults takes place. Just after emergence, male moth starts moving around the female. Males are very much active whereas the females which are loaded with eggs are incapable of flying. If not separated at once in cages males starts copulating with the females but the eggs obtained from this female mated from the male of the same stock is useless for the seed. So, the male and females just after emergence have to be separated in to separate cages without their mating. Now one female of lot is kept with the male of the other lot and at once they form pair and copulate for about 3 hours. After completion of mating, males should be separated and may be used for the fertilization of other females. But one male cannot fertilize more than two females. Now fertilized females are subjected to egg laying.
- B- **Egg Laying-** just after fertilization, females starts egg laying and in the duration of 24 hours it completes egg laying process. The egg laid by one female is about 400-500 varying according to races. Female dies after egg laying. These eggs are called as 'SEED'. These eggs are kept in sterilized trays and stored at 4°C under laboratory condition. The stages of seed (egg) production is of three types viz. production and supply of grandparent eggs, production and supply of parent eggs, rearing of parent

eggs and production of commercial F₁ seed. This commercial seed is supplied to the rearers.

- C- **Hatching-** this is an important phase of sericulture industry because as soon as the larvae are hatched they start feeding voraciously. So only those sericulture scientists who would be able to supply sufficient amount of fresh mulberry leaves to the young hatched larvae, could perform successful sericulture program otherwise young ones will die resulting great loss to sericulture industry. This is why the hatching has to be controlled, accelerated or postponed by artificial treatments under refrigerated condition. For proper hatching of eggs (seed) advanced techniques have been developed in which eggs are collected and kept with mulberry leaves, working as stimulant for hatching in shady places on white sheet of paper in insect proof trays on a table. For this purpose the legs of table must be kept in water so that insects may not crawl and damage the hatching eggs. It is also notable that if the eggs are placed in the same position in which they are laid, hatching will be cent percent. The group of caterpillars hatched at various stages should be kept separately.

Spinning-

After about 30 to 35 days the larvae starts to make cocoon. This process is called spinning. During this period the caterpillar stops feeding and starts to secrete pasty substances from the silk gland. In this condition worms should be picked up and transferred to the spinning tarys and kept in a position of slope to the sun for a short period. It takes about 2 to 3 days. It then settles inside the cocoon as a pupa. The cocoons are collected and are ready for either reeling or for next crop.

Post-cocoon processing-

The method of obtaining silk thread from cocoon is known as post-cocoon processing. This includes-

- A- **Stifling-** The process of killing the cocoons is termed as stifling sericulturists or silk-farming people should be very much careful that before the emergence of silk-worm (the cocoons which do not have cut holes) good sized coccons of 8-10 days old are selected for further processing and dropped into hot water or subjected to steam or dry heat, sun exposure for 3 days or fumigation. In this way pupae or cocoons are killed. The killing of the cocoons in boiling water helps in softening the adhesion of the silk threads among themselves and loosening of the outer threads to separate freely, facilitating the unbinding of silk threads.
- B- **Silk reeling-** The process of removing the threads from the killed cocoon is called reeling. Four or five free ends of the threads of these cocoons are passed through eyelets and guides to twist into one thread and wound round a large wheel from which it is transferred to spools. This obtained silk is called raw silk. The waste outer or damaged cocoons and threads are separated, teased and then the filaments are spun. This is called 'spun-silk'. During these years the improved cottage-type basins have been introduced recently into India. Provisions for button-holes and a proper croisure system to maintain the thickness of the fibre and to control the defects of neetness in the cottage-basin have facilitated the production of better-quality silk. As much as 806 tonnes of silk is produced by 4000 cottage-basins in the country.

Silk-worm Pests- Uzi fly

The uzi fly, *Exorista bombycis* is a serious parasitoid of the silk-worm, *Bombyx mori*, causing about 10- 20% damage to the silk-worm cocoons. Adult is blackish grey with four prominent longitudinal lines on thorax. The female uzi fly enters into rearing house; settle on

silk-worm body for egg laying. The eggs are creamy white. She lays one or two eggs on each silk-worm larva in inter-segmental region. After 2-3 days egg hatches into maggots. Maggots enter inside the larva by making small holes and feed on internal contents. The fully grown maggot cuts the integument of silk-worm and comes out. During early instar infection found that death of worms before spinning. The avoidance of entry of the fly into the rearing room of silk-worm is only means for the prevention of this disease for which mesh/ nylon nets are fixed around the windows/doors. Biological control means release *Nesolynx thymus* (a pupal parasitoid of the uzi fly) inside rearing house on 2nd day of V instar.

Protozoan disease- Pebrine

This is one of the worst diseases of silk-worm. Sericulture was once damaged by this disease in all the countries involved in this industry but some countries have overcome this disease and succeeded in getting pebrine free silk-worm eggs for reeling cocoons. *Nosema bombycis nageli*, belonging to microsporidia is the causative agent of this disease. The infection takes place through the mouth of larvae at the time of feeding or through the mother's ovary. When new spores are formed in the tissues of alimentary canal of silk-worm they are discharged with the faeces and make a source of infection. When the spore enters into the digestive tract of silk-worm, two nuclei, contained in the sporoplasm, are divided into four nuclei and at the same time the polar filament projects and penetrates into the cells of the alimentary canal. Further they enter into the blood and swim in it. They are distributed throughout the host body, attacking various tissues, specially the fat bodies and organs, excluding chitinous tissues and nucleus of cells. Inside the body, the milky white spots are observed on the silk gland. Sterilization of rearing house and equipments with 2% formalin is one of the control measures.

Fungal Disease- Muscardine

First white muscardine (*Beauveria bassiana*) is highly contagious disease. It shows three stages: conidium, vegetative mycelium and arial mycelium. The second green muscardine (*Spicaria prasina*) infection was through skin by conidia. The third yellow muscardine (*Paecilomyces farinose*) infection was through skin by conidia and. Fourth Aspergillosis/ brown muscardine infections is similar to other muscardine and are serious disease of chawki-worm. Disinfection of rearing house and equipments with 2% formalin and rearing bed should be kept dry.

Bacterial Disease

Flacherie- It is a type of syndrome associated with bacterial disease. The infection is mainly due to consumption of contaminated leaves. The term flacherie refers to body soft and loose of larva.

Sotto disease- *Bacillus thuringensis* is the causative agent and affect the nervous system of the worm. It produces toxins which kill the worms. Infection occurs orally or through wounds.

Septicaemia- The causative agent is *Bacillus sps.* caused due to multiplication of bacteria in haemolymph. Infection may through wounds or injury in skin.

Control of bacterial disease avoids high temperature and humidity.

Viral Disease

Nuclear polyhedrosis virus disease (Grasserie)- The causative agent of this disease is *Borrelina bombycis*. The silk-worm gets infected when it feed on contaminated mulberry leaves. The milky white fluid released by the grasserie larvae. After ingestion protein coat dissolves and viral rods are released. Rods attack midgut, releasing infectious subunits. These subunits enters nucleus of cells as well. Younger instars get lack of coordination fails to moult and dies.

Infectious flacherie viral disease- The causative agent of this disease is infectious flacherie virus type 1 or *Morator* virus. Infection occurs orally and the virus infects goblet cells of the host.

Cytoplasmic polyhedrosis- The causative agent of this disease is *Smithia virus*. It is found in cytoplasm of midgut cells. Infection through polyhedral contaminated mulberry leaves.

Kenchu virus disease- The causative agent of this disease is Kenchu virus. Single oral ingestion is sufficient for this disease.

Rearing of silkworm under hygienic condition may control the viral disease. Proper ventilation and sufficient spacing, maintaining optimum temperature and humidity in the rearing house is also minimize the viral infection.

Silk Research Institutes

In this context, Central Silk Board (CSB) has established Central Sericultural Research & Training Institutes, each at Mysore, Berhampore and Pampore, Silkworm Seed Technology Laboratory at Bangalore, Seri-biotech Research Laboratory at Bangalore, Central Sericultural Germplasm Resources Centre at Hosur for mulberry sericulture research. National Silkworm Seed Organization Head Quarters is located in Bangalore. For non-mulberry sericulture research, two institutes namely, Central Tasar Research & Training Institute at Ranchi and Central Muga Eri Research & Training Institute at Ladoigarh are functioning. The post-cocoon related research is carried out at Central Silk Technological Research Institute at Bangalore.

Central Sericultural Research and Training Institute, MYSORE - 570008, KARNATAKA, INDIA- The institute was established in 1961. Nested with the main institute are five Regional Sericultural Research Stations (RSRS), one Satellite Silkworm Breeding Station (SSBS), 17 Research Extension Centres (REC), three Sub-RECs and one P4 station / farm located within the mandated seri zone which includes the states of Karnataka, Andhra Pradesh, Telangana, Tamil Nadu, Kerala, Maharashtra and Madhya Pradesh. Over 90 scientists are working towards constant up-gradation of silkworm races, mulberry varieties, development and evaluation of region and season specific technologies, genetics and biotechnology including tissue culture, transfer of technology, extension management and training offers structural course like M.Sc. (Sericulture technology), Diploma and Certificate courses on regular basis.

Central Sericultural Research and Training Institute, BERHAMPORE-742101, West Bengal, India- The institute was established in 1943. Nested with the main institute are 3 Regional Sericultural Research Stations (RSRS) and 9 Research Extension Centres (REC) located in the mandated seri zones which includes the states of West Bengal, Orissa, Assam, Sikkim, Jharkhand, Tripura, Meghalaya, Nagaland, Mizoram and Arunachal Pradesh. Over 43 scientists are working towards constant up-gradation of silkworm races and mulberry varieties, pest and diseases of silkworm, development and evaluation of region and season specific technologies, genetics & tissue culture, transfer of technology. Also offers structural training courses, Post Graduate Diploma in Sericulture and Certificate courses on regular basis. This Institute has initiated a new service for answering farmers questions related to sericulture through email. Farmers may post their questions and get their reply within short time.

Central Sericultural Research and Training Institute, PAMPORE – 192121- The institute was established in 1990. Nested with the main institute are 2 Regional Sericultural Research Stations (RSRS), 6 Research Extension Centres (REC), 1 P4 Station / Farm, and 1 Sub-REC located in the mandated seri-zones which includes the states of J&K, Himachal Pradesh, Harayana, Uttar Pradesh & Uttarakhand . Over 37 scientists engaged in constant up-gradation of silkworm races and mulberry varieties suitable to temperate zone and hilly regions, development and evaluation of region and season specific technologies, genetics and breeding, transfer of technology, extension, etc.

Central Muga Eri Research and Training Institute, Ladoigarh Charali- The institute was established in 1999. Nested with the main institute are 2 Regional Sericultural Research Station (RSRS), 2 Muga Research Extension Centres (RECs), 1 Eri Research Extension Centres (RECs) and one Muga Field Lab located in muga and eri seri-zone, which includes the states of Assam, West Bengal & UP. Over 30 scientists are working on mandated areas like collection and conservation of muga and eri host plants and its silkworms, evolving suitable package of practices for muga and eri silkworm, rearing technology, seed technology and reeling and spinning in muga and eri sector.

Central Tasar Research and Training Institute, Piska Nagri- The institute was established in 1964. Nested with the main institute are 6 Regional Tasar Research Stations (RTRS), 4 Research Extension Centres (RECs), One P4 Station and One Raw Material Bank (RMB) in tropical and temperate tasar growing region of India viz. Chattisgarh, Orissa, Andhra Pradesh, Maharashtra, Uttarakhand, Jharkhand, Himachal Pradesh, West Bengal and Manipur. The institute has over 32 scientists working on mandated areas like tasar and oak tasar silk production, conservation of eco races, augmentation of food plant, integrated package of rearing and post cocoon technology aspects. Also offer Post Graduate Diploma in Non-mulberry Sericulture on regular basis.

Central Silk Technological Research Institute- The Central Silk Technological Research Institute was established in 1983 to take up R&D activities in Post Cocoon sector with the mandate of Quality improvement, Productivity improvement, Services to the industry, Enterprise development and Market information dissemination. CSTRI has been addressing the problems faced by the industry with constant interactions with the concerned groups. It is extending R&D support, technical services, training for use of improved machinery, skills and entrepreneur development. It undertakes promotional activities in post-cocoon sector. The institute has patented a number of technologies, machineries and equipments available for commercialization. Nested with the main institute are two Regional Silk Technological Research Stations (RSTRS), and 14 Silk Technical Service Centres (STSCs) spread over Andhra Pradesh, Karnataka, Tamil Nadu, Jammu & Kashmir, West Bengal, Maharashtra, Orissa, Uttarakhand, Bihar, Chattisgarh, Assam and Uttar Pradesh. Over 52 scientists are working on areas of reeling, weaving, wet processing and training & extension. CSTRI is propagating the importance of quality of silk yarn by assessment and testing activities through its sub-units.

Central Sericultural Germplasm Resources Centre- The center was established in 1991. It has a mandate to collect, protect and conserve mulberry and silk-worm germplasm resources. This is also a National Repository Centre for mulberry germplasm and a National Active Germplasm Site (NAGS) for mulberry germplasm under NBPGR. Over 10 Scientists are engaged in collection and conservation activity.

Seri-biotech Research Laboratory (SBRL)- The laboratory established in 1993, is conducting research on frontier areas of modern molecular biology and its application towards improving silk-worm races for better productivity. Six scientists are working on molecular biology projects.

Silk-worm Seed Technology Laboratory (SSTL)- The exclusive laboratory for R&D activities on silk-worm seed was established at Kodathi, Bangalore during the year 1991 under National Sericulture Project (NSP).

Few Technical Terms Associated with Silk-Cultivation

1. **Voltism-** It refers to number of life cycles per year. Depending upon race a typical silk-worm may have one (Uni), two (Bi), three (Tri) or Multi (more than three) life cycles.
2. **DFL-** Disease free laying. A DFL is defined as Disease Free Laying that is a group of eggs laid out by a moth which has been certified as disease free. Normally it consists of 200 healthy eggs. After emergence from the cocoon male moths immediately couple with female moths. After a period of 24-36 hours female moth lays eggs in about three batches. These eggs are cleaned washed and examined under the microscope for diseases specially pebrine. After a batch is certified as disease free then only it is used for rearing in the field.
3. **Chawkie rearing-** Initially laid eggs when transferred in the field are hatched under supervision in few selected shrubs for a week. This natal stage rearing is called Chawkie rearing. After a week the one week old larvae are spread all over the forest areas.
4. **Pebrine-** Pebrine is a disease of silk-worms, which is caused by microsporidian parasites, mainly *Nosema bombycis* and to a lesser extent *Variomorpha*, *Pleistophora* and *Thelophania* species. The silk-worm larvae infected by pebrine are usually covered in brown dots and are unable to spin silkworm thread. Louis Pasteur was the first one to recognize the cause of this disease when a plague of the disease spread across France. It is the most dangerous silk-worm disease and often leads to epidemic form there by destroying crops not only at local level but at state and even national level. Precaution includes disinfection and burning of the ground soil surface.
5. **Diapause-** After the cocoon has been spun and the pupa sets inside the cocoon it goes into hibernation or diapauses. In case of Tasar during the first crop at the onset of monsoon the pupa goes into diapause for one week. Since there is still sufficient humidity it emerges as a moth and the lifecycle is repeated. After the second crop winter sets in and there is not sufficient humidity. Therefore the pupa remains in the cocoon in the diapauses state for about six months till the next onset of monsoon.

6. **Grainage**- The process of Tasar egg making in lay mans term is called *grainage*. It involves storage of eggs, facilitating of male female coupling, washing cleaning of eggs and disease checking.
7. **Molt**- A silk-worm goes into molt phase five times in its life cycle of 30-35 days. During this process it sheds its skin and does not eat. This is because there is enormous enlargement in its size. During this process the old skin is shed and new skin comes up.
8. **Ecorace**- Due to agro climatic variations in the country various silk-worm have adopted to local conditions and have evolved into distinct ecoraces. For example *daba, modal, rally, laria* are ecoraces of Tasar. Similarly in case of Mulberry ecoraces are developed by Central Silk Board to get maximum productivity for a particular area.

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Pateriya SD (2020) Biodiversity-cell-ntfp-related issue4

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