**Eri culture: A traditional practice of Assam**

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**Abstract**:

Silk is an animal protein which is woven into textiles with unique lustre, strength and durability. Although a number of organisms are known to produce them, commercial silk is obtained from four types of silkworms namely mulberry (*Bombyx mori* L.), tasar (*Antheraea mylitta* and *Antheraea proylei*), eri (*Samia cynthia ricini*) and muga (*Antheraea assamensis*). About 90% of the commercial silk is produced by mulberry silkworm and the rest comes from non mulberry silkworms commonly known as ‘vanya’ or wild silkworm. Among the commercially exploited vanya silkworms, Eri is a widely spreading most popular silkworm species. Eri silkworms are entirely domesticated and they are not found in nature. It was originated in northeast India and found in the states of Nagaland, Meghalaya, Manipur, Bihar, Orissa, Karnataka, Assam, Andhra Pradesh and Jharkhand.

**Keywords**: Lepidoptera, Eri culture, Assam, rearing, disease

1. **Introduction**

Eri culture is an age old agro-based tradition in the northeastern states of India. It has an important role in the income and employment generation and provide livelihood to around 2.7 lakh families in this region [1]. The tradition of ericulture was inherited from generation to generation and it is majorly taken up by womenfolk as leisure time occupation to meet their requirement of food and warm clothing [2]. As compared to other sericultural activities, ericulture has become more popular among the people as easy source of revenue earning. Apart from their use in silk production, eri silkworms also serve as a delicacy among the tribal people [3].

The word ‘eri’ means castor and is derived from the Sanskrit word “eranda”. Eri silk, also known as ‘fabric of peace’ or ‘ahimsa silk’ is a nonviolent silk as no moth is killed during the fibre extraction process and thus it is preferred by the Buddhist monks and vegans [4]. The name "palma christ" was given to the eri silk produced by the Britishers. According to Captain Jenkins (1771) eri silk possess incredible durability.

Though the origin of the silkworm is not clear, Assam is considered as the home of the eri silk. It is confined to the Brahmaputra valley of Assam and its neighbouring states of Meghalaya, Nagaland, Mizoram, Manipur and Arunachal Pradesh [5]. Except for Tripura, ericulture is predominant in all the Northeastern states of India. The eri pupae is consumed by the Bodo, Rabha, Miri, Kachari, Garo, Khasi, Naga, Adi, Mizo and Synteng tribals of Tibet, Burma and India. Ericulture is also found in China, Korea, Japan and Thailand.

1. **Systematic position**

The systematic position of Eri silkworm is as follows:

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| Kingdom | * Animalia |
| Phylum | * Arthropoda |
| Sub-Phylum | * Mandibulata |
| Class | * Insecta |
| Sub class | * Pterygota |
| Order | * Lepidoptera |
| Sub-order | * Ditrysia |
| Super family | * Bombycoidea |
| Family | * Saturniidae |
| Genus | * Samia |
| Species | * *Samia ricini* |

1. **Species and ecoraces of eri silkworm**

Out of 19 species of eri silk moth of Asia, three species of eri silkworms namely *Samia ricini* (Donovan), *Samia canningi* (Hutton) and *Samia fulva* (Jordan) are reported from India. The most common one is *Samia ricini* which has 26 variants or eco races *viz.*, borduar, barpathar, titabar, khanapara, mendi, sillie, borpeta, imphal, inao, mukokchung, mendipathar, dhanubanga, diphu, genung and nogpho etc [6]. In addition to the eco races six different strains of eri silkworm are also present *viz*., yellow plain (YP), yellow spotted (YS), yellow zebra (YZ), greenish blue plain (GBP), greenish blue spotted (GBS),greenish blue zebra (GBZ).

1. **Life cycle of eri silkworm**

Eri silkworm is multivoltine in nature having 4-5 generations in a year. In summer the life cycle is completed in 44-45 days whereas in winter it takes 80-85 days.

1. **Eri egg**

The freshly laid eggs are ovoid in shape and slightly white in colour with hard chitinous shell. The colour of the shell gradually changes from whitish to yellowish, yellowish to ashy and ashy to blackish just before hatching. A female moth can deposit about 300-500 eggs in a cluster for 3-4 days. However the eggs laid upto 2nd day are only used for rearing. The eri eggs are streakless and no parallel lines are present. The newly laid eggs are attached to the surface with colourless glue. After laying, the egg measures about 1.5 x 1.0 mm and weighs 6 mg. In summer it takes seven days for the eggs to hatch and in winter days it may take upto 24 days.

1. **Eri larva**

The larval body is divided into three regions- head, thorax and abdomen. It is of eruciform type with three thoracic and ten abdominal segments. After hatching the larvae have a tendency to remain together for some time. The head of the newly hatched larvae is black in colour with yellow body which gradually changes to greenish yellow. The colour of the ecoraces is morphologically different in terms of the markings and spots. During its larval life the Silkworm moults four times. During the moulting period the larvae stops eating and becomes motionless. This period usually lasts for 24-48 hours. At the end of the moulting period the larvae breaks through the integument of the head by continuous movement and wriggling. First moult occurs after 3 days of hatching. In the first instar larvae, the prothoracic hood marking appears as a black dorsal band which in second and third instar takes the form of a pair of crescent shape marking. In the fourth instar it disappears. Four to six tubercular spines are present in each thoracic and abdominal segment with numerous hairs in them. The larval duration is for 24-29 days. Depending on the environmental conditions and humidity the larval life may get prolonged. The fully mature larvae measures about 7 x 1.5 cm and weighs 8 gram. Once the larvae get matured they empty their gut content and searches for a suitable place to form cocoon.

1. **Eri cocoon**

It takes three days to spin the cocoon. Inside the cocoon the larvae passes its pupal stage before becoming a moth. One end of the eri cocoon is tapering and the other end is slightly flat and round. Size is 4.0 x 2.5 cm and weights 3 g. Colour is brick red and creamy white. Eri cocoons are unreelable since the larvae spin discontinuous filament and thus moths can be allowed to emerge without killing.

1. **Eri pupa**

Pupa is obtect pupa and brown in colour. The pupa is the stage prior to the moth stage with all the appendages of future moth, such as compound eye, wings, antennae, legs, genitalia etc. which can be seen. The body of the pupae is covered with hard integument. Pupa weighs about 2.6 g and has dimension of 2.8 x 1.5 cm. The duration pupal stage is 14 days. Before emergence as moth the colour of the chrysalis turns black.

1. **Eri adult**

The moth stage is obtained after 2 weeks from the pupal stage. During the early hours of the day the moth emerges from the cocoon by piercing through the open end. Emergence of male moth is occurs earlier than the female moths. The body of the moth like that of the larva is composed of 3 distinct body segments- head, thorax and abdomen. The meso and metathorax bears two pairs of wings. The wings are greenish to orange to blackish brown in colour with white band and crescent shaped marking. In male the wingspan is 13 cm and in female it is 15 cm. Body surface is covered with scales. The male moth measures 2.5 cm in length and the female measures 3 cm. throughout the brief adult stage, it does not feed. Antenna is bipectinate type. After mating for 24 hours, the female moth lays about 300-400 eggs.

**Life cycle of eri silkworm**

**Figure 1: Life cycle of *Samia ricini***

**Host plants of Eri silkworm**

Eri is a polyphagous insect that feeds on a number of host plants. Its primary host plant is castor (*Ricinus communis* Linn.) and Kesseru (*Heteropanax fragrans* Seem). In addition to this a number of secondary host plants are also there namely barpat (*Ailanthus grandi*s), barkesseru (*Ailanthus excelsa*), tapioca (*Manihot esculenta*), gulancha (*Plumeria acutifolia*), gamari (*Gmelina arborea*), payam (*Evodia fraxnifolia*), papaya (*Carica papaya*), jatropha (*Jatropha curcas*), gulanhiphool/champa (*Plumeria acutifolia*) and ber (*Zyzypus mauritiana*).

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| --- | --- |
| **download (3).jpg** | **6105155765_86197f02ca.jpg** |
| ***Ricinus communis*** | ***Heteropanax fragrans*** |
| **Figure 2: Primary host plants of eri silkworm** | |

**Castor varieties/Hybrids**

A non-bloomy red castor cultivar, NBR-1, is advised for rearing in the India's North Eastern region of India [7]. With more than 13 MT leaf yield/ha/year, two other productive accessions, Acc 003 and Acc 004, have been established and are now known as NBR-2 and NBR-3 [8]. Jyothi, GCH-5, GCH-4, DCH-519, DCH-177, CO1, Aruna, TMV, etc. are high oil production cultivars. Castor hybrid YRCH-1, YRCH-2, and YTP-1 are developed by TNAU.

**Package of practises of eri seed production**

Rearing is the most important phase of sericulture activity. The rearing of healthy and disease free larvae is the prime factor for production of good quality silk. A good harvest of cocoon depends on the environmental condition, availability of disease free layings and host plants, proper equipments and facilities etc. The rearing of eri silkworm is done in the indoors and upto 6 rearing can be taken up in a year.

1. **Eri Grainage house:** Well drained and elevated place is selected for the construction of grainage house. The working area of the grainage house should have dimensions of 34 feet length x 18 feet breadth x 12 feet height with veranda of 5 feet x 6 feet in all the four sides. One such grainage room can accommodate 5,000 dfls. Temperature of 25±2ºC and relative humidity of 75±5% is the favourable temperature and humidity for grainage operations. The grainage house should be constructed facing the east direction. It can be made with mud wall, concrete floor and thatched roof. For storage of seed cocoons, oviposition and mother moth examination separate space should be kept.
2. **Disinfection of Grainage room and appliances:** Before the commencement of rearing operations, the entire grainage room and appliances are washed and disinfected. 5% bleaching powder solution is used to wash the appliances. All the cracks and crevices are sealed and fumigation with 2% formaldehyde is done after which the room is kept close for 24 hours. Various other methods of disinfection- sun drying, flame gun**,** slaked lime solution etc.
3. **Seed cocoon collection and transportation**: Seed cocoon collection is done 6-8 days (summer) and 8-10 days (winter) after the formation of pupae inside the cocoon. Cocoons with true to the race characters like shape, size, weight and colour are selected for seed preparation. Too large, too small, malformed and defected cocoons are discarded. The cocoons are transported to the grainage room in bamboo or plastic baskets after harvesting. Proper aeration is provided during transportation. Seed cocoons are transported only during the cooler hours of the day. Exposure to direct sunlight and rain is avoided. During transportation the cocoons should not subjected to pressing, dropping, or vigorous shaking.
4. **Mating of male and female moth:** After the complete metamorphosis of pupae into adult, the moths emerge out of the cocoons. Moth emergence takes place during the early morning and evening after 18to 19days of spinning at 24 -25ºC. The male moths emerge before female moth, however by the end of the day the number of male and female moth is almost equal. Eri moth is capable of mating in their natural environment and thus no need for mechanical mating. After one hour of emergence mating takes place and lasts for 8-10 hours after which the moths are decoupled by hand. The mated female moth is tied to the kharika for oviposition.
5. **Oviposition:** Kharika is an egg laying device made up of bundle of straws. Female eri moths are tied to the kharika with a thread passing under the wings. Since the moths prefer vertical position for egg laying, the kharika are suspended with a thread from the ceiling. The eggs are laid in cluster on the kharika. The optimum temperature and humidity for egg laying is 25-26ºC and 80%-90%, respectively. About 350-400 eggs are laid by one eri moth in semi dark condition. The eggs laid in first two days are only suitable for rearing.
6. **Mother Moth Examination:** To detect the presence of pebrine spores, mother moth examination is done. It is one of the main activity in preparation of disease free layings. This method was invented by Louis Pasteur. After the completion of egg laying process, the mother moth is individually examined by crushing them with 2% caustic potash in a mortar and pestle. A drop of this solution is placed over a glass slide and observed under the microscope. The pebrine spores are detected by the presence of shiny oval spores and the eggs laid by the concerned moth is discarded.
7. **Surface sterilization of eggs:** Surface sterilization is carried out using a 2% formalin solution for 30 seconds, followed by washing with running water for several minutes to completely eliminate all traces of the formalin. The eggs are then laid out on a single layer and dried in the shade. After drying, the disease-free layings (dfls) are packed in cardboard boxes or muslin bags and transported to the rearing house.

**Package of practices of improved eri silkworm rearing**

1. **Host plant availability:** Based on the availability of host plant, the size of the rearing is decided. Though castor is the primary food plant [9], a number of secondary host plants are available in the northeastern states of India. The most common secondary host plants of eri silkworm are kesseru, borpat, borkesseru, tapioca, payam etc. It was reported that after castor, kesseru leaves are the best choice for good economic characters of cocoon [10]. It was also reported that the eri silkworms prefers to feed on castor plants followed by kesseru, tapioca, papaya, barkesseru and gulancha in that order of preference [11]. Sachan and Bajpai [12] reported that eri silkworms raised on Rosy castor variety showed better larval growth and good cocoon characters. S30, EB-31 and EB-16 varieties also gives good cocoon yield. According to Joshi [13], irrespective of the diet utilized during the previous instars, larvae reared on Castor leaves exhibited better growth.
2. **Rearing House:** Since eri silkworms are reared indoors, well equipped rearing house is very important. Rearing house is constructed in an elevated ground with proper ventilation for circulation of air. Sufficient trees are planted around the house to provide cooling effect during summers. The dimensions of the rearing houses are usually 10 m x 5 m with 1.5 m verandah all around it. About 100 dfls of commercial and 50 dfls of cellular stock can be accommodated in one such rearing house. Separate area for leaf storage, leaf chopping, young and late age rearing and mounting should be maintained.
3. **Disinfection and prophylactic measures:** Disinfection of rearing room can be done by physical and chemical methods. The most common chemical disinfectants are formalin, bleaching powder, lime, sodium hypochlorite and chlorine dioxide. Before rearing, all the equipments and the rearing room is disinfected with 2% formalin solution. 5% bleaching powder solution is also effective. Various sericultural research institutions has developed bed disinfectants like vijetha, labex, resham jyothi, sanjeevini, suraksha, reshamkeet oushadh, dithane M45, captan etc.
4. **Egg incubation and hatching:** Eggs should be incubated in a well-maintained room or incubator at 24-26˚C temperature and 80-85 % relative humidity. During pigmentation stage, the egg should be kept in total darkness or wrapped with black cloth or paper. Eggs should be exposed to light in the early morning hours (6 – 8 AM) on the expected day of hatching to get uniform hatching simultaneously. In summer eggs hatch after 9 to 10 days and in winter it takes 15 to 20 days.
5. **Brushing of worms:** On the first day of hatching, tender leaves are put inside the egg box in the early morning. The newly hatched larvae crawl onto the leaf and start feeding. With the help of a soft brush or bird’s feather the larvae along with the leaves are transferred to the rearing tray. New leaves are added thereafter.
6. **Silkworm rearing**

The rearing of eri silkworms upto 2nd instar is called young age silkworm rearing. Temperature of 26-28˚C and relative humidity of 85%-90% is optimum for young age rearing. In case of late age silkworm rearing the favourable temperature and relative humidity is 24-26˚C and 70%-80% respectively. Depending on the environmental conditions and available space, the rearing of silk worm is done by bunch, tray or platform method [14].

1. **Bunch rearing:** The most common method of eri silkworm rearing in Northeastern India is bunch rearing. In this method the worms feeds on the leaves of castor or kesseru which are tied together to form a bundle. Each bundle contains 10-12 leaves or branches. The bundles are hanged vertically on a horizontal support made out of bamboo or wire. Frequent replacement of branches is needed as the leaves get dried quickly in this method. The various advantages of this method includes easy bed cleaning, less manpower requirement, simple method and minimum cost. Since the excreta of the worm’s falls directly on the ground, there is no soiling of the leaves and thus this method is more hygienic as compared to the other methods.
2. **Tray rearing:** In tray rearing the worms are reared on leaves provided on the tray. Wooden trays of size 50 x 60 x 5 cm or round bamboo tray with diameter of 1m are used for rearing the young age silkworms. 10-15 dfls can be reared in one such tray. In case of late age silkworm one round tray can accommodate about 600-700 worms in 4th and 300 worms in 5th instar.
3. **Platform rearing:** This is a mass scale rearing method for eri silkworm reported by [15]. The platforms are made up of bamboo strips of size 1 x 2 m with 1sq m sieve size. Platforms are placed in 3 tier bamboo rack of size 2.2 m length x 0.75 m breath x 1.60 m height. Two numbers of racks can be placed in a room with floor area of 5.4 sq m. (1.2 x 4.5 m). In each platform about 1200 eri silkworms at 5th instar can be reared. A total of 3600 worms are reared in three such platforms.
4. **Maintenance of larvae:** Fresh leaves are provided to the silkworms. When fresh are not available and harvested shoots needs to be stored for future use, preservation of the shoots is done in vertical position in a cool and moist place by covering them with wet gunny cloth. Feeding should be provided 4-5 times and 5 times a day for young age and late age silkworms respectively. The unhealthy worms are removed during bed cleaning. In first instar bed cleaning is done once, in second instar it is done twice, in third and fourth instar thrice and in fifth instar it is done daily. While cleaning, precaution is taken not to spill the bed refuse in the rearing floor. Spacing is also important for healthy growth and development of the worms. For 100 dfls of 5th instar larvae a bed size of 600 sq ft is required. One round bamboo tray of 1m diameter can accommodate 300 nos. of worms. Proper care is taken while handling the worm and when 75%-80% of the worms enter into the moult, feeding is stopped.
5. **Matured worm collection and mounting:** On the 7th day of fifth instar, the eri worms enter into maturity. They release the last semi-solid excreta and become ready for spinning. They stops feeding and search for a suitable place to make the cocoon. The matured worms produce a hollow sound when it is rubbed gently between fingers. This is the best time for mounting the worms in good quality mountages.
6. **Harvesting and assessment of cocoons:** After completion of spinning, the larval skin is cast off and pupation takes place. In summer harvesting of cocoons takes place after 5-6 days and in winter it takes 8-9 days. After harvesting the defective cocoons like double, melted, stained, dead, inferior, cut or pierced cocoons are sorted out. Cocoons are preserved carefully to prevent the attack of pests and diseases.

**Management of pest and disease of eri silkworm**

**Diseases:**

**Pebrine:**

* Causal organism: Protozoan- *Nosema* sp.
* Peak season: Summer season
* Spread of disease: Perbrinized larvae faecal matter, gut juice and vomit containing pathogens. Pebrine spores present in the infected larvae contaminates the rearing environment, leaves of host plants and appliances used in the rearing. Consumption of foliages infected with pebrine spores causes the spread of the disease. It is also caused by transovariole transmission from infected mother moth.

**Management of Pebrine**

* Individual mother moth testing for the detection of pebrine spores during egg production should be followed using proper procedures.
* Practice of disinfection of grainage hall and appliances before and after every grainage operation with 2% formalin.
* Use of only disease free disinfected eggs for rearing.
* Surface sterilization of eggs with 2% formalin for 5 minutes.
* Maintenance of hygienic conditions in grainage and rearing room.
* Destruction of diseased silkworm larvae/ cocoons/moths/ eggs.

**Flacherie:**

* Flacherie is a bacterial disease in eri silkworm.
* It is caused by an exciting agent- a virus followed by secondary infection of bacteria
* Peak season: Throughout the year, intensive during rainy summer months (June to August)
* Source of infection: Diseased larvae, faecal matters, gut juice, body fluid and contaminatedrearing site and appliances.

**Management of Flacherie**

* Use of disease free layings.
* Disinfection of rearing room before rearing with 2% formalin solution.
* In case of high incidence of the disease in preceding rearing, dusting of 0.3% slaked lime in the rearing room and appliances.
* Hands washed with formalin solution before handling of worms.
* Maintenance of hygienic condition during rearing.
* Feeding of good quality disease free leaves.
* Feeding only matured leaves to later stage worms.

**Pest**

The incidence of pest attack is less in eri silkworm as compared to mulberry and muga silkworm. For protection of the worms from uzi fly, nylon nets are provided in the doors and windows. Food plant leaves are the common mode of entry of the fly to the rearing room. Thus the plucked leaves are preserved in a separate site to check the entry of the uzi fly.

**Conclusion and future prospects**

Eri silkworm is one of the most economically important non mulberry silkworm found in northeast and few other states of India. For commercial exploitation, seven eco races and six strains are maintained in these regions. Primarily they feed on castor, while kesseru, barpat, barkesseru, tapioca etc are also preferred by them.

The silk produced by eri silkworms are soft, silky, unique and more durable than mulberry silk in nature. They have a good affinity to dyes and easily take up colour. In addition to the primary product i.e. the silk, a number of secondary products are also obtained from ericulture activities. The cultivation of eri silkworms offers various lucrative benefits. Since the worms consume castor and tapioca leaves as food, castor and cassava farmers can also engage in eri silkworm farming as a side business. The eri pupae also find its use in medication and cosmetics industry. Because of its high protein content, eri pupae are also consumed as food in the Asian countries. In addition to this they can also serve as supplementary protein source in the diet of fish, poultry and swine. Use of silkworm pupae as animal feed can be a cheaper alternative to expensive commercial feeds. The eri silkworm can produce a number of high-profit enterprises. Therefore, the industrialization of eri can be of great significance to the nation.

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