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# UNIT 4 NON-MULBERRY SILKWORM REARING

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## 4.0 OBJECTIVES

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After reading this unit, you should be able to:

- discuss about the procurement of non-mulberry silkworm eggs and their incubation;
- explain the disinfection and hygiene maintenance during silkworm rearing;
- summarise the methods of the rearing of young non-mulberry worms and silkworm rearing outdoors;
- discuss the importance of handling of non-mulberry silkworms during rearing, moulting and spinning;
- analyse the alternative methods of non-mulberry silkworm rearing; and
- assess the time and methods of harvest of non-mulberry silkworm cocoons.

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## 4.1 INTRODUCTION

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In the previous unit, you have studied about the details of Mulberry Silkworm Rearing. In this unit, you will study the non-mulberry silkworm rearing. This unit deals with methods of rearing non-mulberry silkworms (Tasar, Oak Tasar, Muga and Eri Silkworms). Non-mulberry silkworms are not domesticated and are reared outdoors (except Eri, which is domesticated). They are wild in nature and thrive on nature grown host plants or plantations specified for the purpose. Similar to Mulberry silkworm rearing, non-mulberry silkworm rearing also includes the activities like Incubation of eggs, Chawki rearing, Late-age rearing, Harvesting and Marketing of cocoons.

The first step, incubation, needs optimal environmental conditions for development of embryo in the egg and to obtain good hatching rate. The next step is young age silkworm rearing, otherwise called as Chawki Rearing, a vital aspect of cocoon production. The silkworm larvae up to third stage are called Chawki worms. Healthy chawki worms can withstand natural vagaries and yield a good cocoon crop. The third step is late age silkworm rearing. It involves rearing of third, fourth and fifth stages of silkworm larvae. During the late age rearing, the silkworms consume large quantity of leaf. About 90% of leaf is consumed during the late age only and accordingly, the larval body volume increases by 11,000 times of the tiny worm. In non-mulberry late-age silkworm rearing, more labour is required due to repeated transfers of larvae from canopies to canopies. These silkworms can withstand higher temperatures and optimal environmental conditions make the crop more successful.

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## 4.2 TASAR SILKWORM REARING

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Tasar silkworms are primarily feed on Sal (*Shorea robusta*) plants in the forest. Asan (*Terminalia tomentosa*) or Arjun (*Terminalia arjuna*) plants are also the primary food plants in the systematic or natural plantations. The Tasar silkworm is normally Trivoltine or Bivoltine, means, it completes three or two life cycles in one year. The Tasar silkworm shows wide variations in its appearance and biological traits due to its spread over vast areas in the states of Jharkhand, Bihar, Chhattisgarh, Madhya Pradesh and Orissa. Accordingly, two eco-races, i.e. Daba and Sukinda are widely used for commercial cocoon production.

**a) Preparation of Rearing Site and Procurement of Tasar Silkworm Eggs:**

Elevated plantation sites where congenial climatic conditions and abundant sunlight and aeration are selected for quality silkworm rearing. The rearing sites are cleaned-off weeds; over-mature dried leaves and twigs to keep away pests and disease causing organisms. The rearing site is disinfected with spraying of 1 % Bleaching powder solution 5-7 days before the commencement of rearing.

Tasar silkworm eggs loosely packed in clean cloth bags in specially fabricated egg carrying baskets with information on date of coupling, expected date of hatching, date of testing and packing and source of cocoons. They are transported during the cooler hours of the day when the temperature would be <30°C and humidity <70%.

**b) Incubation:** Incubation of tasar silkworm eggs is required to ensure normal embryonic development and uniform hatching. After reaching the destination, the egg bags are removed from the baskets, spread in wooden or bamboo trays in single layers for incubation. The climatic conditions are maintained at a relative humidity of 70-80% and a temperature of 28-30°C to ensure 90-95 % hatching. Wet sand beds are prepared in the incubation room and wet gunny cloths or Khus Mats are hanged to doors and windows when the temperature is more than 30°C during summer days to enhance humidity. During winter, the temperature of incubation room is raised by keeping a charcoal oven with doors and windows closed. The temperature should not go beyond 30°C during incubation. Floors are wet mopped periodically to raise the humidity, if necessary.

**c) Brushing of Larvae:** Tender leaves of Asan / Arjun / Sal plants or freshly cut small twigs are spread thinly over the Tasar silkworm eggs placed in a wooden

or bamboo tray. The young larvae are allowed to crawl on to the leaves for sometime. The twigs with the newly hatched larvae are gently placed on the food plants in the chawki garden, or, the tender leaves with the hatched larvae are stick-pinned to the leaves of chawki plants. After migration of the hatched larvae to the plants, the dried twigs or leaves are removed. The worms up to 3 to 4 dfls are brushed on each plant. Normally, the brushing of Tasar silkworm eggs is taken for three days on different plants.

The brushings for Trivoltine tasar are taken up in 3<sup>rd</sup> week of June, 4<sup>th</sup> week of August and first week of November, and for Bivoltine tasar, the brushings are taken up during first week of July and third week of September. The above brushing periods may change based on onset of monsoon and other factors.

- d) **Chawki Rearing:** Chawki rearing involves rearing of newly hatched larvae up to the second moult in the chawki garden under nylon net prepared in a pre-determined area (Fig. 4.1). The nylon nets of size 12 m (length) x 10 m (breadth) x 3 m (height) are erected with the help of bamboo poles, nails and strings. Rearing under nylon net protects the young silkworms from pests and predators. The health of the chawki worms reflects in healthy larval growth and good cocoon yield.

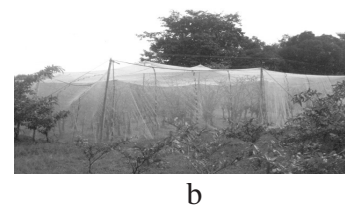


Fig. 4.1: a) Chawki Garden and b) Chawki Rearing under Nylon Net

Hygienic conditions are maintained during young age rearing by regular cleaning of weeds and litter and sprinkling bleaching powder at 10 g per plant on the floor, at intervals of 4-5 days. To ensure adequate ventilation inside the net, raise the sides of the net from the ground for 15-30 minutes daily. After rains, the net should be thoroughly shaken to remove the water film to allow free air. Transfer the worms to new bushes during cool hours of morning or evening when leaf biomass is consumed in full.

- e) **Late-age Rearing:** Late age worms are reared on the trees of economic plantations where good foliage is obtained. The late-age silkworms are less tolerant to high temperature and high humidity. Late-age rearing comprises of transfer of worms to different trees with utmost care, depending on the consumption rate. They feed on coarser and mature leaves. The young age larvae reared on chawki garden are transferred to regular economic plantation after one day of completion of second moult during cool hours of the day.

Initially, the twigs with worms are cut from the chawki garden. They are transferred on to the economic plantation with the help of cane or bamboo made tripod stand where the twigs containing the worms are hanged without exerting any pressure on the worms. Transfer of worms during heavy showers, gusty winds or stormy conditions is avoided. The population density of the larvae is maintained in such a way so as to avoid frequent transfers and is decided basing on the availability of leaf. Generally, one hectare of economic plantation can support rearing of 400-450 dfls. Over-crowding of worms is

avoided to minimise frequent transferring of larvae because these wild silkworms dislike frequent handling. Worms are transferred while 20-25% of foliage is still left out for stability, growth and maintenance. Ensure mounting of uniformly sized worms on a particular plant. Weak and diseased worms should be segregated while transferring. Disinfection of hands is done before and after handling of worms.

Tasar silkworms also moult four times during its larval period. Worms under moult are very sensitive and are handled with care. Disturbance to worms during moulting may result in loosening of grip leading to falling down and partial to no moulting also. Thus, the transfer of worms is normally done after 2-3 hours of moulting.

In Tasar, crawling and wandering of worms is a common feature. This leads to starvation and often leads to reduction in cocoon yield. To avoid crawling down of worms, polythene strips of about 8 cm width with a smear of grease and methyl parathion (100:15) are wrapped on the tree trunk at about 30 to 45 cm from the ground. This prevents the worms crawling down and also acts as a protective measure against ants feeding on the worms.

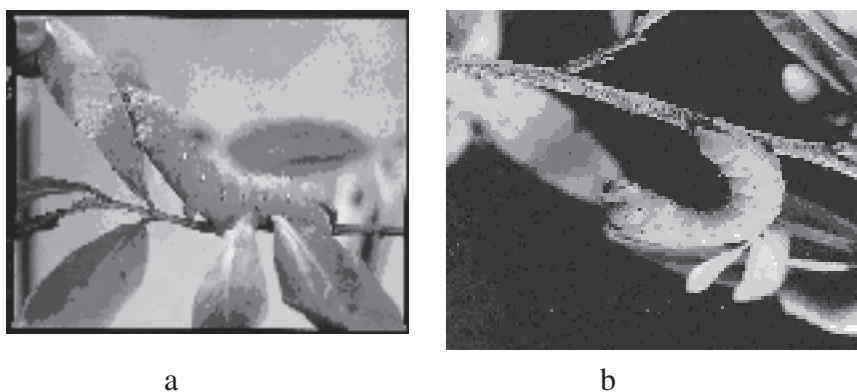


Fig. 4.2: a & b) Tasar Silkworm Mature Larvae - colour morphs (Source: Indian Silk)

In order to protect the larvae from Bacteriosis, Virosis and Mycosis, dusting of Tasar Keet Oushad (TKO) is done once in 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup> instar and twice in final (5<sup>th</sup>) instar at an interval of 7 days with the help of muslin cloth after 24 hours of moult out. Before transfer of the worms, larvae are collected on twigs spread over a polythene sheet and dusted with TKO. Requirement of TKO is 50 g / 1000 larvae during II and III stage and 100 g / 1000 larvae during IV and V stage. During the late age rearing, moulting and spinning larvae need special attention. Dead larvae are collected regularly in 5% Formalin and buried far away from the rearing site. Larvae showing disease symptoms are also destroyed along with the foliage.

- f) **Harvesting of Cocoons:** The process of cocoon spinning and pupation generally takes 4 to 6 days which may slightly extend during winters. Cocoons are harvested only when pupation is complete and cocoon shell becomes hard. The twigs with cocoons are cut and the adhering leaves are removed. Cocoons are collected with peduncles. Good cocoons are sorted and made into garlands for preservation, if the cocoons are required for seed production. Flimsy and Uzi infested cocoons are kept separately. Commercial cocoons are sun dried or stifled for longer and better preservation. They are stored loosely in gunny bags and kept away from pests and predators. The cocoons are marketed in form of Kahans which measure 1,000 to 1,600 cocoons per Kahan in different tasar growing areas.



a



b

Fig. 4.3: a) Cocoon spinning in progress      b) Tasar cocoon showing the peduncle hanging from a twig  
(Source: Indian Silk)

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### Check Your Progress 1

1) Why non-mulberry silkworm rearing done outdoors?

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2) Why Chawki Rearing is important in non-mulberry sericulture?

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## 4.3 OAK TASAR SILKWORM REARING

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The Indian Oak Tasar Silkworm *Antheraea proylei*, is a hybrid of *A. pernyi* (Chinese) and *A. roylei* (wild). The silkworm is polyphagous and feeds on a variety of Oak flora that flourish in the sub-Himalayan belt extending from Jammu and Kashmir, Himachal Pradesh and Uttaranchal in the north to Assam, Meghalaya, Mizoram, Manipur, Nagaland and Arunachal Pradesh in the north-east. Oak tasar silkworm is completely domesticated in North-west and semi-domesticated in North-east region and hence the rearing differs. Thus, Oak tasar is reared indoors in North-west and outdoors in North-east. Because of variations in topography, climatic conditions, distribution of food plants and seasons of these two regions, different methods are adopted for rearing of Oak Tasar silkworm.

In the North-eastern region, outdoor rearing is practiced either completely or after indoor chawki rearing on *Q. serrata* (March/April) at lower altitudes. At higher altitudes, the rearing is carried out on *Q. grifithi* during July/August and with an autumn crop during September-October.

In the Northern region, silkworm rearing from brushing to spinning is done indoors with *Quercus leucotricophora* followed by *Q. serrata* leaves (February/April) at lower altitudes and inside polyhouses with *Q. semicarpifolia* and *Q. floribunda* leaves (April/July) at higher altitudes. Approximately, 200-250 fully grown plants of *Q. floribunda* and *Q. semicarpifolia* are required for rearing 2000 dfls to July.

- a) **Types of Oak Tasar Silkworm Rearing:** Three rearings are conducted in a year viz., advanced seed crop during February - April in lower and mid altitudes, a spring crop in the mid altitude during April to June and a commercial crop in higher altitude during April.

**Rearing at Low Altitude :** Rearing at low altitudes is taken upon *Quercus leucotricophora* and *Q. serrata* plants. Recommended quantity of FYM is applied during December. East facing slopes consisting early sprouting defoliated plants are used for the rearing.

**Rearing in Mid-altitude :** It is a spring rearing taken up on *Quercus leucotricophora* and *Q. serrata* plants during the months of December-January at the altitudes ranging between 1000-2000 m ASL following recommended practices.

**Rearing at High Altitudes:** It is the important commercial crop taken upon *Quercus floribunda* and *Q. semicarpifolia* plants at high altitudes above 2000 m ASL. During the rearing, synchronization of egg hatching with sprouting of plants is very well taken care off.

- b) **Procurement and Transport of Oak Tasar Silkworm Eggs:** Similar to Tropical Tasar Silkworm Rearing.

- c) **Incubation of Eggs:** Incubation of Oak Tasar eggs is done at  $22 \pm 2^{\circ}\text{C}$  and 70-80 % R.H. for 7-8 days placing the eggs in pre-disinfected (washed in 3% Formalin and dried) perforated plastic boxes or inside the paper trays placed on a table. These trays are exposed to natural light for four days and then covered with black cloth. Humidity is maintained by preparing wet sand beds inside the incubation room. On the 8th day (the day of hatching), the egg trays are exposed to light during early hours to allow hatching. In places, where temperature falls below the optimum of  $22 \pm 2^{\circ}\text{C}$ , other incubators like the **kerosene operated device** or Charcoal Singri or Pit Fire are used to raise the temperature and humidity (80 %).

**Incubation at higher altitudes:** In northern region, incubation is carried out at two places - incubation at lower altitudes in the grainage house itself and incubation at higher altitudes in a smaller hut constructed inside the rearing hut, during last four days before hatching. The eggs are thinly spread in the incubation boxes or bamboo /wooden trays placed on a platform near a source of heat, i.e., Charcoal Singri or Pit Fire.

- d) **Brushing:** Normally, eggs hatch in the morning hours. Cut small twigs with tender leaves and gently place them on hatching eggs to facilitate crawling of worms on to the twigs. Place the twigs with young larvae carefully on the chawki plants. Rear the young worms on different days on different twigs/bushes. The worms hatched within 3 days are only reared and the rest are rejected.

**Chawki Garden for rearing Oak Tasar Young Silkworm Larvae:** A chawki garden is also maintained for obtaining quality leaf and nylon net is also used during rearing.

e) **Late-age Rearing**

**Indoor Rearing:** In Northern region, due to topography and climatic conditions, indoor rearing is practiced in poly houses. It is believed that they provide suitable temperature for late age rearing ( $24 \pm 2^\circ\text{C}$  temperature and relative humidity of 70-80%). About 500 dfls are reared per hectare with a fecundity of 120 and 60% hatchability. In North-eastern region, rearing of late age rearing is taken up outdoors.



Structure of 'Poly tunnel'



a



b



c

Fig. 4.4: a) Mature Oak Tasar Silkworm Larva ready for spinning, b) Larva spinning a Cocoon, and c) Oak Tasar cocoon ready for harvest

**Application of Tasar Keet Oushad (TKO):** Use of Tasar Keet Oushad (TKO) has been found effective in Oak Tasar silkworm rearing. It is a combined mechanism for prevention of all the important diseases like Virosis, Bacteriosis and Muscardine. Dusting of TKO is done after bed cleaning, before the worms are given fresh feed as per the following schedule:

Stage of Worms	Frequency of Dusting	Quantity of TKO
I stage	No dusting	Nil
II Stage	Once	5g/100 larvae
III Stage	Once	10g/100 larvae
IV stage	Once	10g/100 larvae
V stage	Twice	10g/100 larvae

NB: Dusting should not be done while worms are in moult.

f) **Handling of Worms:** The moulting larvae are not disturbed at all. Larvae hatched on different days are reared separately to synchronise uniform growth and moulting. Transfer of larvae should always be done two to three hours after moulting.

**Spinning Larvae:** Mature worms attain characteristic green colour, head being dull brown with ten dark brown spots. When mature, the larvae measure about 7.5-10.0 x 1.7-2.1 cm and weigh about 11-21 gm. The ripe larvae are transferred to twigs with sufficient foliage for hammock formation.

**Mountages for Indoor Rearing:** Nearly 2% of mature larvae make naked cocoons for want of proper mountage or cocooning space. To avoid formation of naked or deformed cocoons, ripe worms are picked from the rearing platforms and released on an appropriate mountage.

**Dry Twigs:** Dry twigs of Oak or 30-60 cm long twigs of locally available

non-food plants should be bunched and hung upside down on ropes for the ripe worms to anchor and spin cocoons.

**Nylon Bags:** Nylon bags of the size 45 cm x 45 cm filled with dry leaves or small twigs are also used for cocooning. Ripe worms are kept in the bags on alternate days to avoid formation of double cocoons. Each such bag can accommodate 150-200 worms.

**g) Harvesting of Cocoons and Storage:** Generally, Oak Tasar cocoons mature after 4-6 days from the start of cocoon formation. However, maturity period is decided by the health of larvae and climatic conditions prevailing during rearing. The cocoons are harvested after 5-7 days of spinning. Twigs with cocoons are cut and adhering dry leaves are removed. Destroy the infected, flimsy and dead cocoons by burning. Make cocoon garlands from selected cocoons for seed production. Stifle the cocoons meant for reeling and pack them loosely in gunny bags after drying and sorting depending on their quality and grade.

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### Check Your Progress 2

1) Write down the characteristics of late age rearing in different non-mulberry silks?

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2) Describe late age rearing in Oak Tasar?

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3) How do the Kerosene operated incubator help in incubation?

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## 4.4 ERI SILKWORM REARING

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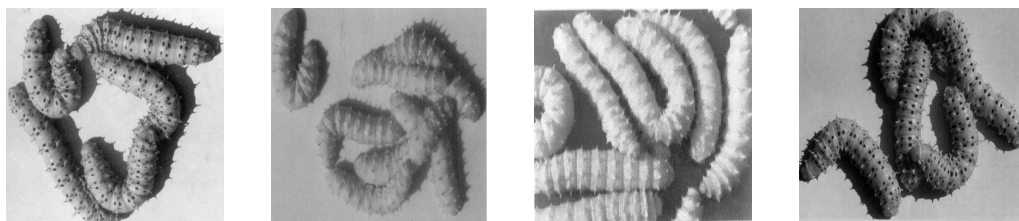
Eri silkworm, *Samia ricini* is the only fully domesticated *Vanya* silkworm feeding on Castor (*Ricinus communis*) and Kesseru (*Heteropanax fragrans*) plants. They are also reared on Tapioca (*Manihot utilissima*) and Payam (*Evodia flaxinifolia*). It is multi-voltine in nature. Eri silkworms can be reared throughout the year in 5-6 crops when the climatic conditions are favourable and food plants are available. The methodology of Eri silkworm rearing is relatively simple. Eri silkworms are hardy and less susceptible to diseases.

**a) Rearing House:** Eri silkworm rearing is done indoors and it needs a rearing house similar to mulberry. A separate rearing house is desired for successful harvest of cocoons. The location is selected in such a way that, planting of trees on all sides of the rearing house is possible to maintain congenial climatic



conditions for the silkworm rearing. The rearing equipment and appliances are cleaned and disinfected with 5% Bleaching powder solution before start of each rearing. Ideal location, good space and fixing of wire mesh to all the doors and windows and ventilators are desirable for a good rearing house.

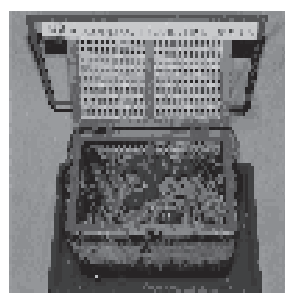
- b) Procurement of Eri Silkworm Eggs:** Quality eri silkworm eggs are procured from government certified private agencies. The eggs loosely packed in clean muslin cloth bags/egg transportation boxes are transported during the cooler hours of the day. They can also be transported in bamboo baskets covered with moist gunny cloth. Greenish Blue Zebra, Yellow Plain, Yellow Spotted and Yellow Zebra are some of the Eri eco-races normally used for rearing. It is appropriate to know that each dfl contains 300-350 eggs with 80-85% hatching.



**Fig. 4.5: Different ecoraces and strains of Eri silkworm**

Silkworms from each laying consume about 10-12 kg of foliage during the larval period that ranges between 18 to 45 days depending on the season. Single cocoon and shell weighs about 3.0 - 3.5 gm and 0.35-0.50 gm, respectively. An average yield of 8-10 kg of shell and 50-60 kg of pupae can be obtained from 100 layings.

- c) Incubation and Brushing:** Eri silkworm eggs hatch in about 9-10 days which may extend to 20 days in winter. The eggs are spread on trays and incubated at optimum temperature and humidity of 24-26°C and 80-85%, respectively for uniform hatching. During this period of embryonic development, the eggs turn yellowish and bluish before hatching. On the day of hatching, the eggs are exposed to sunlight. As the tiny larvae hatch out of the eggs (up to 80%), a few tender and succulent Castor leaves are placed over newly hatched worms. The larvae crawl on to the leaves and start feeding. The larvae are brushed and transferred along with the leaves to the rearing trays.



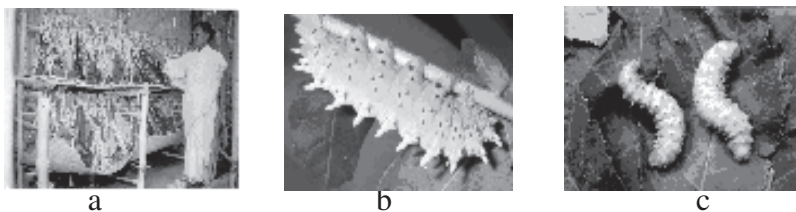
**Fig. 4.6: (a) Cooling Incubating Device**



**Fig. 4.6: (b) Brushing**

- d) Rearing:** Eri silkworm rearing is conducted by two methods - Tray rearing and Bunch rearing. The farmers combine both the methods. Generally, the first three stages are reared in trays and then the late age worms are transferred to bunches. In tray rearing method, the worms are reared with whole or cut leaves in wooden or bamboo trays. In bunch rearing method, 10-12 Castor or Tapioca leaves with petioles are tied together to make a bundle and hung vertically on horizontal ropes or bamboo poles fixed for the purpose (Fig. 4.7a). Fresh bunches of

leaves are placed next to facilitate the crossing over of worms. Below the bunches, a bamboo mat or newspaper is spread to avoid contamination or damage. The bunch rearing is very simple and easy to practice utilizing less manpower. However, care should be taken to replace the bunches with fresh leaf bunches.

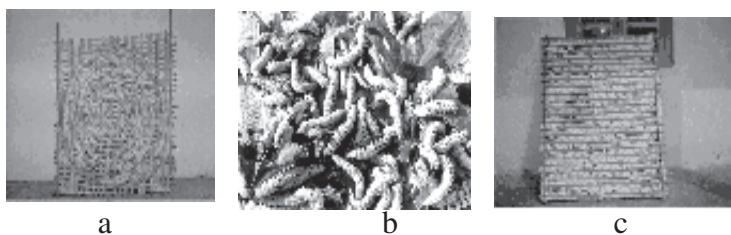


**Fig. 4.7:** a) Bunch Rearing (Source: *Indian Silk*), b) A beautiful bluish-green Eri silkworm mature larva and c) Yellow Plain Eri silkworm mature larvae (Source: *Indian Silk*)

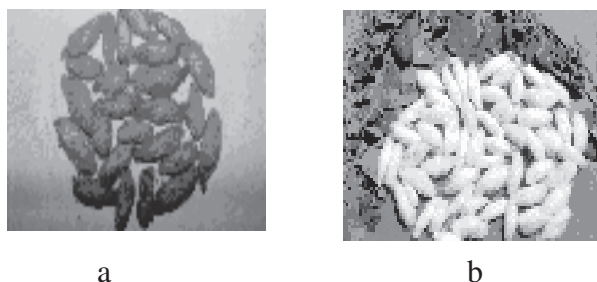
Besides, Eri silkworms are also reared on bamboo platforms in tier system at some places of north-east and Andhra Pradesh. Eri silkworm rearing needs 5 feedings per day. Eri silkworms per each laying consume about 10-12 kg of leaf during the larval period of 18 to 45 days depending on the season. The larval period is generally 19-20 days under favourable conditions and more (45 days) in winter. The complete rearing can also be done in trays where, bed cleaning is done regularly with nets during the initial stages (Once in first instar, twice in second instar, thrice in third and fourth instars and daily in fifth instar with the leaves).

Care is taken to handle the moulting worms. The feeding is stopped when about 75-80 per cent of worms settle for moulting without disturbance. The rearing bed is kept dry to avoid infection with dusting of lime powder on the worms. The feeding is resumed only when 80% of the worms completed moulting as in mulberry.

Eri silkworms have the ripening characteristics similar to mulberry. They spin at 24-25°C temperature and 70-75% relative humidity. As in practice, farmers use semi-dried leaves as mountages for worm spinning. Bamboo Chandrike is also used at different places. When mature (from morning to noon hours), the ripe worms are placed in a bamboo basket or tray filled with the semi-dried leaves and the baskets are covered with newspaper to allow cool and darkness.



**Fig. 4.8:** a) Eri cocoon spinning on Bamboo chandrike, b) Late age rearing under progress and c) Mountage for Eri spinning (Source: *Indian Silk*)



**Fig. 4.9:** a) Brick red Eri cocoons and b) Creamy white Eri cocoons (Source: *Indian Silk*)

- e) **Harvesting of Eri Cocoons:** Eri cocoons are harvested after five days in summer and eight days in winter. The harvested cocoons are cleaned-off the dried leaf remains or other dust particles and spread over a tray protected from lizards and rats. The cocoons are cut open to remove the pupae and dried. The pupae are also removed at pre-pupal stage through open end of the cocoons. Eri cocoon shells yield 8-10 kg per 100 dfls. In addition, the cocoon quality is assessed on the basis of cocoon weight (3.0-3.5 gm), shell weight (0.4-0.5 gm) and silk ratio (13.0-15.0%). Take care not to allow the pupae to develop and emerge as moths.

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### Check Your Progress 3

- 1) Write down the different methods of late age rearing in Eri?

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- 2) What are different spinning mountages in Ericulture?

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## 4.5 MUGA SILKWORM REARING

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The Muga silkworm (*Antheraea assama*) is multivoltine in nature and therefore rearing could be conducted all through the year. Unlike the domesticated species like *Bombyx mori*, the Muga rearing is done outdoors on Som and Soalu trees, while the spinning of cocoon is done indoors. Muga silkworm being a holometabolous insect, it passes through complete metamorphosis from egg to adult. The life cycle lasts for 50 days in summer and 120-150 days in winter. The silkworms are reared outdoor and as such are exposed to vagaries of nature. There are six crops in muga culture depending on the seasons. They are Jarua (Winter), Chotua (Late winter), Jethua (Spring), Aherua (Summer), Bhodia (Late summer) and Kotia (Autumn). Rearing performance is high in Kotia crop followed by Jethua due to favourable conditions. The rearing of muga silkworms starts with the brushing of larvae and the pre-requisites for actual rearing operation are as follows.

- a) **Selection of Rearing Site and Plantation:** The rearing site should be well ventilated and elevated. The area of plantation facing east and south directions is good for rearing of muga silkworms. The rearing is conducted on medium sized plants with fresh and luxuriant growth.
- b) **Preparation for Rearing:** The rearing or plantation site is cleared-off weeds. The green grass below the plants should not be removed completely. The over-mature and diseased leaves, dried and unhealthy twigs, gall infested leaves are removed from the plants much before brushing of worms. Destroy the nests of ants, wasps and spiders, if found available on some plants. A band of straw with little ash on the top is tied around the trunk of the tree or a band of grease is

applied at about 3 to 4 feet height from the trunk base to prevent the downward movement of the larvae. BHC or Lime is applied at the base to avoid ants.

- c) **Disinfection of Rearing Appliances :** The appliances for muga silkworm rearing like Chandali (bamboo sieve with a hook used for transferring larvae), Khora (bamboo basket used for collection of ripe worms), bamboo poles (for putting Chandali on the tree tops), spade, secateurs, basins, mugs etc. which are used in rearing are kept clean and disinfected with 4% formaldehyde solution.
- d) **Procurement and Maintenance of Muga Silkworm Eggs:** Muga silkworm eggs are procured and transported on 4<sup>th</sup> day at  $26\pm 1^{\circ}\text{C}$  temperature and  $85\pm 5\%$  RH to the place of rearing with care during the cool hours without causing damage to the developing embryo. The eggs are brought in loosely packed condition with provisions for sufficient aeration and incubated to ensure uniform hatching. After receipt, the eggs are transferred to perforated egg boxes and kept in the incubation room.

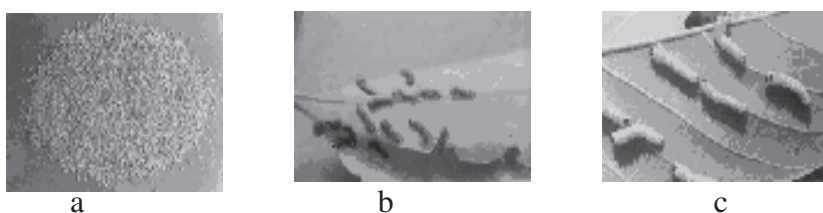


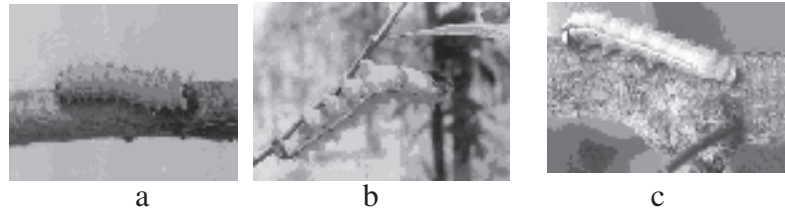
Fig. 4.10: a) Muga silkworm eggs, b) First stage larvae and c) Second stage larvae

- e) **Brushing of Larvae:** Tender leaves or twigs of Som and Soalu plants are placed on the egg boxes in the morning hours. Within 2-3 hours, the worms crawl upon the leaves and start feeding. At this stage, these tender leaves with hatched larvae are stick-pinned to the food plants maintained for rearing young age larvae. Larvae hatching within 48 hours exhibit good growth and vigour. However, for commercial rearing, worms hatched up to three days are also taken. If the brushing of larvae is to be done on the host plants directly, the same may be done towards shade. Overcrowding is always avoided while brushing. Brushing of larvae on the lower branches helps in proper supervision. The nylon net of size 40 x 30 x 20 ft is erected with the help of bamboo poles in all four corners and the centre covering all the cleaned chawki plants. Chawki worms thrive well on tender and juicy leaves and accordingly the chawki garden is maintained.
- f) **Other Methods of Rearing of Chawki Worms during the Monsoon Season:**

Intensive and heavy rains are experienced during monsoon (April-August) and at times, rains continue intermittently for more than 3 to 4 days. Brushing of chawki worms directly on the food plant under such conditions leads to very high larval mortality and frequently, the entire larvae are washed away from the food plants. To avoid such heavy losses, indoor chawki rearing is helpful.

Alternatively, tender twigs of Som/Soalu plants with sufficient leaves are immersed in water in the bottles and the chawki worms are brushed on these leaves. Rearing of muga worms up to third instar does not pose any difficulty and by this method even 20 to 30 thousand worms can be reared. Indoor rearing in bottles is much suitable than earthen pots because the bottles can hold the twigs tightly. Also, the leaves remain fresh for longer period in glass

containers. Such indoor rearings of chawki worms up to third stage can result in 85-90% Effective Rate of Rearing (ERR) even during monsoon season.



**Fig.4.11: a) Third stage Larva, b) Fourth stage larva and c) Fifth stage larva**

**g) Late-age Rearing:** Before the transfer of chawki worms on the plants of late age rearing garden, cleaning of dry twigs, yellow and over mature leaves, weeds,



termite mounts and other wastes is done without fail. Before transfer of worms to the fresh trees, the silkworms should be dusted by the mixture of Slake Lime and bleaching powder @ 97:3. The worms with the plant twigs are placed on the plants. After they crawl onto the branches, the dried twigs are removed. Constant vigil is given to protect the late age worms from the predators. During spring crop, nylon net is used to guard from the attack of pest and birds. The stuffy condition is diffused by maintaining proper ventilation under nylon net. After rain, net is shaken to remove water film from the net.

When the foliage of a plant is consumed, the larvae crawl along the trunks. Such larvae during 4<sup>th</sup> and 5<sup>th</sup> stages are gently kept on a triangular bamboo mat called Chandali or Chalani and transferred to another plant having sufficient leaves with the help of a bamboo pole.

Larvae infected with Pebrine, Grasserie and Virosis are immediately collected in 2% formalin solution and buried or burnt subsequently away from the rearing field. Care is taken to maintain hygienic conditions during rearing.



**Fig 4.12: a) Yellow and b) Blue colour morphs of Muga silkworm**

As the larvae mature, they cease feeding and move down the trunk in search of proper place for spinning. At least two days prior to the maturation, twigs with leaves of mango, som, soalu and masunda are semi-dried and bundled to prepare a cocoonage.



**Fig 4.13: a) Mature worm crawling down the trunk, b) Worm is ready for silk discharge and c) Hammock is on**

Ripening of worms is not uniform and it lasts 4 to 5 days in summer and 8-10 days in winter. Initially, a few worms ripen. After two days, large number of worms ripens for spinning. These days are called 'Bharpok' or peak period of worm ripening. The worms collected for spinning on Bharpok days are believed to be of good quality and generally reserved for seed purpose. Now-a-days, a wooden box or bamboo basket with semi-dried leaves and twigs is also used for cocoonage purpose. It also produces quality cocoons.

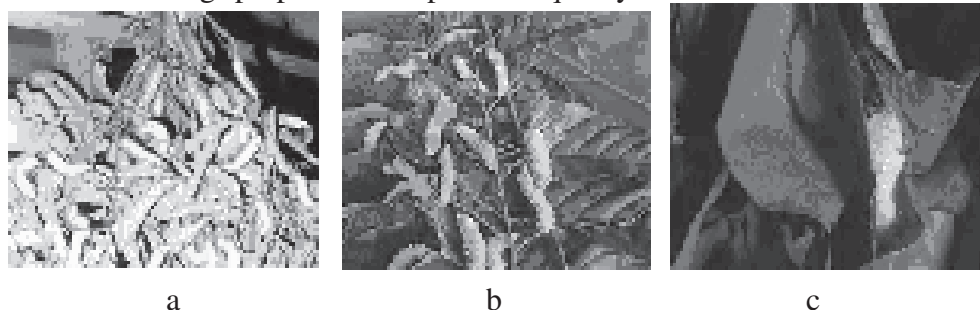


Fig. 4.14: a) Gravid worms placed on Jali, b) Muga worms transforming into cocoons and c) Transformation into cocoon is over.

**h) Harvesting of Cocoons:** After 6 to 8 days of spinning in summer and 10 days in winter the cocoons are carefully removed/harvested from the cocoonage. Good cocoons with hard shell are kept for seed and reeling purpose. The seed cocoons are preserved by methods recommended under grainage technology. The reeling cocoons are stifled by sundrying or in drying chamber. The cocoons are spread on bamboo mats or baskets well protected from rats and lizards etc.



Fig. 4.15: a) Harvested muga cocoons ready for market, b) Garlanding muga seed cocoons and c) Muga cocoons

**i) Some Points to Remember:**

- To improve hatching, the eggs are kept on a moist soil bed and sufficient aeration is allowed at night.
- For transfer of early instar larvae from hatchery, small twigs with leaves of food plants are cut and spread over chawki worms. Once the worms crawl, the twigs with the larvae are tied on to the food plants already prepared for rearing.
- During rains and storms, the larvae can be reared indoors (as detailed above) and later transferred to the food plants.
- Application of bleaching powder or lime is done on observation of ant attack, or application of molasses at the base of the tree trunk attracts the ants making it easier for mechanical control.
- A paste of mud with cow dung is applied to the string which hangs the cocoonage. The larvae will not disperse away.

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### Check Your Progress 4

1) How many crops are taken in Muga culture?

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2) What is a Jali? How is it used in Muga silkworm rearing?

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## 4.6 LET US SUM UP

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The existing technology describes Chawki rearing in Tropical Tasar (*Antheraea mylitta*) and Temperate Tasar (*Antheraea proilei*). The mature worms spin cocoons on the trees through hammock formation. Eri silkworm rearing is done indoors similar to mulberry. It is also done on bunches of leaves hung in the rearing house. Spinning of cocoon takes for about two to six days in different vanya silks. Dried Mango and Palm leaves and small twigs are used for cocooning. The Muga silkworm (*Antheraea assama*) is a semi-domesticated multi-voltine species completing six cycles in a year. Rearing is done outdoors on Som and Soalu trees and spinning takes place indoors. Seed crops are reared on Soalu and commercial crops are reared on Som plants. The life cycle takes 45-50 days in summer and up to 150 days in winter. Jethua and Kotia are commercial crops, Bhodia and Chotua are seed crops and Aherua and Jarua are pre-seed crops. Cocoon yield is higher in Kotia crop followed by Jethua crop.

The Integrated Technology Package of Rearing includes pre-hatching care, chawki rearing on bush plantation under nylon net, indoor chawki rearing during unfavourable conditions and maintenance of economic plantation. The technique helps to minimize loss of young larvae up to 30% during early stages. New technologies bring scope for new entrepreneurs to take up Non-mulberry sericulture on profitable lines.

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## 4.7 GLOSSARY

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- Bharpok** : The stage where the Muga silkworms reach the ripening stage.
- Chalani** : A triangular bamboo mat used for transfer of worms in Muga culture.
- Factor** : An external force (trigger) or condition that affects an organism.
- Jali** : A locally prepared moutage prepared from dried twigs where Muga worms spin cocoons.

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## 4.8 SUGGESTED FURTHER READING

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*FAO Agricultural Services Bulletins: Manual on Sericulture*, reprinted by Central Silk Board, Bangalore.

Goyal, R.K. 2006. *Oak Tasar Culture*, APH Publishers, New Delhi.

Krishna Rao, J.V. 2004. *Report on Eri Culture in India*, Central Silk Board.

*Muga Culture: Report on Sericulture in Cooch Behar* (2005), Department of Sericulture, West Bengal.

*Report on Integrated Package for Rearing of Tasar Silkworm A. Mylitta*, CTRTI, CSB, Ranchi, (2000).

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Thangavelu, K. 1988. *Handbook of Muga Culture*, Published by Central Silk Board.

Thangavelu, K. 2000. *Lessons on Tropical Tasar*, Speed-O-Print, S.N. Ganguly Street, Ranchi, pp. 1-104

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## 4.10 ANSWERS TO CHECK YOUR PROGRESS

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### Check Your Progress 1

- 1) Non-mulberry silkworms are not domesticated and are reared outdoors (except Eri, which is domesticated). They are wild in nature and thrive only on nature grown host plants.



- 2) Chawki rearing is important in non-mulberry sericulture because, it done on specially grown chawki garden under nylon net. Rearing under nylon net offers protection to the young silkworm from pests and predators and also ensures a very natural surrounding for normal growth of the larvae.

### **Check Your Progress 2**

- 1) The important characteristics of late age silkworm larvae are; they are very shy and do not like frequent human handling; they stop feeding for some time when touched, they come down the tree when the leaf is exhausted and when they feel hungry; they form hammock in between a few leaves and form the cocoons inside the hammock and they have a peduncle for support from the branch, an identifying character of non-mulberry silks.
- 2) Late age rearing in Oak Tasar is normally done in Polyhouses. Due to the topography of different regions, the late age rearing is done in indoors in specially prepared polyhouses.
- 3) In places, where temperature falls below the optimum of  $22 \pm 2^{\circ}$  C, the kerosene operated device help in maintaining the optimum temperature conditions required for incubation if oak tasar silkworm eggs.

### **Check Your Progress 3**

- 1) Bunch rearing, tray rearing and platform rearing are different methods for late-age rearing in Eri. All these methods are found successful and produce quality Eri cocoons.
- 2) Brush mountage, Bamboo and Box chandrike are the different spinning mountages in Ericulture. However studies indicate that semi-dried mango leaves found to be the best for cocooning in ericulture.

### **Check Your Progress 4**

- 1) There are six crops normally taken in Muga culture. They are Jarua (Winter), Chotua (late winter), Jethua (Spring), Aherua (Summer), Bhodia (late Summer) and Kotia (Autumn). Amongst these, Spring and Autumn crops are the best.
- 2) Jali is locally made spinning mountage in Muga culture made up of with dried twigs of mango, som, soalu, singari etc. plants. Ripe Muga silkworms are gently kept on the Jali which is hanged indoors for allowing cocooning. Cocoons formed in the Jali are also of good quality.