CHAPTER-1

INTRODUCTION
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Silkworms are one of the most important, valuable and useful group of insects with significant economic value. India has the unique distinction of being the only country in the world producing all the four varieties of silk namely, Eri, Muga, Mulberry and Tassar. India is one of the 58 sericulture industries in the world. As a whole Sericulture is considered as one of the largest and very important cottage industry in India, as it generates employment opportunities for the rural and the weaker sections of people. There are more than 40,000 sericultural villages in North-Eastern region of India. Assam, a north eastern state of India is the largest producer of Muga and Eri silk in the country.

Eri culture in the north eastern region of India, occupies an unique position in the socioeconomic life of the people. It is widespread particularly in this region on account of favourable climatic condition that have aided in the growth of different varieties of food plants in sufficient amount. The cultural operations of the erisilkworm is comparatively easier and cheaper than the other sericultural practices because of its resistance to diseases and availability of host plants as well as efficient in-door rearing methods. Though eri culture is less remunerative occupation compared to the production of other silks, it has its own advantages. They require comparatively less care as they are neither as wild as ‘Muga’ or ‘tassar’ silkworm, nor so much domesticated as mulberry silkworm. The silkworm feeds primarily on castor (Ricinus communis) and its secondary host plant is Kesseru (Heteropanax fragrans).

Though the rearers of erisilkworm in Assam and other states of north east India mostly use castor leaves, the use of secondary food plants has become a regular
practice amongst them at the time of scarcity of castor leaves. But inspite of the abundance of secondary food plants both in the hills and plains of the region, they are not being utilized effectively, which may be attributed to the lack of knowledge and hesitation amongst the rearers.

Consequently, this has led to the process of adopting the practice of curtailment of erisilkworm rearing during the period of food scarcity which ultimately causes a sharp decrease in eri silk production. In this context, the present work has been designed to study the interaction of eri silkworm and different food plants. It was considered as important to evaluate the differential impact of different food plants on silkworm, which might help the rearers to make an option for different food plants.

All the silk producing insects show a great diversity of food habits preferring one kind of food over another. Almost all insects are host specific and select/their most preferred food in order to extract the maximum benefit out of it, although most of them eat a great many varieties (Brues, 1946)

Studies on quantitative aspect of nutrition of any insect are very much essential for better understanding of the insect-plant relationship (Waldbauer, 1968; Bhattacharya and Pant, 1976). The nutritional composition of plant tissues strongly influences the performance parameters, such as growth, development, survival and reproduction associated with healthy condition of the larvae of phytophagous insects (Scriber and Slansky, 1981; Slansky and Scriber, 1985; Mattson and Scriber, 1987).

It is obvious that the larvae attain maturity and finally adulthood by consuming fullest feeding requirements. They utilize the consumed food at a particular rate to achieve proper growth so that the energy in the body later on helps in performing various metabolic activities during non-feeding stages of moulting and subsequent metamorphosis. Moreover the quality of food directly influence the quality and quantity
of insect product i.e. silk. A nutritious balanced food is the prime factor responsible for the healthy growth and development of any insect, as it provides the ultimate source of energy. Thus both the aspect of nutrition (quantitative and qualitative) contributes to a much more prominent knowledge and understanding of the insect-plant relationship that exists between them.

**STATEMENT OF PROBLEM**

Erisilkworm, *Philosamia ricini* is a multivoltine, polyphagous insect. It feeds primarily on *Ricinus communis* and secondarily on *Heteropanax fragrans*. The plant, which the insect instinctively feed on, is its primary host plant and that which is consumed under stress condition is its secondary host plant.

The growth and development of the insect depend upon the chemical composition of their food plant (Kerkut and Gilbert, 1985). Environment has a direct influence on the physiology and chemical properties of plants. Seasonal variation tends to change the quality of food plant, which in turn affects the growth, development and survival of the insect. Seasonal changes correspond to changes in light intensity, temperature and water content which has a direct effect in the metabolism of the plant. Therefore the seasonal evaluation of the biochemical composition of the leaves are necessary to identify the changes that occur during different seasons, and the factors responsible for preferential selection of food plant by the silkworm. Many insects are sensitive to changing environmental factors, light and temperature are considered to be of prime importance in the regulation of growth and development of insect (Giespitz and Zaran'kina, 1963; Danilevskii, 1965; Beck, 1968).
Insect body temperature tends to be the same as the ambient temperature that is the insects are poikilothermic. A diverse environmental temperature affect, various processes relating to growth and development in particular.

Foliar analysis is most essential which acts as a guideline in sericulture to evaluate the nutritional status of different food plants for their selection based on the nutritional value for the feeding of the silkworm and its development (Yadav et al., 1992).

The nutritional composition of the food includes both the absolute and relative amounts of proteins, amino acids, lipids, fatty acids, carbohydrates, sterols, water, minerals, vitamins etc. In order to attain its ideal growth, developmental and reproductive performance (in otherwise favourable environment) an insect must obtain adequate amount of necessary nutrients in a suitable relative balance (Kerkut and Gilbert, 1985).

In this context the present experiments have been designed to study the interactions between eri silkworm and two of its food plants viz. *Ricinus communis* and *Heteropanax fragrans* in different seasons under the following objectives:

(i) Investigations on the biochemical compositions of different food plants used in ericulture.

(ii) Biochemical comparison of different species of food plants with reference to maturity and seasonal variations.

(iii) Rearing of eriworm using different food plants.

(iv) Determination of effect of food plants on biochemical characters of eriworm in terms of DNA, RNA, protein, carbohydrate, amino acids, aminotransferase and total silk production.

(v) Comparison of biochemical parameters of different plants and larvae.
(vi) Evaluation of developmental behaviour in terms of instar duration, larval size, days to maturity, larval morphology, cocoon formation, emergence of moth, fecundity and silk products.

Rearing experiments have been done during three different seasons of the year. The seasons are spring-summer (mid February - mid May), rainy season (mid May-July) and winter (mid December – mid February).

**ERI SILKWORM**: *Philosamia ricini* Boisd.

Eri silkworm *Philosamia ricini* Boisd. (Family: Saturniidae) is the most useful holometabolous, multivoltine and phytophagous insect among the sericogenous insects of commercial value. The life cycle of eri silkworm has a duration of about 44 days in summer and about 85 days in winter (Chowdhury, 1982). The optimum temperature and relative humidity for ericulture is 24°-26°C and 75-85% respectively (Jolly *et al.*, 1979). Different developmental stages are shown in Plate (1-4).

**Egg development:**

The female moth lays fertilized eggs in clusters of 200-350 in number. The medium and oval shaped eggs are white when freshly laid and gradually changes to dark grey at the time of hatching. The shell of the egg is a hard chitinous membrane which is candid white with a colourless glue over it which helps the eggs to adhere in cluster and to the surface on which the eggs are laid. The yolk is green in appearance and is used by the developing embryo as food, as growth proceeds. As the embryo undergo the process of development, the colour of the egg shell changes, first from whitish to yellowish indicating curd development, yellowish to ashy grey indicating mid development and ashy grey to dark grey indicating final development that the tiny
PLATE 1: Developmental stages of the larvae of *Philosamia ricini* fed in castor leaves

a) Eggs  b) 1st instar  c) 2nd instar  d) 3rd instar  e) 4th instar  f) 5th instar
PLATE 2: Developmental stages of the larvae of *Philosamia ricini* fed in *kesseru* leaves

a) 1st instar  b) 2nd instar  c) 3rd instar  d) 4th instar  e) 5th instar
PLATE 3: a) Cocoons of Eri silkworm b) Pupae of Eri silkworm c) Mating of adult moths
PLATE 4: a) Eri Silk  b) Eri shawl
worm is ready to emerge. To hatch out, the worm has to make its way through the chorion in order to reach the outer world.

Larval development:

The hatchlings are tiny hairy caterpillars that begin to establish themselves over the empty egg shells and are found each eating a little part of it. They are nearly 1 cm in length with 12 segments on the body covered by spots in each segment. The head is longer and black in colour. The body is yellow with black tubercles, bearing 3-5 setae. The anal segment is blackish. Tender leaves of food plants are provided, and eating becomes their main job. The larval period lasts for 30-35 days between 24°-28°C. As the larva matures, with increasing age of the larvae, the age of the leaf supplied to it should be increased. As they grow the worm undergo moulting for four times and have 5 instars. The larvae have a good appetite and are voracious eaters. After 5th instar before pupation it stops eating, empties it gut and starts spinning.

Insect silk glands are ectodermal in origin. They are transformed labial glands and they increase in secretory potential by growing in size during the larval stages. The whole silk gland is divisible into three parts – anterior, middle and posterior silk gland. The anterior silk gland is just a passage, middle silk gland secretes sericin and acts as a reservoir for fibroin, the silk protein which is secreted by the posterior silk gland. The major component (by weight) of the silk thread is fibroin. Its amino acid composition greatly varies among Lepidoptera.

Pupal development:

In the ripe larval stage their appetite and care for food decreases and the worm is found to become restless and start moving out from the rearing rack. After finding a dry convenient surface they evacuate their gut and starts spinning cocoons. It takes 3-4
days to spin a cocoon completely. The mature larva passes through a short pre-pupal stage before becoming a pupa. During this stage dissolution of larval organs takes place.

In eri cocoon one end is usually found open. By careful examination it is seen that eri cocoon is almost like the mulberry cocoon, formed by a single continuous uniform silk filament but much more cohesive in the attachment of the filaments compared to mulberry. The open end through which the moths come out is very loose and the silk filament forms abrupt bending around the opening. When the cocoon is tried to be reeled after softening, it breaks at the loose open end due to mechanical stress.

The distinction between female and male is prominent during pupal stage, as the female show a fine longitudinal line on the 8th abdominal segment known as Ishawata’s gland. The female anus is N-shaped without any spot below it unlike the observable round spot below the anus of the male in the 9th segment called as Harolds gland.

Moth:

The pupal development usually takes about 1-14 days in summer and 20-23 days in winter for the emergence of the adult moth. The normal emergence takes place through the open end of the cocoon after casting off the pupal exuvia usually in the morning to early day hours. The moth has a bipectinate antennae and a little below the paired antennae sockets, a pair of large blackish compound eyes situated frontolaterally. The female is normally larger than the males. After their emergence the moths mate and the female starts laying eggs within 4 to 5 days after which they die.