INTRODUCTION
Assam, the tiny state of blue hills and rising Sun, tucked in the north east corner of India, has always been enriched with the 'Blessings of Nature'. One of the prestigious and wealthy gift of nature is the 'Silkworm'. Very few persons know the silkworm by sight, but almost everyone knows the product it manufactures. Those who know this product, most seldom if ever think of its origin, undoubtedly many do not know that silk is caterpillar's spittle.

'Sericulture' or the commercial production of silk is an important industry in Japan, China, India, Italy, France and Spain. In India, Sericulture is considered as an important enterprise for employment generation and subsidiary income in rural areas. The North Eastern region of the country, specially Assam enjoys all the four types of commercially important silkworms, viz. Eri, Philosamia ricini Boisd. (Saturniidae), Muga, Antheraea assama Ww. (Saturniidae), Pat, Bombyx mori L. (Bombycidae) and Tasar, Antheraea mylitta D. (Saturniidae). Among the above cultures, muga, the golden silk is unique to the Brahmaputra valley of Assam.

The shimmering golden-yellow silk, muga, is referred to in literature from as long ago as 1662 B.C. Even today, it occupies a very important place in the life and culture of the Assamese people regardless of community and caste.
As mentioned above the muga silkworm is cultivated only in Assam and scatterly distributed to its adjoining foot hill areas. Eastern Goalpara and the South-Western part of the Kamrup district in lower Assam are the major seed cocoon areas, and there the trade is in the hands of tribal communities (Kacharis, Rabhas and Garos). Commercial rearing on the other hand is practiced mainly by Ahoms of Sibsagar and Lakhimpur and to a lesser extent in Nowgong, Darrang and other districts. The biological factors which are responsible for its restricted distribution within this sub-tropical biosphere is yet to be confirmed. However, humid and temperate climate along with plenty of food plants, luxuriously grown in the thick forest of Assam, are thought to be the prime factor for its confinement.

The most prestigious muga fabric became an indispensable part of Assamese culture and tradition even in the days of ancient kings and was closely associated with the socio-economic life of Assam. The yarn produced by the muga silkworm is used mostly in preparing fine fabric for dress material. Due to its golden yellow colour, muga silk is used to prepare fine works of sculpture and Embroidery. For the high tensile strength of the yarn, it is utilised in preparing fishing net also.
The cocoons used for commercial purposes are reelable. But those cocoons used for seed purposes become unsuitable for reeling. These are used as waste product. These waste and the noil extracted from the boiled cocoons are used in spun silk mill to give some other types of fabric which are also used for beautiful dress material.

There are another aspect of muga trading in Assam. The natural silk fibres Muga is composed of organic proteins. These fibres are semi-crystalline in nature and possess high insulating properties. Their essential features and physico-chemical properties make them important in various textile industries. As Assam has abundant supply of natural oil, it can produce large amount of synthetic fibre from petrochemical wastage. Using advance technology, it will be possible to blend muga silk fibre with these synthetic fibre which will produce a new type of fabric of high quality and it will have a good market potential. More so, due to their characteristic electrical properties, these polymeric fibrous insulators demand utility in electrical and electronic industries as well (Bora et al., 1992).

The glowing golden-coloured silkworm 'Muga' is scientifically named as Antheraea assama Ww. The local name 'muga' was conferred for its cocoon colour. As a
holometabolous insect the life cycle of Antheraea assama is completed in Egg (Koni), larva (Polu). Cocoon (Leta) and adult or moth stage (Chakari) through complete metamorphosis.

The most characteristic feature of this tiny creature is that they are multivoltine in nature i.e. 5 or 6 crops or broods can be reared in a year, of these only two are commercial crops. They are locally known as Jethua crop reared in May-June (late Spring,) and Katia crop reared in Oct.-Nov. (Autumn). Other four are Chotua (Spring, March-April), Aherua (Early summer, June-July) Bhodia (Summer, Aug-Sept.) and Jaruah (Winter, Dec.-Jan.-Feb.) reared only for seed purposes.

The muga Silkworm is termed as semi-domesticated because in the life cycle of a mugaworm the larval period is completed in the trees at natural conditions and when it is mature, it spins to form the cocoon and is taken inside the room. It is kept inside upto the egg preparation stage. At the time of hatching it is brought to the outside tree again. Hence, the muga worm is prone to natural hazards such as fluctuation of temperature, heavy rainfall, winds, hailstorm etc., apart from falling prey to pests and predators. As mentioned above, the muga silkworm being multivoltine does not have any mechanism to skip over the unfavourable season.
Plate I  Life cycle of Antheraea assama Ww.

1. Male Moth  2. Female Moth  3. Egg
4. 1st Instar  5. 2nd Instar  6. 3rd Instar
7. 4th Instar  8. 5th Instar
9. Cocoon (with pupa)  10. Yarn
11. Fabric

larva (5th instar)
Moreover, there are some other problems too in culture of muga silk worm. First, we should mention that the output of cocoons largely depends on the quality of seeds and hence it is imperative that best quality seeds should always be selected for muga rearing. But the village rearers often do not get disease free seed layings. The chemicals produced by ONGC also appear to be hazardous to muga food plants in Upper Assam (Barua et al., 1992). Gradual decrease in number of Som and Soalu trees due to human interference and due to land scarcity, the problem is aggravated and affects muga production badly. Lastly it is pointed out that the rearing technique of age old muga worm has not improved till to day. The rearing process need improvements based on modern scientific lines and proper Research and Development support.

Facing all these problems, gradually, with the turn of centuries, the production of the golden yarn of muga silkworm which represents a proud heritage of Assam has considerably declined and some people would like to say that muga worm is going to be extinct in near future. Now is high time for immediate revival in its rate of production with implementation of various scientific and technological devices.

Probably due to its restricted cultivation habitat in the region, the muga silk insect
Antheraea assama has not drawn much attention to itself from the people of other parts of the world and very little scientific investigation has been done on them. Therefore, a scanty literature is documented regarding the muga silk worm.

Most of the insects are sensitive to changes of external environmental conditions. Among the significant environmental factors, photoperiod (day-length) and temperature are considered to be of prime importance in the regulation of growth and development in insects (Danilevskii, 1965; Geyspitz, 1957; Beck, 1968; Geyspitz & Zarakina, 1963). Although temperature and photoperiod have their major role in insect development, the relative humidity of atmosphere and the nature of food availability are known to have notable influence on the insect life cycle. (Choudhury, 1981).

Since the Muga silkworm Antheraea assama reared in out door condition are subjected to the fluctuation of environmental conditions, Thangavelu et al., (1985) and Borah et al., (1988) observed wide range of variation in cocoon characters of this silkworm in different seasons. Nevertheless, the environmental factors influence on the life cycle in general and on the larval period in particular ultimately affect the production of silk. As a poikilothermic organism any change of the environmental temperature greatly influence the rate of metabolism in insect life (Ratte, 1985; Stein & Fell, 1992).
The metabolic rate has been shown to be inversely related to duration of life which is known as the stage of dormancy and it is nothing but the phenological, physiological and biochemical adjustment to overcome the adverse environmental conditions. There are several forms of dormancy such as quiescence, oligopause, dispausation and delayed metamorphosis etc. Although most of the insects prefer the dispausation stage, muga silkworm undergoes the first type of dormancy mentioned above.

The influence of photoperiod on insects was studied in detail by Kogure (1933) and this aspect has been reviewed by many workers including Lees (1966), Danilevskii (1970), Chippendale & Reddy (1972, 1976), Saunders (1976), Kimura (1990). Several investigations were carried out on the relationship between the larval growth and photoperiodic condition in the silkworm (Hirasaka et al., 1968, 1969, 1970, 1972, 1973; Koyama, 1969; Yazaki et al., 1970 and Koyama et al., 1979). According to them the morphogenetic processes are controlled by environmental factors like photoperiod. Likewise humidity and rainfall have also some far-reaching effect on silkworm life. Choudhury (1981) reports that control of external factors like temperature, light, humidity, nutrition etc. regulates the biochemical activity of the insects in all the stages. For example, the increased concentration of ecdysteroid and juvenile hormone which correlate with the increased egg production in *Grillus binoculatus* (Hoffmann et al., 1981; Koch & Buckmann, 1987).
The biochemistry of insect haemolymph has been the object of many investigations. The interest in insect biochemistry has been more and more directed to studies on the composition of the haemolymph as haemolymph serves like the blood in higher animals (Wyatt, 1961). It is highly considered that the larval haemolymph protein (LHP) plays a major role in insect life. It is an established fact that haemolymph contains lipoprotein (Chino et al., 1981 a), large amount of organic acids (Wyatt, 1961) like citrate, L-Ketogluterate, succinate, fumerate, malate and oxaloacetate.

The relatively high level of organic phosphates found in insects haemolymph has been as L-Glycerophosphate, sorbitol-6-phosphate and Glucose-6-phosphate (Jeuniaux, 1971). Chen (1971) confirms that the aminotransferase activity is detected in a number of insects including Schistocerca gregaria, Calliphora erythrocephala, Musca domestica, Drosophila melanogaster and Peridroma saucia.

Proteins are among the most complex of all known chemical compounds and also the most characteristic of living organism (Chen, 1985). They are the principal constituents of protoplasm which forms the material basis of life. They are linear polymers of high molecular weight.

Silk is a natural protein, produced by the silk gland after a long metabolic processes which actually starts just after feeding of larva on food plants. It is a
polymer mainly consisting of two types of protein, the filamentous 'Fibroin' \( (C_{30}H_{46}N_{10}O_{11}) \) and gum like 'Sericin' \( (C_{30}H_{40}N_{10}O_{11}) \). The latter cementing material coated on the filaments binds them together to be fine glistening, fabulous silk thread.

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\begin{align*}
&\text{Fig. 1 Partial structure of Fibroin. R-Amino acid, the dotted lines indicates how hydrogen might join the chain.}
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The principal amino acid constituents of these proteins are glycine and alanine, with some sericin and tyrosine. Hence, the quality of fibre mainly depends upon the protein content of the larval life of silkworm.

Enzymes are remarkably effective catalyst responsible for the thousands of co-ordinated chemical reactions involved in biological processes of living organism.
Outstanding features of enzymes in comparison to chemical catalysts are substrate specificity and specificity in promoting of only one biochemical reaction with their substrate ensuring synthesis of a specific biomolecular product without the concomittent production of by-products (Armstrong, 1983).

Enzyme action is greatly effected by temperature. If the temperature is increased by 10°C-60°C there is loss of enzymes activity, because denaturation of proteins occur at this temperature.

At optimum $p^H$ the activity of enzyme is maximum. For most enzymes the effective range of $p^H$ is 4-9. Beyond these limits denaturation of enzymes takes place.

All enzymes are proteinous in nature. There is evidence that many of the haemolymph proteins may function as enzymes. In fact, Laufer (1960 a,b ) demonstrated that nearly all haemolymph proteins of *Hyalophora cecropia* and *Samia cynthia* act as specific enzymes including esterases, phosphatases, carbohydride, sulphatase, tyrosine dehydrogenase and chymotrypsin. The protein biosynthesis in the silk gland has been shown to be influenced by photoperiod. Higher photoperiod during summer season seems to induce higher protein bio-synthesis in the silk gland of silkworm (Tazima et al., 1978 ; Kerkut & Gilbert, 1985). Dhinakar et al . (1991) ; Unni & Pant, (1985) reported the photoperiodic effect on
enzymes like aminotransferase. Konikov et al. (1978) suggest that the enzyme system changing in activity in response to the effect of environmental factors, acts as a regulator of the vital activity and density of insects.

Reports on effect of seasonal variation on the enzyme activity of haemolymph of silkworm are not well documented. However, there are no report available about the environmental impact on enzymes of haemolymph of Antheraea assama Ww. of Assam. Hence, a study in this direction was initiated to analyse the relationship between environmental factors and protein alongwith some of the enzymes present in haemolymph of A. assama at different larval stages.

It may be mentioned that rearing alone should not be the aim of muga culture without considering the ultimate return of silk yield. The healthy life cycle completion is the basic criteria for search of quality food for economically successful muga culture. Any change of the nutritional quality of food may result in adverse physiological adaptation. The environmental factors also influence the leaf of food plant at different seasons of a year (Hering & Taguchi, 1951).

The mineral requirement of insects have not been exhaustively investigated, but phosphorus and potassium seems to be limiting growth factors for all insects.
species. Calcium is required for the growth and transformation of mosquito larva. Cobalt which is an essential part of the Vitamin B\textsubscript{12} molecule, magnesium and manganese which are co-factors in various enzymes, must also be essential. Very limited data also indicates the importance of sodium, zinc, iron and copper in insect life. The impact of environmental factors on the elements present in muga silk worm is not yet known.

Insect haemocyte occupies an important position in insect life history. The haemocytes in holometabolous insect comprise of a complex of several different cell types (Arnold, 1982). The haemocytes types are characterized visually by their size and form and by features of the nucleus and cytoplasm in stained mount or in vitro under phase contrast. They can usually be recognised by fine features under Electron microscope (Arnold, 1979). Akai & Sato (1976) studied the haemocytes of Bombyx by SEM using critical point drying (CPD) method and reviewed the characteristic details of the surface structure of oenocytoids, spherule cells and prohaemocytes and observed a relationship between the surface and internal ultra-structure of the cells. However, Bordoloi & Hazarika (1992) reported a significant seasonal variation of the total haemocyte Count (THC) in the 4th and 5th instar stages of Antheraea assama Ww. during four different seasons.
Like other insects, the larval life of muga silkworm is usually characterized by excessive growth. More so, it may be said that the growth is restricted to the larval development and during this feeding period, there will be deposition of all the mass necessary for the final adult. Not only the morphological changes are heterogenic during insect growth, but chemical growth is also found to be heterogenic (Tessier, 1931). Since the larval life of muga silkworm exposed to all types of natural environment, it was considered to be worthwhile that this investigation should be restricted only within the most sensitive stage of development, i.e. at larval stages.

During this course of study, the first larval instar of all the groups were generally avoided, because of their small size and negligible quantity of haemolymph.

Keeping in view the lacuna in our knowledge of the changes of seasons effecting the muga culture, the present study was undertaken with the following parameters.

1. Observation of Physiography and climatic condition of Assam valley, collection and analysis of meteorological data to ascertain the seasonal fluctuation of temperature, rainfall, relative

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2. The nutrient content viz. protein moisture and some elements of the leaves of Som and Soalu in different seasons of a year.

3. Biochemical observations:

a) Total soluble protein content of haemolymph.
b) Enzyme activity of haemolymph viz.

a) Transaminases
b) Alkaline Phosphatase (ALP.).
c) Glucose-6-phosphatase (G-6-Pase).


5. Haematological observations:

I. Haemolymph Volume (HLV.).
II. Total haemocyte Count (THC)
III. Differential haemocyte Count (DHC).
IV. Surface ultrastructure of the haemocytes by SEM.

The investigation was undertaken in anticipation that the findings of this study will help in
understanding the cause of differentiation of quality and quantity of silk affected by the fluctuation of environmental agents. The result of this experiment is expected to contribute substantial evidence on the effect of seasonal variation on the nutritional status of the host plant which will contribute for the better understanding of growth and silk production of *Antheraea assama* Ww.