GENERAL
INTRODUCTION
Sericulture is an agro-based cottage industry, contributing substantially to the economy of the developing countries. Silk has been known to man as a textile fibre from at least 5000 years. No other fibre can match its luxury, luster and elegance; it is still extolled as the "queen of textiles". Now nearly 50 countries in the world are engaged in sericulture; but perceptible production is attained only in few countries namely China, India, Japan, CIS (erstwhile Soviet Union), Brazil and South Korea. According to Indian legend, sericulture in India was introduced about 2000 years ago.

India is a unique, as all the four known commercial varieties of silk namely mulberry, tasar, eri and muga are produced of which mulberry silk alone accounts for about 90% of the total production. Silk production in Japan, however, decreased in 1940s due to rapid industrial development, high labour cost and declined demand for kimonos (Datta, 1994). India is also the second largest producer of tasar silk (650 metric tonnes) after China and it monopolizes in production of natural golden yellow muga silk (Subba Rao, 1994). During the year 1993, the world raw silk production was about 1,00,953 metric tonnes of which India’s share was 13,418 metric tonnes (source; silk man’s companion, central silk board, India; 1993). The target of silk production during VII plan (1992-97) is 21,400 metric tonnes of which mulberry silk is 20,000 metric tonnes. The target achievement during the first two years that is up to 1993 – 94 is 14,554 metric tonnes of which mulberry is
13,418 metric tonnes, tasar 289 metric tonnes, eri 771 metric tonnes and muga is 76 metric tonnes.

India has a strong domestic demand for raw silk and also developed worldwide market for silk goods, Export value of Indian silk goods has been steadily increasing. It exported above Rs.100 crores of silk goods in the early part of 1980; which has jumped to Rs.800 crores during 1993-94 (Ramakrishnan, 1994). Not surprisingly, silk production has been expanded rapidly in recent years in those countries with low labour costs (China and India) and declined in higher labour cost countries (Japan and Korea) (Sinha, 1990). Endowed with salubrious climate and rich sericigenous fauna, India has unique excellence of producing all the four commercial varieties of silk, namely mulberry tasar, eri and muga of which mulberry silk alone accounts for about 90% of the total production. It is also the second largest producer of tasar silk, again after china, and it monopolizes in production of the golden yellow muga silk (Subba Rao, 1994).

Mulberry sericulture takes place mainly in Karnataka, Andhra Pradesh, Tamilnadu, Jammu and Kashmir and West Bengal, which account for about 99% of all the mulberry raw silk production in the country. Andhra Pradesh considered as a non-traditional area and achieved the distinction of being the second largest mulberry silk producing state next to Karnataka. It has a great scope to improve the economic status of poor and marginal farmers. During the year 1993-94, Andhra Pradesh raw silk production was about 2,858 metric
tonnes. At present, 1.38 lakh acres of area is covered under mulberry plantation; mainly concentrated in drought prone districts of Rayalaseema i.e. Anantapur, Chittoor, Cuddapah and Kurnool, where, over 60% of the farmers are small and marginal. It is estimated that the seven-lakh families are dependent on sericulture and about 60% of the activity are undertaken by women (Sheela Bhide, 1994). Sericulture is mostly localised in Anantapur district more particularly in Anantapur, Dharmavaram, Hindupur, Kadiri, Madakasira, Kothacheruvu, Gorantla, and penukonda which ranks first in the area of mulberry cultivation. More than 55,000 farmers are engaged in silkworm rearing, majority of them is below poverty line (Venkatanarsaiah, 1992). Recognising the importance of sericulture, government took series of developmental measures to popularise it. As a result sericulture has really come to age and is now poised for a great leap forward.

The success of sericulture industry depends upon several environmental factors, which plays a major role. Among the environmental factors, there are biotic and abiotic factors. The leaf quality, seed quality, fecundity etc., are the biotic factors, while temperature, humidity, spacing etc., are the abiotic factors. Among these, environment plays a greater role at various stages during the course of insect development. Silkworm crop loss occurs in the entire silkworm rearing areas of the world, but its kind and severity vary (Barman, 1990). There is no silkworm race at present which be deemed totally resistant to pests, but different races of silkworm show
variations in their susceptibility to different pests and pesticides (Liu, 1984). Even in Japan the incidence of loss due to silkworm diseases was around 10% during nineteen fifties, but has been brought down to 3.7% in nineteen eighties (Samson, 1987).

The relationship between environmental factors and duration of different stages in the life history has been reviewed by several investigators (Bursell, 1964; Laudein, 1973). Similarly, protein levels in relation to environmental factors has been reported (Locke and Collins, 1965; Butterworth and Bodenstain, 1967). Mulberry fields are occasionally being contaminated with pests and insecticides and problems have cropped up in sericulture due to silkworm fed on contaminated mulberry leaves. Research on the effects of pests on silkworm larvae is therefore directed in different countries in order to have knowledge about the toxication of various pests and their modes of action on the silkworm metabolism and growth. Moore (1967) has discussed in detail the problem of pests and its management in ecological research.

PRESENT INVESTIGATION ON PROTEIN METABOLISM IN BOMBYX MORI (L) AND SOME ASPECTS OF TUKRA AFFECTED LEAVES IN MORUS ALBA (MULBERRY).

Proteins are the derivatives of high molecular weight polypeptides. They play a vital role in the formation of structures in organisms like carbohydrates and fats; proteins also can be utilized for energy purposes. However, tissue proteins represent the last source of energy, which are used
only when there are no carbohydrates or fats available in extreme conditions such as starvation.

Any stress on an animal invokes compensatory metabolic adjustments in its tissues through modification or modulation of proteins (Bano et al., 1981; Assem and Hanke, 1983). Proteins also function as regulators in that they control the chemical reactions and metabolic processes, which occur in organisms. Many hormones are proteins, which regulate the physiological processes such as growth and reproduction; but it is the enzymes that perform the most important regulatory functions. The total protein content consists of structural and soluble proteins involved in the architecture and metabolism of a cell. They constitute about one-fifth of an animal’s body on the wet weight basis (Swaminathan, 1983). Hence, the total protein profile of a tissue may be taken as a diagnostic tool in assessing the physiological status of it or the animal as a whole (Young, 1970; Harper et al., 1979). According to (Nagy et al., 1981 and Nemcsok and Bross 1981), pests are known to interfere in the protein synthesis and degradation and thereby altering the dynamic equilibrium.

Haemolymph is an important pool of free amino acids in insects (Chen, 1985; Mullins, 1985). Fluctuations in blood protein concentration during metamorphosis of insects are known since, many years (Heller et al., 1960). There were many studies on the blood protein patterns of Bombyx mori (Aizawa and Murali, 1957; Denuce, 1958; Steihauern and Stephen, 1959;
Groulade et al., 1961; Sugimori et al., 1991). Shidhara and Ananthaswamy (1963) studied in detail the electrophoretic behavior of blood protein of the silkworm, *Bombyx mori*, throughout its life cycle by the technique of agarose electrophoresis. Fat bodies, silk glands synthesise the globulins of the blood. The electrophoretic pattern of silkworm blood shows three main protein components, albumin, globulin-I and globulin-II (Shigematsu, 1958; 1960). The insect haemolymph does not markedly differ from that of vertebrates with respect to its protein nitrogen, but its very high aminoacidemia seems to be one of the most exceptional peculiarities.

The degradation of proteins is mainly brought by protein hydrolyzing enzymes, which cleave proteins into amino acids. Horie (1963), studied proteolytic enzymes of digestive juice and mid gut of the silkworm, *Bombyx mori*. They are the currency through which protein metabolism operates (Krishnamohan Reddy, 1986) and contribute much in meeting the energy demands (Ferguson, 1982). Studies have been reported variations in qualitative and quantitative aspects of haemolymph, silk glands free amino acids in *Bombyx mori* (Fukuda, 1957; Arai, 1964; Corrignu, 1966; Inokuchi, 1971). The enzyme glutamate dehydrogenase (GDH) also plays a significant role in the catabolism of amino acids. Reports on *Bombyx mori* on the shifts in its protein metabolism during stress are limited. Sinha et al., (1985) studied the changes in protein content in haemolymph of tasar silkworm, *Antheraea*
mylitta, and reported that protein content in it increases enormously during larval development.

There are number of reports on the composition of free amino acids of haemolymph and silk glands of larvae of the silkworm, Bombyx mori (Fukuda et al., 1955; Wyatt et al., 1956; Kondo and Watanabe, 1957; Bricheux Gregorie et al., 1959; Duchateau and Florkin, 1959; Kawase, 1965; Inokuchi et al., 1972 a,b; Bose et al., 1989). Thee quantity of proteins and total free amino acids increased rapidly in the body wall, mid gut, silk gland and haemolymph during the feeding period and reached a maximum at the beginning of moulting. Total proteins in the mid gut and the silk glands decrease at an early half of the moulting period and increased in the later half.

There are substantial studies on the biochemical process of the insect metamorphosis (Wyatt, 1968; Sridhara, 1981). The report herein analyse the quantity of proteins, total free amino acids and changes in incorporation of C\(^{14}\)-Leucine in to proteins in the silk gland, the haemolymph and the whole body of the silkworm, Bombyx mori, through the larval moulting cycle. The observations on the changes in quantities of proteins and free amino acids in various organs during larval development conform previous studies like, the quantity of proteins in the silk glands of Bombyx mori (Morimoto et al., 1968), the concentration of proteins and free amino acids in the haemolymph of Bombyx mori (Bito, 1927; Doira, 1968; Kiguchi and Kimura, 1981). Insect blood is known to carry unusually high content of free amino acids (FAA)
which in some species may be sixty times or more than that in human blood (Chen, 1962). The studies showed that higher the concentration of FAA occur in the insect haemolymph and also in tissues (Kermack and Stein, 1959; Price, 1961). Various authors suggested that the amino acids may be concerned with protein synthesis or osmotic hemostasis (Buck, 1953), energy production for flight (Stacktor, 1961). The silk gland synthesizes silk protein and the supply of amino acids needed is derived from the blood (Fukuda and Florkin, 1955). Considerable attention has been given for biological significance of high titre value of free amino acids (Inokuchi, 1972; Inokuchi and Ito, 1973). The best known case of utilization of haemolymph, FAA in silk protein synthesis precursors is *Bombyx mori* (Corrigan, 1970).

The quantity, rate and quality of mulberry leaf consumed by the silkworm larvae has a great influence on its survival, growth rate, developmental period and larval weight. The quantity of leaf consumed directly or indirectly influences the digestibility and conversion efficiencies. Raman *et al.*, (1993) studied the nutritional efficiency in silkworm, *Bombyx mori* (L). Pink mealy bug, *Meconellicoccus hirsutes* (Green) is a common “hard to kill pest” of horticulture crops all over the world. Mulberry being a perennial crop and forms a sole food of silkworm, *Bombyx mori* (L) which is affected by several insects, among them *M.hirsutus* is, of late, severe one (Dhahira Beevi, 1991; Manjunath *et al.*, 1992). Since, the literature available (Thangamani and Vivekanandan, 1983; Pradip kumar *et al.*, 1992) on the
quality of tukra leaves and its biochemical constituents in silkworm *Bombyx mori* are scanty and controversy constituents compared to healthy mulberry leaves. The mealy bug, *Maconellicoccus hirsutus* (Hemiptera; seudococcidae) is reported as a vector of the viral disease, popularly known as ‘Tukra’ disease of mulberry (Rangaswami *et al.*, 1976) and an effort has been made to find out the effect of feeding tukra affected mulberry leaves on silkworm rearing performance. Mulberry, *Morus alba* forms the basic food for the silkworm *Bombyx mori*. The efficiency in the amount of food required to reach its full potential will be manifested in various ways and degrees (Waldbauer, 1968). Nutritional efficiency in the larval stages significantly influences the resulting pupae, adult and production of silk particularly in the economically important insects like *Bombyx mori* (Aftab ahmed *et al.*, 1998).

Of all the diseases, tukra is considered to be more dreadful and is mostly found in tropical regions like India mainly in South India, South East Asia, South China and some parts of Africa. The affected part of the plants show curling of leaves at the growing point and arrested growth indicating altered metabolism of the host (Thangamani and Vivekanandan, 1983). Since rearing of young age silkworms is solely dependent on tender leaves, tukra affected diseased leaves are considered to be unfit for rearing (Govindaiah and Bhakuni, 1988). Hence the farmers discard the tukra affected mulberry leaves.
The mealy bug, *Maconellicoccus hirsutus* (Green) is a polyphagous insect infesting more than 125 species of plants in various Zoogeographical regions (Ghose, 1972). Tukra-affected mulberry plants show malformation of the depletion in quality (Kumar *et al*., 1992) and quantity of leaves of such plants does not allow the farmers to make an expected profit out of silkworm rearing for unit area of garden.

Mukerji, (1999) first reported that “Tukra” in mulberry is caused by a minute insect. Kumar *et al*., (1989) showed that feeding tukra affected leaves of V1 variety to the silkworm, *Bombyx mori* (L) caused a highly significant decline in commercial characters like larval weight, slowly reducing the rate of haemolymph concentration and silk proteins in silk gland, silk ratio percentage, cocoon weight, as compared to the results obtained on the above parameters by rearing the silkworm on healthy mulberry leaves on the other hand. (Thangamani and Vivekananda, 1983; Chinya, 1987; Shree *et al*., 1989 and Umesh kumar *et al*., 1989) have studied a few biochemical parameters of tukra infected leaves in some varieties of *Morus alba* which effects regarding to the *Bombyx mori* (L).