CHAPTER I
INTRODUCTION

Sericulture industry with its rural based on-farm and off-farm activities and enormous employment generation potential has been recognized as one of the most appropriate avenues for socio-economic development particularly in a developing country like India. The industry also plays a very vital role in alleviating rural poverty due to its high work participation rate and thereby can check migration from rural to urban areas. The development of sericulture and silk industry can achieve good ecological, economic and social benefit (Gao, 2011). Geographically, Asia is the main producer of silk in the world and produces over 95% of the total global output. Though there are over 40 countries on the world map of silk, bulk of it is produced in China and India, followed by Japan, Brazil and Korea. China is the leading producer of silk in the world with an annual production of 1,04,000 MT followed by India, the second largest producer of silk with 23,060 MT (2011-12). In India, sericulture related activities ensure the livelihood security of over six million families spread over in about 59,000 villages across the country (Anonymous, 2013). Raw silk production is the most appropriate tool to provide gainful employment to the poorer sections of the society, as net incomes range from Rs. 12,000 to 70,000 per annum depending upon the variety of the silk to be produced and the unit area (under host plants). It is estimated that sericulture can generate employment @ 11 man-days per kg of mulberry raw silk production (in on-farm and off-farm activities) throughout the year out of which more than 6 persons-days are women (Lakshmi, 2007). In India, mulberry silk is produced mainly in the states of Karnataka, Andhra Pradesh, Tamil
Nadu, Jammu & Kashmir and West Bengal, while the non-mulberry silks are produced in Jharkhand, Chattisgarh, Orissa and North Eastern states. Out of total silk production of 23,060 MT during 2011-12, mulberry silk production was 18272 MT, while non-mulberry silk i.e. Tasar, Eri and Muga was produced 1590 MT, 3072 MT and 126 MT, respectively (Source: Regional Office, Central Silk Board, Guwahati, Assam).

Among the commercially exploited silkworms, eri silkworm is completely domesticated species under non-mulberry (Vanya Silk) sector that is reared throughout the year. Ericulture is an age-old tradition and culture of the tribals and other weaker sections of the society particularly in North Eastern India. Eri silkworm together with its food plants particularly with associated byproducts is considered as important bioresources for sustainable source of livelihood (Singh et al. 2012). Over the period of a decade annual production of eri raw silk has significantly increased to 3072 MT (2011-12) from 974 MT (1999-2000) which may be due to the horizontal expansion of plantation and not due to the increase in productivity (Ahmad and Rajan, 2011). About 1.30 lakh families having 29,632 hectare of land under eri food plants are associated with ericulture to produce 3055 MT of eri raw silk which is 99% of the total eri raw silk production in the country (3072 MT). Often the fibre spun from Eri cocoon is called “Heavenly thread”, because of its graceful gloss, coarse denier, higher elongation rate and stainability (Singh and Benchamin, 2002). Eri silk fibre which is quite finer next to the mulberry silk, is the softest and warmest among all silks and can be blended with wool, other silks, cotton and synthetic fibres imparting a special texture and feel to the fabric. Various diversified products viz., furnishings, stoles, dyed fabrics, hand bags, caps, jackets, quilts etc can also be obtained by virtue of its thermal property with vast marketing avenues. Eri silk worm
litters, excreta, unused leaves/ stalk/ petioles of food plants are recyclable waste. Naik (1994) reported that the litter, excreta and pupa form the important by-products as litter/unfed leaves and stalks are used as manure and as substrate in biogas production.

Nutritional value of food plants either alone or in combination plays an important role in the larval growth and silk productivity. The growth, development and economic characters are influenced to a great extent by the nutritional content of the leaf (Krishnaswami et al. 1971). The host plants have profound effect on survival, rate of food intake, digestion and assimilation which directly influence the growth and development of silkworms. The amount and quality of food intake of larvae influence different parameters like growth rate, larval duration, survival rate and reproductive potential (Das and Das, 2003). Raychaudhury (1974) stated that the quality of leaf influence the growth and development of silkworm and overall silk production. Since quality of leaf has got a direct influence on the health, growth and survival of silkworm, selection of the food plants possessing superior nutritive value is of importance for the healthy development of silkworm and in obtaining quality cocoon crops (Dutta et al., 1997). The importance of good nutrition in mulberry silkworm rearing has been widely recognized both within and outside India (Krishnaswami et al., 1970; Fonseca et al., 1993; Sarkar et al., 1997; Bongale and Chaluvachari, 1995; Sujathamma and Dandin, 2000; Bose and Bindroo, 2001). In non mulberry sericulture, quantitative estimates of seasonal variation of foliar nutrients have been done in different silkworm host plants like Tropical tasar (Sinha and Jolly, 1971; Sinha et al.,1992; Sinha et al.,2005), Muga (Yadav and Goswami, 1992; Dutta et al., 1997; Choudhury et al., 1998; Kakati and Kakati, 2011), Oak tasar (Sinha et
Nutritive value of non-mulberry and mulberry silkworm pupae and consumption pattern in Assam was studied by Rao (1994) and Mishra et al. (2003). Eri pupa is a delicacy and dietary staple for many ethnic tribes like Rabhas, Bodos, Abor, Miri, Kachari, Garos, Khasi, Naga, Adis, Mizo and the Syntengs in North-East India, who eat eri silkworm in its pre-pupal or pupal stage after formation of cocoons (Roychoudhury and Joshi, 1995). Eri pupae are naked and are suitable for human and animal consumption directly as raw staple food or after processing, which includes basically, frying, deep frying, baking and boiling with spices (Singh and Suryanarayana, 2003). The pupae in these cases are used fresh and the food prepared is highly perishable as different biochemical changes have been observed during metamorphosis of eri pupae at different temperature (El-Shaaraway et al., 1982). Eri silk worm pupae have high nutritional values of protein, fat, carbohydrates and vitamins on dry weight basis. Pupa oil has pharmaceutical and medicinal value while deoiled pupae are the valuable source of essential amino acids. Eri pupae are also used in protein extraction (Datta et al., 1993) and in pisciculture (Majhi et al., 1991).

North Eastern region of India is physiographically categorized into the Eastern Himalayas, Northeast Hills (Patkai-Naga Hills and Lushai Hills) and the Brahmaputra and the Barak Valley Plains. The region lies between 22-30°N latitude and 89-97°E longitude and expand over 2, 62, 379 sq. km. with variable altitude from almost sea-level to over 7000 metres above MSL. With the enormous climatic variations and development of a great range of ecological habitats, North East India is considered as the genetic treasure house comprising 33% of the biodiversity resources of India which is itself one of the twelfth mega biodiversity countries of the world accounting
for 60-70% of the world’s biodiversity. The region is the abode of at least 21 species of sericigenous insects (Kakati, 2011) and is considered as the centre of wild silk culture as several kinds of non-mulberry silks are produced in the region (Peigler and Nauman, 2003). In fact, because of North Eastern region, India enjoys the unique distinction of being the only country in the world producing all varieties of commercially important natural silk viz., Mulberry, Tasar, Oak Tasar, Eri and Muga. The contribution of mulberry, tasar, muga and eri silk from North Eastern region to respective variety of country’s silk production during 2011-12 was 1.08%, 0.38%, 99.81% and 98.23 respectively which uphold its indomitable position in muga and eri silk production.

While eri silkworm is largely reared by the farmers of North Eastern India, particularly in Assam, in recent years the farmers of several other states viz. Andhra Pradesh, Madhya Pradesh, Tamil Nadu, Karnataka, Maharashtra, Uttarakhand, Uttar Pradesh, Jharkhand, Bihar, West Bengal, Orissa and Sikkim have taken up eri culture (Sahu et al, 2006). Dayashankar (1982) studied the performance of eri silkworm *Samia cynthia ricini* Boisduval on different host plants and economics of rearing on castor in Dharwad (Karnataka) conditions. Nangia et al. (1998) recorded positive correlation between volumetric attributes and cocoon characters while rearing of three eri silkworm races on five different host plants like Castor, Gulancha, Papaya, Tapioca and Barkesseru under Karnataka climatic condition. Rajaram (2004) conducted rearing of eri silk worm on wild grown castor plantation in nontraditional areas of Uttar Pradesh and Himachal Pradesh and revealed that eri culture can develop a profitable industry with immense potentiality for self employment. Mahobia et al. (2005) highlighted the potential of eri silkworm rearing in Chhattisgarh. Kar et al. (2005) studied the grainage performance of *S.ricini* under Orissa climatic condition
and observed that emergence, fecundity and hatching were found to be varied with seasonal environmental parameters. Jaiswal et al. (2006) made a comparative study on rearing performance of different eco-race of eri silkworm (Philosamia ricini) in monsoon season of Uttar Pradesh. Brahma et al. (2006) successfully conducted rearing of eri silkworm Samia cynthia ricini under Eastern Ghat high land Zone of Orissa. Verk et al. (2009) analysed the performance of eri silkworm, Samia ricini Boisduval in different seasons in Punjab. However in another study conducted under Odisa (Sambalpur) climatic condition Ray et al. (2010) observed that Borduar ecorace exhibited supremacy over Titabar and Mendipathar with better rearing performance during winter season.

Seven eco-races of eri silkworm have been reported from North Eastern region based on the endemicity and distribution pattern, while six pure strains of eri silkworm have been isolated from the Borduar and Titabar eco-races based on the larval colour and marking patterns (Debraj et al., 2001; Singh et al., 2003). So far 24 food plant species are reported for polyphagous eri silkworm (Bindroo et al., 2007) of which Ricinus communis L. (Castor) and Heteropanax fragrans Seem. (Kesseru) are used as the primary food plants and Manihot utilissima Phol. (Tapioca), Evodia fraxinifolia Hook (Payam), Ailanthus grandis Roxb. (Barpat), Carica papaya (Papaya) and Jatropha curcas (Jatropha) are considered as the important secondary host plants (Rao et al., 2002; Singh and Das, 2006; Chakravorty and Neog, 2006; Das et al., 2006; Chowdhary, 2006). Hazarika et al. (2003) studied on the effect of different food plants and seasons on the larval development and cocoon characters of silkworm Samia cynthia ricini Boisduval in Assam. Dutta and Khanikor (2005) studied the rearing performance of S. ricini with interchange of food plants and observed that while castor was the best food plant for silkworm rearing, productivity
can also be increased by rearing the silkworm in combination of leaves of different food plants more particularly castor (1<sup>st</sup> to 3<sup>rd</sup> instar) to Barkesseru (4<sup>th</sup> to 5<sup>th</sup> instar). Chowdhury (2005) observed that the embryonic developmental stage in silkworm is very susceptible to environmental conditions i.e. light, temperature, humidity and greatly influenced by quality of seed cocoons. While eri silkworm seed can be produced throughout the year in Assam climatic condition, there is variation in grainage performance among seasons recording rainy as the best season followed by summer (Sarkar and Sarmah, 2010). Singh et al. (2011) made a comparative rearing performance and economic traits of eri silkworm on Castor and Kesseru during different seasons and the prospects for utilization of byproducts as sustainable source of livelihood.

About 10,000 families involve in the different part of Nagaland state having 4433 (15%) hectares of land under eri food plants and contribute to about 9.7% percent of the total eri silk production in North Eastern region. Though castor is the primary host plant of eri silkworm, castor leaf is not available throughout the year particularly during dry months. Moreover, castor seed are to be sown every year and its cultivation practice depend on rainfall condition resulting in uncertainty in raising the castor crop and inturn ericulture which necessitates searching for alternate host plants for continuous rearing of eri silkworm. Kesseru is one of the major food plants ranking next to castor (Thangavelu and Phukan, 1983), however it is not frequently used in Nagaland as there is no regular plantation crop. Growth of Tapioca, one of the secondary food plants of eri silkworm suits well to the State’s climatic conditions. It requires low manpower and can be managed by the family labour inputs. The crop has gained importance as a cheap source of carbohydrates, mainly for human consumption through its tubers and leafy food supplement for pigs. Eri culture offers
opportunity for additional income without affecting the tapioca tuber production and also generates additional employment avenues without disturbing the existing socio-cultural and ecological balance. It is established that partial utilization of about 25-30 percent leaves for eri silkworm rearing does not affect tuber yield (Bhat et al. 1991; Rama Rao et al., 2005). Joshi (1985) observed that feeding the eri silkworms with tapioca up to the end of the third instar and subsequently with castor was found to be superior to feeding with castor followed by tapioca. Govindan et al. (1992) also reported that eri silkworm can be reared on castor leaves up to the end of the fourth instar and subsequently on tapioca leaves without any deterioration in the quantitative characters. Payam, a middle-sized evergreen perennial plant with lusty growth substitutes other primary host plants during dry seasons particularly when the leaves of other food plants are scarce and also can be used as combinely along with other primary host plant. The leaf yield/acre of plantation was estimated up to the tune of 10,125 kg/yr (Borah et al. 2003).

Being blessed with favourable hilly climatic conditions, eri culture become a traditional vocation of the people of Nagaland and forms an integral part of the socioeconomic and cultural life of the tribal people in almost all districts. While six pure lines of eri silk worm strains namely Yellow plain (YP), Yellow spotted (YS), Yellow Zebra (YZ), Greenish blue plain (GBP), Greenish blue spotted (GBS) and Greenish blue zebra (GBZ) are recommended for commercial exploitation (Debraj et al., 2001; Sarmah et al., 2002) only yellow plain strain have been popular among the rearers in Nagaland and they are not very much aware of other five strains. Further rearers prefer to consume pupae of yellow plain strain and they either discard or throw away the larvae or pupae of other strains once they observe them during rearing period. It may be due to presence of spots and stripes on mature larvae or green pupae
which they do not like and relish. Among the four host plants, Castor, Kesseru and Tapioca are not sufficiently available during dry season to feed eri silkworm, however Payam, the evergreen perennial plant has been used for feeding eri silkworm throughout the year in Nagaland. Hence there is an immense need for paying special attention to Payam plant to diversify ericulture so that this traditional occupation could be made sustainable and economically profitable in Nagaland. In a study on seasonal rearing performance of different ecoclasses and strains in four host plants under Assam climatic condition Singh et al. (2010) highlighted significant and demonstrable potential of ericulture having tremendous impact in the context of sustainable livelihood among the marginal farmers. However except for preliminary study on rearing performance of Philosamia ricini Hutt. in certain secondary host plants (Imtinaro et al., 2005), there is no systematic and detail scientific document in Nagaland. Further, as silk productivity depends on quality of eri cocoons, which in turn depend upon the feeding response of silkworm; it is also pertinent to have qualitative and quantitative analysis of leave of different host plants. Considering the tremendous potentialities of ericulture, it is felt necessary to have a sound strategy involving investigation, analysis, evaluation and complete understanding of qualitative and quantitative traits of different strains and utilization of most available host plants in Nagaland. Hence a comparative and systematic study of six strains of eri silk worm in relation to their four host plants is undertaken in Ungma sericulture farm Mokokchung for two years with the following objectives:

1. Analysis of foliar constituents of eri food plants

2. Qualitative and quantitative morphometric larval variation of six strains of eri silk worm in relation to seasons and host plants.
3. Comparative seasonal rearing performance of six strains of eri silk moth species on four host plants.

4. Cocoon and Yarn analysis of six strains in different seasons and host plants

5. Pupal nutrient analysis in relation to food plants

6. Determination of ecological efficiencies of certain selected strains