2. Review of literature
The exploitation and commercialization of tropical tasar silkworm, *Antheraea mylitta* originated in India, and the tribals of Chotanagpur are its inventors. The tasar culture provides livelihood to about 1.5 lakh tribals in Jharkhand, Chhattisgarh, Odisha, Madhya Pradesh, West Bengal, Uttar Pradesh, Maharashtra, Bihar, and Andhra Pradesh states (Reddy, 2010) with total raw silk production of about 1724.97 mt (CSB, 2013). Creation of rural employment, alleviation of poverty and elevation of socio-economic status of tribals are the unique features of Indian tropical tasar culture (Suryanarayana and Srivastava, 2005; Manohar et al., 2009).

The foundations for the study of insect-host plant relationships were clearly defined by Charles T. Brues in 1920’s (Brues 1920 and 1924). Brues used three categories of phytophagous insects, which are being still used. Insects, which feed on a single host plant species, Brues called them monophagous; while those insects that feed on a definite few host plant species, he called oligophagous and for those insects, which feed on a wide variety of host plant species, Brues called polyphagous. *A. mylitta* is a polyphagous insect and has opted forty-five forest tree species as primary, secondary and tertiary food plants (Srivastav and Thangavelu, 2005). The polyphagous nature of the tasar silkworm is a boon for many rural tribals in central India, as their livelihood are linked with the collection and sale of naturally grown tasar wild cocoons (Hansda et al., 2008; Ojha et al., 2009).

The knowledge on insect-host plants relationship has highlighted the food preference by insects with regard to its nutritional value. Long back, Hiratsuka (1920) carried out a comprehensive quantitative study on digestion and utilization of *Bombyx mori* on mulberry leaf. Thereafter, Evans and Goodliffe (1939) worked on utilization of food by insects. Earlier studies on utilization of food by insects were not clearly described because several indices were used to report more or less the same measurement in different names (Hopkins, 1912; Evans and Goodliffe, 1939; Crowell, 1941; Smith, 1959; Mathur, 1967; Saxena, 1969). Study on the effects of host plants on the biology of insects is important in understanding the host suitability under different environmental condition (Xue et al., 2009).
A. mylitta in its natural habitat hatches and multiplies in favourable season and synchronises with available forestry host plants to develop an appropriate voltinism according to the prevailing agro-climatic conditions (Thangavelu, 2000a). A. mylitta eats out its total food requirement during its larval stages and accumulates sufficient food energy to survive during non-feeding pupal and adult stages. Depending upon the altitude of the place of occurrence, the life cycle of the tasar silk moth may be univoltine, bivoltine, trivoltine, or multivoltine (Nayak and Guru, 1998a). Bivoltine A. mylitta has two annual life cycles, the first being the seed crop (July-August) having shorter larval span, yielding non-diapause cocoons; while the subsequent second crop is called commercial crop (September-December) with longer larval span, yielding cocoons with thicker shell having prolonged pupal diapause period of 6-7 months (Suryanarayana and Srivastava, 2005).

First, Thangavelu (1992, 1993) emphasised the need for conservation of wild sericigenous insects in Himalayan states of India. He highlighted the importance of systematic research on various aspects of non-mulberry silks, because studies on the host plant interaction of sericigenous insects are necessary for better management and development of the sericulture industry (Sinha et al., 2000). Siddiqui et al. (2006) stressed that conservation of A. mylitta in different pockets of forest under different geographical and climatic areas is necessary and some of the commercial ecoraces of A. mylitta viz., Raily, Modal, Bhandara, Sukinda, Daba and Andhra local are being maintained in different forest areas of central India; but it is lacking in Uttarakhand. As suggested by many sericulturists, the specific climatic and geographical pockets in India can serve as new natural habitat for forest silkworm (Tripathi et al., 1988b; Sinha et al., 2000; Naik et al., 2010; Reddy et al., 2010). Deka and Kumari (2013) stressed that in order to increase the raw silk production of A. mylitta, exploitation of all the ecoraces and their food preferences should be established through comparative study of the effects of different food plant species under new agroclimatic conditions.

Cocoon crops of A. mylitta are influenced by the season, host plants and their interactions (Venugopal and Krishnaswami, 1987). A. mylitta has adapted to different environmental conditions and 44 ecoraces with phenotypic variations are reported from India (Suryanarayana and Srivastava, 2005), out of which only Daba and
Sukinda eco races are mainly contributing for country's tasar raw silk (Rao et al., 2004; Hansda et al., 2008; Ojha et al., 2009; Reddy et al., 2010). *A. mylitta* is commercially exploited, only in India.

The cocoon of *A. mylitta* shows considerable variations in their colour, size, shape, pupal weight, shell weight, and the silk output (Jolly et al., 1974, 1979). Such variations in the cocoons mainly occur due to the variations of races, climatic conditions, food plants, altitude etc. (Nayak and Guru, 1998b). Several workers have reported that host plants influence the weight gain by larva, survival percentage, growth index, pupal weight, adult emergence, and fecundity of different lepidopterans (Basu, 1944; Srivastava, 1959; Thobbi, 1961; Pandey et al., 1968; Singh and Byas, 1975; Dubey et al., 1981). All these workers concluded that lesser larval developmental period, more larval weight gain, and higher percentage of adult emergence are the major criteria to determine the superiority of a host plant. Studies have also been carried out on the biological parameters of different insects on different host plants under different environmental conditions (Etman and Hooper 1979; Bae et al., 1997; Guan and Chen 1999; Ahmad et al., 2007).

During the last fifty years, many research papers have been published on insect-host plant interactions of Daba ecorace of bivoltine tropical tasar silkworm, *A. mylitta*, but all these studies were mainly carried out on *Terminalia arjuna*, *T. tomentosa*, and *Shorea robusta* in traditional tasar silk producing states of India, viz., Jharkhand, Odisha, Chhattisgarh, Andhra Pradesh and West Bengal, but no literature is available on performance of *A. mylitta* on any forestry host plant from any Himalayan states of India including Uttarakhand.

Major studies on *A. mylitta* includes: morphology of the larva (Narasimhanna and Jolly, 1969; Narasimhanna et al., 1969), influence of temperature and photoperiod on termination of pupal diapauses (Jolly et al., 1970), effect of habitat and food (Nayak and Dash, 1989), effect of refrigeration on hatching (Dash et al., 1988), growth and leaf yield of Asan and Arjun (Nayak et al., 1988, 1998), and larval energetic on different food plants (Dash and Dash, 1989; Dash et al., 1996; Dash, 2001), occurrence of deformed cocoons (Dash and Nayak, 1990), rearing performance of *A. mylitta* with artificial diet (Akai et al., 1991), effect of food plants on cocoon
crop performance (Dash et al., 1992, 1994), preservation of seed cocoons (Kapila et al., 1992), voltinism (Nayak et al., 1992), rearing and cocooning (Ojha et al., 1994), abnormal tasar cocoons (Mohanty and Behera, 1998), effect of starvation on larva (Dash et al., 1988), cocoon and post cocoon studies (Rao and Samitha, 2000), bioenergetics during diapauses (Satpathy, 2003) and effect of outdoor cocoon preservation (Chakrabarty et al., 2003).

Uttarakhand in general and “Doon Valley” in particular have salubrious climatic conditions for development of the forestry host plants and rearing of A. mylitta. There are wide stretches of forest with various species of tasar food plants, which can serve as the best habitat for A. mylitta (Thangavelu, 1992; Siddiqui et al., 2006). Most of the forest areas in Uttarakhand fall under Shivalik hills, foot hills of Himalayas and Tarai region, which are bestowed with good sunshine, rich rainfall and sandy loam soil that are good for growth of tropical tasar food plants. Geographically, these forest areas can ensure good growth of forestry host plants with quality leaf, which in turn may provide most favourable conditions and natural home for A. mylitta (Siddiqui et al., 2006).

The following highlights of the literatures are particularly relevant to the evaluation of tropical tasar silkworm, A. mylitta on different host plants of forestry importance in Uttarakhand.

2.1 Effect of rearing seasons on Antheraea mylitta

Season indicates the inter-annual variation in temperature, humidity, sunshine, rainfall, etc. of a particular place, which is governed by different geographical parameters (Murthy et al., 1996). Studies have shown the importance of seasonal variations in biology and development of a given insect (Odum, 1983; Ouedraogo et al., 1996). Insects are cold-blooded (Poikilothermic) organisms, so their body temperature is more or less same as that of their surrounding microenvironment. Temperature influences everything that an organism does (Clarke, 2003), humidity affects embryonic development (Tamiru et al., 2012), and rainfall affects both.

Temperature is probably the single most important environmental factor that influences behaviour, development, survival, reproduction and geographical
distribution of insects (Benjamin and Jolly, 1986; Shiva Kumar et al., 1997). All the insect species have their own choices of temperatures for usual growth and very high temperature usually slow down the growth that may lead to developmental malfunctioning, such as larval ecdysis and adult emergence (Chapman, 2002). Temperature regimes and different levels of relative humidity are known to play an important role in the life cycle of an insect and its adaptability to the local climate (Tamiru et al., 2012). Some researchers believe that the effect of temperature on insects largely overwhelms the effects of other environmental factors (Bale et al. 2002). It has been reported that the temperature has highly significant effects on all developmental parameters of insect than humidity and rainfall (Bhat and Bhattacharya, 1978). Developmental time of an insect is inversely proportional to temperature (Tamiru et al., 2012). Among the various environmental factors that influence the silkworm cocoon crops, the most important is temperature followed by humidity. Temperature has a direct effect on the growth, development and physiological activity, nutrient absorption, digestion, blood circulation, respiration etc. Temperature plays an important role in egg hatching, larval growth and quality of the cocoons, adult fertility etc. With the increase in temperature, the larval growth and development is accelerated resulting reduction in larval duration, cocoons of lower weight and quality, while at low temperature growth and development is slow leading to prolong larval period, some time abnormal growth and sensitivity against several diseases (Singh et al., 2009).

Second abiotic factor that has significant impact on the performance of lepidopteran insects is humidity. Humidity interacts with free water availability and with the water content of the food plants. During egg incubation, it is important that humidity should be maintained at 80% on an average for normal growth of embryo. If humidity falls below 70% during incubation, it affects silkworm hatching (Singh et al., 2009).

Rainfall alters the functioning of microhabitat, which along with soil and other environmental factors affects foliage and water levels, which consequently affect on performance of insect (Mattson and Haack, 1987). Chemically the variation from
succulent leaves to mature is so large that it may halve the growth rate of lepidopteran larvae (Rausher, 1981).

Fluctuation in temperature, humidity and other seasonal factors prevents insects from attaining their physiological potential and performance (Slansky and Scriber, 1985). However, forest insects display a remarkable range of adaptations to changing environments and maintain their internal temperature (thermoregulation) and water content within tolerable limits, despite wide fluctuations in their surroundings, because impact of temperature is modified by habitat and other physical conditions (Singh et al., 2009). Temperature, humidity, air circulation and photoperiod show the significant interaction in their effects on the physiology of silkworm depending upon the combinations of factors and developmental stage affecting growth, development, productivity and quality of silk (Singh et al., 2009). Seasonal and environmental interactions have great role to play on the expression of commercial characters of A. mylitta (Siddiqui et al., 2006).

According to Krishnaswami (1978), the silkworm rearing seasons are broadly classified as spring, summer, and rainy crops, based on the temperature, humidity, and rainfall. Identification of best rearing season is a prerequisite for the success of Sericulture in a given area. Sengupta (1988) opined that the success of sericulture in Japan could be attributed to the identification of the suitable rearing seasons. Jayswal et al. (1990) reviewed the interaction between genotype and environment for economic traits in hybrid combinations of silkworm and asserted that environment causes effective restrain on biological characters of silkworm like, effective rate of rearing (ERR), single cocoon weight, single shell weight, shell ratio and filament length. Shiva Kumar et al. (1997) also concluded that the quality of food and rearing temperature, largely influence silkworm productivity. The phenotype A. mylitta is the result of interaction between genotype and environment in which it develops (Sengupta, 1991). A. mylitta expresses divergent phenotypic characters in response to varying ecological and climatic conditions (Lokesh et al., 2012). It has been reported that variations in the fluctuations of temperature prevent insects from attaining their physiological potential performance (Singh et al., 2009), which involve changes in the consumption and utilization of food, rate and time of feeding behaviour, metabolism,
enzyme synthesis, nutrient storages and other physiological and behavioural process (Slansky and Scriber 1985).

Sinha and Chaudhury (1992) asserted that phenological parameters of *A. mylitta* are mostly dependent on the ambient temperature and relative humidity available during the period of larval and pupal development; hence, the developmental pattern of *A. mylitta* is season specific. Srivastava *et al.* (1998) reported that environmental conditions causes variability in *A. mylitta*, because the fecundity, hatchability, cocoon weight, shell weight, absolute silk yield, filament length, denier, and sericin percentage varied significantly during different rearing seasons.

Sengupta *et al.* (2002) found that all the commercial characters of Daba ecorace (BV) of *A. mylitta* viz., cocoon weight, shell weight, SR%, cocoon volume, filament length, denier, average silk recovery percentage and silk yield/1000 cocoons was significantly higher in second crop rearing than the first crop.

Dash *et al.* (1994) assessed cocoon crop performance of the Indian wild tasar silkworm, *Antheraea paphia* on different food plants viz., *T. tomentosa*, *T. arjuna* and *Shorea robusta* during different rearing seasons in agro-climatic condition of Durgapur, Odisha. They evaluated cocoon crop performances in terms of effective rate of rearing (ERR), total cocoons yielded, cocoon weight, pupae weight and shell weight for each category of food plants in each rearing season. Their results showed that cocoon crop performances were better in autumn crop (Sept.-Oct.) than in rainy (July-Aug.) and winter (Nov.-Dec.) seasons. The larval form of tropical tasar silkworm can invade diverse habitats and can utilise food sources of many forest tree species to feed and grow at phenomenal rates (Rath *et al.*, 2004). However, under suboptimal environmental conditions, *A. mylitta* larvae can survive for delayed period at much slower growth rates (Jolly *et al.*, 1974). The abiotic and biotic environmental factors during different seasons greatly influence the life history of *A. mylitta* reflecting in larval weight, cocoon weight, pupal weight, shell weight, shell percent, percent emergence, percent coupling, adult longevity, fecundity, percent hatching, and reelability of the silk (Jolly *et al.*, 1974; Nayak *et al.*, 1993).
Due to outdoor mode of forest based rearing, the silkworm larvae of *A. mylitta* may suffer heavy loss due to predator, parasitoid, and diseases. It is estimated that on an average, 30% of total crop loss due to various diseases is observed per year (Sahay *et al.*, 2008). Silkworm diseases are major constraints in realizing full crop yield (Kumar and Naik, 2011).

Tanaka (1951) remarked that the rainy season is unsuitable for rearing of *B. mori* due to high RH and changing temperature. Kishnaswami *et al.* (1973) reported that temperature and RH exceeding 20-26°C and 60-70%, respectively, affected the cocoons quality of *B. mori*. Jolly *et al.* (1974) remarked that heavy rainfall disrupted spinning and resulting inferior cocoons. Sarkar (1980) stated that sudden fluctuation in temperature is harmful to the rearing of *Philosamia ricini* worms. Ullal and Narasimhanna (1987) reported that high temperature followed by severe weather fluctuation resulted in poor cocoon quality in *B. mori*. Barah *et al.* (1988) studied variations in cocoon characters of *A. assama* during different seasons and found that cocoons produced in different seasons are not uniform in their commercial characters. It was found by Kar *et al.* (1998) that the commercial traits of eri silk moth, *Samia ricini* such as cocoon, shell and pupal weight varies significantly during summer and winter seasons. Naik *et al.* (2010) found significant difference in growth index of eri silkworm with respect to host plants, seasons, and their interaction. Rahmathulla *et al.* (2012) concluded that *B. mori* made physiological adaptations during summer season to withstand suboptimal conditions.

Information on the effect of seasons and rearing conditions on different parameters of rearing has also been reported on other groups of insects (Johansen, 1997), in mulberry silkworm (Krishnaswami *et al.*, 1971a and 1971b; Mathur *et al.*, 1995) and in non-mulberry silkworms, (Choudhary, 1981; Sinha and Chaudhury, 1992; Sahu, *et al.*, 1998; Situmorang, 2002; Das *et al.*, 2004).

### 2.2 Host plants nutrients and their effect on *A. mylitta*

The success of an insect depends significantly upon an optimal diet in both quantity and quality (Hassell and Southwood, 1978), which provides the energy, nutrients, and water to carry out life’s activities (Slansky, 1993). The rate of food consumption is influenced by the physical and chemical nature of food and the
physiological state of insects (Waldbauer, 1968). The consumption and utilization of food constitute a *sine qua non* for growth, development, and reproduction. The amount, rate and quality of food consumed by a larva influence its performance i.e., growth rate, developmental time, final body weight, dispersal ability, mating success, timing, extent of reproduction and probability of survival. These influences can also carryover to affect subsequent larval performance that reflects in the quality of offspring produced (Slansky, 1985). Decreased food abundance in nature has an adverse effect on development, metabolism, and reproduction (Slansky, 1980; Grabstein and Scriber, 1982).

The lepidopterans require a number of organic compounds viz., carbohydrates, fats, lipids, vitamins, steroids and amino acids as nutrients. In the course of digestion and respiratory pathways, the energy is released from these organic molecules through a series of physiological and biochemical changes (Jolly *et al.*, 1974). The foliar constituents in a number of tasar food plants have been analysed for moisture, crude fibre, total minerals, reducing sugar, total sugar, starch, total nitrogen, and crude protein (Jolly *et al.*, 1979; NISCAIR, 1976; Puri, 1994; Sinha and Jolly, 1971)

The water content of mature leaves provides a useful quantitative index of plant growth (Scriber and Slansky, 1981). Water forms a large proportion of insect tissues and survival depends on the ability to maintain water balance in the body. The water content in insects ranges from less than 50% to more than 90% of the total body weight and there may be much variation within the same species even when reared at identical conditions (Mathur and Lal, 1994). Rath (2010b) found that the dietary water is very closely associated with number of feeds/day that plays a crucial role in the growth in *A. mylitta* as in other herbivorous larval lepidopterans. It was also found that consumption of food of lower water content could result in significant reduction in relative growth rate and efficiencies of conversion of digested food (Reese and Beck, 1978; Timmins *et al.*, 1988). Benchmark and Jolly (1986) reported that silkworm larva prefers to consume the leaves that contain high moisture and less dry matter. Periaswamy (1994) reported that water content of leaf play a significant role on food utilization and growth in phytophagous insects. Basavarajappa and Savarunmuth (1997) observed that on feeding over matured and wet leaves enhanced
the incidence of virosis diseases and cocoon melting. Vage and Ashoka (1999) reported that when fifth instar larvae fed with tender shoots up to 3 days followed by matured shoots marked better values of cocoon characters; however, Elumalai et al. (2001) reported that coarse leaves feeding enhance the most of the economic characters of bivoltine pure races in mulberry silkworm.

It has been reported that the rearing performance of the *A. mylitta* has a positive correlation with the moisture content of the leaf (Krishnaswami, 1978; Thangamani and Vivekanandan, 1984). High moisture content in the leaves has favourable effects on the palatability and assimilability of nutrients (Parpiev, 1968). Narayanan et al. (1967) also revealed that tender leaf having higher nutritional value favours growth of the silkworms, and then increasing the cocoon characters. Rashid et al. (1993) reported that growth rate and digestibility of any insect depends on nutritional quality and water content in its food.

Rearing performance of *A. mylitta*, larvae are strongly correlated with the water and nitrogen content of the leaves (Prasad et al., 2004). Sribner and Slansky (1981) investigated the influence of food quality on larval performance by comparing performance values of similarly aged larvae of several insect species raised under similar photoperiod, temperature, and humidity. They indexed food quality by leaf water and nitrogen contents and concluded that differences in food quality may be due to differences between food species or within a food species due to changes in growth conditions or with the seasonal aging of leaves.

Proteins are the ubiquitous organic nitrogenous compounds in the foodstuff of silkworm larvae, which are involved practically in all the structure and function of the cells (Chapman, 1998). Slansky (1982) reported that proteins are required not only for adult maintenance but also to supply the energy and nutrients for provisioning the eggs and egg production in insects. *A. mylitta* is a tool to convert leaf proteins of food plants into silk. Sinha et al. (1998) found that the crude protein content was significantly high in *T. alata* (12.17%) and low in *S. robusta* (10.80%). Deka and Kumari (2013) estimated the protein content in the leaves of *T. tomentosa* (15.94 mg/g); *T. arjuna* (13.20 mg/g); *T. bellirica* (11.60 mg/g); *T. chebula* (12.23 mg/g) and *Lagerstroemia speciosa* (13.37 mg/g) fed to the larvae of *A. mylitta*. They found a
positive correlation between protein content of the leaves with larval, cocoon, pupal
and shell weight of the *A. mylitta*.

The previous studies conducted by Narayanan *et al.* (1967), Sudo (1981),
Bongale *et al.* (1991) and Krishnaswami *et al.* (1970) proved that tender leaves are
having more water as well as protein content. This protein content of the tender leaves
is absorbed by the silkworm epithelium tissue of the gut and is transferred to the body
matter as well as in to the cocoon formation. Machii and Katagiri (1991) reported that
mulberry varieties containing higher contents of protein in leaves have higher
production efficiency of cocoon shell. It was found by Krishnaswami (1978) and
Singhvi and Bose (1991) that the *Bombyx mori* larvae fed with protein rich mulberry
leaves showed significant enhancement in its larval, cocoon and shell weight.

Carbohydrates occupy a very important place especially in case of
phytophagous insects. It is the most commonly distributed and widely occurring
compounds in plants with enormous variations in their quantity and quality (Sinha *et al*., 1998). Carbohydrates are utilized by the silkworm as an energy source and for
synthesis of both lipids and amino acids. The degree of fat body glycogen and
haemolymph trehalose is also dependent on the carbohydrate contents in diet of
silkworm (Ito, 1967). Sinha *et al.* (1998) found significantly higher quantity of total
sugar in *T. tomentosa* (7.9%) followed by *T. arjuna* (5.7%) and *S. robusta* (5.3%).

Carbohydrates, proteins, and lipid are known to be the main sources of energy
at the time of larval-larval, larval-pupal, pupal-adult transformation (Krishnaswami,
1978; Thangamani and Vivekanandan, 1984). Availability of these nutritional
components have been reported to be on higher side in *T. alata, T. tomentosa, T
arjuna* and *L. speciosa* than *T. bellirica, T. chebula and L. tomentosa* (Agrawal *et al*.,
1980; Sinha and Jolly, 1971; NISCAIR, 1976), which improves the performance of
larval and cocoon characters of *A. mylitta* according to host plants (Sinha *et al*., 1986).

Further, higher crude fibre content in the leaves of forestry host plants of *A.
mylitta*, is known to cause detrimental effect on silkworm nutrition (Krishnaswami,
1978). Crude fibre is the ash free material largely composed of cellulose and lignin,
but cannot be digested by the silkworm larvae. It is not included under nutrient, but its
intake along with diet is essential because of regulatory function that helps to maintain the peristaltic movement of the intestine to remove waste products from it (Sinha et al., 1998). Digestibility of lepidopteran insects is affected by imbalanced diet or high content of crude fibre in the food (Waldbauer, 1964).

Deka and Kumari (2013) estimated crude fibre content in six forest tree species viz., *T. tomentosa* (9.49 %); *T. arjuna* (9.86 %); *T. bellirica* (12.32 %); *T. chebula* (12.02 %); *L. speciosa* (10.23 %); and *L. parviflora* (13.46 %). They found that the weight of the matured larvae of *A. mylitta* was maximum on *T. tomentosa* (41.98 g) followed by 37.03 g on *T. arjuna* and 31.91 g on *L. speciosa*. Reduction in fibre content has been established as an advantage for better silkworm crop yield (Vasuki and Basavana, 1969). According to Sinha *et al.* (1998), *T. arjuna* is the best for *A. mylitta*, because of it contains having lowest quantity of crude fibre (12.82%) than *T. tomentosa* (16.09%) and *S. robusta* (18.50%).

Bose et al. (1995) reported that succulent leaves with less fibres and higher mineral contents stimulate the metabolic activities in silkworm, resulting in quantitative improvement of cocoon and silk of *A. mylitta*. *T. tomentosa* and *T. arjuna* were found superior to *S. robusta* in this respect, because they contain higher percentage of total minerals (8.08% and 6.82% respectively) and lower amount of crude fibres (16.09% and 12.82% respectively). The lowest content of total minerals (3.61 %) and the highest amount of crude fibre (18.50%) were estimated in *S. robusta* (Sinha et al., 1998).

Amino acids are the next most important constituents in silkworm nutrition (Ito, 1967). *A. mylitta* extracts amino acids from the leaves of host plants and produce silk thread (Jolly et al., 1974). Amino acids, obtained from the leaf, are utilized by the silkworm larvae for body growth, development, and cocoon formation. Sinha et al. (1998) reported twenty-three amino acids in *T. tomentosa*, *T. arjuna* and *S. robusta*. They found the number of amino acids same in all these plants; however, leaves of *T. arjuna* contains higher quantity of total amino acids (61975 µg/g dry leaf powder), followed by *T. tomentosa* (61250 µg/g dry leaf powder). Dhavalikar (1962) reported presence of seventeen amino acids in raw silk of *A. mylitta*. 

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In a comparative biochemical study of *T. tomentosa* and *T. alata*, Sinha *et al.* (2007b) found that non-hairy leaves of *T. alata* are better than hairy leaves of *T. tomentosa*. The moisture level, total carbohydrate, protein, amino acid and mineral contents were found higher in non-hairy leaves than the hairy leaves; however, total fibre content was found higher in hairy leaves of *T. tomentosa* and lower in non-hairy leaves of *T. alata*.

Deka and Kumari (2013) evaluated physiological parameters of different forestry host plants of *A. mylitta* grown under agro-climatic condition of Ranchi, Jharkhand. All the plant species viz., *T. tomentosa*, *T. arjuna*, *T. bellirica*, *T. chebula*, *L. speciosa*, and *L. parviflora* showed significant variations in respect to physiological and biochemical parameters. The highest value of total chlorophyll content of leaf was recorded in *T. tomentosa* (2.69 mg/g) followed by *T. arjuna* (2.59 mg/g) and *L. speciosa* (2.56 mg/g). The total soluble protein content of leaf was found highest in *T. tomentosa* (15.94 mg/g), followed by *L. speciosa* (13.37 mg/g) and *T. arjuna* (13.20 mg/g). They drawn a conclusion that the higher value of total carbohydrate content of the leaf of *T. tomentosa* (8.54%) was followed by *L. speciosa* (8.27%) and *T. arjuna* (8.01%) might be due to the highest value of net photosynthesis rate among these three plant species.

Ponnuvel *et al.* (1996) reported that biochemical constituents of oak (*Quercus serrata*) leaves varying due to seasonal effect. They recorded maximum moisture (71.9%) and crude protein (10.2%) levels in spring season and the levels declined sharply as season progressed. Whereas, minimum crude fibre content (0.9%) was found in spring season and maximum (9.96%) during autumn season.

Jayaramaiah and Sannappa (1998) studied relationship between foliar constituents of Castor genotypes and economic parameters of eri silkworm at UAS, Bangalore. They found that the larval duration, weight, survivability, and effective rate of rearing (ERR) were having significant positive relationship with the moisture and nutritional contents of the host plant. They also found a significant positive correlation between foliar constituents of the host plant and weight of cocoons, pupae, shell weight and shell ratio. Grainage parameters such as moth emergence, fecundity,
and hatchability were also showed significant positive relationship with nutritional components of the host plant fed by the eri silkworm.

2.3 Suitability of forestry host plants for *A. mylitta*

Green plants are the indispensable foundations for all the ecosystems that harness the energy of sunlight and by photosynthesis, produce energy rich sugars that are the foods for insects (Waldbauer, 1996 and 2003). The relationship between phytophagous insects and plants is essentially nutritional, because phytophagous insects visit the plant solely to procure food for themselves or for their progeny (Bhattacharya and Pant, 1976).

One of the outstanding contributions on consumption, digestion, and utilization of food by silkworm was made by Hiratsuka (1920). Further, Waldbauer (1968) made a significant contribution in bringing uniformity in the use of various growth indices for the study of growth behaviour of insects. The host plants affect silk production of the insect by affecting survival behaviour, rate of quantity of food intake, digestion, and assimilation, which directly influences the growth and development of the silkworm (Krishnaswami et al., 1970; Sinha et al., 2000; Ray et al., 1998; Rahman et al., 2004; Saikia et al., 2004).

The development and reproduction of *A. mylitta* correlate directly with the quantity and quality of the food they consume, and the ingestion of this food depends on its availability, acceptance, digestion, and assimilation (Rai et al., 2006). The success of tasar silkworm rearing is mainly depends on the accessibility and nutritional status of the food plant, as a consequent silkworm larval rearing could result to higher number of cocoons or the cocoons of superior quality in terms of pupation or silk content (Kumar et al., 2009; Ojha and Panday, 2004; Reddy et al., 2012).

Ahsan and Griyaghey (1973) undertook first systematic study on the effect of different host plants on rearing performance of *A. mylitta*. They conducted outdoor rearing of *A. mylitta* on seven forestry host plants viz. *T. arjuna*, *T. tomentosa*, *S. robusta*, *Careya arborea*, *L. parviflora*, *Q. serrata* and *Z. jujuba* in the agro-climatic conditions of Ranchi. Their basic criteria for evaluating different host plants was
based on the time taken for the first instar larvae of *A. mylitta* to reach pupal and adult stage, per cent pupa formation, adult emergence, gain in body weight and sex ratio.

Jolly *et al.* (1974) reported that the larvae of *A. mylitta* differ greatly from their adult form, not only in outer structure but also in musculature, nervous system, tracheation, and many internal organs by feeding on different forestry host plants.

Tripathi *et al.* (1988a) have reared the larvae of *A. mylitta* on nine species of forestry host plants in the agro-climatic conditions of Jharkhand and found that *T. tomentosa, Shorea robusta* and *T. arjuna* trees support better growth of larvae, leading to formation of cocoons of large size and greater yield of tasar yarn than others forestry host plants, viz., *L. parviflora* and *Careya arborea*. Tripathi *et al.* (1988b) reported that transfer of *A. mylitta* larvae from inferior to superior host plant species result in heavy mortality of the larvae and reduction in cocoon yield.

Dash *et al.* (1992) studied the effect of rearing seasons and different food plants viz. *T. tomentosa, T. arjuna, S. robusta, Z. jujuba, L. parviflora* and *Anogeissus latifolia* on cocoon crop performance of *A. mylitta* under the agro-climatic conditions of Durgapur, Odisha. *S. robusta* appeared uneconomical in terms of total cocoon shell (raw silk) production in spite of a superior cocoon formation. Overall performance of *A. mylitta* was found superior on *T. tomentosa* than all other food plants. The gradation of food plants with regard to performance (total raw silk production) was, in decreasing order of productivity: *T. tomentosa > T. arjuna > Z. jujuba > S. robusta > L. parviflora and A. latifolia*.

Srivastava *et al.*, (1994) tested the efficiency of rearing of muga, eri, and tropical tasar silkworm on different host plants and found that host plants significantly affected the rearing and grainage traits of all the non-mulberry silkworms. Their observations on silk ratio and number of eggs per laying of *A. mylitta* revealed that *S. robusta and Ziziphus jujuba* fed cocoons had higher silk ratio and number of eggs per laying than the other two primary host plants viz. *T. tomentosa and T. arjuna*. However, survival on *A. mylitta* larvae on *S. robusta and Z. jujuba* was quite low in comparison to the *T. tomentosa and T. arjuna*. Hence, based on total silk yield and
fecundity $T.\ tomentosa$ and $T.\ arjuna$ are the most suitable and the efficient host plants for tasar silkworm rearing.

Rath et al. (1997) found significantly higher consumption, assimilation, growth and respiration of $A.\ mylitta$ on $T.\ tomentosa$ than $T.\ arjuna$. While significantly higher feeding rate was observed on $T.\ arjuna$ during II and V instar over $T.\ tomentosa$.

Patil (1998) reported that $Ricinus\ communis$ is a potential new host plant for rearing of $A.\ mylitta$. He found that the growth parameters and the cocoon characters of the tasar silkworm reared on castor leaves were normal and $A.\ mylitta$ completed its life cycle in 71 to 85 days. The incubation period, larval and pupal duration ranged from 8 to 10 days, 33 to 40 days and 30 to 35 days, respectively. Further, the effective rate of rearing, weight of matured larvae, cocoon, shell, and pupae ranged from 70-85 per cent, 30 -35g, 10 -12 g, 1.2 -1.5 g and 8 -9 g, respectively. The fecundity ranged from 250 to 275 eggs.

Sinha et al. (2000) studied the consumption and utilisation of $Shorea\ robusta$ leaves in Laria larvae of $A.\ mylitta$ and found that the average total consumption of an individual larva was 108.06 gram.

Rath (2000) studied the growth, development and oviposition potential of $A.\ mylitta$ after feeding the larvae with three host plants viz., $T.\ tomentosa$, $T.\ arjuna$ and $Z.\ jujuba$ in first rearing season. They found $T.\ tomentosa$ as best host plant for the larvae of $A.\ mylitta$ in all respects. The larval, pupal, and adult characters along with the oviposition potential were found to be better on $T.\ tomentosa$.

Banagade and Tembhare (2002) studied the effect of some exogenous factors such as photoperiod, starvation, food plants, and supplementary food on silk gland protein in $A.\ mylitta$ and concluded that starvation caused significant reduction in total protein concentration. Among the three food plants tested viz., $T.\ tomentosa$, $T.\ arjuna$ and $Anogeissus\ latifolia$, the highest total silk gland protein concentration was recorded in case of feeding on $T.\ tomentosa$ leaves, suggesting the most preferable host plant for $A.\ mylitta$. 

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Rath et al. (2003b) carried out trial rearing of *A. mylitta* on Cashew nut (*Anacardium occidentale*) in Ranchi condition and recorded an average yield of 25 cocoons per dfl. They recorded an average fecundity of 230 eggs; average hatching of 78%; but ERR was very low 13.85%, cocoon weight was 12.85 g; shell weight was 1.40 g; filament length was 10.89 m; NBFL was 505 m; SR% was 16.4% with denier of 10; Pupation (90%); pupal weight (10.07 g); adult emergence (90%); male emergence (63.0%); female emergence (37%); average weight of male moth (2.5 g); average weight of female moth (6.0 g); average fecundity (193 eggs) with average hatching (82.8%).

Rath et al. (2003a) studied food allocation budgeting in *A. mylitta* fed on *T. tomentosa* and found that the relative growth rate (RGR) reached its peak during II instar (0.523), and declined thereafter until V instar (0.088). They further reported that RGR of the developing larva was 0.396 during I instar reached its highest value during II instar (0.523), which again tend to decline to the lowest during V instar (0.088).

Rath et al. (2008) studied the impact of food plants on reproductive and commercial parameters in *A. mylitta* by feeding the same host plants for six generations. Larvae were fed upon *T. tomentosa, T. arjuna* and *Z. jujuba*. They found 85.9 % improvement in the fecundity on *T. tomentosa*, 58% on *T. arjuna* and 49.7% on *Z. jujuba*. Likewise in commercial parameters, the shell weight in male showed an improvement of 52.9%, 45.8% and 42.1% on *T. tomentosa, T. arjuna* and *Z. jujuba*, respectively. Their study revealed the comparative superiority of *T. tomentosa* over *T. arjuna* and *Z. jujuba*.

Reddy et al. (2009) studied the performance potential of Daba ecorace of *A. mylitta* on *Terminalia arjuna* under agro-climatic condition of Ranchi and recorded observations on various parameters viz., fecundity (180-280 eggs); hatching (80-90 %); cocoon yield/dfl (45-70); peduncle length (3.51-6.83 cm); cocoon length (4.85-5.21 cm); cocoon width (2.95-3.17 cm); cocoon volume (26.70-32.24 cc); cocoon weight (09.20-12.83 g); pupal weight (07.72-10.33 g); shell weight (1.25-2.36 g); silk ratio (14.13-16.28%); silk yield/1000 cocoons (812-1417 g); silk recovery (52-71%);
silk filament length (475-1240 m); non-breakable filament length (79-475 m); and denier (9-11 d).

Yadav and Mahobia (2009) reared Daba ecorace of *A. mylitta* on *T. tomentosa*, *T. arjuna* and *L. parviflora* and in their combinations. The productivity of cocoons from a single disease free laying remained 4.8 cocoons on *L. parviflora* being the lowest and 45.6 cocoons on *T. tomentosa* being the highest. However, there was no difference in the yield/dfl on *T. tomentosa* and *T. arjuna*. They concluded that the cocoon yield on *L. parviflora* can be increased if this food plant is used in the fifth instar of larvae, which accounts 80% of leaf consumption, after rearing either on *T. arjuna* or *T. tomentosa* up to fourth instar. They concluded that *L. parviflora* can be utilized for tasar silkworm rearing in the fifth instar where the food of prime choice; *T. tomentosa* and *T. arjuna* are in scarce and *L. parviflora* are in abundance.

Kumar et al. (2011) carried out a bioassay studies of *A. mylitta* in different accessions of *Terminalia arjuna* (18), *T. tomentosa* (9), *T. chebula* (1) and *Anogeissus latifolia* (1) during first rearing season of July-August 2010 and found the larval weight of 40.55 g on *T. tomentosa*, followed by 40.4 g, 39.4 g, 32.8 and on *T. arjuna*, *A. latifolia*, and *T. chebula*, respectively. However, maximum larval period was 30 days on *T. chebula*, followed by 29 days on *A. latifolia*, 28 days on *T. tomentosa* and 27 days on *T. arjuna*, respectively.

Deka and Kumari (2013) assessed the effect of six food plant species viz., *T. tomentosa*, *T. arjuna*, *T. bellirica*, *T. chebula*, *L. speciosa* and *L. parviflora* on rearing performance and cocoon characteristics of *A. mylitta* in the agro-climatic conditions of Ranchi, Jharkhand. Performance of *L. speciosa* on the cocoon productivity and silk ratio of *A. mylitta* was found comparable to *T. tomentosa* and *T. arjuna*. Further they reported that the leaves of *T. arjuna*, *T. tomentosa* and *L. speciosa* possesses more leaf moisture, chlorophyll, protein and carbohydrate contents to support better larval growth of *A. mylitta* in comparison to its rearing on *T. bellirica*, *T. chebula* and *L. parviflora*. Their study indicated the commercial perspective of *L. speciosa* as alternate primary food plant for forest based rearing of *A. mylitta* in agro-climatic conditions of Ranchi.
Kumar et al. (2012) studied the effect of different forestry host plant viz., Terminalia arjuna, T. bellirica, T. chebula, T. tomentosa, L. parviflora and L. speciosa on larval duration (days), larval weight(g), single cocoon weight (g), single shell weight (g) and silk ratio (%) of Daba ecorace of A. mylitta during first crop of July-August under agro-climatic conditions of Ranchi. They found that the host plants significantly affected all the studied parameters.

Reddy et al. (2012) analysed the economic viability of A. mylitta on Lagerstroemia parviflora food plant in comparison with T. tomentosa plant in the agro-climatic conditions of Jharkhand. Their comparative study on rearing and cocoon quality among L. parviflora and T. tomentosa revealed that the effective rate of rearing (ERR), cocoon and silk yield were lower in L. parviflora, while the other commercially important characters like, larval, cocoon and shell weights, pupation and silk ratios have shown improvement over T. tomentosa. Their study indicated that the commercial prospective of L. parviflora might be explored in Jharkhand as alternative food plant for A. mylitta during exigencies.

A number of studies have been carried out on cocoon and silk characteristics of other silk producing insects, reared on different host plants in different agro-climatic conditions. For example, Poonia (1978) studied utilisation of food and rate of growth of eri silkworm larvae Philosamia ricini on Castor, Ricinus communis. Reddy and Alfred (1979) studied the utilisation of Castor by Philosamia ricini larvae of fifth instar and found that there was direct correlation between the age of larvae and body weight obtained. Thangavelu and Phukon (1983) studied the rearing performance of eri silkworm Samia cynthia ricini on Castor, Kesseru, tapioca, and Barkesseru. Badan and Tara (1984) recorded the comparative weight gain in silkworm Bombyx mori fed on five different varieties of mulberry to find out best mulberry variety of the region based on studying various indices of silkworm. Devaiah et al. (1985) evaluated five different host plants viz. Castor, tapioca, white plumeria and red plumeria for the rearing Samia cynthia ricini. Saraswat (1992) studied efficacy of Quercus incana, Q. himalayana, and Q. semecarpifolia on quantitative characters of oak tasar silkworm, A. proylei. They found significant gain in ERR and cocoon weight of A. proylei on Q. semecarpifolia than other two host plants. Biswas and Das (2001) studied the impact

Besides silkworm, literatures are also available on effect of host plants on growth and development of other insects also. Barbosa and Jane (1979) reported that the development and survival of gypsy moth (*Lymantria dispar*) larvae is strongly influenced by the host plant, upon which they feed. Hamilton and Lechowicz (1991) conducted outdoor rearing of gypsy moth larvae under natural temperature and photoperiod regimes on red oak (*Quercus rubra*) and sugar maple (*Acer saccharum*). Xue *et al.* (2009) studied the effects of different host plants on larval and pupal development and survival, longevity and fecundity of adults of *Spodoptera litura* and found that all of the biological parameters were significantly affected by the host
plants. Shahout et al. (2011) assessed the influence and mechanism of different host plants on the growth, development and, fecundity of reproductive system of common cutworm *Spodoptera litura*. Assadi et al. (2012) conducted a study on the effect of feeding on four different forest trees viz. *Quercus castaneifolia, Alnus glutinosa, Parrotia persica* and *Acer velutinum* on the biology and feeding indices of *Lymantria dispar*. Shields et al. (2012) investigated the feeding preferences of fifth-instar larvae of *Lymantria dispar* on seven over story tree species. Several workers undertook studies on polyphagous insects by offering them different host plants on larval growth, weight gain, pupal formation, adult emergence, fecundity etc. (Basu, 1944; Srivastava, 1959; Singh and Byas, 1975; Dubey et al., 1981).

### 2.4 Reproductive potential of *A. mylitta* on different forest tree species

The fertility of an adult insect depends as a whole or partially upon the adequacy of its nutrition during the larval stages (Waldbauer, 1968). Lepidopteran larvae consume their total food requirements during larval stages to accumulate sufficient food energy to tide over the non-feeding adult to eggs laying stage (Rath, 2005). *A. mylitta* take neither food nor water during the adult stage, so all the nutritional requirements for body activities during adult life of a week or two and for eggs development by the female is obtained from food stored during larval stage (Trager, 1953).

According to Bhattacharya and Pant (1976), the calculation of the adult formation from pupal stage throws light on the nature of inhibitory effect or nutritional requirements for a definite stage of the insect. In general, unmated males and females live longer than mated sexes; however, under natural conditions it would be desirable if both sexes live longer even after mating. Relatively little attention has been paid in this field for evaluating a diet for *A. mylitta*.

The pupal weight of eri silkworm *Samia cynthia ricini* was found to influence the adult longevity on castor (Nagalakshmmam, 1987). The longevity of male and female moths influences the grainage performance of *B. mori* (Rajanna et al., 1999; Krishnaprasad et al., 2002) and *A. mylitta* (Rath et al., 2007).
There are reports that incubation period of silkworm egg vary with variation in host plant species (Jolly et al., 1979; Sarkar, 1980; Reddy et al., 1989; Naik et al., 2010). Sengupta and Singh (1974) recorded the shortest incubation period (8 days) of eri silkworm, *Samia cynthia ricini* fed on Castor.

According to Raja Ram and Samson, (1991) hatching percentage of silkworm is affected by the kind of the host plants. Hamilton and Lechowicz (1991) found that the egg masses of gypsy moth reared on oak tree hatched completely than did those from moths reared on maple tree.

Mishra et al. (1997) studied the reproductive behaviour of *A. mylitta* reared on *T. tomentosa, T. arjuna* and *S. robusta* plants in different seasons in Durgapur Odisha, and reported that the type of food plants as well as seasonal variations affect the reproductive behaviour in term of percent emergence, coupling, hatchability and fecundity in *A. mylitta*.

Rath et al. (2003a) found that food consumption and utilisation differ significantly in male and female. Female has greater nutritional accumulation, which is associated with egg production. They reported that a female of *A. mylitta* larva ingest 15.7 % more food than the male.

Rath (2005) studied the effect of quantitative nutrition on adult characters and reproductive fitness in *A. mylitta*. He found that the adult weight had strong effect on the reproductive potential in the form of moth survivability, emergence percentage, fecundity, fertility, eggs weight and weight of hatched out larvae.

Reddy et al. (2010) reported that host plants had significantly affected the total coupling percentage of *A. mylitta* reared on *T. tomentosa* and *L. parviflora*. Coupling percentage was found significantly higher on *T. tomentosa* (70.4 %) than *L. parviflora* (60.8 %).

It is reported that different varieties of food plants influence considerably the fecundity and cocoon weight in the mulberry silk moth *B. mori* (Govindan and Magadum, 1987; Oponder and Tikku, 1979; Bari and Islam, 1985; Sharma and Badan 1986; Basu et al., 1995).
Srivastava et al. (1982) studied the effects of food deprivation on larval duration, weight of cocoon and fecundity of eri silkworm Philosamia ricini. Sankarperumal et al. (1989) assessed the influence of three host plants, viz. Ricinus communis, Helianthus annuus and Arachis hypogaea, on the organic constituents and fecundity of Spodoptera litura. Bogawat (1967) studied on the biology of mustard saw fly Athalia proxima on twelve different host plants and reported that pre-oviposition period of Athalia proxima was not affected, but the fecundity was found variable with the host plants. Bhardwaj and Kushwaha (1976) found that the pupae formation and the adult emergence of Amsacta lineola got affected when offered five different host plants. Singh (1976) described that when Utetheisa pulchella was fed with leaves of Crotalaria juncea and Heliotropium indicum resulted in variations in the adult emergence ranging from 71% to 88%.

2.5 Economic traits of cocoons and silk production efficiency of A. mylitta on different forest tree species

According to Abraham et al. (2004), tropical tasar silk is superior in quality to other silks including mulberry, muga, and eri silks. Akai (1998) reported that cocoon filament of A. mylitta is the thickest among all the silkworm species and with a porous structure; it is most suitable for fashionable clothing and sport-wear.

Panda (1972) collected tasar seed cocoons of Antheraea paphia from different regions of Odisha, separated them according to their peduncle characters, colour, and sex, and further calculated the correlation coefficient values for different characters. He also reported that live weight of females cocoons of A. paphia was significantly more than males, irrespective of variety and colour.

Srivastava et al. (1994) suggested that silk ratio is the second most reliable economic character after effective rate of rearing for assessing the efficacy of forestry host plants for A. mylitta. Devaiah and Dayashankar (1982) reported that cocoon weight and shell weight largely depend on type of hosts provided to the silkworm.

Sengupta et al. (2002) recorded significantly higher filament length of Daba (Bivoltine) ecorace of A. mylitta in second crop (959.750± 119.486 m) than first crop (517 ± 50.697 m). Srivastava (1986) found that the Sal fed cocoons of A. mylitta were
rich in silk ratio percentage, while effective yield of cocoons was low. Efficacy of Arjun towards cocoon weight was found higher but low for effective yield and silk ratio percentage. Further, Asan has shown better performance for cocoon yield, cocoon weight, and silk ratio.

Kumar et al. (2006) carried out bioassay studies of *A. mylitta* on different accessions of *Terminalia* spp. and *L. speciosa* in Ranchi condition and recorded cocoon weight, shell weight, SR percentage, filament length, non-breakable filament length and Denier.

Kumar et al. (2011) reported that *T. tomentosa* fed larvae of *A. mylitta* produces highest cocoon weight of 13.45 g in comparison to the larvae fed on *T. arjuna* (12.37 g); *A. latifolia* (12.48 g) and *T. chebula* (10.70 g). They found maximum shell weight of *A. mylitta* cocoon on *T. tomentosa* (2.06 g) followed by *T. arjuna* (1.78 g), *A. latifolia* (1.67 g) and *T. chebula* (1.19 g) during first crop rearing in Ranchi agro-climatic condition. They also recorded that *A. latifolia* fed larvae produced maximum SR percentage of 14.27% followed by *T. tomentosa* (14.02%), *T. arjuna* (13.71%) and *T. chebula* (11.4%), respectively.

Rath et al. (1997) found significant variation in silk productivity of *A. mylitta* reared on *T. tomentosa* and *T. arjuna*. Their results indicated that the larvae fed on *T. tomentosa* produced higher quantity of silk than those were fed larvae on *T arjuna*. Thus, *T. tomentosa* proved its comparative superiority over *T. arjuna*.

Dash et al. (2012) evaluated the length, breadth, and weight of pupa of *A. mylitta* reared on different forestry host plants viz., *T. alata*, *T. arjuna*, *S. robusta*, *Z. jujube*, *L. parviflora*, *A. latifolia*, *T. bellirica*, and *S. cumini* in rainy season at lower, medium, and higher altitudes in Odisha. Their study indicated that *A. mylitta* larvae reared on *S. robusta* showed significantly highest values of all the pupal growth parameters. The gradation of eight food plants in respect of the pupal growth of *A. mylitta* was found as *S. robusta > T. alata > T. arjuna > Z. jujube > L. parviflora > A. latifolia > T. bellirica > S. cumini*.

Raja Ram and Saradchandra (1998) reared eri silkworm on the leaves of phutkoul, castor and kesseru and observed highest cocoon weight of 2.45 g on castor
followed by 2.19 g on kasseru, whereas it was found lowest (2.00 g) on phutkoul. Reddy et al. (1989) studied pupal weight, cocoon yield, shell ratio, and reproduction of *Samia cynthia ricini* on castor, tapioca, plumeria and ailanthus and found highest shell ratio of 12.10 on Castor. Sengupta and Barah (1991) studied female pupal weight and fecundity of mother moth of *A. assama* with four different food plants. Raja Ram and Samson (1998) assessed the effect of different forestry host plants viz., Som (*Persea bombycina*), Soalu (*Litsea polyantha*), Diloli (*Litsea salicifolia*), and Majankuri (*Litsea citrata*) on rearing performance and cocoon characters of muga silkworm, *A. assama*. Xue et al. (2009) reported that larval food directly affects size and weight of the pupae of *Spodoptera litura* and the female pupae are always heavier than male pupae.

### 2.6 Correlation and regression studies on different variables of *A. mylitta*

Jolly (1965) reported that the shell weight has positive and highly significant correlation with breadth of cocoons. Panda (1972) found that the live weights of cocoons of *Antheraea paphia* were positively correlated with its length and breadth. He also found that length of the cocoons has significant positive correlation with breadth of the cocoons, but he observed negative correlation with peduncle length.

Rahman and Rahman (1989) studied the correlation and path analysis of six cocoon characters of eri silkworm *Samia cynthia ricini* and found that cocoon shell ratio showed significant positive correlation with cocoon.

Siddiqui et al. (1989) concluded that larval weight and fecundity has the highest direct effect on silk yield. Effective rate of the rearing (ERR) was identified the other important components that contribute directly in positive direction towards silk yield through cocoon weight and shell weight.

Krishna et al. (1990) carried out multiple regression analysis for some quantitative traits in mulberry silkworm, *Bombyx mori*, considering cocoon weight, shell weight and shell ratio as dependent variables and other traits being independent variables. They found that with cocoon weight as dependent variable, pupal weight
alone contributed for 99.20% variation, while cocoon filament weight accounted for 97.5% variation in cocoon shell weight.

Yadav et al. (2001) found significant positive correlation between weight of female moth and its fecundity in *Antheraea paphia*. Their study indicated that fecundity of a moth increases with the increase in body weight of female moth.

Subramanian et al. (2012) carried out correlation studies between cocoon weight, adult emergence, copulation potential, fecundity, eggs per gram and egg hatchability of *Samia cynthia ricini* and found that the cocoon weight; fecundity and egg hatchability have significant positive correlation. Whereas, cocoon weight and eggs per gram have significant negative correlation.

Yadav and Goswami (1989) carried out correlation and regression analysis between cocoon weight and shell weight in muga silkworm on two different types of food plants.

Calvo and Molina (2005) studied fecundity and body size relationship of *Srebiote panda* and found strong relationship among fecundity and pupal weight and adult weight.