CHAPTER-II

Review of Literature

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Phenological Aspects

The information on the works of the phenological aspects in other groups of insects have been done by Wigglesworth (1973). King(1975) studied the cyclic and seasonal natural phenomena on sugar-cane froghopper *Aeneolamia varia* in relation to climate. Ali (1982) on the same line worked on hatching of eggs of Bombya locust *Patang succinita*. Congdon *et al.*,(1983) studied on the effect of temperature on development and fecundity of *Oligonychus pratensis.* Cunnington(1985) studied on the effect of temperature and humidity on the oviposition and fecundity in the grain mite, *Acarus siro*. Ranga Rao *et al.*,(1989) worked on the threshold temperatures and thermal requirements for the development of *Spodopter litura.* Johansen(1997)investigated on the influence of temperature development, fecundity and survival of cabbage moth *Mamestra brassicae* in relation to the forecast and control methods. Reference to such studies in mulberry silkworm can be made to Yokoyama and Takashima (1952) for qualitative and quantitative production of silkworm hybrids. Krishnaswami *et al.*, (1971) reported that cocoon yield under protected condition was higher than that under conventional condition increases by 30%. Mathur *et al.*, (1975) observed the seasonal effect of temperature and relative humidity on ovulation, fecundity and retention of eggs and their interdependance in multivoltine silkmoth, *Bombyx mori L.* under two broad seasons, viz.,unfavourable season (March-September) and favourable season (October-February). Tikoo *et al.*,(1975) has reported that the hatchability of silkworm *Bombyx mori L* also found to be affected by the season. A number of factors which include hormonal, chemical environmental, physical and behavioural involved in hatchability by an adult silkmoth. Rahman *et al.*, (1980) studied expression of heterosis in differentseasons for six economically exploitable traits in crosses between multivoltine races. These were crossed in all possible combinations including reciprocals. The results indicated

variation in the magnitude of heterosis during different rearing seasons. BSR1O x M2P2 was found to perform best during winter, which is normally the favourable rearing season and Nistari x M2P2 during summer, which is the unfavourable rearing season.

Phenological studies in non-mulberry silkworm have been made by Yamazaki(1939); Hodai(1949); Regniere *et al.*, (1989); Choudhury (1992); Sinha and Choudhury(1992) and others. The multiracial character of tasar silkworm *A. mylitta*, adaptable to various eco-climatic conditions have been studied by Jolly (1968).

Genetic variability

Genetic variability in non-mulberry silkworm *Antheraea mylitta,* have been studied by Siddique *et al.*, (1983, 1988, 1994a.). Dash *et al.*, (1994) evaluated crop performances of *Anthraea Paphia* on food plants Asan (*Terminalia tormentosa*) and Arjun (*Terminalia arjuna*) in different seasons. In tasar silkworm *Anthraea mylitta*, there are two to three crops in a year based on the regional and seasonal variations (Sharan *et al.*, 1994 and Srivastava *et al.*,1996).

Generally highly inbreed lines in plants are used for commercial exploitation whereas in silkworm, the F1 hybrids are utilized for commercial silk production (Chang *et al.*, 1981; Gamo and Hirabayasih,1983). Extensive studies have been carried out on the manifestation of hybrid vigor in silkworm (Harda, 1949;Nagaraju *et al.*,1989; Subba Rao and Sahai, 1989; Singh *et al.*, 1990, 1992; Nagaraju *et al.*, 1996; Shekar *et al.*, 2011, Kumar *et al.*, 2013). A total of 31 multivoltine and 60 bivoltine silkworm breeds are being maintained in the germplasm bank of CSR&TI, Berhampore (Anon., 2000-01).

Raghavendra Rao *et al.*,(2001) evaluated the productive multivoltine x bivoltine hybrids in the irrigated areas of South India. Five multivoltine x bivoltine hybrid combinations *viz.*, BL62 x CSR2, BL65 x CSR5, BL67 x CSR5; BL 68 x CSR5 and BL69 x CSR5 were selected for evaluation. Results showed that the newly evolved multivoltine x bivoltine hybrid BL67 x CSR5 performed better than both the controls BL24 x NB4D2 and PM x NB4D7.

Economic Characters

The investigations on economically important characters of some tassar eco-races have been recorded (Chetterjee *et al.*, 1993; Siddque *et al.*, 1983, 1988, 1994a). The tropical tasar eco races of India are of different major varieties which include Daba, Raily, Sukinda, Bogai, Bhandara etc. which are the major commercial varieties well known for its superior commercial qualities such as compact and hard cocoons, high reelability, high shell ratio and low denier (Thangavelu,1991&92).

Studies have been done on the variety/genotype of mulberry, *Morus indica* L. suitable for south India may not be suitable for climatic conditions of north India with different pH level and soil. (Dorcus and Vivekanandan 1991; Jain *et al.*, 1992).

Datta (2000) has reported that though the trend of sericultural development in India clearly depicts a quantum jump in mulberry silk production for the last three decades, the cocoon-shell ratio realized in bivoltine hybrids at commercial level was found around 18% only.

Improvement of qualitatively superior raw silk necessitated the evolution of productive bivoltine strains. Keeping this in view, attempts have been made to evolve hybrids with high survival (above 90%) and cocoon-shell ratio (above 23%) coupled with better reeling. He developed a robust oval breed CSR18 XCSR19 (dumbbell breed) and utilized for commercial use for stability in production.

Hajare *et al.*,(2008) and Kumar *et al.*,(2013) studied the performance of silkworm breeds (*Bombyx mori* L.) in Vidarbha region during summer and

performance of eri silkworm (*Philosamia ricini*) during the autumn season of Uttar Pradesh revealed that the average rate of rearing by percentage were increased by 9.8% and 27% respectively.

Varied Climatic Conditions

Seasonal studies made in both mulberry and non- mulberry silkworm revealed a different expression of different breeds to varied climatic conditions during different seasons. The rearing seasons are classified broadly as spring season , summer season, rainy season, autumn season and winter season based on temperature, humidity and rainfall. (Krishnaswami and Narasimhana , 1974;Watanabe, 1928).

Ueda (1969) studied the factors viz. rearing conditions, spacing, rearing temperature etc. on silkworm growth and established that direct correlation of these factors with the health of silkworm, larval growth, quality of cocoons and productivity.

Hajare *et al.*, 2007, Virk *et al.*, 2009, Rajadurai *et al.*, 2010) Identification of different season specific silkworm hybrids for the Kashmir climatic condition were carried out and three specific hybrids were identified (Quadir *et al.*, 1997). Scientific experiments were worked out on new mulberry silkworm hybrid under semi arid conditions of Andhra Pradesh. Several promising multivoltine x bivoltine hybrids were identified and evaluated by CSR&TI, Berhampore and Mysore (Subba Rao *et al.*, 1989). CSR&TI, Mysore, have developed a series of hybrids like CSR2 x CSR4, CSR2 x CSR5 and CSR18 x CSR19. Ravindrasingh *et al.* (2001) reported the hybrid, BL54 (SL) x CSR18 to be the best combiner in respect of fecundity, yieldI10,000 larvae both by number and weight, cocoon weight and shell weight in crosses with the sex limited in trait of coloured cocoons.

Nirupama and Ravindra Singh (2007) worked on evaluation of polyvoltine breed of mulberry silkworm and found that the hybrids are more tolerant than pure

races such as cocooning rate, effective rate of rearing, cocoon characters, fecundity and productivity. Significance differences were observed with negative heterosis for total larval period in most of the hybrids.

Some promising bivoltine x bivoltine hybrids like Dun 6 x Dun 21, Dun 6 x Dun 22, ATR 16 x ATR 29 and RSJ3 x RSJ1, RSJ3 14 x RSJ 11 developed by RSRS, Deharadun and RSRS, Jammu respectively performed well in the field (Khan, 2006). KSSRDI, Bangalore has developed two bivoltine hybrids KSO-1 x NP2 and KSO-1 x SP2 suitable for rearing during summer season (Krishna Rao, 1998) and two multivoltine hybrids PM X C110 and PM X C104 for unfavourable seasons during April-May, June- July, August-September and December- January (Krishna Rao *et al.*, 2006). China also developed many productive hybrids for rearing during different seasons. Shao(1987) evolved a hybrid "Latin x Baiyun" for rearing during summer seasons. Hee *et al.*, (1989) developed hybrid "Feng1 x 54a" for both summer and autumn rearing.

In India, Sengupta (1968) also evolved sex–limited larval marking bivoltine strains of J112 and C110. Later, a sex-limited larval marking strain of Pure Mysore was evolved by Nagaraju *et al.*, (1989).

Harda (1961) reported higher level of heterosis from crosses between European and Chinese races rather than the intra racial hybrids of Chinese origin and the univoltine strains of Europe were found to have better general combining ability for some of the quantitative characters. Nirmal Kumar *et al.*, (1998) reported an improvement of 12-13% in egg yield in double hybrids. Rama Mohana Rao *et al.*, (1995) revealed that the filament length is more in the hybrids. Also, Boil-off loss ratio varies in different silkworm breeds (Sinha *et al.*, 1992). Rao *et al.*, (2012) worked in the identification of polyvoltine x Bivoltine hybrids of the silkworm *Bombyx mori* L. with superior fibre quality: a break through in silkworm breeding. The mulberry silkworm *Bombyx mori* L. has immense economic value which displays genetical , physiological and quantitative differences (Gamo *et al.*, 1980, 1983).

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Studies on the different economic traits on the combining ability of the silkworm were made for commercial use for better production (Tayade, 1989). Chaterjee *et al.*,(1993) summarised that combining ability studies assume significance so as to determine the nature of gene action involved in the expression of different economic traits, besides identification of specific desirable combinations. Sen *et al.*,(1995) opined that combining ability of the silkworm plays an important role in determining the perspective hybrids.He categorized several important genetic parameters like cocoon weight, shell weight, silk ratio and effective rate of rearing.

Rao *et al.*,(1998) reported that comparison of parents on the basis of general combining effects indicated the superiority of the breeds as good combiners. Singh *et al.*, (2000) reported that the breeds APS5 and APS11 were found to be good general combiners for all six characters of cocoon yield by weight, pupation rate, cocoon weight, shell weight, shell ratio and filament length.

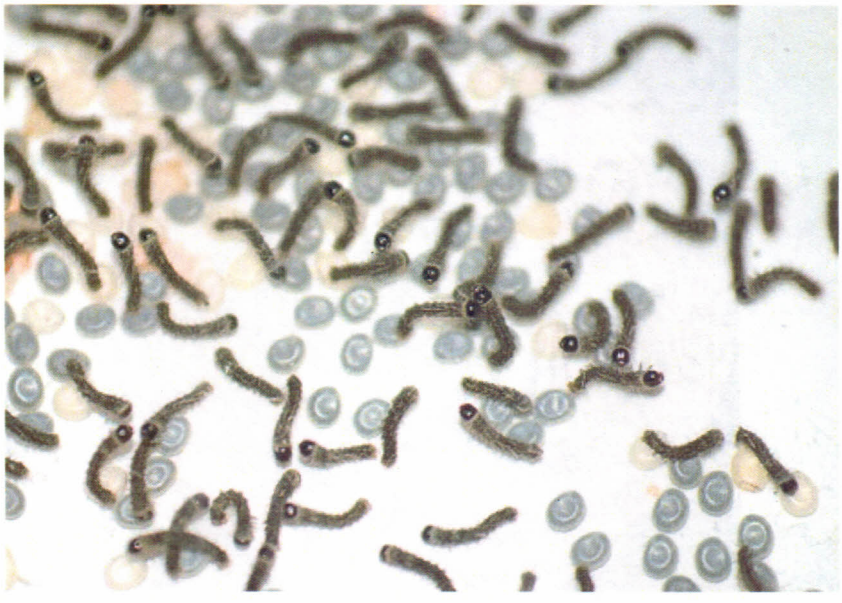
Study have been done on superior bivoltine and polyvoltine races with a genetic potential to express maximum under the tropical conditions (Sekharappa *et al.*, 1999) and observed that the rearing performance of poly x bivoltine combinations like PM x CN2, MH1x CN2 express the same under the tropical condition.The cocoon weight was significantly high 1.82 to 1.88 gram with an average shell percentage of 16.83.

Inspite of numerous works which have been cited above, the present investigated work "Studies on some mulberry silkworm *(Bombyx mori* L) hybrids for commercial rearing with special reference to cocoon yield" have been left behind. So it has been decided to work in this line with the objectives which are mentioned in the concluding part of the introduction chapter.

Annexure-I

Fecundity of a mulberry silkworm moth (*Bombyx mori*)

Annexure-II



Mulberry silkworm (*Bombyx mori*) hatched from eggs

Annexure-III

Spinning of ripened mulberry silkworm (*Bombyx mori*)

for formation of cocoons