

**BIOECOLOGICAL STUDIES OF INDIAN GOLDEN
SILK MOTH, *ANTHERAEA ASSAMENSIS* HELFER
(LEPIDOPTERA: SATURNIIDAE)**

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ABSTRACT: The bio-ecology of wild parental stocks of muga silk moth, *Antheraea assamensis* Helfer collected from the natural habitat of Meghalaya (India) and its potential for breeding in North-East India are studied. The morphological characteristics and behaviour at the different developmental stages of the silkworm are discussed. Colour polymorphism of the larva is observed. The wild silk moth is purely multivoltine in nature and four life cycles are completed in a year. After October-November crop it undergoes diapause at the pupal stage and remained in this stage till 2nd or 3rd week of March of the next year. The average fecundity ranged from 132 -147 in wild race and from 130 to 150 in semidomestic race during the different rearing seasons. The ERR% of wild race ranged from 12.54 to 48.50 with the highest value during Late Kotia (November-December), while in semi-domestic stock it ranged from 14.48 to 60.12 with the highest value during Baisakhi (April-May). The cocoon shell weight ranged from 1.32g to 1.51g in wild race without any significant variations during the different seasons ($p > 0.05$). In semi-domestic race the shell weight ranged from 0.39g to 0.49g without any significant variations during the different seasons ($p < 0.05$). The wild race can be used in breeding for introgression of the genes for higher shell weight to the semi domestic race.

KEY WORDS: *Antheraea assamensis* Helfer, bioecology, characterisation, conservation.

The muga silkworm *Antheraea assamensis* Helfer is a holometabolus insect endemic to North East India only. This silkworm produces the unique golden colour silk which is more durable and has high demand in the global market. This silkworm is polyphagous in nature and feeds on a wide range of host plants. (Choudhury, 1970). Among the food plants, 'som' *Persea bombycina* and 'soalu' *Litsea monopetala*, are the two major primary food plants. Out of these two primary food plants 'soalu' *Litsea monopetala* is semi-deciduous in nature while the other is evergreen. The cultivated race of muga silkworm is multivoltine in nature and completes five to six life cycles in a year and the farmers rear this silkworm for production of the muga silk. Annually, India produces about 150 tons of muga raw silk. The parental stocks of this silkworm still exist in the wild habitat in different zones of North-East India. Many economically important characters are still observed in the wild race of this silkworm. The climatic conditions of North-Eastern region of India are congenial for the lepidopteran species and are found distributing up to 1370m AMSL (Das et al., 2000). The Indian Sub-Himalayan belt in the North East India is the natural abode of many wild sericigenous insects. Out of the thirty five species of *Antheraea* recorded so far, thirty one species belong to Indo-Australian biographic region (Seitz, 1933; Crotch, 1956). A few workers have studied some aspects of wild silkworms in general and *Antheraea* species in particular in North east India during last four decades (Jolly et al., 1976; Thangavelu, 1991; Singh & Singh, 1998; Baruah et al., 2000; Singh et al., 2000, 2011a,b,c; Singh & Maheswari, 2003).

The naturally existing wild race of muga silk moth will become extinct due to deforestation, pest and predators and rapidly changing environmental conditions. Therefore, proper strategies must be taken up for the in-situ and ex-situ conservation of the important wild genetic resources of muga silk moth for utilization in future breeding programme and subsequent commercial exploitation for higher production of muga silk. Therefore, the present study was undertaken to know the bio ecology of wild parental race of *A. assamensis* Helfer and its potential for breeding in North-East India. The results are presented in this paper showing the potential of the silk moth for future breeding programmes.

MATERIALS AND METHODS

The survey and collection of wild parental races of *Antheraea assamensis* Helfer were conducted in Tura, Meghalaya (India). The collected seed cocoons were consigned for conducting grainage in the laboratory of Central Muga Eri Research & Training Institute, Lahdoigarh, Assam (India). The characteristic features of the wild silk moth were recorded and compared with the semi-domestic race maintained in the Institute. The behaviour of moth emergence, coupling and oviposition were recorded. The moths were allowed to couple for 6-8 hours and after decoupling moths were kept individually for egg laying in the straw made sticks locally called 'Khorika' by binding the female moth with the help of cotton thread. The prepared disease free layings (dfl) were disinfected by dipping in 3% formalin for 10 minutes followed by washing in plain water, dried in shade and kept each dfls of the mother moths in small paper packets. The dfls were incubated at $24 \pm 2^\circ\text{C}$ and 70-80% R. H. Eggs packets were kept in a plastic tray covered by a perforated black cotton cloth to obtain uniform hatching till the morning hour of the date of hatching. A few tender twigs of 'som' *Persea bombycina* or 'soalu' *Litsea monopetala* were placed on the hatched larvae inside the paper packets. The worms crawl over the leaves within half an hour and then the twigs were directly shifted in outdoor on the foliages of 'som' *Persea bombycina*. The paper bags containing eggs may be directly shifted on branches when the hatching starts so that the worms can crawl over the leaves.

The rearing field was well cleaned and disinfected before 15-20 days of rearing by spraying of 5% bleaching powder solution in the whole rearing plot and there after dusting of slacked lime and bleaching powder mixture (9:1). The early stage rearing was conducted in the properly pruned plantations of 'som' *Persea bombycina* or 'soalu' *Litsea monopetala* following RBD with four replications successively for ten generations in outdoor condition under nylon net cover in five seasons per year i.e., April-May, May-June, July-August, September-October, and October-November for two years in Lahdoigarh (Assam), India. While using nylon nets especially during summer crops, nets were lifted up as much as possible during day time, while during night time, trees were fully covered with nylon nets to protect the larvae from predators. Normally, larvae are transferred by picking up on a triangular bamboo made tray locally called 'Chaloni' when they come down after consuming the leaves of the tree and the tray with the larvae are shifted to a new bush having quality leaves. Worms are not touched by hand as far as practicable. The grainage and rearing performance along with salient features of different life stages of the silk moth were recorded and analysed. The conservation in the *ex-situ* condition of the moth was continued for six generations to acclimatize in the semi-domesticated condition. The important yield contributing characters viz., fecundity, hatching percentage, number of cocoons per dfl, effective rate of rearing (ERR %), average cocoon weight, single

cocoon shell weight, cocoon shell ratio (SR %), single cocoon filament length were recorded.

RESULT AND DISCUSSION

Regular field survey revealed that the wild parental stocks of *A. assamensis* is distributed in the undisturbed forest of North-East India on the foliages of 'som' *Persea bombycina* or 'soalu' *Litsea monopetala* at the altitude of 780-2000 m AMSL. It was particularly more abundant in South Garo hills district of Meghalya (India). The cocoons and larvae are found mostly on 'soalu' *Litsea monopetala* and less on 'som' *Persea bombycina* showing more preference on foliages of 'soalu' *Litsea monopetala* in wild habitat.

Life cycle and Voltinism: Voltinism is one of the important self regulating character in the life cycle of *Antheraea assamensis*. The wild silk moth is purely multivoltine in nature and four life cycles are completed in a year viz April-May, June-July, August-September, and October-November respectively. After October-November crop it undergoes diapause at the pupal stage and remained in this stage as such till 2nd or 3rd week of March. The moths undergo 70% self coupling under captive condition. Inducing of mechanical coupling of the uncoupled moths though possible, however, it is very time consuming and labourious task. The life cycle (egg to adult) of this silkmoth under fluctuating environment varies from 52-55 days in summer (temp. 26-35°C) and 90-95 days in winter (12-23°C) with four moulting stages during the entire larval period (Fig. 1). The pupal diapause of this wild silk moth may be a physiological mechanism to withstand the cold climate of the winter.

Moth emergence and Coupling: The emergence of moth occurs in the night from 18.00 to 22.00 hr. Self coupling of moths just after emergence is not allowed by keeping male and female moths separately in the cages for about 2-3 hr so as to allow full development of the emerged moths. Coupling starts in the night time mostly from 20.00 hr and continued up to 07 hr of next day. Coupling upto 70% takes place in the captive condition inside cages and the coupling of the remaining moths was induced mechanically. The optimum temperature and relative humidity for moth emergence and coupling are 22-24°C and 75-85% respectively. On reaching the female moth, the male moth starts courtship behaviour with raised antennae, fluttering wings around the female followed by mating. The antennae of the male moth bent downwards during mating period. Mating lasts for 10-12 hr but it continues up to 24 hr of the next day if not disturbed. Similar behaviour of mating was reported was reported in other wild silk moths (Kuang-Ming & Ta-Yuan, 1958; Singh & Debaraj, 2011; Singh et al., 2011a,b,c). Copulation by one male moth is enough for complete fertility of the female moth. Male moths are utilized for second time mating when there is shortage of fresh male moths. In the natural condition the male moth flies long distances in search of females and the female moth also flies particularly after mating to lay the eggs on the leaves and branches of the food plants. However, they usually do not fly at day time. The moths do not lay all eggs at one place only but in a scattered way. The coupled moths detach at the slight mechanical disturbance. The life span of the adult moths is 7-10 days.

Oviposition: After decoupling, the individual female moths are kept for egg laying in straw made stick (locally called 'Khorika') in dark condition at 24 ± 2°C and 75 ± 5% R.H. Eggs are collected after 72 hr of oviposition but egg laying continues up to 5-6 days. The average fecundity ranges from 120-185 eggs in all the different cropping seasons.

Incubation and Hatching: After proper disinfection the eggs are incubated at the temperature of $24 \pm 2^\circ\text{C}$ and relative humidity of 70-80%. Hatching takes place after 8-10 days of incubation. Profuse hatching does not occur initially and it continues up to late hours of the day. The average hatching varies from 70-80%.

Larval Development and behaviour: The larva spins the cocoon after about 21-22 days of active feeding in summer and 40-45 days of active feeding in winter through five larval instars but it is prolonged up to 50 days depending upon the climatic condition. The brushing and rearing of *A. assamensis* need special care. The duration of development of first, second, third, and fourth instars varied seasonally depending upon environmental temperature. Generally it takes 3-4 days, 3-5 days, 5-7 days, 7-10 days in summer and 6-8 days, 7-10 days, 10-12 days, 11-14 days in winter respectively while the fifth instar took prolong time 9-11 days in summer and 14-18 days in winter. From 3rd instar onwards the larvae have the habit of moving to the base of the food plants very frequently which may be due to rising of temperature or in search of suitable leaves. Therefore, strips of plastic sheet (12 inch breadth) are tied around the trunk of the food plant to prevent them from straying. Laboratory studies have shown that the optimum favourable temperature and relative humidity for larval development are 24°C - 28°C and 80-85 % from first to fifth instars respectively. During the entire larval period, it passes five larval instars through four moulting stages.

Feeding behavior: The larvae prefer tender leaves to mature and hard leaves irrespective of the instars. Just after hatching the larvae crawl in search of food. The newly hatched larvae have the habit of eating bits of egg shell just after hatching which provides immediate energy. It is observed that the worms crawl up to the tip of the branches and start eating tender leaves. It is desirable to provide tender leaves to the chawki worms (1st-3rd instars) while semi-mature and mature leaves should be provided to the 4th and 5th instars respectively for healthy growth of the larvae. The larvae feed on the entire leaves including midrib. It stops feeding at the slight disturbance. A larva consumes about 70-75 g of leave during the entire larval development.

Cocooning Pupation and Adult development: The mature larva stop feeding and either rest on the food plant or comes down to the tree trunk near the strips of plastic sheet tied around the tree trunk. The larvae remain there by raising their head upwards till evening and released their last excreta. Afterwards the larvae start searching suitable location for cocooning and pupation. In that time the matured larvae are picked up and put in the bundle of dry twigs or in the bamboo made moutage for cocooning. It completes the pupation inside the cocoon within 5-7 days in summer and 12-15 days in winter. Cocoons are harvested after full pupation. The pupa develops into adult moth after about 18 days in summer and 30-35 days in winter.

Morphological characteristics

Egg: Egg shell is brown and oval in shape (Fig.2). The size of the egg varies from 2.3-2.8. mm in length and 1.9-2.5 mm in breadth. The weight of the egg ranges from 0.06-0.07 mg. At the time of oviposition, the eggs look brownish grey in colour but after washing they appear light green or creamy. At the cephalic end there is a minute hole called micropyle.

Larva: The colour of the newly hatched larvae is black with distinct yellow lines at the intersegmental region. The length of the newly hatched larva is 6.50 mm to 12 mm while in the second, third, fourth, and fifth instars it ranged from

13-20 mm, 20-26 mm, 26-36 mm and 42-55 mm respectively. The weight of the first instar larva ranges from 0.07 mg to 0.075 mg while the second, third, fourth, and fifth instars it ranged from 0.83-9.10 mg, 4.2-6.4 mg, 21-36 mg and 45-120 mg respectively. There is colour polymorphism in the late instar larvae. The larval colour varies from light green, dark green, blue, Yellow and orange (Fig. 3a,b,c). The weight of mature larvae varies from 6-8 gm in male and 9-12 g in female. The colour of the tubercles varied in different instar and it becomes red in 5th instar. Some of the mature larva forms cocoon on the tree itself in wild condition (Fig. 4), however normally they comes down in search of suitable location for cocooning during which, they are picked up by hand and keep in specially made cocooning devices. The peduncle supports the cocoon in hanging from the branch.

Cocoon: Cocoons are oval in shape, length varies from 3.4-4.6 cm and breadth varies from 1.6-2.6 cm and golden-brown in colour (Fig. 5). The cocoon weight ranges from 3.5-5.75 g in male and 6.2-9.5 g in female. The shell weight ranges from 0.35-0.55 g in male and that of female ranged from 0.5-0.75 g. The shell ratio ranges from 10-12% in male while in female it ranges from 6-8%. The length of the peduncle ranges from 3.2-6.4 cm. The filament length varies from 250-440 m. The denier ranges from 4.15-5.30 during the different seasons and the reelability varies from 55-75%. The boil-off loss is 20-25%. The silk recovery is 25-40%.

Pupa: The pupa is light metallic in colour (Fig. 6). The length of the pupa varies from 2.5-3.5 cm in male and 3.5-4.5 cm in female. The breadth varies from 1.2-1.8 cm in male and 1.5-2.8 cm in female. The pupal weight varies from 3.05 - 5.2 g in male and 5.5-8.2 g in female respectively.

Moth: There are variations in the colour of both male and female moths. Males are reddish dark brown while the females are reddish brown in colour (Fig. 7a,b). The body length of the moth varies from 2.5-3.4 cm. The wing span varies from 12-13.5 cm in male and 11 -13.5 cm in female. The fore wing area of the male moth is 1370-1400 mm² and the hind wing area is 1015-1040 mm², while in the female it range from 1470-1510 mm² and 1030-1085 mm². The eye spot in both forewings and hind wings of both the sexes is very distinct and is round to oval with a large transparent round to elliptical fenestra. The ground colour of the male moth is reddish dark brown and that of female is reddish brown. The lateral line over the wings is almost black colour in male and that of female is black flanked by whitish line in both sides. The male moth can be distinguished from the female moth by the prominent antennae, smaller abdomen and shape and colour of the wing.

Comparative Rearing performance of the Wild silk moth and the Semi-domestic moth:

Seasonal influence on rearing performances have been observed in fecundity, hatching percentage, weight of male and female matured larvae, ERR%, cocoon weight, Shell weight and Shell ratio percentage in both wild silk moth and the Semi-domestic silk moth races in *ex-situ* condition as presented in table 1(A) and 1(B).

Fecundity: The average fecundity ranged from 132 -147 in wild race and from 130 to 150 in semidomestic race throughout different rearing seasons. Significantly highest fecundity was recorded during "Baishaki" crop i.e. April-May and July-August, while, there was no significant difference in realized fecundity during May-June, September-October and October-November in wild race ($p > 0.05$). In semidomestic race, significantly higher fecundity was observed during April-May and July-August ($p > 0.05$) but no significant differences was

observed in other seasons ($p > 0.05$). However, no significant difference was observed in the fecundity of wild and semi-domestic races throughout different rearing seasons.

Hatching: The hatching percentage ranged from 60.08% to 80.62% in wild and from 70% to 78.8% in semi-domestic race throughout different rearing seasons. The hatching percentage of wild race was significantly higher during April-May crop than the other seasons ($p < 0.05$). Significant differences in hatching percentage were not observed in other crops in wild as reflected in table-1(A). In semi-domestic stock, there was no significant difference of hatching percentage in all the rearing seasons ($p > 0.05$). No significant difference was observed in the hatching percentage between the wild and semi-domestic races throughout the different rearing seasons.

Larval weight: The male larval weight ranged from 6.74g to 7.96g in wild race whereas in the semidomestic race it ranged from 4.92g to 6.02g. Female larval weight in wild ranged from 8.96g to 11.16g and in semidomestic it ranged from 8.66g to 9.42g during different seasons. In male and female larval weight significant differences were observed in wild and semi-domestic races during different rearing seasons ($p < 0.05$).

ERR%: The ERR% of wild race ranged from 12.54 to 48.50 with the highest value during Kotia (October-November), while in semi-domestic stock it ranged from 14.48 to 60.12 with the highest value during Baisakhi (April-May). No significant difference was observed in the ERR% between the wild and semi-domestic races during different rearing seasons ($p > 0.05$).

Cocoon weight: The cocoon weight ranged from 5.86g to 7.24g in wild whereas it ranged from 5.42 g to 6.84 g in semidomestic race throughout all rearing seasons. However, there was no any significant difference of cocoon weight between the wild and semi-domestic races during different rearing seasons ($p < 0.05$).

Cocoon Shell weight: The cocoon shell weight ranged from 1.32g to 1.51g in wild race without any significant variations during the different seasons ($p > 0.05$). In semi-domestic race the shell weight ranged from 0.39g to 0.49g without any significant variations during the different seasons ($p < 0.05$). Highly significant difference was observed in the shell weight between the wild and semi-domestic races throughout different rearing seasons ($p < 0.05$).

Cocoon Shell ratio(SR%): Significantly higher SR% in wild race was recorded during Sept-Oct crop ($p < 0.05$) but no significant differences was observed in other seasons. In semi-domestic race, the SR% was significantly higher during September-October and October-November crop ($p < 0.05$). In this character, highly significant difference was observed between wild and semidomestic races during different rearing seasons ($p < 0.05$).

The wild silk moths play an important role in the conservation and utilization of biodiversity (Frankel, 1982; Peigler, 1993). The conservation links genetic diversity to utilization, protecting diverse gene pool, habitat or ecosystem for human socio-economic needs (Metzler & Zebold, 1995). The ecorace conservation is must for utilizing their valuable genes in enhancing productivity and to build variation in new population through hybridization (Mirhoseini et al., 2004; Kumaresan et al., 2004). The studies carried out in the silkworm have shown that the characters could be pooled to suit the breeder's choice since selection for one trait has a correlation with genetic changes for other traits (Gamo, 1976; Tazima, 1984). The stability of the characters like cocoon weight and cocoon shell ratio of the muga silkworm shows that the expression of these characters are more of genetic nature and the genes controlling these characters can be introgressed

from the wild variety to the semi domestic variety through suitable breeding method. Siddiqui & Das, (1998) have reported the high heritability of the traits-cocoon shell weight, single cocoon filament length, weight of reeled silk, reelability, reelability ratio, denier and weight of waste silk in muga silkworm.

Biodiversity conservation is increasingly recognized as a fundamental component of sustainable development of natural resources by protecting and using biological resources in the ways that do not diminish the world's variety of genes and species or destroy important habitat or ecosystem. The wild muga silk moth constitutes a significant component of wild silk moth genetic diversity that cannot be ignored in the assessment of quantitative and qualitative characters, conservation and utilization of silk moth biodiversity. The stability of the different rearing parameters in all generations of the wild race showed that it can be successfully conserved in ex-situ condition in climatic condition of Lahdoigarh (India). The present study showed that this wild muga silkworm can be effectively utilized for commercial muga silk production and in the breeding for introgression of the genes controlling the shell weight.

LITERATURE CITED

- Baruah, B., Duarah, D. & Chakraborty, D.** 2000. Performance of wild silkmoths. International Journal of Wild Silkmoths & Silk, 5: 376-378.
- Choudhury, S. N.** 1970. Muga Silk Industry, Directorate of Sericulture, Govt. of Assam.
- Crotch, W. J. B.** 1956. A silkworm rearers handbook. Amat. Entomol. Soc., 12: 165 pp.
- Das, P. K., Sahu, A. K. & Babulal** 2000. Management of muga silkworm and germplasm. In proceeding of workshop on Management of sericulture Germplasm for posterity, held at Central Sericulture Research centre Hosure, p.133-139.
- Frankel, O. H.** 1982. Can genetic diversity survive? Advances in Cytogenetics and Plant improvement. Kalyani publication, New Delhi.
- Gamo, T.** 1976. Recent concepts and trends in Silkworm breeding. Farming Japan, 10: 11-12.
- Jolly, M. S., Sonwalkar, T., Sen, S. K. & Prasad, G. K.** 1976. Non-mulberry silks. Sericultural Manual, FAO, United Nations, Rome.
- Kuang-Ming, C. C. & Ta-Yuan, C.** 1958. The tasar silkworm. Journal of Silkworm, XI: 111-125.
- Kumaresan, P., Sinha, R. K., Mohan, B. & Thangavelu, K.** 2004. Conservation of multivoltine silkworm (*Bombyx mori* L.) Germplasm in India – an overview. International Journal of Industrial Entomology, 9 (1): 1-13.
- Metzler, E. H. & Zebold, R. A.** 1995. Twenty eight species of moths new to Ohio from Huffman prairie, Green County (Lepidoptera). Ohio Journal of Sci., 95: 240-242.
- Mirhoseini, S. Z., Seydavi, A. R., Ghanipoor, M. & Etebari, K.** 2004. General and special combining ability estimation and heterosis in new varieties of silkworm *Bombyx mori*. Journal of Biological Sci., 4: 725-730.
- Nagaraju, J. & Jolly, M. S.** 1986. Interspecific hybrids of *Antheraea roylei* and *A. pernyi*- a cytogenetic reassessment. Theor. Appl. Genet., 72: 269-273.
- Peigler, R. S.** 1993. Wild silkmoths of the World. American Entomologist, 39: 51-160.
- Seitz, Z. A.** 1933. The Macrolepidoptera of the world. Palearctic fauna. Stuttgart Alfred Kernel. 10: 509-516.
- Shimada, T. & Kobayashi, M.** 1992. Fertility of F1 hybrids between *Antheraea yamamai* (Guerin-Meneville) and *Antheraea pernyi* (Guerin-Meneville). Wild Silkworm, pp. 186-195.

Siddiqui, A. A. & Das P. K. 1998. Genetic variation and correlation studies for technological traits in *Antheraea assama*: endemic species of North East India. Proc. Third Int. Conf. on Wild Silkmths. 145-147.

Singh, K. C. & Singh, N. I. 1998. Biology and ecology of temperate tasar silkmths, *Antheraea proylei* Jolly and *Antheraea pernyi* Guerin-Meneville (Saturniidae) – A review. Indian Journal of Sericulture, 37 (2): 89-100.

Singh, N. I., Singh, N. I., Keisa, T. J., Singh, Y. R. & Singh, K. C. 2000. Conservation and utilization of Indian oak fed *Antheraea* fauna. International Journal of Wild Silkmths & Silk, 5: 330-331.

Singh, N. I., Singh, L. S. & Singh, K. C. 2011a. Characterization and evaluation of oak tasar silkworm genetic resources in India. Sericologia, 51 (1): 1-12.

Singh, N. I., Debaraj, Y., Singh, L. S. & Singh, K. C. 2011b. Bioecological Studies of an oak Tasar Silkmth, *Antheraea frithi* Moore in North East India. Uttar Pradesh Journal of Zoology. Uttar Pradesh J. Zool., 31 (1): 75-81.

Singh, N. I. & Debaraj, Y. 2011b. Bionomics of Indian oak tasar silkmth, *Antheraea roylei* Moore and its potential for breeding in India. Mun. Ent. Zool., 6 (2): 987-994.

Singh, R. N. & Maheswari, M. 2003. Conservation and utilization of sericigenous insects in North East Region of India. Sericologia, 43: 1-15.

Tazima, Y. 1984. Silkworm moths; In *Evolution of domesticated Animals*. Mason, I.L. (eds), Longman, London and New York, pp. 416-424.

Thangavelu, K. 1991. Recent studies in tasar and other wild silkmths. Wild Silkmth, pp. 20-29.

Table 1(A). Pre-Cocoon characters of wild and semidomestic (s/d) races of muga silkworm.

Crops	Fecundity		Hatching		Mature Larval wt. (g)				ERR%	
	Wild	Semi Domestic (S/d)	Wild	S/d	male		female		Wild	S/d
					wild	S/d	wild	S/d		
April-May	147*	150**	80.62**	73.8	7.96	6.02*	11.16*	9.42	12.54	60.12*
May-June	136	138	60.28	72.2	7.54	5.32	10.02	8.82	44.39*	38.48
July-Aug	143*	144**	63	70	7.88	6.00	9.84	9.08	29.80	14.48
Sept-Oct	132	132	62.42	71.2	6.74	5.94	8.96	8.72	20.73	34.44
Oct.-Nov.	135	130	60.08	78.8*	7.14	4.92	10.78	8.66	48.50	37.04
CD 5%	8.27	10.94	11.62	45.94	0.68	0.66	1.14	0.42	20.47	21.73
CD 1%	11.39	15.06	16.00	6.33	0.93	0.91	1.58	0.57	28.20	29.93

* significant at 5%, ** significant at 1%

Table 1(B). Cocoon characters of wild and semidomestic (s/d) races of muga silkworm.

Crops	Cocoon wt(g)		Shell wt(g)		Shell ratio(%)	
	Wild	s/d	Wild	s/d	Wild	s/d
April-May	7.24	6.2	1.32	0.41	18.23	6.61
May-June	6.36	6.84	1.35	0.48	21.22	7.02
July-Aug	6.08	5.46	1.32	0.39	21.71	7.14
Sept-Oct	5.86	5.42	1.51	0.49	25.77	9.04
Oct.-Nov	6.08	6.12	1.32	0.49	21.71	8.01
CD 5%	0.72	0.79	0.36	0.07	3.01	0.78
CD 1%	0.99	0.09	0.50	0.09	4.15	1.08

* significant at 5%, ** significant at 1%

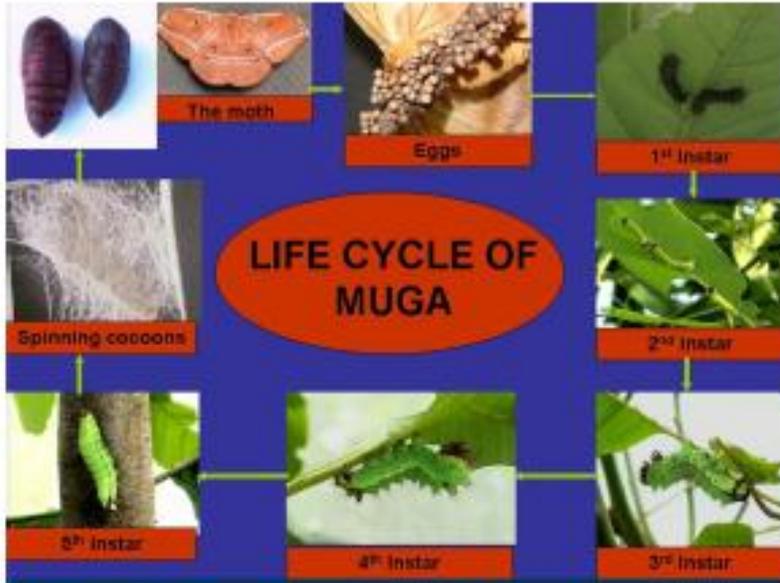


Fig. 1- Life Cycle of muga silkworm.



Fig. 2-Egg



Fig. 3-A Larva



Fig. 3-B Larva



Fig. 3-C Larva



Fig. 3-D Larva



Fig. 4-Cocoon on Tree



Fig. 5-Cocoon



Fig. 6-Pupa



Fig. 7-Male Moth



Fig. 8-Female Moth