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Impact of Natural and Mechanical Mating on Fecundity and Egg Retention in Muga Silkworm, *Antheraea assamensis* (Lepidoptera: Saturniidae)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Lepidopteran muga silkworm *Antheraea assamensis* belonging to Saturnidae is an economically important insect geographically endemic to Assam and the northeastern region of India. Like any other insect species, oviposition is one of the most vital aspects of *A. assamensis* as it allocates the majority of its energy during its lifecycle. Muga silkworm seed production technology has still not been studied much in detail. The demand for silkworm seeds rises during the commercial rearing season in the region, Central Silk Board has established seed production centres to cater for the demand of the sericulture industry. The number of seed cocoons processed for commercial seed

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production is 1.5-2.5 lakhs per annum. Muga silkworm emergence pattern is asynchronous, no. of male and female moths is not equal during operations. *A. assamensis* is nocturnal in habit, and emergence and coupling take place at night. Due to the asynchronous pattern of emergence, it is quite often that female moths run out of mates in the seed production centres. Due to the depleting number of potential male mates, the mating will be done mechanically by putting male female moths in a bamboo box to save the time and energy of silk moths. So, an experiment was conducted to study the difference in fecundity between naturally mated and mechanically mated muga silkworms and its impact on mating duration at Silkworm Seed Production Centre, Kaliabari, Boko, Assam during commercial crop (April-May & Oct-Nov) of 2023. The results of the study showed that maximum fecundity was observed in silkworms which are naturally mated with 214±12.08 eggs per female. Whereas, the mechanically mated muga silkworm females showed slightly less fecundity compared to naturally mated females with 203.2±12.77 eggs per female. The results on egg retention showed a clear difference with 18.6±4.77 and 16.6±8.64 eggs per female in natural and mechanical mating, respectively. The slightest reduction in fecundity and increased egg retention in female moths might be due to the impact of mechanical mating on mating duration which reported only 5.5±1.29 hrs, whereas natural mating facilitated a higher mating duration with 8.2±1.30hrs, respectively. This study showed the significance of mating type (natural and mechanical) and its impact on fecundity and egg retention of muga silkworm.

Keywords: Mechanical mating; natural mating muga silkworm; fecundity; oviposition; egg retention.

1. INTRODUCTION

Muga silk is known for its natural shimmering golden color and is pride of Assam. The silk is produced by the silkworm *Antheraea assamensis*, whose production is exclusively confined to Brahmaputra valley of Assam and its neighboring states. The silkworm is semidomesticated and multivoltine in nature, with 5 to 6 generations in a year. The quality of silkworm seed is vital for a viable sericulture industry and refers to the richness of egg laying, viability, uniform hatching and subsequently good rearing performance of the progeny. The quality of silkworm seed may be defined as to the one where the layings are entirely free from diseases, has more numbers of viable eggs, gives uniform hatching and assures a stable crop of muga silkworm, (*Antheraea assamensis* Helfer). During summer the temperature raises up to 35˚ to 38˚C with fluctuation of temperature and humidity proportionately interfere in the muga seed production for commercial crop, and leads to emergence of crippled moths, poor coupling and egg laying capacity, increased number of unfertilized eggs, poor embryonic development, desiccation of eggs and hatching failure [1]. Timely supply of adequate quantity of good quality disease free eggs to the farmers is crucial for successful harvest of commercial crops. Since egg production of the silkworm is managed by seed producers, various processes, such as, procuring the quality cocoons, emergence of moth, mating, egg laying, preservation and hatching of eggs are all important from of the point of maximizing viable egg production [2,3,4,5,6,7,8,9]. 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 [10,11,12,13]. In the natural condition the male moth fly's 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. Mating type and duration plays a decisive factor that not only influences the total number of eggs but also plays a crucial role in inducing regular oviposition. It has been reported that mating duration has a significant impact on fecundity and fertility of silk moths [9,14,15,16]. The present investigation is undertaken with the aim of finding out the effect of natural and mechanical mating on mating durations, fecundity and egg retention of muga silkworm.

2. MATERIALS AND METHODS

The present study was conducted at SSPC, Kaliabari, MESSO, Boko, Assam during April-May and October-December, 2023. Seed cocoons of Muga silkworm collected were preserved in well ventilated wire mesh cocoon storage cages at normal room temperature till moth emergence following Thangavelu et al. [17] and Sarkar et al [1]. The freshly emerged male

and female moths were allowed to couple naturally and mechanically (see Plate.2) in the cocoon preservation cages. The grainage experiment was conducted with preservation of 1000 nos. of seed cocoon with equal number of male and female cocoons in one control and treated lot. The coupled moths were tied to oviposition device (*kharika*) made up for the study by binding the female moth with the help of cotton thread (see Plate.1). The data on different parameters such as moth emergence pattern, percentage of healthy and invalid moth emergence, potential fecundity, realized fecundity; fertilized eggs, unfertilized eggs and hatching percentage in each treatment and controlled lots were recorded. Emerged male and female moths were paired in the moth cage (Plate1). After completion of 8 h pairing in case of natural coupling and minimum 6 h in case of mechanical coupling, gravid female moths were tied in *kharika* for egg laying and fecundity with hatching percentage were recorded to study the suitability of different lots. After decoupling, the individual female moths are kept for egg laying in dark condition at 25 ±2˚C and 75+5 % R.H. Eggs are collected after 72 hr of oviposition. Observations pertaining to oviposition rate, retention rate and mating period were recorded.

Plate 1. Showing females tied to *Kharika* with the help of cotton thread

Plate 2. Showing procedure of mechanical mating in Muga silkworm couples

3. RESULTS AND DISCUSSION

The results showed that, maximum mean fecundity (214±12.08) was observed in naturally coupled moths whereas fecundity was slightly lower (203.2±12.77) in mechanically coupled moths. The results on egg retention showed a clear difference with 18.6±4.77 and 16.6±8.64 eggs per female in natural and mechanical mating, respectively. The slightest reduction in fecundity and increased egg retention in female moths might be due to the impact of mechanical mating on mating duration which reported only 5.5±1.29 hrs, whereas natural mating facilitated a higher mating duration with 8.2±1.30hrs, respectively (Fig.1; Table 1). The results pertaining to mating duration were on par to the findings of Thangavelu et al [17] and Goswami and Singh [16] who also reported mating duration of 4 to 6 hours. The higher fecundity in natural mating might be due to longer mating period which supported by Barah and Sahu [18], who reported that mating duration plays a key role in fecundity. In Oct-Nov, significantly higher fecundity was observed in comparison to April-May ($p>0.05$) but no significant differences were observed in hatching during different rearing seasons. The hatching percentage ranged from 72% to 85% throughout different rearing seasons. No significant difference was observed in the hatching percentage between the natural and mechanically coupled eggs throughout the different rearing seasons. However, duration of coupling has significant effect on fertility of eggs. In case of mechanical coupling, mating/coupling period less than 5 hours had some significant effect on total fecundity. Total fecundity is much lower and egg retention in the abdomen is significantly higher than naturally coupled muga silkworms during grainage. In this study it is observed that the coupling duration ≥8 hours shown better performance in terms of total number of fecundity i.e (214±12.08).

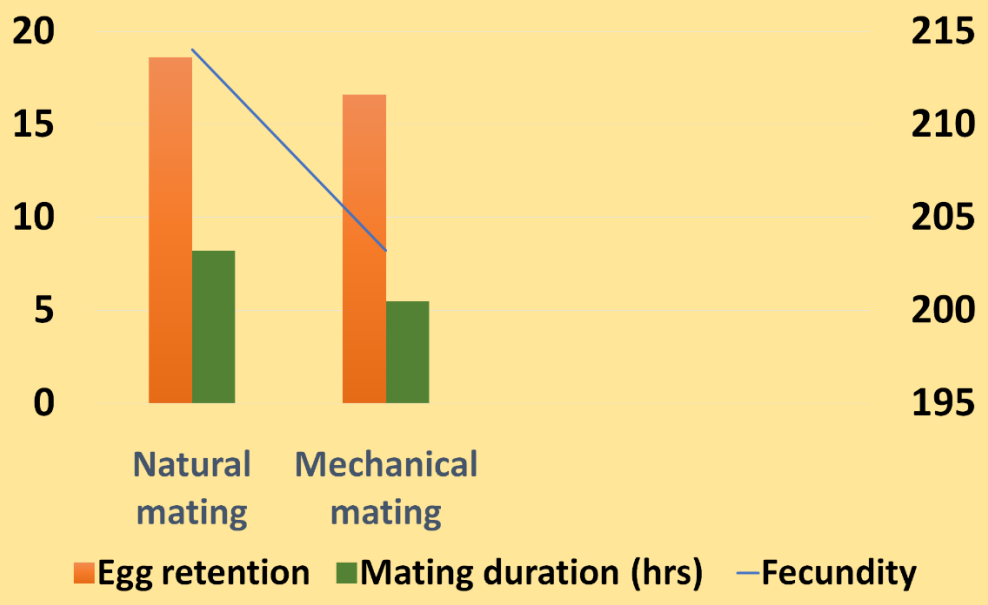

Fig.1. Graph showing egg retention, mating duration and fecundity in natural and mechanical mating

Table 1. Showing egg retention, mating duration and fecundity in natural AND mechanical mating

Natural mating			Mechanical mating		
Fecundity	**Egg Retention**	**Mating Duration (hrs)**	**Fecundity**	**Egg Retention**	**Mating Duration (hrs)**
Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
214±12.08	18.6±4.77	8.2±1.30	203.2±12.77	16.6±8.64	5.5±1.29

4. CONCLUSION

Silkmoths have a tendency to mate immediately after emergence. In *A. assamensis*, an extremely brief period of gap exists between the time of emergence of male and female and actual mating. Often required number of males for mating with the female moths are reused in grainage as female moths' emergence is often delayed by few hours. The temporal aspects of mating in terms of duration may also have impact on the number of eggs laid, pattern of egg laying and their viability. These types of relationship also have been demonstrated in several insects other than *Bombyx mori* [19-22]. Duration of coupling assumes great importance in commercial egg production. It was also noticed that 5 hours coupling is not sufficient to fertilize all the eggs in certain cases. During irregular emergence of moths, duration of coupling is automatically reduced. So here an effort is made to predict actual coupling duration without affecting the chance of fertilization of eggs [23-25]. This study also reported differences in variation in oviposition and time-limited fecundity in two different mating types which helped us to understand the importance of mating span and how it can be utilized to boost the egg production in seed production centers. These studies also pave a way for calculating the reproductive trade-offs and cost of reproductive fitness in female moths in near future.

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COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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