EFFECT OF MULTIPLE MATING ON REPRODUCTIVE RATE IN THREEPOPULAR RACES OF SILKWORM *Bombyx mori* L.

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ABSTRACT

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Economics of egg production is vital for grainages since it is a commercial preposition which necessitates recovery of maximum number of layings with high fecundity. Attempts have been made to increase reproductive rate by multiple mating in Pure Mysore (PM), a multivoltine race and Kalimpong-A (KA) and N_B4D_2, the bivoltine races of silkworm *Bombyx mori* L. The studies revealed increase in egg laying coefficient for multiple-mated moths of all three races. The possible mechanism in multiple mating which stimulates oogenesis and thereby reproductive rate is discussed.

KEY WORDS: *Bombyx mori* L. Fecundity. Multiple mating.

INTRODUCTION

In insects, oviposition is stimulated by males during copulation by some factors passing along with sperms, which influence the physiology of the female and hence enhance the reproductive rate (Engelmann, 1970). As pointed out by Benz (1969) and Pickford et al (1969), mating in insects provides a stimulus for oogenesis. Leahy and Lowe (1967) have observed that the same stimulus brings about changes in oviposition. Further, Gillot and Friedel (1977), reported a linear relationship between number of matings and fecundity. This also corroborates the findings of Davey (1967) and Gordon and Bandal (1967). The reproductive consequences of several important aspects of mating systems and nature of impetus to egg laying provided by mating seem to differ

among insects (Lawrence, 1990). However, only a few reports are available on the effects of multiple matings (Subramaniam et al, 1988) and mating duration on total egg output and hatching in insects as reported by Shahi and Krishna (1979). It is important to note that in *Bombyx mori*, 3 h of mating is found to be optimum for achieving higher fecundity as suggested by Petkov et al (1979) and also as observed by Raju (1990). However, under large-scale egg production, a sizeable number of eggs are retained in the abdomen resulting in lower fecundity, in turn affecting the sericulturists in terms of larvae brushed and ultimately the average yield for 100 Dfls. In the present investigation, an attempt has been made to increase fecundity and to decrease the egg retention among popular races of *Bombyx mori*.

MATERIALS AND METHODS

The present experiment was undertaken utilizing Pure Mysore (PM), a multivoltine race; and Kalimpong-A (KA) and NB_4D_2, two bivoltine races. They were maintained in the laboratory provided with temperature desirable for specific development stages (24-28°C) and a humidity range of 75-90%. The batches with higher pupation rate and cocoons of either sex were selected to study the reproductive rate in all the races.

Male and female moths of three replicates for each of the races were categorized into six treatment groups: three for single mating comprising 3, 4 and 5 h; and the other three for multiple mating of 1.5 + 1.5, 2 + 2 and 2.5 + 2.5 h duration. In multiple mating, newly emerged female moths once mated for specific duration were decoupled and remated with another set of newly emerged males for the same duration. After 4-8 h of oviposition, the moths of different treatments were dissected to record the number of eggs retained in the abdomen to calculate egg-laying coefficient and egg retention percentage. The eggs of different treatments of the three races were incubated under standard conditions and allowed to hatch to calculate hatching percentage. Egg laying coefficient and egg retention percentage were calculated using the following formulae:

$$\text{Egg laying coefficient} = \frac{\text{Number of eggs laid}\cdot\cdot}{\text{Total number of eggs present}} \times 100$$

$$\text{Egg retention percentage} = \frac{\text{Number of eggs retained}}{\text{Total number of eggs present}} \times 100$$

The pooled data were analyzed statistically through a three-way classification.

RESULTS AND DISCUSSION

The mean values of fecundity, number of eggs retained, sum total of eggs, egg laying coefficient, egg retention percentage and hatching percentage in PM, KA and NB_4D_2 are presented in Table 1. The ANOVA for the above observations are in Table 2.

There was marginal increase in fecundity between single mating and multiple mating in PM and KA. However, with respect to NB_4D_2, there was a significant increase in fecundity in multiple-mated moths. The number of eggs retained in the moth was found to decrease significantly in multiple-mated moths in all the three races compared to single-mated moths. As regards egg laying coefficient, there was improvement in all the races by multiple mating. Consequently, the egg retention percentage was found to decrease in multiple-mated batches of all the races. However, there was no significant difference in hatching percentage between single and multiple mating.

Mating duration both for single (3, 4 and 5 h) and multiple (1.5+1.5, 2+2 and 2.5+2.5 h) mating did not reveal any significant difference between the races under study.

The eggs of *Bombyx mori* generate interest since scientific studies are of immense value from both embryological as well as practical viewpoints. In terms of experimental designs, silkworm eggs have several advantages since the number of eggs laid by a moth ranges from 400 to 600 and oviposition invariably occurs during late evening and within 4-8 h, 80% of the eggs are laid. The quality of silkworm egg is the backbone of the silk industry, and accordingly, in advanced countries like China and Japan, there is a well-knit seed production program. In India, such activities are programmed during peak sericulture seasons when there is a deficit in seed production and also at times when the quality falls below the standards. In

Table 1. Effect of single and multiple mating on Pure Mysore (PM), Kalimpong-A (KA) and NB_4D_2 races of silkworm *Bombyx mori* L.

Race	Treatment	Pairing duration (h)	Fecundity (A)	No. of eggs retained in moth (B)	Total no. of eggs (A+B)	Egg laying co-eff.	Egg retention (%)	Hatching (%)
PM	Single mating	3	483.0	55.0	538.0	89.77	10.20	91.31
		4	467.0	53.5	520.5	89.72	10.27	92.01
		5	496.5	61.0	557.5	89.05	10.94	93.27
	Multiple mating	1.5+1.5	460.5	43.0	503.5	91.45	8.54	94.99
		2+2	459.5	44.5	504.0	91.17	8.82	94.34
		2.5+2.5	475.5	24.0	499.5	95.19	4.80	90.79
KA	Single mating	3	467.5	121.0	588.5	79.43	20.56	84.71
		4	485.5	120.0	605.5	80.18	19.81	87.49
		5	451.5	146.8	597.5	75.55	24.43	88.86
	Multiple mating	1.5+1.5	414.5	93.0	507.5	81.67	18.32	88.99
		2+2	419.5	75.5	495.0	84.74	15.25	86.87
		2.5+2.5	387.5	44.0	431.5	89.80	10.19	95.86
NB_4D_2	Single mating	3	542.0	71.5	613.5	88.34	11.65	99.25
		4	501.5	113.5	615.5	81.47	18.45	86.52
		5	523.0	76.0	599.0	87.31	12.68	98.51
	Multiple mating	1.5+1.5	565.0	42.5	607.5	93.00	6.99	96.72
		2+2	588.5	34.0	622.5	94.53	5.46	95.85
		2.5+2.5	618.5	45.5	664.0	93.14	6.85	98.81

Table 2. Analysis of Variance (ANOVA) on the effect of single and multiple mating on Pure Mysore (PM), Kalimpong-A (KA) and NB_4D_2 races of silkworm *Bombyx mori* L.

Source of Variation	df	Mean of squares					
		Fecundity	No. of eggs retained in the moth	Total no. of eggs	Egg laying coefficiency	Egg retention (%)	Hatching (%)
Races (A)	2	4541.86**	8817.69**	32893.41**	322.04**	274.44**	476.75ns
Single and multiple pairing (B)	1	90.25ns	15334.69**	20976.16**	376.19**	314.56**	8.43ns
Pairing duration (C)	2	92.11ns	170.86ns	153.18ns	10.77ns	5.31ns	43.91ns
A vs B	2	12921.75**	1188.52ns	17211.04**	23.81ns	19.21ns	68.53ns
A vs C	4	1120.02ns	176.31ns	1617.48ns	3.02ns	6.40ns	27.08ns
Error	18	1713.63	347.97	1873.61	12.21	9.04	159.01
C.D. at 5%							
Races (A)		35.50	16.00	37.12	3.04	2.01	10.81
Single and multiple pairing (B)		28.99	13.06	30.04	2.41	2.45	8.83
Pairing duration (C)		35.50	16.00	37.97	3.07	2.69	10.81
A vs B		50.21	22.62	52.16	4.24	3.71	15.29
A vs C		61.49	27.71	64.56	5.25	4.56	18.73

** P<0.01

Karnataka, the major silk-producing state in the country, out of approximately 150 crores of bivoltine cocoons produced, only 47 are utilized for seed purpose, mainly as the male parent in the preparation of cross breed layings, out of which nearly 23-24 crores of cocoons are females; 25% of these females are used for the production of either the bivoltine hybrid or the pure layings, while the rest (17-18 crores) of the cocoons are preserved to be discarded upon emergence (Rajendra and Raju, 1994). Further, the average number of eggs per laying realized in the field for either multivoltine x bivoltine and bivoltine x bivoltine hybrids ranges around 450-500. Any attempt to improve the seed quantity and quality will be an advantage in the overall improvement of silk yield.

The present studies have clearly revealed that by multiple mating, all the three races under evaluation (PM, KA and NB_4D_2) have shown significant increase in the egg laying coefficient and has contributed for lower values of egg retention percentage. With regard to fecundity, NB_4D_2 registered higher values in multiple-mated moths over single-mated moths for all the three different durations of mating. The possible reason for higher fecundity in NB_4D_2 is the contribution of sperm and fecundity-enhancing substance in the female reproductive tract (Engelmann, 1970). Further, multiple mating ensures the availability of sperm and other fecundity-enhancing substances (Gillot and Friedel, 1977). It is evident that the secretion of male accessory gland plays an important role in enhancing fecundity as mated females lay more eggs than virgins. However, it is interesting to note that in the present studies, twice-mated moths have laid more number of eggs compared to the moths mated once, confirming the results of Ravikumar et al (1995).

Repeated matings have been shown to increase fecundity in a number of insects. As observed by Thomas Punithan et al (1987), mating duration up to 6 h in *Bombyx mori* increased total egg output.

Multiple mating, although advantageous, needs skillful management by graineurs to ensure effective achievement of rich layings particularly in the preparation of industrial seed for commercial exploitation.

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