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EFFECT OF SEASONAL TEMPERATURE AND HUMIDITY ON OVULATION, FECUNDITY AND RETENTION OF EGGS IN SILKMOTH, *BOMBYX MORI* (L.) [LEPIDOPTERA : BOMBYCIDAE].

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INTRODUCTION

Studies on reproductive biology in silkmoth, *Bombyx mori* (L.) have shown that temperature and relative humidity, prevailing at the time of rearing, play an important role in egg production and oviposition (Tikkoo *et al.*, 1975 ; Tazima, 1978 ; Rahman *et al.*, 1980). In the tropical plains of West Bengal, there is a high degree of fluctuation in temperature and relative humidity throughout the year. During the period from March to June, temperature is comparatively higher with lower humidity and from June to September, both these parameters are on higher side. Therefore, the silkworm cocoon crops, obtained during the period from April to September, are comparatively poorer, when the season is unfavourable. The other half of the year from October to March, when both the average temperature and relative humidity are comparatively lower, these grow richer, and the season is called favourable (Krishnaswami *et al.*, 1971).

It is observed in *Bombyx mori* that all the eggs produced in the ovary ate not oviposited, but some are retained. Therefore, studies have been launched to find out the effect of seasonal temperature and relative humidity on ovulation, fecundity and retention of eggs and their interdependance in multivoltine silkmoth, *Bombyx mori* (race *nistari*). The results of the study are discussed under two broad seasons, viz., unfavourable season (March-September) and favourable season (October-February).

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Materials and methods

The indigenous multivoltine silkworm race nistari of *Bombyx mori* (L.), from West Bengal which is generally reared during the four commercial seasons, viz., Jaistha (May), Bhaduri (August-September), Agrahayani (November) and Chaitra (February), was selected as an experimental material. Larvae were reared in mass under the room conditions. On completion of spinning, cocoons were taken at random on the 5th day of pupation from the mass lot. After cutting the cocoons, 30 each of female and male pupae of approximate weight (0·9 g. ±0·05 g.) were selected on the 5th day of pupation for the experiment. The 5th day pupae were selected, because their weight at this stage is less influenced by moisture content than that of the fresh pupae (Drooz, 1665). Pupae and moths were maintained under room conditions. On emerangence, mating of male and female moths were allowed to lay eggs for 24 hours on egg cards bearing serial number (1-30). Each female was then dissected to find out the number of retained eggs in the ovarioles ; the number of eggs laid were also counted individually. Prevailing data of room temperature and relative humidity were recorded four times a day (6 A.M. 10 A.M., 4 P.M. and 9 P.M.) with the help of a dry and wet bulb zeal thermometer from rearing to oviposition. Average data of dry temperature and relative humidity were noted and their mean seasonal readings are presented in Table 1 and 2.

Results and discussion

(A) **Unfavourable Season** (March-September) :

Analysis of the data presented in Table 1 and 3 has revealed that ovulation, fecundity and retention percent of eggs showed significant differences in the seasonal mean readings, as discussed below.

(i) *Ovulation* : The rate of egg production during the seasons of August-September and March-April differed significantly from that during May-July. Number of eggs produced in the ovary was recorded maximum (292) during August-September, when the average temperature was high (27·65°C ± 0·157°C) with high relative humidity (89·99% ± 0·434%). It decreased insignificantly during March-April, when temperature was comparativly higher (29.49°C ± 0·249°C) with lower relative humidity (55·95% ± 1·58%). Production of eggs in the ovary was found minimum (283-293) during May-July when

TABLE : 1

Mean Ovulation, Fecundity and Retention Percent in *Bombyx mori* (Race-Nistari) with Temperature and Humidity during Unfavourable Season.

Seasons	Ovulation (No.)	Fecundity (No.)	Retention of eggs (%)	Temperature (°C)	Humidity (%)
March-April, 1984	386	376	2·47	29·49±0·429	55·95±1 581
May-June, 1984	283	275	2·81	29·81±0·392	80·26±1·209
June-July, 1984	293	281	3·85	28·33±0·216	90·10±0·320
Aug.-Sept., 1984	392	367	6·51	27·65±0·157	89·99±0·434
C. D. at 5%	23	23	2·71		
C. D. at 1%	30	30	3·59		

C. D. = Critical Difference.

higher temperature (28-30°C) prevailed with higher relative humidity (80-90%). This indicated that higher temparature with higher relative humidity was detrimental to production of eggs in the ovary. Ovulation was found to have positive significant ($P < 0 01$) correlation with both fecundity and retention per cent (Table-3).

(ii) *Fecundity* : The rate of oviposition during the both seasons of March-April and August-September differed significantly from that during May-July. Maximum count of fecundity (376) was recorded during March-April, when temperature was very high (29·49°C ± 0·429°C) with low relative humidity (55·95% ± 1·581%). It deecreased insignificantly (367) during August-September when temperature was comparatively low (27·65°C ± 0·157°C) with higher humidity (89·99% ± 0·434%) .The fecundity was recorded minimum (275-281) during the period from May to July when high temperature (28-30°C) was marked with higher relative humidity (80-90%). This indicated that high temperature with high relative humidity influenced egg-laying operation adversely. Fecundity was found to have positive significant ($P < 0·01$) Correlation with both ovulation and retention per cent (Table-3).

(iii) *Retention per cent of eggs* : The phenomenon during the season of August-September differed significantly from that of the period during March-July. Retention per cent of eggs was recorded (2·47%) during March-April, when the average temperature was high

(29·49°C ± 0·429°C) with low relative humidity (55.95% ± 1·581%), while it was recorded maximum (6·51%) during August-September, when the average temparature was high (27·65°C ± 0·157°C) with higher relative humidity (89·99% ± 0·434%). This indicated that high temperature with high humidity favoured high retention per cent of eggs in the ovary. Retention per cent also showed positive significance ($P<0·01$) correlation with ovulation and fecundity (Table-3).

(B) **Favourable season** (October-February) :

Analysis of data presented in Tables-2 and 3 showed significant difference amongst the seasonal mean-readings for the biological processes under study, as discussed below.

(i) *Ovulation* : The data of ovulation during the seasons of November-December and December-January differed significantly from each other and also individually from that of the seasons of October-November and January-February. However, there was no significant difference between October-November and January-February seasons. Total number of eggs produced in the ovary was recorded maximum (497) during November-December, when the temperature was 25·36°C ± 0·176°C with relative humidity 69·20% ± 1·037%. It decreased insignificantly (471) during December-January, when the temperature was comparatevely low (24·43°C ± 0·94°C) with relative humidity 70·15% ± 0·782%. However, egg production in the ovary reduced to minimum of 408 (January-February) and 415 (October-November), when the temperature and relative humidity altered from 25·36°C ± 0·176°C and 69·20% ± 1·037% (optimum) respectively. Ovulation

TABLE : 2

Mean Ovulation, Fecundity and Retention Percent in *Bombyx Mori* (Race—Nistari) with Temperature and Humidity during Favourable Season

Seasons	Ovulation (No.)	Fecundity (No.)	Retention of eggs (%)	Temperature (°C)	Humidity (%)
Oct.-Nov., 1984	415	405	2·22	26·14±0·240	73·93±1·164
Nov.-Dec., 1984	497	495	0·37	25·36±0 176	69·20±1·037
Dec.-Jan., 1984	471	464	1·49	24·43±0·194	70·15±0 782
Jan.--Feb., 1984	408	399	2·20	23·18±0·185	71·53±0 862
C. D. at 5%	23	23	N.S.		
C. D. at 1%	31	36	N.S.		

C. D. = Critical difference.

N. S. = Not Significant,

was found to have high positive significant (P<0·01) correlation with fecundity and high negative significant (P<0·01) correlation with retention percent (Table-3).

(ii) *Fecundity* : The data of this process during the season of November-December differed significantly from that of other three seasons. The same in December-January also differed significantly from that in October-November and January-February seasons. The count of fecundity was recorded maximum (495) during November-December, when the prevailing temperature was 25·36°C ± 0·176°C and relative humidity 69·20% ± 1·037%. It decreased insignificantly (464) during December-January. When the temparature was 24·43°C ± 0·194°C with relative humidity 70·15% ± 0·782%, but significantly to 405 (October-November) and to 399 (January-February), when the temperature and relative humidity varied from 25·36°C ± 0·176°C and 69·20% ± 1·037% (optimum) respectively. Fecundity exhibited high positive significant (P<0·01) correlation with ovulation and high negative significant (P<0·01) correlation with retention per cent (Table-3).

(iii) *Retention percent of eggs* : There was no significant difference amongst the different seasonal mean readings of this phenomenon. However, it was recorded maximum (2·22%) during October-November, when the temperature was high (26·14°C ±0·240°C) with comparatively high relative humidity (73·93% ± 1·64%). It decreased 2·20%) during January-February, when the temperature was low (23·18°C ± 0·185°C) with comparatively low humidity (71·53% ± 0·862%). The retention was recorded minimum (0·37%) during November-December, when the temperature was 25·36°C ± 0·176°C and relative humidity 69·20% ± 1·037% (optimum). It increased (1·49%) during December-January, when the temperature was 24·43°C ± 0·194°C and relative humidity 70·15% ± 0·782%. This indicated that slight variation in temperature and relative humidity from

TABLE : 3

Correlation among Ovulation, Fecundity and Retention Percent in *Bombyx mori* (Race—Nistari) during Unfavourable and Favourable Seasons.

	Seasons	Fecundity	Retention Percent
Ovulation	Unfavourable	0·994**	0·417**
	Favourable	1·000**	-0·951**
Fecundity	Unfavourable		0·314**
	Favourable		-0·960**

** - Significant at 1% level.

optimum level favoured higher retention per cent of eggs in the ovary. Retention percent of eggs exhibited high negative significant ($P < 0.01$) correlation with ovulation and fecundity (Table-3).

Keeping all the seasons in view in the tropical plains of the state, the phenomena of reproductive biology, viz., ovulation, fecundity and retention per cent of eggs of *Bombyx mori* were greatly influenced by both temperature and relative humidity. Wigglesworth (1972) reported that the rate of egg production varies with temperature. It is accelerated up to point and then falls rapidly. The range of temperature, at which reproduction can occur, is often much narrower than that of other normal activities of the same species. Further, if the temperature be of adaptive importance for a particular species, different aspects of life-cycle should be under the strict control of temperature-bound factor (Schnebel and Joseph, 1986). Congdon and Logan (1983) found that at high temperature (up to 31°C), fecundity decreased in Bank Grass Mites (BGM), *Oligonychus paratensis*. Nickel (1960) found that in high humid condition (85-90%) BGM, *Tetranychus desertorum* Banks laid fewer eggs. Boyne and Hain (1983) also noted a similar relationship with *Oligonychus ununguis*. Boudreaux (1958) reported that four *Tetranychus sps.* laid more eggs at a faster rate in dry condition (<35% R. H.)

Data presented in Tables 1-3 reveal only one factor alone, i. e., temperature or relative humidity was not responsible for increasing/decreasing ovulation, fecundity and retention of eggs, but indicated that it was a combined effect of temperature and relative humidity.

Considering all the seasons of unfavourable and favourable period in view, it indicated that temperature at 25·36°C ± 0·176°C with relative humidity 69·20% ± 1·037% was found optimum (November-December) for maximum production of eggs in the ovary (495), and minimum retention of eggs (0·37%). Any increase or decrease in temperature and relative humidity from the optimum level increased retention of eggs or decreased egg production and fecundity respectively. Fecundity was found to have high positive significant ($P < 0.01$) correlation with ovulation irrespective of seasons. However, with retention per cent of eggs, it exhibited positive significant ($P < 0.01$) correlation during unfavourable season and highly negative significant ($P < 0.01$) correlation during favourable season (Table-3).

Stamenkovic (1985) reported that the effect o temperature plays a significant role on the fecundity of summer fruit tortix moth, *Andoxophyes orana*. Cunnington (1985) suggested that the most favourable condition for oviposition by gain mite, *Acarus siro* were 20-25°C and 80-90% relative humidity. Ouhelli and Pandey (1984) also found that 25°C temperature and 84% relative humidity were suitable for laying viable eggs in *Hyalomma lusitanicum*. The above studies indicate that an inter-relationship might exist between temperature and relative humidity affecting oviposition. Keeping seasonal conditions in view, above findings corroborate our results that about 25°C temperature and 70% relative humidity is most favourable for maximum egg production and oviposition with minimum retention in multivoltine silkmoth, *Bombyx mori* (race-nistari).

The results reported are useful for predicting silkworm seed production as a function of seasonal temperature and relative humidity in the tropical plains. This is an important aspect of efforts to determine their impect on silkworm rearing and silk yield, because it allows one to determine the degrees of seasonal synchrony with potential egg production.

SUMMARY

In the tropical plains of West Bengal, there is a high degree of fluctuation in temperature and humidity throughout the year. With this, ovulation, fecundity and retention of eggs in mulivoltine silkmoth, *Bombyx mori* (L.) [race nistari] vary in different seasons. Maximum ovulation and fecundity with minimum retention of eggs was recorded in November-December, 1984 when the temperature was 25·36°C ± 0·17°C and relative humidity 69·20% ± 1·03 (optimum). Any fluctuation of temperature and humidity from the optimum level decreased ovulation and fecundity and increased retention of eggs. All these phenomena together with their possible interactions during favourable (October-February) and unfavourable (March-September) season have been discussed.

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