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Moth longevity of multivoltine genotypes of silkworm, *Bombyx mori* L

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Abstract
In silkworm, the total life span from egg to adult moth death varies from one voltinistic group to another as it is a genetically controlled biological phenomenon. In the present study, adult moth longevity of eighty-one multivoltine genotypes of silkworm, *Bombyx mori* conserved in the silkworm Gene Bank of CSGRC was utilized as material. Adult moth longevity of virgin and mated female and male was calculated by following standard procedure. The longevity and survival curve proved to be characteristic for each of the genotypes. The average moth longevity for the females was 8.81 (virgin) and 7.73 days (mated) and it was 7.65 (virgin) and 6.86 days (mated) in males. It is clear from the present findings that there is sexual difference in the silkworm *Bombyx mori* for adult moth longevity. The importance of moth longevity as an index of breeding is discussed and it is proposed that the heterogametic sex (XY as female) have shown longer duration of survival than the homogametic sex (XX as in male). Also, the variations in moth longevity observed are may be because of the racial identity.

Keywords: Moth longevity, biological, multivoltine, racial, inheritance, genotypes.

Introduction

Indian Sericulture is mostly multivoltine oriented and more than 87% of the mulberry silk produced is of multibivoltine origin and the rest being bivoltine (Anonymous, 1997) [1]. It is estimated that more than 3,500 silkworm strains are available all over the world due to various ongoing silkworm breeding programs (Nagaraju, 2002) [9]. These silkworm varieties include univoltine, bivoltine and multivoltine. Univoltines and bivoltines are qualitatively and quantitatively superior breeds whereas multivoltines are relatively inferior in both the traits but superior in their survival and hardiness. But in tropical countries like India, multivoltine silkworm breeds play important role in the production of silk, since they are well accustomed to the tropical climatic conditions. Hence, maintenance and evaluation of multivoltine silkworm genetic resources has become very important for meeting the desired objectives of the breeders for immediate or long-term utilization as resources in silkworm breeding studies.

Growth, aging and death, being the sequential biological events, are the characteristic features of bisexual organism. Prior to onset of spinning, the larvae consume last feed and insect development shows the dynamic unfolding of events of larval, pupal and adult moth transformation when the cells differentiate to assume newer and more complex functions (Narayan, 1972) [10] which are termed as life span (Rockstein, 1972) [11]. The strategies and mechanism of insect aging were studied (Collatz, 1986) [3] and relevance of insect aging to senescence processes in higher bisexual organisms was highlighted.

Silkworm offers an important laboratory model to understand the mechanism of adult moth longevity because its status lies between that of microorganisms and human creature. Further, silkworm biomass, organism complexities, etc., are very conspicuous and easy to handle and analyze (Murakami, 1990) [7]. Detailed investigation on housefly and honeybee (Clark and Rockstein, 1964) [2] demonstrated that the adult longevity is known to be greatly influenced by the environment and other factors such as food, temperature, humidity, season and genotype of the individual. In the present study, an attempt has been made to study the moth longevity of multivoltine silkworm breeds to understand its relevance in silkworm breeding.

Materials and Methods

Eighty-one multivoltine genetic resources (indigenous and exotic) of different geographical locations maintained at CSGRC, Hosur were utilized as material for the present study. The rearing performance of these multivoltine accessions were assessed during favorable spring and winter seasons of the year by conducting cellular rearings, maintained in triplicates under standard rearing conditions and by following the standard rearing techniques (Krishnaswami, 1979) [5]. The larvae were fed with V1 variety of mulberry leaves harvested from the irrigated mulberry garden maintained at CSGRC, Hosur.

Subsequent to moth emergence, 20 virgin (unmated) male and female moths from each replicate were collected and were kept on brown sheet spread in the rearing tray covered with a cellule. Observations were carried out thrice daily at 09.30 a.m., 12.30 p.m. and 04.30 p.m. The death of the adult moth was identified when moths showed no biological response to being poked by the point of a pencil. The mean adult moth longevity for each accession and sex were calculated by following the standard procedure (Murakami, 1989) [6].

Results

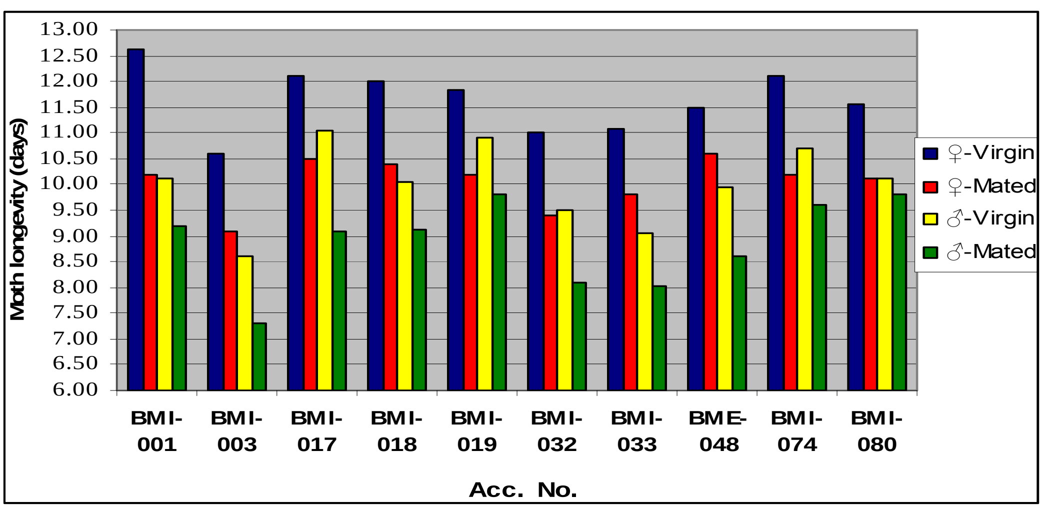
The data of the studies pertaining to the multivoltine breeds regarding the average adult moth longevity are presented in Table 1. Multivoltine breeds showing longer and shorter duration of moth longevity in respect of virgin and mated female and male moths are as in Fig. 1 and 2.

Table 1: Moth longevity in multivoltine genetic resources

(Avg. of 2 trials)

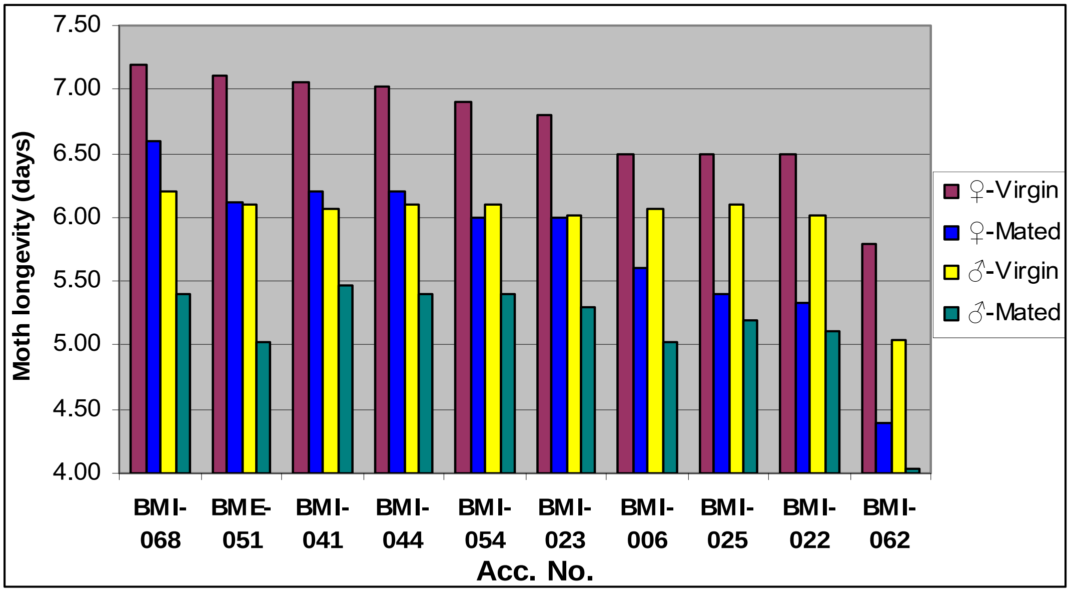
Acc. No.	Moth longevity (days)			
	Female		Male	
	Virgin	mated	Virgin	Mated
BMI-001	12.63	10.19	10.11	9.19
BMI-002	7.50	6.90	6.60	5.80
BMI-003	10.60	9.10	8.60	7.30
BMI-004	7.21	6.33	6.19	5.72
BME-005	12.03	10.01	11.19	9.81
BMI-006	6.50	5.60	6.06	5.03
BMI-007	8.81	8.10	8.21	7.60
BMI-008	8.20	7.40	7.01	6.20
BMI-009	8.60	8.03	8.20	7.40
BMI-010	8.20	7.20	7.10	6.60
BMI-011	9.11	8.20	7.60	7.01
BMI-012	7.50	6.40	6.01	5.10
BMI-013	9.20	8.10	8.03	7.20
BMI-014	10.20	9.20	9.00	8.20
BME-015	7.80	7.01	6.60	6.03
BMI-016	8.50	7.20	7.03	6.20
BMI-017	12.10	10.50	11.05	9.10
BMI-018	12.01	10.40	10.05	9.11
BMI-019	11.85	10.19	10.91	9.82
BMI-020	9.10	8.20	7.80	6.80
BMI-021	10.11	9.01	9.03	8.13
BMI-022	6.50	5.34	6.01	5.11
BMI-023	6.80	6.00	6.01	5.30
BMI-024	8.10	7.00	7.20	6.50
BMI-025	6.50	5.40	6.10	5.20
BMI-026	7.60	6.80	7.01	6.11
BMI-027	6.20	5.10	5.00	4.20
BMI-028	9.00	8.00	7.70	6.10
BMI-029	9.10	7.50	7.24	6.80
BME-030	8.11	6.80	7.00	6.10
BMI-031	9.00	7.40	8.00	6.60
BMI-032	11.00	9.40	9.50	8.10
BMI-033	11.07	9.80	9.06	8.03
BMI-034	7.80	7.01	6.10	5.60
BMI-035	7.20	6.10	6.03	5.40
BMI-036	9.07	7.40	8.10	6.80
BMI-037	9.10	8.10	8.11	7.20
BMI-038	8.05	7.20	7.07	6.40
BMI-039	7.50	6.40	6.60	6.03
BMI-040	9.50	8.60	8.01	7.20
BMI-041	7.05	6.21	6.06	5.46

Acc. No.	Moth longevity (days)			
	Female		Male	
	Virgin	mated	Virgin	Mated
BMI-042	8.10	7.20	7.05	6.20
BME-043	7.40	6.10	6.20	5.60
BMI-044	7.03	6.20	6.10	5.40
BMI-045	7.40	6.50	6.20	5.10
BMI-046	8.50	7.20	7.00	6.25
BME-047	10.40	9.20	9.10	7.60
BME-048	11.50	10.60	9.96	8.62
BME-049	10.10	8.20	8.80	7.20
BME-050	8.00	7.40	7.10	6.20
BMI-051	7.10	6.11	6.10	5.03
BMI-052	9.60	7.60	8.20	7.10
BMI-053	8.07	7.01	7.10	6.20
BMI-054	6.90	6.00	6.10	5.40
BMI-056	8.00	7.40	7.53	7.07
BMI-057	9.10	7.40	8.00	7.20
BMI-058	8.40	7.30	7.10	6.30
BMI-059	8.80	7.60	8.05	7.40
BMI-060	9.20	8.40	8.11	7.50
BMI-061	8.50	7.70	7.10	6.60
BMI-062	5.80	4.40	5.05	4.03
BMI-063	8.60	7.30	7.40	6.51
BMI-064	8.10	7.01	7.21	6.40
BMI-065	9.05	8.30	8.11	7.20
BMI-066	7.40	6.10	6.20	5.11
BMI-067	8.60	7.20	7.70	7.00
BMI-068	7.20	6.60	6.20	5.40
BMI-069	8.50	7.60	8.11	6.40
BMI-070	8.80	7.60	7.80	7.02
BMI-071	8.30	7.20	7.55	6.60
BMI-072	8.20	7.03	7.10	6.40
BMI-073	8.03	7.20	7.19	6.20
BMI-074	12.10	10.20	10.70	9.60
BMI-075	9.02	8.40	8.21	7.10
BMI-076	9.50	8.10	8.50	7.70
BMI-077	9.10	8.00	8.20	6.80
BMI-078	8.82	7.60	7.50	6.40
BMI-079	9.11	8.80	8.05	6.46
BMI-080	11.55	10.12	10.11	9.80
BMI-081	7.51	6.20	6.30	5.44
BMI-082	8.50	7.20	7.80	6.60



(Avg. of 2 trials)

Fig 1: Multivoltine breeds showing longer moth longevity



(Avg. of 2 trials)

Fig 2: Multivoltine breeds with shorter moth longevity

In the multivoltine breeds evaluated, the average adult moth longevity of females is higher than those of males. Similarly, virgin moths showed longer duration of survival than the mated ones. In virgin females, the longest adult moth longevity of 12.63 days was observed in BMI-001 followed by BMI-017, BMI-074 (12.10 days), BMI-005 (12.03 days) and 12.01 days in BMI-018 and BME-048. Similarly, the higher adult moth longevity in mated females was observed in BMI-048 (10.60 days) followed by BMI-017 (10.50 days), BMI-018 (10.40 days) and BMI-074 (10.20 days). However, average virgin male moth longevity ranged from least of 5.00days (BMI-027) to maximum of 12.63 days (BMI-001). In respect of the mated multivoltine breeds, the maximum average male moth longevity of 9.82 days was found in BMI-005 and least mean longevity of 4.20days was clearly evident in males of BMI-027. From this study data it is clear that, female moths lives longer than males and virgin female moths have maximum longevity than the mated ones. Also, variations in moth longevity observed make it easy to understand that it may be due to racial specificity.

Discussion

A developmental event observed in the adult stage of the silkworm as a laboratory model system for various experimental investigations next to Drosophila and other insects for basic and applied studies (Tazima, 1978) [13]. The desirable characters need an understanding of inheritance and their response to selection for silkworm breeding and correlation of adult moth longevity.

The rearing performance of 81 genetic resources assessed in two trials during favorable seasons of the year present the data on the adult moth longevity of multivoltine breeds of the silkworm *Bombyx mori*. The multivoltine breeds have revealed longest moth longevity in the virgin females than those of mated female and male moths. Such variations in adult moth longevity may be due to racial specificity and is in conformity with the observations of Murakami (1989, 1991) [6]. Further, the studies of Kang *et al*. (1999) [4] reveals that longevity in adult moths depends on the aboriginal races used and also correlated moth longevity with those of commercial characters of the silkworm and demonstrated that silkworm exhibits a tendency that commercial characters become better when longevity of the adult moth is longer.

The present study also clearly indicated that the virgin and mated female moths were found to live longer when compared to the virgin and mated male moths and the finding has relevance to the findings of Murakami (1989) [6] who in his studies on temperate bivoltine breeds and hybrids has showed that the virgin female moths have the highest longevity and proposed that the diet plays an important role in moth longevity and hence the bivoltine breeds / hybrids consuming maximum leaf compared to multivoltines were found to be long lasting in the adult moth stage. Further, as males are more active than females in *Bombyx mori* and hence energy consumption and metabolic rate could be the main factor for sex-wise difference in adult moth survival and this finding is in accordance with the in accordance with the observations of Murakami and Shimada (1988) [8]. It is clear from the findings of silkworm breeding studies that there are some silkworm genotypes where such correlation related to adult moth longevity is difficult to draw. As reported by Subramanya and Murakami (1994) [12] the death of moths occur quickly (3-4 days) in Diazo strain and the short adult moth longevity is due to a single recessive gene located on autosomes (Murakami, 1989) [6].

It is a known fact that, male lepidopteran insect is homogametic and female is heterogametic whereas, in dipteran insects, male is heterogametic. Thus it becomes clear that sexual difference may not be dependent on sex-chromosome constitution. But one of the reasons for the adult moth mortality in silkworm is shown to be due to brain function in each strain and sex (Murakami and Shimada, 1988) [8]. The findings of the present study may serve to extend our understanding on the knowledge of aging in insects and moths of silkworm in particular in tropics. A detailed research study utilizing many tropical silkworm breeds with regard to adult moth longevity and correlated economic parameters will become a valuable device for further silkworm breeding. The breeds with better moth longevity may become potential parents to synthesize superior hybrids that are suitable for culture under tropical climatic conditions and for better prospects of sericulture.

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