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Evaluation of morphometric traits of adult and their longevity of selected multivoltine and bivoltine breeds of mulberry silkworm, *Bombyx mori* L.

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Abstract
The present investigation has been made for the comparative evaluation of adult morphometric traits *viz.,* weight, length and breadth by utilizing two bivoltines (CSR_2 and NB_4D_2) and two multivoltines (PM and C.nichi) of mated and unmated male and female moth stage regularly after the emergence day to day changes were recorded with aging parameters and are subjected to the analysis of variance through standard statistical procedure utilizing opstat software package. The highest gravimetric weight of the female virgin moth of CSR_2 breed revealed 1.122±0.074g on the first day of emergence and the lowest weight of male mated moth of C.nichi represented 0.105±0.035g on 8th day, PM is multivoltine race showed with 0.103±0.052g on 9th day and NB_4D_2 on tenth day showed 0.118±0.006g. Among these two breeds, the magnificent distinct changes in the weight of silkmoth. On the other hand, the length and breadth of the virgin and crossed moth in the bivoltine and multivoltine silkworm breeds exhibits concurrent manifestation only in the virgin female moth and concurrently least in their length and breadth were maintained in the mated male in C. nichi with appropriate statistical analysis (F-test, SE (m), SE (D), CD at 5% and CV%). The different aboriginal silkworm were subjected to understand the fundamental features of aging and progressive development during the course of aging with the selected morphometric traits related to aging were discussed among the two bivoltine and multivoltine race/breeds of the silkworm.

Keywords: Silkworm, Longevity, Morphometic traits. Multivoltine and Bivoltine breeds.

1. Introduction
The domesticated silkworm is monophagous insect feeds only on mulberry host plant leaf for the growth, development and reproduction of the organism and important laboratory model system and is very interesting to understand its wonder mechanism of adult's lifespan phenomenon of insects, which are growes older and older to the extend finally dies due to the intricate aging process complexities and the study of aging process is overall defined as gerontology. However, the opinion gives different definition in their own views, *i.e,* aging, lifespan, senescence, longevity, *etc*. But, earlier "lifespan" name has given by Rockstein, (1972) [26], a great gerontologist, since prior and beyond to that several terms named for the phenomenon of aging. The aging is a process bearing characteristic features of sequential interlinking phenomenon through occurrence of the growth and development, aging and finally death of the organism. Further, Several gerontologists have carried out their investigation utilizing aging parameter in different insects like, Medawar (1946) [19], Kang *et al.* (1999) [13], Gavrilov (1980), Khaliq *et al.,* (2014) [15], *etc*. Moreover, few other organisms were also utilized to study the aging process by numerous popular gerontologists namely, Brooks *et al.,* (1994) [4] and Johnson (1987) [12] in nematodes, Gavrilob and Gavrilova (1991) [10] in flour beetles and human lice and Strehler (1978) [30] in horses, *etc*. Apart, it is very important to note down that, there were very few research work carried out utilizing mulberry silkworm, *Bombyx mori* as a laboratory model to study the aging process Murakami (1989) [21] and Kang *et al.* (1999) [13] in temperate breeds, Doddaswamy *et al.,* (2007) [7]. Reported that, bivoltine silkworm races have the longer longevity than compare to multivoltine races and Ananth *et al*., (2009) [2]. Explained the correlation between adult life span and commercial characters using silkworm breeds as tool for their research work, *etc.* Interestingly, the silkworm, *Bombyx mori* is a most suitable and appropriate insect to study

the longevity is one among all other insects are concern, because it has several benefits, its shorter life cycle, physiological/biological mechanism, *etc.,* are needed to understand the concept. In this regard a gerontologist, Rockstein (1973) [27] has suggested that, the shorter the life cycles of animals/organisms/insects have highly desirable to study the lifespan. Hence, in this connection, keeping all above concepts/ideas in mind, a detailed research effort was put forward to understand the longevity evaluating and comparing the selected morphometric traits and differences existed were observed and recorded among bivoltine and multivoltine silkworm.

2. Materials and Methods

Two multivoltine (PM, C.nichi) and two bivoltine (CSR_2 and NB_4D_2) races/breeds were drawn from the Germplasm, Department of Sericulture, University of Mysore, Mysuru and they were maintained and observed under the standard laboratory conditions. The layings preparation and rearing of bivoltine silkworm breeds/races (CSR_2 and NB_4D_2), Multivoltine breeds/races (PM and C.nichi) were undertaken as per the standard procedures described by Tazima, (1978) [31] and of Krishnaswami (1978) [16] respectively. The incubation of the silkworm eggs at 25±1 ^{0}C and relative humidity of 80±5%, three layings of each of the four races / breeds were selected for the experiment and the silkworm larvae were fed with suitable quality of mulberry leaves for both young and late ages. Simultaneously, the research data were recorded for selected morphometric traits namely, weight, length and breadth of virgin, mated female and unmated and mated male adult moths of the selected silkworm races/breeds. The healthy good cocoons were harvested from the experimental batches and allowed for the pupation and to ensure moth emergence under optimal environmental conditions, temperature and relative humidity. Further, the evaluation of the morphometric traits namely, weight, length and breadth of male and female silkmoths of the selected silkworm breeds have subjected for determining the weight, length and breadth of the turneral moths measured with standard scale in grams and centimetres respectively for the record of day to day changes till last day of switch off mechanism of biological response or death. The obtained data was subjected to ANOVAs (Analysis of Variance) by utilizing opstat statistical package in the evaluation of adult moth longevity of selected races/breeds the scientific formula was utilized described by Murakami *et, al*., **(**1989) [21].

3. Results and Discussion

The changes in the morphometric traits namely, weight, length and breadth of selected multivoltine and bivoltine breeds in the present investigation, the female and male of virgin and crossed adults were subjected for the daywise observations till the attainment and termination of adult longevity period. The observed results clearly shown a highest weight of virgin female moth of 1.112±0.074g was recorded in CSR_2 breed on the day of emergence. Whereas, the lowest weight of 0.078±0.078g was revealed during tenth day in Pure Mysore followed by changes in the gravimetric weight in C. niche and NB_4D_2 breeds (Table-1) and appropriate statistical tests (F-test, SE(m), SE(D), CD at 5% and CV%) were established for the interpretation of the data. On the other hand, The same mated female moth showed highest weight of 0.475±0.011g in CSR_2 breed followed by NB_4D_2, PM and C.nichi were observed of 0.468±0.023g, 0.403±0.033g and 0.382±0.020g moth weight during first day respectively and least of 0.126±0.033g and 0.103±0.052g were revealed in C.nichi and PM during ninth day respectively (Table-2). Further, in the same way, a comparative observation of the unmated and crossed male of bivoltine races/breeds of adult silkmoth depicted (Table -3 and 4) were revealed a higher magnitude of differences in the selected morphometric traits when compare to the multivoltine silkmoth. Among the bivoltine breeds namely, CSR_2 and NB_4D_2 from the day of emergence silkmoth, the weight of the male and female mated and unmated male and virgin female silk moths shown a slow degrades and reduction in the weight till the termination of the longevity at which the weight of the silk moth represents concordant decrease in the adult stage is considered to be non feeding stage during the emergence of the silkmoth all the metabolic reserves are continuously utilized. Therefore, it is defected that the weight was significantly reduced, it is evidenced that, a similar results was obtained by Osanai. M. (1978) [22]. utilizing silkworm moth as model organism to understand the longevity and body weight loss and suggested due to the temperature variability in environment. Hence, there is a distinguished remarkable difference in male and female silk moth on day to day changes in all the silkworm breeds (Tables 1-4). Such changes are occurred also in housefly and honey bee insects revealed from few researches conducted by Clark and Rockstein (1964) [5] suggested changes in the longevity depends on several factors *i.e.,* environment, food, temperature, seasons and also races. Presumably, the virgin female showed the large quantum of the accumulation of the fat body tissue reflected an increased weight in the virgin female than the male during the course of developmental period in CSR_2 followed by NB_4D_2 breed. Whereas, the weight of the crossed silk moth relatively exhibits lower and comparable among the male and female. few corroborative results were observed by Kang *et al.,* (1999) [13], Stephenie *et al.* (2005) [29] and Doddaswamy *et al*., (2007) [7] have suggested that, manifestation of the longevity differences depends not only environmental / food / temperature, *etc.,* but also complexes the existing on sexual differences in the organisms. Furthermore, the multivoltine races are found that remarkable differences among the selected races and breeds. The longevity parameters namely, weight of the male silk moth is relatively low than the female silk moth, it is recorded that both in unmated and mated silk moths of Pure Mysore and C.nichi (Table 3 - 4). The female silk moth of virgin in all the two multivoltine races exhibits the maximum weight in the day wise progressive development of the adult parallel, it is reduced till the completion of adult life period. The significant differences found to be observed in male and female virgin and crossed silk moths in all the multivoltine races increases in the weight during emergence incurred the better longevity period observed in female compare to the longevity of male silk moth is limited and extent of 8 days in Pure Mysore, 9 days in C.nichi except virgin female silk moths observed a significant differences in relation to the weight of the silk moth except in NB_4D_2 was statistically non-significant (NS) among the mulberry silkworm. Table -5, showed the measurement of length of virgin female silk moths in two selected voltine groups among four races/breeds, the NB_4D_2 race measured an highest length of 2.478±0.051cm followed by 2.452±0.046cm, 2.123±0.054cm and 1.975±0.046cm were clearly observed in CSR_2, PM and C.nichi during first day

of emergence respectively. It is very interesting to know that same races/breeds were gradual decreased in their measurement of length till tenth day and a least length is limited (0.511±0.511cm) in case of virgin female moth of C.nichi race on tenth day. Moreover, statistical data revealed significant differences in most of the selected races except CSR_2 breed (Non-significance). Furthermore, Table-6 indicates that, the length of mated female silk moths of four races/breeds were showed similar results, as exhibited in earlier table and herein too revealed same pattern of results (CSR_2, NB_4D_2 and PM) and remaining least of 0.572±0.072cm was recorded in case of C.nichi race during ninth day moth developmental stage. It is noteworthy that, all the races showed statistical significant difference till 9th day of moth stage. However, the measurement of length of the male and female virgin and crossed bivoltine breeds revealed a similar pattern of observation in male and female during the adult period but the reduction in the measurement of the length of the silk moth was slowly attained almost 25% at the end compare to the day of emergence in almost all the cases. The multivoltine races in relation to the length showed the lowest magnitude in the length compare to the bivoltine. In Pure Mysore and C.nichi attributed almost similar in their length of the silk moth (Table- 5 to 6). It is very interesting to know that, the results of the present findings in Table-7 and 8 showed, the length of unmated male silk moths(cm) of four races/breeds is highest of 2.423±0.029cm was recorded in NB_4D_2 race as compare to earlier results of female moths recorded highest in the pattern in same races during first day and least of similar pattern observed in case of C.nichi race (1.801±0.075cm) during same day. However, on the other hand CSR2, NB_4D_2 were exhibited the survivability till 10th day of unmated male (Table-7). More interestingly, in case of mated male survivability length showed till 8th day in all of races/breeds (Table -8) and statistical showed significant difference in all the races/breeds of the silkworm, from present finding as an voltine groups were concerned it collaborates with the results carried by Anantha and Subramanya (2009) [2]. utilizing six multivolitne races and four bivoltine races/breeds have output correlation between longevity of adult moths with cocoon characters in both the voltine groups of selected silkworm. Apart, understanding the longevity of the bivoltine races/breeds revealed highest in case of unmated female moth compared to the multivoltine races due to fat body content in the respect the voltine groups is found to be long lasting in the moths of the silkworm, *Bombyx mori* (Murakami, 1989) [20]. Henceforth, the present research is also indicated the adult females were observed that longer living than compare to adult male moths in both the selected voltine groups of the silkworm. Moreover, the breadth of virgin and mated females were measured in centimetre for four selected races/breeds are presented in Table-9 and 10 respectively and resulted highest breadth (1.103±0.032cm & 1.015±0.013cm) in CSR_2 breed alone for both virgin and mated female during first day. On the other hand, similar work is carried out for the breadth of unmated and mated males was recorded and observed increased breadth in unmated for the CSR_2 (0.790±0.019cm) breed followed by NB_4D_2 (0.722±0.022cm), PM (0.693±0.026cm) and C.nichi (0.651±0.014cm) during first day and PM survived till 8th day with the breadth of 0.348±0.026cm at ninth day C.nichi with 0.104±0.004cm and remaining races/breed extended to survivability till tenth day of adult developmental stage (Table-11). Whereas, mated male moth observation was presented in Table-12 and, analysis of the morphometric traits were measured and resulted highest breadth of 0.761±0.015cm (CSR_2) and lowest of (0.613±0.008cm) was recorded in C.nichi during first day and till the end of its adult stage life (8th day) showed least in the measurement of length (0.211±0.006cm) than other all races/breeds other hand, statistical significance differences was observed in all the races/breeds. However, the breadth of the male and female virgin and crossed silkmoths of two bivoltine breeds namely, CSR_2 and NB_4D_2 revealed a significant difference among the male and female and a considerable decrease in the breadth from the first day of emergence till the day of termination of the longevity. Hence, the virgin female and unmated male of almost all the breeds revealed the increased breadth compared to crossed male and female silk moth. Whereas, the female silk moth CSR_2 and NB_4D_2 presumably expressed the maximum breadth in virgin and crossed silk moth compare to the virgin and crossed silkmoth of PM and C.nichi (Tables: 9-12). The same pattern of observation was made in the multivoltine races namely, Pure Mysore and C.nichi, it is a considerable parameter in the female compare to the male, as a result of the abdominal growth in which numerous number of eggs and fat body deposition reflected in the form of breadth in the silk moth (Tables: 11-12). Hence, the differences in their longevity of selected traits is depends on many factors like, some aspects related to biochemical of aging in insects (Rockstein, 1956), genetics of aging (Finch and Tanzi, 1997, Puca *et al.,* 2001 and Stephan *et al.,* 2003) [8, 24, 28], Hormonal and growth factor signaling (Flurkey *et al.,* 2001), body weight (Piantanelli, 2001) [23], fat body content and environmental factors (Coschigano *et al.,* 2000, Masoro, 2000, Kawasaki *et al*., 2008 and Khaliq *et al.* 2014) [6, 17, 14, 15]. Apart, in some organisms longevity effects due to restricted feeding on lifespan studied in rodent for more than 60 years (Mccay *et al.,* 1935, Horrison *et al.,* 1984, Bertrand *et al.,* 1980 and Weindruch and Walford, 1998) [18, 11, 3, 32]. Moreover, few researchers were also conducted on biochemical/molecular biology suggested that, longevity depends on protein profiles and adult life span (Kang *et al.,* 1999) [13] and between species and their DNA (Ames *et al.,* 1993 and Richter *et al.,* 1988) [1, 25]. Ultimately, results observed in this research work through utilizing multivoltine and bivoltine races/breeds were showed remarkable differences in the sense of morphometric traits (weight, length, breadth) in both virgin and crossed male and female silk moth from day to day changes till the day of the termination of the life and resulted comparative differences among the two aboriginal voltine groups of the silkworms. Presumably, these are very significance to judge the evaluation and comparative variability in the longevity and data generated in the present investigation will be appropriately being utilized.

Table -1 - 4: Weight of virgin, mated (female) and unmated, mated (male) silk moth (g) of four bivoltine and multivoltine races/ breeds of the silkworm, *Bombyx mori*

Races/breeds / Days	Weight of virgin female silk moth (g)			
	CSR_2	**NB_4D_2**	**Pure Mysore**	**C.nichi**
1	1.122±0.074	0.999±0.026	0.812±0.050	0.787±0.023
2	0.964±0.018	0.891±0.005	0.656±0.049	0.751±0.053
3	0.925±0.066	0.855±0.016	0.628±0.086	0.729±0.040
4	0.879±0.025	0.790±0.017	0.490±0.073	0.691±0.039
5	0.832±0.020	0.717±0.094	0.395±0.075	0.652±0.021
6	0.793±0.015	0.645±0.009	0.360±0.066	0.623±0.017
7	0.720±0.011	0.598±0.013	0.316±0.062	0.583±0.011
8	0.683±0.020	0.526±0.007	0.275±0.055	0.534±0.007
9	0.615±0.011	0.467±0.017	0.178±0.090	0.505±0.048
10	0.545±0.097	0.423±0.067	0.078±0.078	0.452±0.042
F – Test	*	*	*	*
SE(m)±	0.046	0.039	0.276	0.034
SE(d) ±	0.065	0.055	0.070	0.048
C.D. at 5%	0.138	0.116	0.207	0.100
C.V. (%)	15.836	17.532	29.58	27.237

Races/breeds / Days	Weight of mated female silk moth (g)			
	CSR_2	**NB_4D_2**	**Pure Mysore**	**C.nichi**
1	0.475 ±0.011	0.468±0.023	0.403±0.033	0.382±0.020
2	0.413 ±0.019	0.405±0.043	0.394±0.042	0.346±0.010
3	0.356 ±0.008	0.346±0.021	0.372±0.091	0.314±0.014
4	0.343 ±0.028	0.321±0.014	0.351±0.057	0.273±0.012
5	0.281 ±0.012	0.261±0.021	0.347±0.071	0.240±0.022
6	0.263 ±0.013	0.239±0.016	0.302±0.047	0.211±0.020
7	0.256 ±0.022	0.182±0.014	0.259±0.035	0.182±0.014
8	0.208 ±0.004	0.171±0.010	0.228±0.039	0.154±0.019
9	0.166 ±0.006	0.140±0.012	0.103±0.052	0.126±0.033
10	-	-	-	-
F – Test	*	*	*	*
SE(m)±	0.017	0.024	0.052	0.018
SE(d) ±	0.023	0.034	0.073	0.026
C.D. at 5%	0.049	0.071	0.154	0.055
C.V. (%)	9.484	17.738	29.678	18.251

Races/breeds / Days	Weight of unmated male silk moth (g)			
	CSR_2	**NB_4D_2**	**Pure Mysore**	**C.nichi**
1	0.490±0.013	0.439 ±0.006	0.394±0.032	0.367±0.015
2	0.440±0.006	0.395 ±0.004	0.334±0.044	0.330±0.020
3	0.383±0.004	0.281 ±0.009	0.297±0.041	0.296±0.013
4	0.257±0.005	0.252 ±0.019	0.262±0.043	0.262±0.014
5	0.244±0.010	0.215 ±0.006	0.245±0.037	0.228±0.006
6	0.232±0.018	0.190 ±0.007	0.235±0.043	0.199±0.010
7	0.229±0.012	0.178 ±0.004	0.190±0.032	0.162±0.004
8	0.188±0.007	0.159 ±0.006	0.159±0.019	0.131±0.005
9	0.178±0.015	0.133 ±0.013	-	0.105±0.033
10	0.148±0.048	0.118 ±0.006	-	-
F – Test	*	N/S	*	*
SE(m)±	0.018	0.141	0.033	0.015
SE(d) ±	0.026	0.200	0.047	0.021
C.D. at 5%	0.054	N/S	0.099	0.045
C.V. (%)	12.979	124.148	27.828	17.149

Races/breeds / Days	Weight of mated male silk moth (g)			
	CSR_2	**NB_4D_2**	**Pure Mysore**	**C.nichi**
1	0.431 ±0.028	0.399±0.013	0.381±0.002	0.342±0.020
2	0.352±0.013	0.335±0.020	0.279±0.005	0.315±0.006
3	0.288 ±0.086	0.284±0.087	0.245±0.001	0.281±0.012
4	0.264 ±0.012	0.258±0.011	0.244±0.013	0.246±0.008
5	0.229±0.006	0.236±0.012	0.235±0.019	0.214±0.009
6	0.191 ±0.016	0.211±0.008	0.217±0.020	0.175±0.004
7	0.175 ±0.016	0.181±0.009	0.203±0.024	0.134±0.007
8	0.163 ±0.022	0.152±0.013	0.180±0.025	0.105±0.035
9	-	-	-	-
10	-	-	-	-
F – Test	*	*	*	*
SE(m)±	0.034	0.033	0.015	0.018
SE(d) ±	0.047	0.047	0.021	0.025
C.D. at 5%	0.100	0.099	0.044	0.053
C.V. (%)	24.526	23.817	13.437	21.744

Table-5-8: Length of virgin, mated (female) and unmated, mated (male) silk moth (cm) of four bivoltine and multivoltine races/ breeds of the silkworm, *Bombyx mori*

Races/breeds / Days	Length t of virgin female silk moth (cm)			
	CSR_2	**NB_4D_2**	**Pure Mysore**	**C.nichi**
1	2.452 ±0.046	2.478± 0.051	2.123±0.054	1.975±0.046
2	2.23±0.062	2.448±0.072	2.100±0.051	1.951±0.059
3	2.330±0.045	2.355±0.059	2.040±0.051	1.902±0.050
4	2.306±0.041	2.283±0.041	1.986±0.064	1.864±0.035
5	2.218±0.061	2.246±0.044	1.955±0.078	1.829±0.039
6	2.185±0.063	2.197±0.039	1.949±0.036	1.783±0.035
7	2.172±0.091	2.109±0.059	1.917±0.050	1.743±0.034
8	2.119±0.055	2.057±0.031	1.862±0.032	1.672±0.036
9	2.042±0.065	1.990±0.047	1.217±0.610	0.564±0.564
10	1.360±0.680	1.293±0.648	0.605±0.605	0.511±0.511
F – Test	N/S	*	*	*
SE(m)±	0.223	0.210	0.276	0.724
SE(d) ±	0.315	0.297	0.390	0.244
C.D. at 5%	N/S	0.625	0.820	0.345
C.V. (%)	17.852	16.979	26.917	26.41

Races/breeds / Days	Length of mated female silk moth (cm)			
	CSR_2	**NB_4D_2**	**Pure Mysore**	**C.nichi**
1	2.398±0.040	2.319±0.037	2.061±0.031	1.933±0.024
2	2.128±0.049	2.283±0.044	2.060±0.030	1.906±0.024
3	2.023±0.051	2.256±0.028	1.987±0.013	1.886±0.040
4	2.189±0.060	2.230±0.044	1.960±0.030	1.858±0.040
5	2.136±0.066	2.209±0.025	1.916±0.010	1.805±0.045
6	2.084±0.070	2.174±0.037	1.879±0.030	1.765±0.042
7	2.034±0.081	2.091±0.046	1.827±0.020	1.722±0.036
8	1.949±0.053	2.053±0.053	1.781±0.031	1.658±0.051
9	1.902±0.056	1.971±0.032	1.143±0.574	0.572±0.072
10	-	-	-	-
F – Test	*	*	*	*
SE(m)±	0.202	0.615	0.183	0.184
SE(d) ±	0.285	0.207	0.259	0.260
C.D. at 5%	0.600	0.293	0.543	0.547
C.V. (%)	17.167	17.434	19.067	20.65

Races/breeds / Days	Length of unmated male silk moth (cm)			
	CSR_2	**NB_4D_2**	**Pure Mysore**	**C.nichi**
1	2.366±0.006	2.423±0.029	2.152±0.037	1.824±0.041
2	2.286±0.005	2.368±0.034	1.980±0.070	1.808±0.079
3	2.244±0.031	2.328±0.048	1.847±0.095	1.753±0.085
4	2.150±0.058	2.303±0.032	1.733±0.097	1.715±0.100
5	2.099±0.049	2.243±0.051	1.683±0.098	1.639±0.069
6	2.048±0.046	2.186±0.010	1.644±0.087	1.582±0.063
7	2.011±0.035	2.146±0.021	1.572±0.049	1.511±0.059
8	1.979±0.021	2.044±0.073	1.489±0.068	1.434±0.063
9	1.933±0.033	2.001±0.085	-	0.472±0.472
10	1.635±0.000	1.267±0.636	-	-
F – Test	*	*	*	*
SE(m)±	0.204	0.206	0.070	0.163
SE(d) ±	0.288	0.292	0.099	0.230
C.D. at 5%	0.605	0.613	0.207	0.483
C.V. (%)	17.818	16.764	8.730	20.155

Races/breeds / Days	Length of mated male silk moth (cm)			
	CSR_2	**NB_4D_2**	**Pure Mysore**	**C.nichi**
1	2.322±0.036	2.404±0.020	1.954±0.131	1.801±0.075
2	2.286±0.038	2.390±0.012	1.915±0.123	1.762±0.060
3	2.238±0.042	2.360±0.004	1.883±0.165	1.724±0.062
4	2.157±0.018	2.307±0.005	1.849±0.212	1.682±0.058
5	2.065±0.046	2.270±0.004	1.805±0.204	1.633±0.067
6	2.034±0.034	2.197±0.007	1.778±0.190	1.592±0.055
7	1.998±0.056	2.149±0.017	1.694±0.198	1.534±0.050
8	1.900±0.058	2.099±0.025	1.633±0.184	1.422±0.563
9	-	-	-	-
10	-	-	-	-
F – Test	*	*	*	*
SE(m)±	0.205	0.650	0.160	0.259
SE(d) ±	0.290	0.219	0.226	0.366
C.D. at 5%	0.609	0.310	0.474	0.769
C.V. (%)	18.240	18.159	18.554	29.953

Table-9-12: Breadth of virgin, mated (female) and unmated, mated (male) silk moth (cm) of four bivoltine and multivoltine races/ breeds of the silkworm, *Bombyx mori*

Races/breeds / Days	Breadth of virgin female silk moth (cm)			
	CSR_2	**NB_4D_2**	**Pure Mysore**	**C.nichi**
1	1.103±0.032	0.989±0.059	0.892±0.019	0.862±0.019
2	1.042±0.060	0.916±0.026	0.861±0.038	0.840±0.014
3	0.959±0.030	0.877±0.031	0.825±0.014	0.794±0.006
4	0.909±0.027	0.816±0.026	0.802±0.027	0.743±0.007
5	0.820±0.020	0.777±0.024	0.753±0.010	0.718±0.010
6	0.740±0.030	0.725±0.014	0.727±0.015	0.678±0.022
7	0.694±0.023	0.683±0.010	0.667±0.016	0.628±0.015
8	0.629±0.036	0.628±0.003	0.632±0.007	0.587±0.031
9	0.573±0.025	0.589±0.011	0.371±0.186	0.178±0.178
10	0.355±0.179	0.387±0.194	0.183±0.183	0.172±0.172
F – Test	*	*	*	*
SE(m)±	0.065	0.067	0.085	0.08
SE(d) ±	0.092	0.094	0.12	0.113
C.D. at 5%	0.192	0.198	0.251	0.237
C.V. (%)	14.342	15.602	21.587	22.264

Races/breeds / Days	Breadth of mated female silk moth (cm)			
	CSR_2	NB_4D_2	Pure Mysore	C.nichi
1	1.015±0.013	0.963±0.029	0.859±0.021	0.821±0.018
2	1.011±0.034	0.902±0.035	0.821±0.034	0.796±0.015
3	0.943±0.038	0.874±0.035	0.805±0.020	0.751±0.015
4	0.882±0.020	0.809±0.029	0.777±0.029	0.718±0.010
5	0.765±0.023	0.777±0.031	0.725±0.013	0.685±0.015
6	0.712±0.020	0.707±0.022	0.698±0.016	0.641±0.013
7	0.660±0.014	0.661±0.018	0.635±0.008	0.605±0.011
8	0.604±0.025	0.611±0.005	0.597±0.009	0.566±0.019
9	0.567±0.033	0.585±0.013	0.369±0.185	0.271±0.171
10	-	-	-	-
F – Test	*	*	*	*
SE(m)±	0.058	0.057	0.061	0.056
SE(d) ±	0.082	0.080	0.087	0.079
C.D. at 5%	0.172	0.169	0.182	0.165
C.V. (%)	13.365	13.66	16.652	16.705

Races/breeds / Days	Breadth of unmated male silk moth (cm)			
	CSR_2	NB_4D_2	Pure Mysore	C.nichi
1	0.790±0.019	0.722±0.022	0.693±0.026	0.651±0.014
2	0.766±0.019	0.651±0.009	0.651±0.028	0.611±0.012
3	0.641±0.021	0.572±0.030	0.610±0.024	0.554±0.019
4	0.584±0.016	0.516±0.010	0.568±0.025	0.437±0.016
5	0.528±0.017	0.502±0.014	0.521±0.027	0.402±0.017
6	0.498±0.037	0.459±0.014	0.485±0.024	0.376±0.020
7	0.431±0.017	0.430±0.007	0.423±0.020	0.335±0.022
8	0.385±0.011	0.412±0.006	0.348±0.026	0.237±0.015
9	0.344±0.029	0.395±0.005	-	0.104±0.004
10	0.122±0.022	0.121±0.021	-	-
F – Test	*	*	*	*
SE(m)±	0.044	0.041	0.022	0.036
SE(d) ±	0.062	0.058	0.032	0.051
C.D. at 5%	0.130	0.121	0.067	0.108
C.V. (%)	14.926	14.77	10.753	17.783

Races/breeds / Days	Breadth of mated male silk moth (cm)			
	CSR_2	NB_4D_2	Pure Mysore	C.nichi
1	0.761±0.015	0.718±0.038	0.679±0.012	0.613±0.008
2	0.733±0.019	0.705±0.031	0.622±0.012	0.574±0.016
3	0.635±0.016	0.644±0.036	0.583±0.025	0.521±0.025
4	0.561±0.015	0.557±0.047	0.551±0.025	0.462±0.013
5	0.516±0.01	0.500±0.019	0.517±0.029	0.397±0.017
6	0.476±0.016	0.456±0.028	0.480±0.033	0.350±0.026
7	0.430±0.007	0.438±0.031	0.446±0.02	0.309±0.019
8	0.397±0.006	0.420±0.020	0.387±0.017	0.211±0.006
9	-	-	-	-
10	-	-	-	-
F – Test	*	*	*	*
SE(m)±	0.043	0.048	0.02	0.049
SE(d) ±	0.060	0.068	0.029	0.069
C.D. at 5%	0.127	0.143	0.061	0.144
C.V. (%)	14.731	16.74	10.231	25.786

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