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STUDIES CONCERNING THE EFFECT OF THE INBREEDING ON THE PROLIFICITY AND HATCHING PERCENTAGE AT SILKWORMS (*Bombyx mori* L.)

Georgeta DINIȚĂ, Monica Paula MARIN, Minodora TUDORACHE, Ioan CUSTURĂ, Andra Dorina ȘULER

University of Agronomic Sciences and Veterinary Medicine of Bucharest,
59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: georgetadinita@yahoo.com

Abstract

The practicing of mating the individuals with a certain kinship degree leads to ostaining of inbreed lines through which crossing are ostained descendants characterized by performances superior to parental populations average.Using the inbreed lines in the hybridization process has as final result the obtaining of commercial hybrids. This is easily achievedin silkworms, species characterized by a short interval between generations and by high prolificity. Thirty silkworm inbreed lines were studied during six generations and the effect of the inbreeding on some physiological characteristics. The prolificity ranged between 632-494 eggs/layinginside the White Baneasa lines and 748-522 eggs/layingin Baneasa 75 lines. The number of eggs/layingwas lower at I_6*whit 10.39% in Baneasa 75 lines and 11.41% in White Baneasa lines by comparision with* I_0*. Hatching percentage was affected by inbreeding depression beginning with* I_3 *in both lines groups. This was lower with 6.10-15.66 percentages in White Baneasa lines and 6.80-15.90 percentages in Baneasa 75.*

Key words*: silkworm, inbreed lines, inbreeding depression.*

INTRODUCTION

The inbreeding represents the process by which there are mated individuals more close related between them than the population kinship average. The genetic effect of inbreeding consists in changing genotypes freqvency, in the sense of increasing the homozygous genotypes freqvency and implicitly of decreasing the heterozygous genotypes freqvency.

The inbreeding degree is measured by the inbreeding coefficient (Wright). In silkworm case is most practiced the brother x sister mating system (incest).

Following the application of a higher number of generations it appears the inbreeding depression, phenomenon opposite to heterozys and which consists in decreasing the production and reproduction performances for a population. In silkworm, the inbreeding depression is manifested by prolificity, hatching percentage and larvae viability decreasing.

From the researches of Craiciu and Tițescu (1971) results that after six generations of inbreeding, the hatching decreases with up to 2%, reducing larvae viability with up to 18% and increasing the larvar period with 1-2 days. The inbreeding favourable effect has been manifested in some technological characters, as silk percentage and filament length, situations in which the control (I_0) has been exceeded with 1.3-4.7% for the first character and with 7-10% in the case of the second character (Table 1).

The experiences also demonstrated that after the sixth generation, the inbreeding favourable effect is no longer noted.

Concerns related to obtaining silkworms inbreed lines used to achieve hybrids for production, were reported Romania since 1969 (Craiciu and Otărășanu, 1969; Craiciu and Tițescu, 1971; Craiciu et al., 1974; Braslă and Matei, 1992).

The mentioned papers specifies the inbreeding effect and respectively of hybridization on some characters important for the sericicultural production, as hatching percentage, silk cocoons weight, silk percentage, etc.

Table 1. The inbeeding effects on some biological and technological characters*)

Inbreed line	Character/Inbeeding generation							
	Hatching (%)		Larvae viability (%)		Silk percentage(%)		Fibre length(m)	
	I_0	I_9	I_0	I_9	I_0	I_9	I_0	I_9
C1 7/2	97.1	95.1	90.0	85.4	17.7	22.4	805	973
C10 1/7	97.2	96.6	91.0	77.8	17.9	20.2	715	965
AB 2/5	98.4	99.3	87.2	80.2	18.3	22.1	855	978
AJ 1/1	98.0	99.5	83.4	78.8	18.6	19.9	750	898

*) Craiciu et al., 1971

There haven't been approached yet subjects of research with fundamental character, as would be the inbreeding and hybridization consequences on the physiological and biochemical processes which are happening at organism level (modification of protein spectrum under quantitative and qualitative point of view, of nucleic acids content, enzyme activity, intensity of some metabolic processes).

In general, from the papers consulted and presented in refferences, it results that the improvement process by inbreeding is used in creation of new populations, on a limited number of generations, usually no more than three.

MATERIALS AND METHODS

The material used in the obtaining of inbreed lines was representend by two founding races, White Băneasa and Băneasa 75, the main active races used as parents to obtain industrial hybrids.

The creation of inbreed lines in order to manifest heterozys phenomenon by crossing, has been achieved in several stages, as follows:the extracting of lines and their inbreeding up to a variable number of generations; testing their specific combining capacity by dialele crossing; reproduction of high combining capacity lines; obtaining hybrids by crossing inbreed lines.

The inbreeding lines from the two founding races have been obtained by practicing the related crossings of brother x sister type during six successive generations. To avoid the effects of too accentuated inbreeding depression, it has been practiced the inter-family selection (linear) on the basis of their own performances in each family. The number of lines (families) on which the selection works have been expanded varied in accordance with the technological stage and the specific selection criterion.

The inbreeding coefficient/generation has been calculated with Wright formula:

$$F_x = (1/2)^{n_1+n_2+1}(1 + F_A)$$

in which:

F_x – the inbreeding coefficient of the individual X;

n_1, n_2 – number of generation exchange between mother or father and common ancestor;

F_A – the inbreeding coefficient of the common ancestor.

The prolificity has been determined by counting the eggs from each laying and the hatching by the ratio between the number of hatched eggs and the total numberof eggs from laying.

RESULTS AND DISCUSSIONS

The inbreeding effect on prolificity

The prolificity expressed by the number of eggs layed by a female represents a character taken into conssideration in particular in the works of silkworm reproduction, this influencing the specific number of silk cocoons needed to obtain 1 kg of eggs. The silk moth is characterized by high prolificity, a female producing 400-800 eggs, the number being influenced by the quality of larvae food, moth age, and also by the temperature and humidity conditions during ovogenesis and laying formation (Haniffa etal., 1992).

The prolonged inbreeding also represents a factor that may influence the prolificity, thing observed in the case of 30 inbreed lines studied. The inbreed lines coming from White Băneasa have presented a prolificity between 632-494 eggs/laying during the six inbreeding generations (Table 2).

Table 2.The inbreeding effect on prolificity in White Băneasa inbreedlines (number eggs/laying)

Line	Inbreeding generation						
	I_0	I_1	I_2	I_3	I_4	I_5	I_6
AB – 1/1	588	596	601	598	583	576	545
AB – 3/2	636	628	613	611	605	587	572
AB – 4/3	612	615	617	618	603	608	596
AB – 5/4	592	604	606	603	606	596	545
AB – 7/5	638	626	612	616	596	588	576
AB – 8/6	616	612	605	588	587	591	590
AB – 9/7	602	605	597	566	559	548	552
AB – 10/8	594	604	592	598	576	556	536
AB – 12/9	642	632	612	594	582	552	514
AB – 14/10	632	616	603	610	606	596	530
AB – 15/11	597	606	585	591	585	591	527
AB – 18/12	624	610	606	603	593	556	536
AB – 20/13	612	603	593	595	576	544	514
AB – 22/14	598	595	577	588	581	532	494
AB – 25/15	622	614	612	603	601	596	532
Average	614±4.68	611±2.85	602±2.93	599±3.38	589±3.55**	576±5.65**	544±7.48**

*P<0.05; **P<0.01; ***P<0.001.

Following the evolution of this parameter it is noticed that with the increasing of inbreeding coefficient its value is reducing, especially in I_4-I_6generations, which present differences in minus to the control (I_0), statistically significant. If in I_0average of 15 inbreed lines highlighted a number of 614 eggs/laying, in I_4-I_6 generations this represents 589, 576, 544 eggs/laying, finding a reduction with cu 4.08-11.41% of the analyzed character's value.

A similar evolution regarding the prolificity have registred the inbreed lines coming from Băneasa 75 race, the number of eggs/laying ranging between (Table 3).

Table 3.The inbreeding effect on prolificity in Băneasa 75 inbreedlines (number eggs/laying)

Line	Inbreeding generation						
	I_0	I_1	I_2	I_3	I_4	I_5	I_6
B75 – 2/1	635	632	627	629	624	585	544
B75 – 4/2	689	674	683	675	666	632	596
B75 – 5/3	713	716	707	693	692	612	588
B75 – 6/4	612	610	589	585	587	576	555
B75 – 8/5	756	748	702	702	696	644	636
B75 – 10/6	712	715	693	695	673	632	596
B75 – 11/7	525	565	589	601	572	538	522
B75 – 13/8	621	606	632	594	586	572	552
B75 – 15/9	668	636	672	633	640	636	614
B75 – 16/10	702	698	699	645	636	628	610
B75 – 18/11	531	536	594	588	582	576	540
B75 – 19/12	596	603	575	576	566	563	553
B75 – 21/13	636	621	632	604	598	594	562
B75 – 23/14	632	618	630	628	614	606	593
B75 – 24/15	648	646	631	632	615	610	602
Average	645±16.86	642±15.18	644±11.82	632±10.93	623±11.10	600±8.09	578±8.47**

*P<0.05; **P<0.01; ***P<0.001.

Analyzed on inbeeding generations, in I_1-I_3were obtained values close to $I_{0,}$ to whom the differences in minus have represented only 0.47-2.02%. Although in $I_4$and $I_5$the differences in minus to $I_0$are amplifying, being of 3.42-6.98%, they are not statistically significant. Only in the last inbreeding generation (I_6) the average of the 15 inbreed lines (578 eggs/laying) presents significant differences (P<0,05) to the control (645 eggs/laying).

Analyzing the prolificity inside each line from the two groups and comparing its evolution from a generation to another, in most cases we find differences in minus which value is smaller in the first inbreeding generations and higher in the last 2-3 generations.

The inbreeding effect on hatching

Presenting as well as prolificity, a low heritability, the hatching was affected by the inbreeding depression. During the six generations, the hatching has varied between 98.60-80.14% in lines of White Băneasa group and between 99.15-82.10% in lines Băneasa 75 group (Tables 4 and 5).

Table 4. The inbreeding effect on hatching percentage inWhite Băneasa inbreedlines (%)

Line	Inbreeding generation						
	I_0	I_1	I_2	I_3	I_4	I_5	I_6
AB – 1/1	96.36	94.40	93.01	93.20	91.90	85.96	83.40
AB – 3/2	97.42	94.66	95.20	94.90	92.86	91.60	89.20
AB – 4/3	95.80	93.30	91.60	92.13	90.16	84.60	84.42
AB – 5/4	97.40	95.84	96.40	94.16	93.00	93.20	91.30
AB – 7/5	99.27	97.70	98.60	95.20	88.46	88.32	87.16
AB – 8/6	97.35	96.44	93.20	94.40	92.30	89.60	88.15
AB – 9/7	98.27	97.30	94.40	93.80	91.40	90.13	90.40
AB – 10/8	98.50	95.18	95.20	92.90	92.00	91.12	90.26
AB – 12/9	98.60	94.16	93.30	92.10	87.60	85.30	88.30
AB – 14/10	94.40	93.23	92.20	91.40	85.30	82.20	81.40
AB – 15/11	93.20	96.66	97.30	95.20	87.20	85.31	82.60
AB – 18/12	94.80	93.40	92.40	93.30	88.16	84.60	83.30
AB – 20/13	95.20	94.60	93.66	93.10	91.36	87.32	85.20
AB – 22/14	96.14	95.80	95.40	94.14	93.14	91.12	89.16
AB – 25/15	95.80	96.60	96.20	95.80	87.13	83.12	80.14
Average	96.43± 0.426	95.28± 0.318	95.54± 0.521	93.72± 0.331*	90.13± 0.666**	87.57± 0.883**	86.29± 0.925**

*P<0.05; **P<0.01; ***P<0.001.

Table 5. The inbreeding effect on hatching percentage in Băneasa 75 inbreedlines (%)

Line	Inbreeding generation						
	I_0	I_1	I_2	I_3	I_4	I_5	I_6
B75 – 2/1	98.99	98.10	98.40	97.94	93.32	92.80	89.96
B75 – 4/2	98.12	97.80	97.53	97.05	97.05	92.36	91.32
B75 – 5/3	98.72	98.36	93.15	89.90	83.87	83.50	84.40
B75 – 6/4	97.30	94.60	97.04	93.36	94.47	90.96	89.60
B75 – 8/5	99.16	98.12	95.50	95.20	93.52	92.16	86.72
B75 – 10/6	98.10	96.32	97.60	89.86	82.46	83.22	82.20
B75 – 11/7	97.75	95.18	96.07	88.14	83.78	84.36	85.40
B75 – 13/8	98.76	97.72	98.60	93.32	91.66	89.98	86.22
B75 – 15/9	97.75	95.66	94.95	93.60	92.10	90.92	88.66
B75 – 16/10	98.72	97.33	94.48	91.16	90.88	88.77	88.20
B75 – 18/11	97.80	96.90	97.98	94.66	93.80	91.26	87.46
B75 – 19/12	99.10	97.80	99.15	95.30	92.20	91.76	89.90
B75 – 21/13	97.73	95.60	94.73	89.80	85.30	86.83	87.23
B75 – 23/14	98.16	97.90	96.89	88.62	82.10	83.10	84.60
B75 – 24/15	97.96	97.12	94.33	87.76	84.60	82.86	83.20
Average	98.27± 0.151	96.97± 0.311	96.43± 0.471	92.38± 0.850**	89.41± 1.313**	88.32± 1.006**	87.60± 0.691**

*P<0.05; **P<0.01; ***P<0.001.

In the first two generations of inbreeding there are noted close values of hatching percentage 95.28 and 94.54% in White Băneasa race and 96.97% and 96.43% respectively, in Băneasa 75 race, the differences in minus to the I_0 representing 1.15-1.89 percents. Starting with I_3, the differences in minus to the control (I_0) become significant for both groups of races, the hatching percentage decreasing with the inbreeding depression's increasing, such that in the last generation (I_6) were recorded values lower to $I_0$with 10.52% in the group of White Băneasa races and with 10.86 % in the group of Băneasa 75 races. Following the evolution of hatching percentage from a generation to another it is observed that although between them there are differences in minus, these are not statistically significant, excepting I_3which presents significant differences in minus to $I_2$for the both groups of races. Analyzing the hatching percentage for each line during the six inbreeding generations it is noted a descending evolution of it from a generation to another, in most cases.

In the group of White Băneasa lines, the most affected by the inbreeding depression for this character was the line AB-25/15 which in I_6has achieved a hatching of 80.14% compared to 95.80% în I_0, the difference in minus being of 15.66 percentes. Less influenced was the line AB-5/4 in which the difference in minus I_0-$I_6$was 6.10 percentes. Values of hatching percentage higher than 90.00% in I_6 were noted in the case of 3 of 15 lines from the White Băneasa group, the maximum value (91.30%) being recorded by line AB-5/4.

The same descending evolution presented the hatching percentage for the group of Băneasa 75 lines, in which the differences in minus I_0-I_6ranged between 6.80 percents (B75-4/2) and 15.90 percents (B75-10/6). The maximum value of hatching percentage in I_6 belongsto B75-4/2 (91.32%), and the minimum to B75-10/6 (82.20%).

CONCLUSIONS

The prolificity varied with the inbreeding generations between 632-494 eggs/laying in the lines from White Băneasa race and between 748-522 eggs/laying in those from Băneasa 75 race and it was negatively influenced by the inbeeding process. Comparing to $I_0$the prolificityis low in I_6 with 10.39% in Băneasa 75 lines and with 11.41 % in White Băneasa lines.

The hatching percentage has been affected by the inbreeding depression starting with I_3, in both groups of races. The differences in minus between $I_6$and I_0 have varied between 6.10-15.66 percents in the group of White Băneasa lines andbetween 6.80-15.90 percentsin the group of Băneasa 75 lines.

The experimental works which aimed the study of inbeeding and hybridization effect in silkworms allowed the selection of a number of 6 inbreed lines and 8 hybrids characterized by superior biological and technological parameters, recommended for the sericicultural production.

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