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Hybridization Schemes For Developing New Silkworm (*Bombyx mori* L.) Races by Using Populations From Different Ecogeographical Zones

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Abstract: Different hybridization schemes with populations from various ecogeographical zones were studied with a view to developing new silkworm races. Hybrid populations of Japanese and Chinese types were bred by using the following methods: Simple crossing ($A \times B$); Complex crossing [$(A \times B) \times C$ and $(A \times B) \times (C \times D)$] and Backcrossing.

It was established that the efficiency of silkworm breeding programmes is determined not only by the hybridization methods and schemes, but also by the ecogeographical determinism of the source populations used. Therefore, the inclusion of populations with different ecogeographical origins into the silkworm breeding programmes would lead to improvement of the most important economic traits, determining cocoon- and raw silk productivity, instead of increasing the genetic potential of the source material used.

Key words: *Bombyx mori* L., hybridization, silkworm, silkworm hybridization schemes.

Introduction

The problem of silkworm breeding efficiency is rather complex and has different aspects. It is, first of all, connected with the use of a large set of initial populations with different ecogeographical origins (Исламов, 1983; Gupta et al., 1992; Brasla et al., 1992), the selection of different methods and breeding schemes (Brasla and Matei, 1992; Chatterjee, 1993), the inheritance of the main selected traits (Насириллаев, 1985; Шукин, 1986), the direction and the intensity of selection, as well as the number of the main traits and individuals tested, used in the breeding programmes (Абаджиева, 1987; Насириллаев, 1978; Chatterjee et al., 1992; Петков, 1995).

The objective of the present study was to investigate different hybridization schemes using populations from different ecogeographical zones, with a view to developing new silkworm races and lines with high productive and adaptive potentials.

Material and Methods

The experimental work was done at the Sericultural Experiment Station in the town of Vratza during the period 1996-1999. The subject of investigations were four populations from the silkworm genetic resources in Bulgaria (Sup.1, Hessa 2, Vr.35 and Mer.2), one from Ukraine (Ukr.20) and three from Japan (AC, KC, and ShV),

Different methods and hybridization schemes were used in the development of hybrid populations of Japanese and Chinese types, i.e. Simple cross ($A \times B$), Complex cross [$(A \times B) \times C$ and $(A \times B) \times (C \times D)$] and Backcross.

The hybrid populations of the Japanese type were characterized by white silkworms with patterns of clearly expressed masks and half-lines and white elongated cocoons with a slight or more expressed constriction, while the Chinese type had no silkworm patterns, and its cocoons were white and oval-elliptic in shape.

The races Sup.1 and Hessa 2 - the source forms of the commonly used in Bulgaria industrial hybrid Sup. 1 x Hessa and its reciprocal, were used as controls for the first and the second group, respectively.

The study was conducted by the methods and regimes, adopted in Bulgaria (Петков, 1995), and the mathematical treatment of data - through one-factorial analysis of variance (Лидански, 1988).

Results and Discussion

Comparative data for the mean values of the most important biological traits of silkworms are given in Table 1.

It is seen, that egg hatching in the newly bred hybrid populations, both of the Japanese and the Chinese types, was high - 97,38-99,63% and 98,48-99,59%, respectively. The highest relative and statistically significant values

simple hybrid AC x Vr.35 populations of the Japanese and in Ukr.20 x ShV of the Chinese type, surpassing their respective controls by 2.50 and 3.50 points.

The productivity in our studies, as estimated by the raw cocoon yield per 1 box of eggs (20000 ± 200 viable eggs), an integral index functionally dependent on other biological traits (egg hatching, silkworm viability, mean cocoon weight, etc.) was relatively high in all newly developed hybrid populations of both Japanese and Chinese types.

Tab. 2. Technological traits of raw cocoons

Hybrid populations	Raw cocoon weight, mg			Shell weight, mg			Silk ratio, %		
	$\bar{X}$	$\pm D$	Significance	$\bar{X}$	$\pm D$	Significance	$\bar{X}$	$\pm D$	Significance
<i>Hybrid populations - Japanese type</i>									
AC x Vr.35	2372	+187	++	530	+62	+++	22.30	+0.88	+
Sup.1 x KC	2353	+168	++	530	+62	+++	22.52	+1.10	+
(AC x Vr.35) x Sup.1	2348	+163	++	530	+62	+++	22.78	+1.36	+++
(AC x Vr.35) x KC	2293	+108	-	526	+58	+++	22.96	+1.54	+++
(ACxVr.35)x(Sup.1xKC)	2261	+76	-	526	+58	+++	23.28	+1.86	+++
(ACxVr.35)xSup.1xKC	2303	+118	-	525	+57	+++	22.81	+1.39	+++
AC x Vr.35 - BC ₁	2294	+109	-	540	+72	+++	23.54	+2.12	+++
AC x Vr.35 - BC ₂	2365	+180	++	537	+69	+++	22.71	+1.29	++
AC x Vr.35 - BC ₃	2364	+179	++	554	+86	+++	23.43	+2.01	+++
Sup.1 (control)	2185	-	-	468	-	-	21.42	-	-
GD at P- 5%		120			24			0.84	
P- 1%		162			33			1.13	
P - 0.1%		216			44			1.51	
<i>Hybrid populations - Chinese type</i>									
Ukr.20 x ShV	2222	+184	++	527	+109	+++	23.74	+3.22	+++
Hessa 2 x Mer.2	2263	+225	+++	513	+95	+++	22.66	+2.14	+++
(Ukr.20xShV)xHessa 2	2239	+202	-	504	+86	+++	22.50	+1.98	+++
(Ukr.20xShV)xMer.2	2263	+225	+++	509	+91	+++	22.50	+1.98	+++
(Ukr.20xShV)x(Hessa2xMer.2)	2273	+235	+++	509	+91	+++	23.39	+1.87	+++
(Ukr.2xShV)xHessa2xMer.2	2245	+207	+++	511	+93	+++	22.74	+2.22	+++
Ukr.20xShV-BC ₁	2079	+41	-	485	+67	+++	23.33	+2.81	+++
Ukr.20xShV-BC ₂	2049	+11	-	466	+48	+++	22.77	+2.25	+++
Ukr.20xShV-BC ₃	2004	-34	-	450	+32	+	22.43	+1.91	+++
Hessa 2 (control)	2038	-	-	418	-	-	20.52	-	-
GD at P- 5%		114			27			0.95	
P- 1%		154			36			1.28	
P - 0,1%		204			48			1,70	

As a rule, proceeding from the genetic determinism of the pure initial populations in both types of hybrid populations, the highest and statistically significant (first and second significance thresholds) cocoon productivity was obtained by using the Simple cross (AxB) method - in AC x Vr. 35 and Sup.1 x KC of the Japanese, and Ukr.20 x ShV and Hessa 2 x Mer.2 of the Chinese type, surpassing their respective controls by 4.16-4.69 kg (11.19-12.62%) and 6.16-6.57 kg (17.95-19.14%). The data obtained are in full accordance with the established

by other authors, that the efficiency of silkworm breeding programmes depends to a great extent on the methods of breeding used (Brasla and Matei, 1992; Hatterjee, 1993).

In this aspect, both in the present and other investigations of ours and other authors (Исламов, 1983; Gupta et al., 1992; Петков, 1995), the crossing of populations with different ecogeographical and genetic origins proved to be most effective in the heterosis breeding programmes. Thus, using the same methods of hybridization in three ecogeographically remote populations, we established differences in the cocoon productivity between the Japanese type populations [(AC x Vr.35) x Sup.1 and (AC x Vr.35) x KC)] and the Chinese type [Ukr.20 x ShV) x Hessa 2 and (Ukr.20 x ShV) x Mer.2)] of 0,82 kg (2.3%) and 3.42 kg (9.21%), respectively.

Data for the effect of the methods and schemes of hybridization in populations of different ecogeographical origin upon the most important raw cocoon technological traits are given in Table 2.

Similarly to the case of raw cocoon yield, for cocoon weight and shell weight (the latter with a definite contribution to the formation of raw silk productivity and yield, without ignoring the genetic determinism of pure populations), comparatively high and statistically significant (first and second significance threshold) values were obtained in the simple hybrid populations, surpassing the respective controls by 168-187 mg (7.69-8.56 %) and 62 mg (13.25%) for the Japanese type, and by 184-225 mg (9.03-11.04%) and 95-109 mg (22.73-26.08%) for the Chinese type.

As for the ecogeographical determinism of the populations used in the different hybridization schemes, here also, like in other publications of ours and other authors (Brasla et al., 1992; Петков, 1995), it was proved that the large set of populations of different origin leads to improvement of the main productive traits and heterosis efficiency, at the expense of increasing the genetic potential of the source material used.

Conclusion

Along with the methods and schemes of hybridization, the efficiency problem in silkworm breeding programmes is determined to a great extent by the ecogeographical determinism of the source populations used. In this aspect, the inclusion of populations with different ecogeographical origins into the breeding programmes leads to improvement of the most important economic traits, responsible for the productivity and yield of cocoons and raw silk, instead of increasing the genetic potential of the source material used.

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ŠEME HIBRIDIZACIJE ZA RAZVITAK NOVIH VRSTA SVILENIH BUBA (*Bombyx mori* L.) KORIŠĆENJEM POPULACIJA RAZLIČITIH EKOGEOGRAFSKIH ZONA

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Rezime

Različite šeme hibridizacije sa populacijama raznih ekogeografskih zona ispitivane su s obzirom na razvitak novih vrsta svilenih buba. Hibridne populacije japanskih i kineskih vrsta gajene su primenom sledećih metoda: prostog ukrštanja ($A \times B$); složenog ukrštanja [$(A \times B) \times C$ i $(A \times B) \times (C \times D)$] i povratnog ukrštanja.

Ustanovljeno je da se efikasnost programa gajenja svilenih buba određuje ne samo uz pomoć metoda hibridizacije, već i ekogeografskim određivanjem upotrebljenih izvornih populacija. Stoga bi uključenje populacija različitog ekogeografskog porekla u programe gajenja svilenih buba dovelo do poboljšanja najvažnijih ekonomskih osobina i određivanja produktivnosti čaura i sirove svile, umesto do uvećanja genetskog potencijala upotrebljenog izvornog materijala.