THE PRESENTATION OF SILKMOTH BOMBYX MORI L. SP. GENETIC RESOURCES IN ROMANIA AS SOURCE OF INITIAL MATERIAL IN AMELIORATION WORKS

Alexandra Matei[1], G. Chioveanu[2], M. Androne[1], D. Dezmirean[3], M. Dolis[4], I. Pasca[3], M. Bentea[3]

[1]*CS SERICAROM SA-Research Department, Bucharest, e-mail: monicamatei47@yahoo.com*
[2] *Institute for Diagnosis and Animal Health, Bucharest*
[3]*University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca*
[4] *"Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Iasi, Romania*

Abstract

The importance of gene bank existence as an essential condition for amelioration programs elaboration is unanimously known for every plant and animal species, from which the permanent preoccupation for its diversification and maintaining by appropriate proceedings of preservation "in situ" or "ex situ". This way, there is being avoided the loss of biological material, especially of the local races resistant to diseases and adapted to environmental conditions. This study aims the analysis of phenotypic characters variability within the genetic stock of Bombyx mori sp., according to its biological development stages (egg, larva and pupa). Native genetic stock of silkmoth Bombyx mori L. sp. resulted by: identification of local populations gene sources, bilateral exchange of biological material with similar foreign institutes, creation of new genotypes using specific breeding methods. Within its structure, the genetical stock of silkmoth include 72 races. The silkworm specific experimental technique has been applied, differentiated by technological and biological development stages. The sample size that were the base for phenotypic parameters determination as well as the working methods correspond to sericulture technical standards. The main phenotypical and quantitative parameters of the races that represent the gene stock of Bombyx mori sp., have the following values: prolificacy (230-710 eggs/laying), hatchability (80.6-100%), larval stage duration (26-32 days), larvae weight (4.2-5.7 g), larvae pupation rate (80.8-96.6%), raw cocoon weight (1.445-2.361 g), cocoon shell weight (0.240-0.520 g), fiber length (746-1356 m), filament size (2917-3764 m/g). Depending on the quantitative parameters value, the silkworm races are being used differently, entire genetic stock being destined for various technological levels, as follows: 4 active races (parents of hybrids), 3 candidate races for parents of hybrids, 65 races in preservation.

Key words: Bombyx mori, genetic stock, raw cocoon weight, cocoon shell weight, fiber length

INTRODUCTION

The heredity, variability and selection represents the main factors of the animal and vegetable organisms evolution. If heredity provides the resemblance of the individuals from successive generations, the variability represent the inconsistent side of heredity, determining the differences between individuals that exists more or less to all the living beings groups. The presence of variability makes the application of selection possible, action that leads to improving animal populations.

The necessity of studying the conservation of genetic stock, has been taken into consideration by many authors [3], [1], [8], [9], [6], [4], [5], existing two reasons for which the animal populations need to be preserved:

a) the statute of being in menace of disappearance;

b) their genetic value.

Taking into consideration the structure and functions of the organisms to whom the variability operates to, there are being dinstinguished: morphological variations including shape and size changes of the body regions or organs; physiological variations which refers to physiological processes, especially to the ones with implications upon some economical characters like production, food conversion, fecundity; structural variations regarding the structure of organs and tissues.

The variability of individuals which form a population, it refers both on quantitative and qualitative features, on this aspect being distinguished: quantitative variations that can be measured, which refers to differences between metric characters and mostly with economical implications; qualitative variations that can't be measured, they only can be described.

MATERIALS AND METHODS

The biological material has been represented by 72 races consisting of the gene stock of Bombyx mori sp., grouped by their origin.

The silkworm specific experimental technique has been applied, differentiated by technological and biological development stages [2]. The sample size that were the base for phenotypic parameters determination as well as the working methods correspond to sericulture technical standards.

RESULTS AND DISCUSSIONS

1. The variability of egg phenotypic characters

1.1. The variability of egg morphological characters

Egg size. The egg size at Bombyx mori L. sp. races is presented as follows: length 1.4 mm (native races), 1.3 mm (chinese races), 1.5 mm (japanese races) and 1.1 mm (tropical races), and the egg width varies between 0.89 and 1.02 mm.

The egg weight is 0.50 mg (native races), 0.49 mg (chinese races), 0.54 mg (japanese races) and 0.39 mg (tropical races).

Prolificacy (number of eggs/laying) (Table 1). Concerning Bombyx mori sp., the number of eggs/laying ratio varies between 200 and 800.

This character is being influenced by race, food quality provided to larvae, temperature and humidity conditions during laying depose.

In case of the races existing within the genetic sericultural stock, the prolificacy by race group registered values between 490 and 710 eggs/laying (native races), 276-562 eggs/laying (japanese races), 276-616 eggs/laying (chinese races) and 230-450 eggs/laying (tropical races).

Table 1
Egg biological parameters

Race groups	Prolificacy (number of eggs/laying)		Hatching (%)	
	Min	Max	Min	Max
Native races	490±10	710±12	90.0±0.47	99.0±0.47
Japanese races	276±11	562±6	81.3±1.70	99.6±0.47
Chinese races	276±2	616±15	80.6±1.89	100.0±0.21
Tropical races	230±16	450±29	83.6±2.49	97.6±1.25
Races average	318±9	584±15	83.9±1.64	99.1±0.60

Egg colour. During laying depose the egg colour is gradually yellow and in the next 3-4 days its colour becomes violet-pink and in the end the final colour is grey with different shades: dark grey, light grey, greenish grey but also orange, pink etc. All of these refers to embryonated egg colour.

The chorion colour, visible after larvae hatching, presents a serie of mutants: white, light yellow or dark yellow, green, grey. Being a race character, both the embryonated egg colour and chorion colour represent a silkworm selection character.

The races existing in sericultural native genetic stock present the egg colour in different shades: dark grey (japanese races), greenish-grey (chinese races), meanwhile the chorion is white at the first races group and yellow at the second one.

1.2. The variability of egg physiological characters

The voltinism (generations/year) represent a physiological character determined by environmental and genetical factors. Between environmental factors, the temperature and light plays an essential part. Incubating eggs from bivoltine races at the temperature 15-18°C and short photoperiod (less than 12 hours), silkmoth appear and depose non-hibernated eggs, that is 2 generations/year, in case of incubating eggs at high temperature (25-26°C) for a longer photoperiod (more than 12-14 hours), silkmoth appear and depose hibernated eggs (one generation/year).

The genetical determinism of voltinism is being attributed to a number of 3 multiple sex alleles (Hs, Hs^2, h_S) modified by a number of autosomal genes (H1, h_1, H_2, h_2, H_3, h_3).

The structure of sericultural native genetic stock includes bivoltine races (tropical type).

The hatching rate, by race group, varies between 90.0 and 99.0% (native races), 81.3-99.6% (japanese races), 80.6-100.0% (chinese races) and 83.6-97.6% (tropical races).

2. The variability of larva phenotypic characters

2.1. The variability of larva morphological characters

The larvae length is influenced by external factors, such as the rearing conditions, feeding but it also represents a race character specific to breeding races. By race group, the larvae average length is presented in Table 2.

Larvae weight is influenced by the factors that determined the previous character and their variability by race group is presented in Table 2.

Table 2
The variability of adult larvae length and weight by races groups

Race groups	Larvae length (cm) X±Sx	Larvae weight (g) X±Sx
Native races	7.6±0.02	5.7±0.12
Japanese races	7.0±0.03	5.6±0.08
Chinese races	6.2±0.06	5.1±0.10
Tropical races	5.8±0.06	4.2±0.11
Races average	6.7±0.04	5.2±0.10

Larvae colour represents a complex and variable character and refers to the tegument cephalic capsule and eyes.

In the breeding works, tegument colour and larval marks are selection criteria taken into consideration, as being race characters.

Body colour is normally white with a shade of light blue in chinese races and pink in japanese races, visible to the union place of the larva body segments.

2.2. The variability of larva physiological characters

The **moulting**, respectively the moults number, represent one of the most important physiological character of the larva. The primitive races are characterized by 3 moults, while developed races have 4 moults.

The geneticists appreciate that the presence of 3 moults represent the dominant character and the responsibles for hereditary transmition of the moults number are 3 multiple alleles: M^3 and M^5, the dominant relationships being tri>tetra>penta [7].

At the same time, the moulting is controlled by the combined action of the juvenile hormone secreted by corpora allata and the moulting hormone-ecdysone-secreted by the prothoracic gland, both being under the control of activator hormone secreted by neuro-secrethoris cells of the cerebroid ganglions.

The races existing within the sericultural native genetic stock, are characterized by the presence of 4 moults, excepting “Three Molter” race with 3 moults.

The duration of **larval stage** characterizes every race group, being shorter in tropical races (26-28 days), followed by native races (28-29 days) and longer in japanese ones (30-32 days) (Table 3).

Table 3
The variability of larval stage duration and pupation rate

Race groups	Larval stage (days)			Pupation rate (%)		
	Min	Max	Average	Min	Max	Average
Native races	28	29	28.5	90.2	96.6	92.50
Japanese races	30	32	30.0	85.6	96.4	92.30
Chinese races	28	30	28.6	80.8	93.8	89.14
Tropical races	26	28	27.0	90.0	92.6	91.3

Chrysalis transformation percentage (**pupation rate**) - character which reflects the viability state and their capacity of metamorphosis, have been high at the native race group (90.2-96.6%) and inferior at the other groups, as follows: 85.6-96.4% at the japanese races, 80.8-93.8% at the chinese races and 90.0-92.6% at the tropical races.

3. The variability of cocoon phenotypic characters

3.1. The variability of cocoon morphological characters

The **cocoon shape**, depending on the race group which belongs to, can be:

- elongated with constriction that characterize the japanese races;
- oval elongated with rounded extremities specific to chinese races;
- spherical, elongated without constriction, characterizing also some chinese races;
- spindle, elongated without constriction and with sharp extremities is the specific cocoon shape to the tropical races.

The **cocoon size**, expressed by the longitudinal and transversal axle length, presents a high variability within the sericultural genetic stock.

By races group, the cocoon size varies between the limits presented in Table 4.

Table 4
The variability of cocoon size

Races group	Longitudinal axle (cm)		Transversal axle (cm)		Cocoons/l	
	Max	Min	Max	Min	Max	Min
Native races	4.20±0.131	3.20±0.171	2.26±0.105	1.95±0.031	69±3	65±1
Japanese races	4.25±0.152	3.77±0.125	2.49±0.135	1.83±0.104	59±5	67±3
Chinese races	3.60±0.134	3.50±0.135	2.50±0.116	2.08±0.078	42±2	48±2
Tropical races	3.30±0.141	2.98±0.111	1.90±0.113	1.66±0.107	100±7	85±6
Races average	3.84±0.140	3.36±0.136	2.29±0.117	1.88±0.080	67±4	66±3

3.2. The variability of cocoon technological characters

Cocoon weight (Table 5) present, by race group, the following average values: the minimum value is between 1.445 (chinese races) and 1.632 g (japanese races), maximum value being between 1.709 (tropical races) and 2.361 g (chinese races).

Cocoon shell weight, corresponding to Table 5, has minimum values at tropical races (0.240 g) and maximum value at japanese races (0.520 g).

Silk content (Table 5) represent one of the most important selection's objective. Generally, the japanese races have maximum values (25.06%) on this parameter.

Table 5
The technological parameters of raw cocoon (g)

Races group	Raw cocoon weight (g)		Cocoon shell weight (g)		Silk content (%)	
	Min	Max	Min	Max	Min	Max
Native races	1.604±0.045	2.273±0.066	0.315±0.011	0.504±0.008	18.05±0.71	22.37±0.58
Japanese races	1.632±0.042	2.233±0.092	0.328±0.013	0.520±0.005	19.04±0.52	25.06±0.30
Chinese races	1.445±0.019	2.361±0.092	0.340±0.003	0.482±0.011	16.53±0.60	24.15±0.64
Tropical races	1.469±0.060	1.709±0.050	0.240±0.007	0.369±0.013	16.79±0.62	22.76±0.55
Races average	1.538±0.042	2.144±0.075	0.306±0.009	0.469±0.009	17.60±0.61	23.59±0.52

The **dry cocoon weight** (Table 6) registers maximum values at japanese races (1.250 g) and minimum values at tropical races (0.676 g). The **fiber length** (Table 6), same as dry cocoon weight, has the maximum value at the japanese races (1356 m).

Table 6
The technological parameters of dry cocoon and silk fiber

Races group	Dry cocoon weight (g) X±Sx		Fiber length (m) X±Sx	
	Min	Max	Min	Max
Native races	0.843±0.028	1.163±0.033	1119±22	1324±38
Japanese races	0.870±0.036	1.250±0.035	1037±16	1356±33
Chinese races	0.724±0.028	1.184±0.031	908±15	1236±24
Tropical races	0.676±0.018	0.823±0.026	746±10	950±27
Races average	0.778±0.028	1.105±0.031	952±15	1216±30

Reeling silk registers also maximum values at native races (44.8%) and minimum values at tropical races (32.0%).

Filament size, expressed by metres/g, has maximum values at native races (3241-3764 m/g). Lower performances, but still notables, have the japanese races (3041-3460 m/g).

Notable performances of filament size have the chinese races (3016-3762 m/g). At the tropical races, the filament size is between 2917 and 3090 m/g, being lower to the previous groups.

CONCLUSIONS

Depending on the quantitative parameters value, the silkworm races are being used differently, entire genetic stock being destined for various technological levels, as follows:

- 4 active races (parents of hybrids);
- 3 candidate races for parents of hybrids;
- 65 races in preservation.

REFERENCES

Journal articles

[1] Brasla A., Matei A.: Study on the variability of the main quantitative traits in some silkworm races, Archiva Zootechnica, 1989, vol. 1, p. 63-70.

[4] Matei A. and coll.: The diversification and utilization of genetical stock as source of initial material in breeding works of Bombyx mori L. – Romanian Animal Science in the EU integration perspective – Session of scientific communications, Iasi, Romania, 2004, p. 218-222.

[5] Matei A.: The structure, origin and performances of races sp. Bombyx mori L. existing in sericultural genetic stock in Romania – The XXIII[th] National Symposium of history and agrarian retrology, 23-24 august, Bacau, 2007.

[6] Petkov N., Matei A., Natcheva Y., Vasileva Y., Petkov Z., Ciulu M.: The phenotipical characters of some Romanian silkworm Bombyx mori races in relationship to the use of selection programmes-AGRAL Scientifical Symposium "Research upon chain from Romania in a European Context, Romania, 2004, p. 280-286.

[8] Thangavelu K.: Role of germplasm bank in sericulture – Indian Silk, 1997, 36/3, p.5-11.

[9] Tzenov P., Vasileva Y.: Silkworm genetic resources in Bulgaria – XIX[th] Congress of International Sericultural Commission Proceedings, Bangkok, Thailand, 2002, p.243.

Books

[2] Grekov D., Kipriotis E., Tzenov P.: Sericulture training manual, Komotini-Greece, 2005.

[3] Hebean V.: Study upon phenotipical and genotipical characters in the imposted Phylosamia ricii race and possibilities to create native biological material – Ph.D. thesis, Romania, 1986.

[7] Tazima Y.: The genetics of the silkworm, Logos Press, 1964.