Genetic determinism of sex in poultry

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Abstract

The results of experiments conducted on the genetic determinism of sex in poultry explain the role of genes x and y+ from the heteromal locus x/y in sex inheritance. The gene theory of sexuality is proposed instead of the chromosome theory of sex inheritance by heterosomes. This theory explains both the roles of genes x and y+ in the genetic determinism of sex and the role of the other genes from the heterosomes (including from chromosome Y) in the inheritance of some autosomal traits.

Keywords: *parents, hybrids, heterosomes, locus, gene, silver, gold, phenotype, genotype, heterozygous, codominant, dominant, epistasy*

Introduction

The first discoveries in the genetic determinism of sex are from 1891, when the German cytologist Henking conducted studies on Phirrocoris insects. They had two types of gametes: half displayed some particular nuclear formations, which he called X, while the other half represented the specific nuclear structure.

Subsequent studies (Drăgănescu, 1979; Negruțiu and Petre, 1975; Panfil, 1984; Petre *et al.*, 1975; Pipernea, 1979; Popescu Vifor, 1978; Pricop *et al.*, 1996, 1998, 1998, 2001; Sandu, 1983; Sandu *et al.*, 1999; Văcaru-Opriş, 2000; Văcaru-Opriş *et al.*, 1999; Vintilă *et al.*, 1976) confirmed that chick separation by sex is in 1/1 ratio. This ratio between sexes, constant in nature, is based on the fact that both in plants and in animals there is a homogametic sex XX or ZZ and a heterogametic sex XY or ZW or ZO. In the latter, ‘O’ signifies the lack of chromosome Y or W.

The purpose of this paper is to set the scientific grounds for the gene theory of sexuality.

Material and method

The present study was conducted in S.C. AVICOLA Bucureşti, S.A.

The commercial hybrid ROSO SL-2000 is produced by crossing red Rhode Island cocks pure for golden gene (AB parent – simple father hybrid) with white Rhode Island hens pure for silver gene (CD parent – simple mother hybrid) (see Fig. 1 in Pricop *et al.* - Genetic determinism of feather color in ROSO SL-2000 hybrid layers).

Throughout 10 years we conducted three rounds of investigations both experimental and in production with the purpose to observe the manner of feather color inheritance in ROSO SL-2000 hybrid layers.

The stock of Rhode-Island parents (AB cocks × CD hens) produced eggs which were used for two hatching batches.

A total of 10,000 eggs were used for each batch.

From each batch we obtained 8,000 double hybrid chicks that were sexed by the feather color.

Results and discussion

Following are the results of the investigations concerning the genetic determinism of feather color inheritance in ROSO SL-2000 hybrid layers and the role of x and y+ genes from the heterosomal locus x/y in sex inheritance.

The homogametic sex was marked XX (cocks) and the heterogametic sex was marked XY (hens).

Table 1 (see Pricop *et al.* - Genetic determinism of feather color in ROSO SL-2000 hybrid layers) shows the results of day-old chick sexing.

Fig. 1 (see Pricop *et al.* - Genetic determinism of feather color in ROSO SL-2000 hybrid layers) shows the design for producing ROSO SL-2000 hybrids and the manner of transmitting the genes involved in the genetic determinism of sex and down/feather color.

Silver gene (S) determines the white color in most day-old hybrid cockerels (86.6%). There also were cocks with a dark brown spot on the head and three dark brown stripes on the back and white cocks with a brown spot on the back. These codominant phenotypes accounted for 13.4% of the produced cocks (see Fig. 2 in Pricop *et al.* - Genetic determinism of feather color in ROSO SL-2000 hybrid layers).

After the age of 4 weeks, red feathers appear in the white cocks, which shows that the golden gene (G) expresses phenotypically its effect, being codominant in relation to silver gene (S).

Four types of color appear in day-old pullets, the down being white, reddish or completely red (Fig. 2).

In the hybrid hens feathers are preponderantly red, with some white ones; the small feather hooks are yellow-red, which is accounted by the action of silver gene present on chromosome Y.

The lack of white down in day-old hybrid pullets corroborated with the low proportion of white feather in the adult hens is due to the action of a heterosomal epistatic gene located on chromosome Y. This gene has epistatic effect on golden gene from the hetersomal locus golden/silver. Under these circumstances, golden gene (G) expresses phenotypically its effect in the hybrid hens, most feathers being red.

Under these conditions the genes from chromosome Y do not display phenotypically their effect from the beginning of ontogenesis, but later, when the epistatic gene alleviated its effect.

The heterosomal epistatic gene and silver gene are sex-linkate genes, located on chromosome Y, which explains the difference of color between the cocks (XX) and the hybrid hens (XY).

The hybrid hens have preponderantly red feathers with yellow-red feather hooks, while the cocks have a mixture of white and red feathers. Silver gene displayed differently its effect in the two sexes. While in males (XX) the white feathers are very well represented, in the female sex (XY) they are much less represented (see Fig. 3 in Pricop *et al.* - Genetic determinism of feather color in ROSO SL-2000 hybrid layers).

On the other hand, the heterosomal gene of chromosome Y, which is in linkage with silver gene and on which it has epistatic effect, is gene y+ located in locus x/y.

On chromosome X at locus x/y there is gene x. Genes x and y+ play a very important role in the genetic determinism of sexes.

The female sex has the heterozygous phenotype xy+ in which gene y+ is dominant and gene x id recessive (codominant).

The male sex has a homozygous phenotype xx, the two genes being codominant as gene gold and silver are.

Our studies revealed in the heterogametic sex (XY) the presence of some loci on chromosome Y (for instance golden/silver) with corresponding loci on chromosome X.

The difficulties encountered so far in locating heterosomal loci and genes on chromosome Y were due to the epistatic action of the dominant gene y+. The presence of gene silver corroborated with the different feather color showed that on chromosome Y there are genes with identical autosomal roles with the ones on sex chromosome X. In other poultry populations there are no heterosomal genes on the sex chromosomes such as slow-feathering dwarf and others.

The role of silver gene is very important because it allowed us to identify the dominant gene y+, which plays an important role in the genetic determinism of sexes. At the same time, gene silver allowed us to observe its linkage to gene y+ from chromosome Y and the existence of epistasy between gene y+ and gene silver (S).

Following these results we propose to replace the chromosomial theory of sex inheritance by heterosomes, with the <u>gene theory of sexuality</u>. This theory explains both the role of genes x and y+ in the genetic determinism of sexes and the role of the other genes from the heterosomes (including those from chromosome Y).

When a heterozygous female (xy+) is crossed with a homozygous male (xx) the resulting offsprings are in a 1:1 ration males (50%) and females (50%).
The science of genetics will continue to present the heterosomes as being the chromosome pair where the genes playing a role in the genetic determinism of sexes are located. The other genes with autosomal role fro heterosomes are linked inherited with genes x and y+ situated on the heterosomal locus x/y.

Conclusions

Feather color inheritance is determined genetically, by hetersosomes and is achieved through genes golden (G) and silver (S), codominant genes.
The lack of white down in day-old hybrid pullets corroborated with the low proportion of white feathers in adult hens is due to the action of the heterosomal epistatic gene on gene silver, both located on chromosome Y.
The existence of the heterosomal locus golden/silver is confirmed, which means the existence of gene silver on chromosome Y in the hybrid hens.
The existence of genes golden (G) and silver (S) on golden/silver locus was observed in the hybrid ROSO SL-2000 hens; at least in this case the existence of the phenomenon of hemizygocy is denied.
On the sex chromosomes at x/y locus there are genes y+ (dominant) and x (recessive), involved in the genetic determinism of sexes. In poultry genotype xy+ determines the female sex and genotype xx determines the male sex.
When a heterozygous female (xy+) is crossed with a homozygous male (xx) the resulting offsprings are in a 1:1 ration males (50%) and females (50%).
Gene y+ is dominant towards gene x and it also has an epistatic role on gene silver on chromosome Y in the hybrid hens.
The feather color differences between the hybrid hens and cocks support the proper effect of gene silver in the cocks (XX) where the white feathers are properly represented (no epistasy). In the hybrid hens (XY) the proportion of white feathers is very low, due to the action of gene y+ with epistatic role on gene silver.
The existence of genes x and y+ on locus x/y on the heterosomes and of the heterozygous genotype (xy+) in the female sex and of the homozygous genotype (xx) in the male sex supports the gene theory of sexuality.
The heterosomes differ from the autosomes by the presence of locus x/y where the genes involved in sex inheritance are located.

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