A HEN WHICH CHANGED COLOR¹

A Note on the Hereditary Behavior of a Normal Blue Andalusian Hen Whose Feathers Changed to Snowy White

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CASTLE and Phillips' (1911) studies on ovarian transplantation in guinea-pigs have been most useful as classroom illustrations of the separateness of the soma and germ-plasm. They have conveyed to the elementary student as no amount of explanation might, just what the underlying principle of Weismann's (1893) great concept was. These results are too familiar to biologists to need review.

In connection with a study of the inheritance of blue in poultry, the writer has observed a marked somatic change in a blue Andalusian hen, which, as was to be expected, did not in any way change the gametes she produced. Because the change was a rather striking one and might serve as an example of the independence of the body-plasm and germ-plasm from another point of view, it has seemed worth while to give a detailed account of the case.

What appeared to be a normal blue Andalusian hen was turned over to the writer in the early spring of 1917 by Professor J. G. Halpin of the University of Wisconsin. She came from the flock of the University Poultry Department and was then almost two years old. This hen was from a pedigreed family, among the members of which nothing unusual had been noted. She carried the University legband number C2032, and was, among others, used in breeding work carried on at the University during that spring.

In August 1917 she was taken to Kansas State Agricultural College at Manhattan where she has since been kept on the farm of the Department of Poultry Husbandry.

In October 1917 it was observed that white feathers were appearing on her

neck and a little later that her developing primaries also were white. It was noted that new feathers were coming in in other regions of the body which were the normal blue, and by December 1st it was apparent that she had completed her molt for that season.

Her appearance on December 20, 1917, is shown in Fig. 1. There was no further noticeable change until the following July when it was observed that she was again in full molt, her old feathers both blue and white being replaced only by white. Photographs taken August 7, 1918, may be seen in Figs. 2, 3 and 4, which show her during the progress of her molt. Six weeks later she was snowy white throughout (Fig. 7). She has since never displayed a blue feather and is now (October 1920) in apparent good health and laying occasionally.

CAUSES OF COLOR CHANGES

Supposing that similar color changes among domestic birds were not uncommon, a search of the literature was made. While it has not been exhaustive, the writer has been surprised not to find, in the journals at his disposal, accounts of similar changes. The account of Finches' (1908) hen indicates that the color change was first due to loss of pigment from the feathers after growth and not to a failure of the pigment-manufacturing mechanism to function. The color change came after, and not as the accompaniment of, a molt. During a subsequent molt pigmented feathers were grown which later turned white. Whether the pigment forming mechanism was somewhat interfered with during this molt, or the bird passed through a partial molt only, is not clear.

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BLUE ANDALUSIAN HEN (C2032) CHANGING TO WHITE

This hen, from the University of Wisconsin Poultry Department, was considered in the spring of 1917 to be a normal blue Andalusian. In October of the same year white feathers appeared on her neck. The illustration shows her as she appeared December 20, 1917, after completing that season's molt. Photograph by James Machir. (Fig. 1.)

The particular interest in the case in hand arises not alone from the fact that the subject changed color but that in addition her ancestry and breeding performance are known.

As shown by Lippincott (1918) blue Andalusians are usually of the genetic constitution $PP (Re) (rE)$. P is a factor necessary for the production of black pigment. Its allelomorph p produces a recessive white. R is a dominant, acting on black pigment, restricting its distribution in such a way as to give a characteristic bluish gray appearance. E is a dominant factor render-

ing an individual carrying P self colored. Self-blue is the result of the combined action of R and E on black pigment. For reasons developed in the paper noted, and in a further paper soon to be published, it appears reasonable to assume that R and E are each closely, perhaps completely, linked to the allelomorph of the other, hence written (Re) and (rE) .

As shown earlier by Bateson and Punnett (1906), when blue Andalusians are mated *inter se* they produce blacks, blues, and white-splashed, in the ratio of 1 to 2 to 1. Genetically the reason

THE BLUE ANDALUSIAN HEN (C2032) EIGHT MONTHS LATER THAN FIG. 1

"There was no further noticeable change (from the condition shown in Fig. 1) until the following July when it was observed that she was again in full molt, her old feathers, both blue and white, being replaced by only white." These three views show the hen as she appeared August 7, 1918. No. 3 is a front view. A comparison of the two sides with regard to the order in which the blue feathers were dropped is a matter of considerable interest to poultrymen. Was the change in color due to loss of pigment from the feathers after growth or to a failure of the pigment-manufacturing mechanism to function? Photographs by James Machir. (Figs. 2 and 3.)

for this is shown in the following cross.

Blue Andalusian ♂	X	Blue Andalusian ♀
$PP(Re)(rE)$		$PP(Re)(rE)$
Offspring	$\begin{cases} 1PP(rE)(rE) \text{ black} \\ 2PP(Re)(rE) \text{ blue} \\ 1PP(Re)(Re) \text{ white-splashed} \end{cases}$	

The white-splashed individuals, as would be expected if the symbolism proposed is correct, are splashed with blue, and sometimes referred to as blue-splashed.

RESULTS OF BLUE AND WHITE MATINGS

During the spring of 1917 before C2032 had exhibited any tendency toward a color change, she was mated to a blue Andalusian, ♂ S19, from the

LEFT SIDE VIEW TAKEN SAME TIME AS THOSE ON OPPOSITE PAGE

The photographs on this and the opposite page were taken August 7, 1918, eight months later than the photograph reproduced in Fig. 1. Six weeks after the above condition obtained, all the feathers had changed to snowy white, a condition which the hen has retained to the present time. See Fig. 7. (Fig. 4.)

University of Wisconsin flock. But five chicks here hatched, of which one was blue-splashed and four were blue, the theoretical expectation being 1.25 splashed, 2.50 blue and 1.25 black.

The following year, 1918, while in the condition, as regards color, shown in Figure 1, she was mated with white Wyandotte ♂118M from the Kansas State Agricultural College flock. As shown in an unpublished paper the genetic constitution of 118M was $pp(rE)(rE)$, so far as the factors under consideration are concerned. The expectation from such a mating would be equal numbers of blues and blacks.

Twenty eight chicks were hatched, of which thirteen were blue and fifteen were black.

The next breeding season, 1919, after C2032 had become pure white, she was mated to a white Plymouth Rock ♂155 M (see Fig. 5). Twenty five chicks were hatched, of which seven were blue and eighteen were black, the theoretical expectation being 12.5 for each color. This deviation is probably not significant since $\frac{\text{Dev.}}{\text{P.E.}} = 3.2$. A black and a blue chick, offspring of this mating, are shown in Figure 6.

A WHITE PLYMOUTH ROCK (155M)

During the breeding season of 1919, the blue Andalusian Hen (C2032), after she had become pure white, was mated to this White Plymouth Rock (155M). Out of twenty-five chicks hatched, seven were blue and eighteen were black. Two of the offspring are shown on the opposite page. Photograph by James Machir. (Fig. 5.)

During the breeding season of 1920 she was mated with white Wyandotte ♂206M. This bird was similar in genotype to 118M and 155M except that he was heterozygous for I^P (inhibitor of pigment), a factor for dominant white. Nine chicks were hatched of which three were blue, four were black and

two were white. The theoretical expectation would be 2.25 blue, 2.25 black and 4.50 white.

It is evident that C2032, though snowy white, was continuing to breed as a blue Andalusian. A genetically recessive white female mated to the white Plymouth Rock used would have

A BLUE-BARRED AND A BLACK-BARRED CHICK

These two chicks were among the offspring from the mating of white Plymouth Rock 155M and blue Andalusian C2032 during the season of 1919. The barring factor was brought in by the male. "It is evident that C2032, though snowy white, was continuing to breed as a blue Andalusian." Photograph by James Machir. (Fig. 6.)

produced only white chicks, unless it was the kind of white peculiar to the Japanese Silky. A genetically dominant white female would also have produced only white offspring, if she were homozygous. If she were heterozygous dominant white but homozygous for *P*, half her chicks by a white Plymouth Rock would have been white and half pigmented. Other possible

combinations might be suggested, but none fits the case except the assumption that she is genetically a blue Andalusian though a beautiful snowy white in appearance. A similar conclusion is reached from the results of her mating with white Wyandotte ♂ 206M. A photograph of the hen after she had become completely white is shown on the following page.

REFERENCES

- Bateson, W., and Punnett, R. C., 1906. Reports to the Evolution Committee of the Royal Society, III pp. 11-23.
 Castle, W. E., and Phillips, John C., 1911. On germinal transplantation in vertebrates. Carnegie Inst. of Wash. Pub. 144, pp. 26.
 (Finch, W. Coles), 1909. Miscellanea VII. Note on partial leucosis in a hen. *Biometrika* 7:234-236.
 Lippincott, W. A., 1918. The case of the Blue Andalusian. *Amer. Nat.* 52:95-115.
 Weismann, A., 1893. The germ-plasm. Eng. trans. by W. N. Parker and Harriet Rönnefeldt. New York.

BLUE ANDALUSIAN HEN (C2032) CHANGED TO SNOWY WHITE

This photograph was taken September 21, 1918 after the hen had completed her annual molt, and shows her condition six weeks after that illustrated in Fig. 4. She has since remained snowy white, is in apparent good health, and lays occasionally. Photograph by James Machir. (Fig. 7.)