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VARIATIONS IN THE DOWN COLOR OF WHITE LEGHORN CHICKS AND THEIR ECONOMIC INSIGNIFICANCE[1]

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INTRODUCTION

Although adult White Leghorns are all pure white (except for an occasional female with salmon breast, or a male with "brassiness" or with red on the shoulders), the down color of the chicks varies from an almost pure white in some individuals to a rich, golden yellow in others. Some poultrymen consider that the paler chicks are less vigorous and less desirable than the richly colored ones, but no actual test to determine the validity of such beliefs has hitherto been reported. Therefore, when striking differences in down color were observed in two strains of White Leghorns being selected at this laboratory for high and low requirements of riboflavin, a study was undertaken to find (1) the genetic basis for these variations, and (2) the relation, if any, of down color in the chick to such economically important characters as body size, viability, age at sexual maturity, and capacity for egg production.

MATERIAL AND METHODS

BASES OF SELECTION

In the first year of selection in Single-Comb White Leghorns for high and low requirements of riboflavin, it became evident that most of the chicks from dams considered to have a high requirement of that vitamin were darker in color than those in the "low" line. Because riboflavin is yellowish, it seemed possible that the intensity of yellow color in the down might be related to the chick's quantitative requirement of that vitamin. For that reason, all chicks in both lines were classified according to color. Later evidence showed that riboflavin had little or nothing to do with the color of the down feathers. Moreover, possibly because of difficulties inherent in the procedures used, the selection practised proved to be ineffective, and the two strains did not really differ in requirement of riboflavin. For that reason, they are hereafter designated in this paper merely as the "dark" and "light" strains.

Selection of breeders in 1936, 1937, and 1938 was based upon previous tests of their ability to reproduce when on diets deficient in riboflavin. Color of down was not considered. However, in 1939, chicks

[1] Received for publication February 14, 1941. This paper is No. 14 in a series by the junior author entitled "Genetics of the Fowl."

of the dark strain were obtained from pullets belonging to the two darkest (dams') families hatched in the previous year. Similarly, chicks of the light strain were hatched from pullets in the two lightest (dams') families of the year before.

Although eggs were incubated in two different forced-draught incubators, during any one period all eggs were placed together in the same machine, so that any changes in humidity or other environmental conditions could not affect the chicks of one strain more than those of the other.

CLASSIFICATION

For purposes of this study, the chicks were classified with respect to down color, as follows:

Dark.—Golden brown color on the back of the neck, across the shoulders, and along both sides of the breast.

Medium.—Intermediate between dark and light.

Light.—Very light cream color, sometimes with a greenish cast. White is rare.

Typical representatives of these three grades, reproduced by color photography, are shown in plate 1. In the two strains studied, there seemed to be a clear, natural distinction between dark chicks and those classified as medium or light. The medium and light chicks were therefore combined in one group so that the populations might be compared with greater ease. When this is done, any population can be briefly described by stating merely the proportion of dark chicks that it contains. On the other hand, in unselected control populations, and in the F_1 progeny from certain crosses, there was a uniform gradation in the intensity of color from dark to light. The chicks of medium color are considered separately in some of the analyses reported in this paper in order to compare either the extremes in pigmentation, or their effects. Chicks of the dark, medium, and light shades are quite indistinguishable later on when fully feathered.

A classification of colors using only three grades followed by a combination, for some purposes, of the two lighter shades may seem inadequate. It must be remembered, however, that the range of color in White Leghorns is not great. A comparison of the color standards used in the present work with those used by Warren (*11*)[2] in classifying Rhode Island Reds shows that the range of intensity of color was less in the writers' dark, medium, and light chicks than in the lightest three of his five grades.

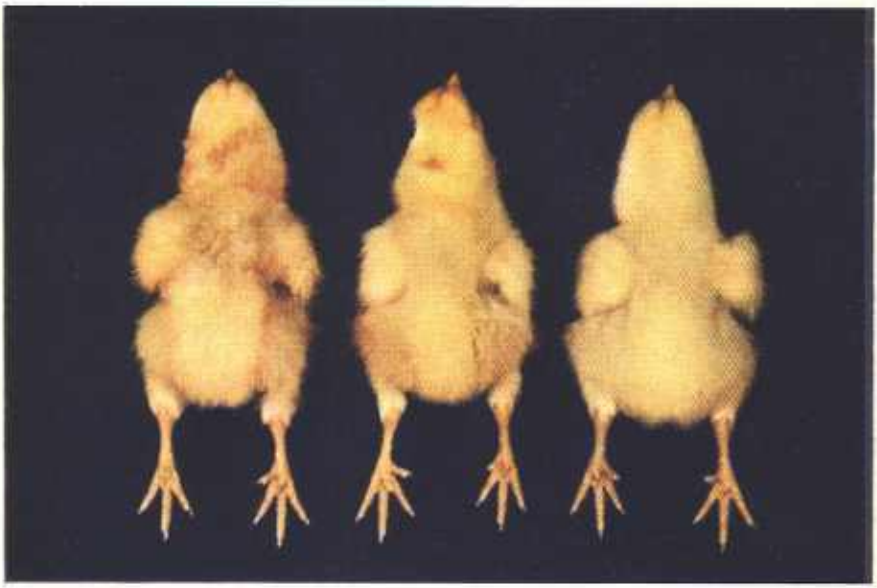
GENETIC ANALYSIS

DOWN COLORS IN THE ORIGINAL STRAINS

The proportions of chicks in the dark and light strains that were graded as dark are shown in table 1.

It should be noted that in 1937, even though color of down had not been considered as a basis for selection of breeding stock, there was such a difference between the strains that 94.4 percent of the chicks in one strain graded as dark, while only 2.8 percent of those in the other were so classified. So far as is known, the selection practiced could have had no effect upon the segregation of genes for color. It is assumed, therefore, that the original differences between the two strains were the result of chance segregation of the genes responsible.

[2] Italic numbers in parentheses refer to Literature Cited, p. 205.



Typical representatives of dark, medium, and light colored White Leghorn chicks. In the two strains studied there seemed to be a clear, natural distinction between dark chicks and those classified as medium or light. For this reason the two lighter shades were sometimes combined to facilitate comparison.

The rapid differentiation of the dark and light strains, without selection for color, suggests that if more than one gene is responsible for the differences in down color, they must be few in number.

TABLE 1.—*Proportions of chicks having dark down in the dark and light strains and in controls, 1936–40*

Year	Dark strain		Light strain		Unselected controls	
	Chicks classified	Chicks with dark down	Chicks classified	Chicks with dark down	Chicks classified	Chicks with dark down
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
1936	42	61.9	257	19.5	----	----
1937	124	94.4	428	2.8	827	27.7
1938	91	85.7	296	12.5	----	----
1938S [1]	52	92.0	45	4.0	----	----
1939	14	100.0	44	4.5	----	----
1940	68	83.8	217	3.7	----	----

[1] A selected population including only chicks of the 2 darkest and 2 lightest families.

After 1938, selection of breeders from the two darkest and two lightest families in the dark and light strains, respectively, effectively maintained the proportion of dark chicks at a high level in one strain and at a low level in the other. The data in table 1 show that neither strain "bred true" for its predominant shade of down, but even the exceptions of 14.3 and 12.5 percent (in 1938) are not great if one considers the difficulty of making the somewhat arbitrary classifications necessary in dealing with shades of chick down. Most of the variation occurred in a few families. Others, particularly those having darkest color, bred true to type.

In table 1, the populations labeled "1938S" include all chicks in the two darkest and two lightest families (of dams) in the dark and light strain respectively. Exceptions to the rule of color in these families were fewer than in the unselected 1938 populations from which they were taken. These few selected birds provided the parents of the 1939 generation, and these in turn were used to produce the chicks of 1940.

To determine the frequency of dark and light downs in an unselected population, 827 chicks representing four different strains of Leghorns were classified in 1937. Of these, 27.7 percent were dark, 59.6 percent medium, and 12.7 percent light. This distribution is in marked contrast to the uniformity of the dark and light strains and serves to emphasize the degree of differentiation between them.

RECIPROCAL CROSSES OF DARK AND LIGHT STRAINS

Because of the evidence, already discussed, that only a few genes were responsible for the differentiation of the dark and light strains, and the additional fact that both were breeding fairly true to type, it seemed probable that crosses between the two strains would shed some light on the genetic bases for the difference. Reciprocal crosses were made so that the effects of any sex-linked genes involved would be evident in the F_1 generation. Several different matings spread over 2 years were used for these crosses. An F_2 generation was hatched and also backcrosses of the F_1 to both the dark and light lines. The results in these various types of matings are shown in figure 1.

For simplicity, the nature of the dark and light strains, F_1, F_2, and backcross populations is shown in figure 1 merely by giving the proportion of each population that was classified as dark. The same dark females that produced the dark-strain chicks shown in figure 1 were also mated with males of the light strain (but at a different time) to produce part of the F_1 chicks considered in that figure. Similarly, the light-strain chicks and the F_1 generation from light females × dark males are all progeny of the same dams. The difference between the first and third columns in figure 1 shows, therefore, that the light-down males yielded only about two-thirds as many dark chicks as did the dark-down males when both kinds were mated to the same dark-

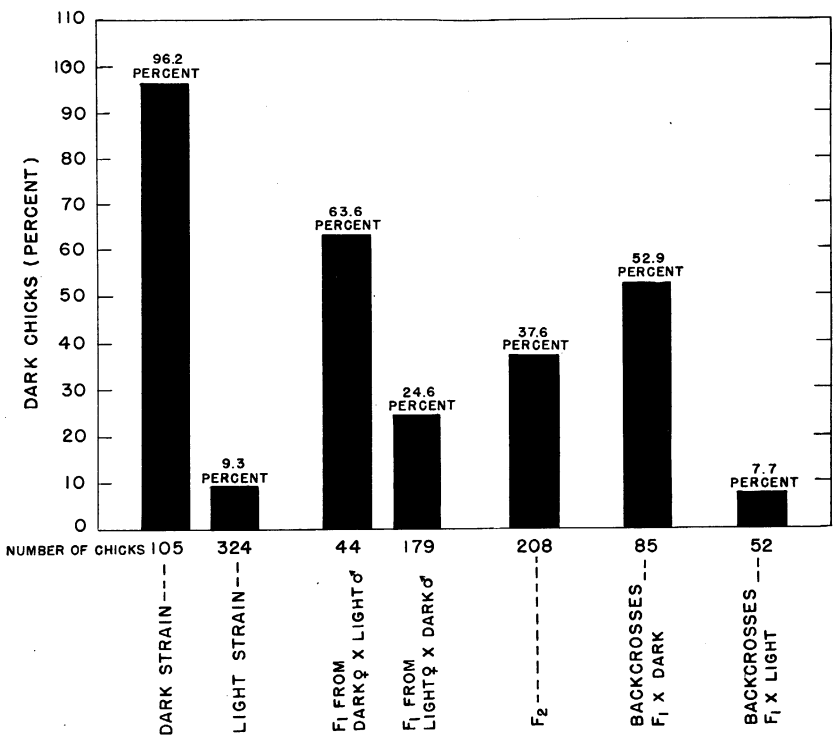


FIGURE 1.—Proportion of darkly-colored chicks in the dark and light strains, in the F_1 generations, in the F_2 generations, and in backcrosses.

down females. In the reciprocal cross, use of the dark males raised the proportion of dark chicks from 9.3 percent within the light strain to 24.6 percent in the F_1 generation.

To determine whether or not the progeny of dark males are significantly different from those of light-strain males when both are mated to the same hens, the results of such matings with 15 hens representing both strains were tabulated. The proportion of dark-colored chicks among the progeny of each of the 30 different matings was calculated in percent, and then converted to equivalent angles for statistical treatment as suggested by Snedecor (*10, p. 381*). An analysis of variance then showed that there were significantly more dark-colored chicks from the dark- than from the light-strain males, with odds of more than 100 : 1 that the difference was not due to chance.

In the two F_1 populations, the proportions of chicks with dark down were intermediate between those in the parent strains. Because of the discrepancy between the proportions of dark chicks in these two populations (63.6 and 24.6 percent), it is doubtful whether the dark and light downs can be simple allels differentiated only by a single autosomal gene. In that case, one would expect about the same proportion of dark chicks in each population.

The discrepancy between the two progenies from reciprocal crosses suggests that sex-linked genes were exerting some influence on the down color in the F_1 generation. However, if this were so, one would expect a sharp difference between the two F_1 populations of females (since in the fowl the female is the heterogametic sex) with respect to color of down.

This is illustrated by assuming a condition of incomplete dominance, but assigning to the character light down, the gene symbol L, and to dark down the symbol l. From reciprocal crosses, only one color of female could then be expected from each of the crosses as follows:

Dark female ($l-$) × light male (LL) ⟶ only light females ($L-$).
Light female ($L-$) × dark male (ll) ⟶ only dark females ($l-$).

In the first reciprocal cross (table 2, No. 1), there were obtained 21 dark females and 27 light ones. In the second cross, a great excess of light-colored females was found (table 2, No. 2) where only dark ones would be expected if the character were controlled by a sex-linked gene. These results show, therefore, that sex-linked genes have little control, if any, over the color of down, and that the differences in pigmentation of chicks obtained from reciprocal crosses must be explained in some other way.

TABLE 2.—*The colors of male and female chicks from reciprocal crosses between the light and dark strains*

Reciprocal cross No.	Mating	Males		Females	
		Dark	Medium and light	Dark	Medium and light
		Number	*Number*	*Number*	*Number*
1	Dark females × medium or light males	36	22	21	27
2	Medium or light females × dark males	17	57	16	61

In this same mating (table 2, No. 2), there was a corresponding excess of light chicks among the males, so that whatever influence the dams exerted upon the color of the progeny was approximately equal in both sons and daughters. The fact that less than 22 percent of the progeny of light dams bore dark down, while more than 53 percent of the progeny of dark dams did so (table 2), strongly suggests that some maternal influence is exerted upon the color of down in both sexes. The mechanism responsible for such an effect is unknown.

In the F_2 population as a whole, 38 percent of the 208 chicks had dark down. However, among those from a medium-down F_1 male, son of a dark dam, the proportion of dark chicks was only 23 percent, while the the F_2 progeny of a dark F_1 male from a light-strain female 60 percent were dark.

The numbers of chicks in table 2 differ from those of similar matings shown in figure 1 because different numbers of breeders were used.

Some hens were used in reciprocal matings (table 2) that were not also used for matings within their strains, as was required for figure 1.

RELATION OF DOWN COLOR TO SEX

In chicks classified as having medium down color, the ratio of males to females was almost identical with the normal expectation of 1:1 (table 3). However, among the dark chicks there was a marked excess of males, and among the light ones a corresponding excess of females (table 3).

TABLE 3.—*Distribution of down colors in relation to sex, showing an excess of males in the dark chicks and an excess of females in the light ones, 1937–39*

Population	Year	Dark		Medium		Light	
		Males	Females	Males	Females	Males	Females
		Number	*Number*	*Number*	*Number*	*Number*	*Number*
Unselected controls	1937	165	64	257	236	40	65
Light strain	1937	6	6	135	133	63	85
	1938	29	8	106	111	13	29
F_2 generation	1939	47	21	43	52	5	13
Total		247	99	541	532	121	192
		Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Proportion in each color class		71	29	50	50	39	61

Down colors and sex ratios in the dark strain are omitted from table 3. Populations of that strain contained approximately equal numbers of males and females, but, since 84 percent or more of the chicks in that strain were of the darkest shade, with only 16 percent or less distributed through the medium and light shades, it could yield little information about the relation of down color to sex. The unselected control population, the light strain, and the F_2 generation showed more variability in down color. In all of these, the predominance of males among the dark chicks and of females among the light ones was consistent (table 3).

It may be noted that the populations included in table 3 contain 909 males, but only 823 females. This deficiency of females below expectation, and the discrepancies between the numbers in table 3 and those for the unsexed chicks of figure 1, probably resulted from the fact that the sex of all males was recorded when they were segregated at about 8 weeks of age, whereas the sex of females was not recorded until they were housed at about 5 months of age. By that time, their numbers had been diminished somewhat by predators. However, there is little likelihood that the females lost differed in color of down from those that survived (see table 5). For that reason, the deficiency of females cannot have affected the proportions of dark, medium, and light females given in table 3, although it has undoubtedly reduced the number in each of these classes.

Since families of dark chicks in the selected strains were differentiated from medium chicks more sharply than were the light-colored ones, there is some basis for combining the medium and light chicks in one class. When this is done, the totals for the populations given in table 3 are as follows: In males, 247 dark : 662 medium and light; in females, 99 dark : 724 medium and light.

Application of the chi square test to this distribution yields a value for χ^2 of 62 and for P of <0.001. This shows that the proportion of dark chicks among males is significantly higher than in females.

RELATION OF DOWN COLOR TO CHARACTERS OF ECONOMIC IMPORTANCE

To verify or disprove the belief of some poultrymen that the paler Leghorn chicks are less desirable than the dark ones, females of the dark and light strains, previously classified according to down color,

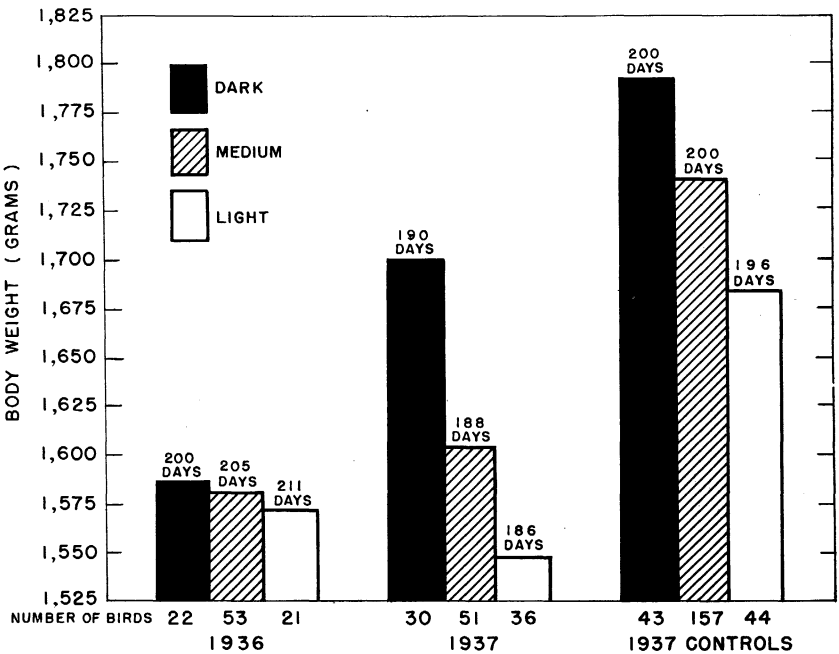


FIGURE 2.--Body weights and ages at first egg for dark, medium, and lightly colored chicks, 1936 and 1937. The numbers on the tops of the columns are the mean ages at first egg in each group.

were kept in 1936 and 1937 for measurements of their viability, productivity, body size, and age at sexual maturity. The results, presented in tables 4 to 6 and in figure 2, are not given separately for each strain, but rather for dark, medium, and light chicks as classes, regardless of the strain from which they originated. In addition, 359 chicks of the unselected control population of 1937 were utilized for similar comparisons.

BODY WEIGHT AND AGE AT SEXUAL MATURITY

It was not possible to take weights regularly of all the available birds, but, to determine whether or not the paler chicks were smaller at hatching or developed into "runts" at an early age, two lots of chicks were weighed at hatching and again at 11 days of age. The

mean weights in these two lots (table 4) show that light chicks were no smaller than the others at 11 days of age, were larger than the medium-colored ones at hatching, and smaller than the dark ones at hatching by differences that could hardly be significant with the numbers involved. Weight of the chick at hatching is highly correlated with the weight of egg. Since light and dark chicks do not differ in size, it seems improbable that the down color could be related in any way to size of egg.

TABLE 4.—*Relation of down color of chicks to weight at hatching and early growth*

Lot No.	Age	Mean weight [1] of chicks with indicated down color			Lot No.	Age	Mean weight [1] of chicks with indicated down color		
		Dark	Medium	Light			Dark	Medium	Light
	Days	*Grams*	*Grams*	*Grams*		*Days*	*Grams*	*Grams*	*Grams*
1	1	36.5	33.2	33.8	2	1	36.7	35.4	36.2
	11	65.0	63.1	65.0		11	68.5	57.3	69.1

[1] 15 to 75 chicks per group.

Weights at sexual maturity in three separate lots of birds were consistently highest for the dark chicks and lowest for the light ones (fig. 2). Chicks of medium down color had body weights intermediate between those of the other two classes. The consistent association of larger size with darker down in all three classes looks significant. However, further study of these data by the analysis of covariance (*10*) showed that in the birds of 1936 and in the 1937 controls there existed no significant differences in body weight when the groups were adjusted to a common basis with respect to age at first egg. A value for P of <0.05 was obtained with the data from 1937. This value is often used to show that a significant difference does exist, but in view of the fact that significant differences were not found in the other two populations, one is forced to conclude that no important relationship between color of down and body weights exists in these data.

VIABILITY

Mortality from hatching to 160 days of age, when pullets were put in winter quarters, did not differ significantly or consistently in dark, medium, and light chicks of three separate lots (table 5).

TABLE 5.—*Independence of down color and viability in White Leghorn pullets to 160 days of age, 1936 and 1937*

Year	Total chicks in all 3 down-color classes	Mortality to 160 days of age			Total pullets in all 3 down-color classes	Mortality from 160 days to Jan. 23 [1]		
		Dark down	Medium down	Light down		Dark down	Medium down	Light down
	Number	*Percent*	*Percent*	*Percent*	*Number*	*Percent*	*Percent*	*Percent*
1936	175	14	18	18	142	10	12	26
1937	177	23	21	21	139	9	15	11
1937, controls	359	11	12	9	250	[2] 42	[2] 46	[2] 38

[1] This period had an average length of 122 days in 1936 and 108 days in 1937.
[2] Mortality from 160 to 500 days of age.

For two of these lots, comprising pullets hatched in 1936 and 1937 from the dark and light strains, subsequent mortality was recorded from 160 days of age to January 23 of the following year. In 250 unselected control pullets of 1937, mortality was recorded from 160 days to 500 days of age. The figures, given in table 5, show that mortality differed slightly in the dark, medium, and light chicks, probably by chance and because of small numbers in some classes, but was not consistently higher in any one color class. In the largest lot, the 1937 controls, mortality from housing time to 500 days of age was 4 percent less in 65 pullets originally having light down than in 81 birds that had the darkest down when hatched. Moreover, considering only the pullets in this lot that died after 160 days of age, the mean ages at death for birds of dark, medium, and light downs were respectively 368, 387, and 390 days. These differences in favor of the light-down pullets are not significant, but they do show that viability in such birds was equally as good as in those that originally had dark down.

CAPACITY FOR EGG PRODUCTION

TABLE 6.—*Independence of down color and egg production in White Leghorn pullets, 1936 and 1937*

Year	Period of test, from first egg to—	Pullet egg production for indicated chick down color					
		Dark		Medium		Light	
		Pullets	Mean eggs	Pullets	Mean eggs	Pullets	Mean eggs
		Number	*Number*	*Number*	*Number*	*Number*	*Number*
1936	Feb. 1, 1937	23	38	54	33	23	30
1937	Jan. 23, 1938	21	42	41	58	26	55
1937, controls	500 days of age	47	162	56	160	40	166

The relation of down color to productivity was studied in the same three populations as were used to study viability. The results, given in table 6, show no relation whatever between ability to lay eggs and color of down. By chance, the most productive class had dark down in one lot, medium-color down in another, and light down in the third. In the longest and most significant test, that of the 1937 controls, pullets that originally had light down laid four eggs per bird more than those that had dark down as chicks. The difference is quite insignificant but this test does show that the light chicks are not inferior to the dark ones.

IS THE YELLOW COLOR RELATED TO RIBOFLAVIN?

Because the light and dark strains of White Leghorns were differentiated while selecting for high and low requirements of riboflavin, which has a yellow color, it was desirable to determine to what extent differences in content of riboflavin were associated with differences in color of the down. The yellow pigment in the down of White Leghorn chicks is not soluble in petroleum ether, or in chloroform. It is partially dissolved, but not completely so, by digestion for 1 to 2 hours in a mixture of 25 percent normal sulfuric acid and 75 percent acetone. The extracts used in this study were obtained by this method.

Assays of the riboflavin content of these extracts were made in two ways. Photometric analyses of extracts from down collected in 1937 showed that the dark down contained the most riboflavin and the light down the least. Other samples taken in 1940 were kindly assayed by Dr. A. Z. Hodson according to the improved method of Hodson and Norris (*4*). The average content of riboflavin in two series of dark, medium, and light downs was respectively 3.9, 2.5, and 1.8 micrograms per gram of down. Since these are much smaller amounts of riboflavin than are found in red muscle or in glandular tissues, the concentration of that substance in the down is comparatively low.

It seems unlikely, therefore, that the differences in down color are related to riboflavin. The method used for its extraction is considered to remove most of the riboflavin, but even after its extraction the differences between the dark, medium, and light downs were practically as conspicuous as before extraction, despite marked coloration of the extract from the dark down. Furthermore, when the extracts were treated with a reducing solution of sodium hydrosulfite and sodium bicarbonate, the brownish pigment in them was not reduced to a colorless form as riboflavin usually is when so treated. For all these reasons, it seems improbable that differences in color of the down were dependent upon the presence of different amounts of riboflavin.

HEAD SPOTS

RELATION OF HEAD SPOTS TO COLOR OF DOWN

In contrast to chicks of most other breeds, White Leghorns are conspicuously lacking in patterns or stripes in the down. The nearest semblance to a pattern is a dark, brownish spot occurring on the back of the head. Some of these spots are quite large and conspicuous, others barely visible. Difference in size of the spot depends, not upon intensity of the color, but upon the number of long strands of pigmented down. Some of these include only two or three dark-colored strands and are barely evident. These head spots in White Leghorns are quite different from those of Rhode Island Reds, where a black or brown spot contrasts sharply with the lighter-colored, adjoining down.

TABLE 7.—*Distribution of head spots among White Leghorn chicks having down of dark, medium, or light color*

Population	Proportion of chicks with head spots in groups having indicated down color							
	Dark		Medium		Light		3 down-color classes combined	
	Total	With head spots	Total	With head spots	Total	With head spots	Total	With head spots
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Dark strain, 3 years	209	99	20	100			229	99
Light strain, 3 years	51	76	521	26	196	51	768	36
Controls, 1937	229	96	493	77	105	27	827	76
F_2 generation from cross light × dark	68	91	95	74	18	39	181	77

The distribution of head spots in relation to color of down is shown in table 7. Head spots occurred in nearly every chick of the dark strain, but only in 36 percent of those in the light strain. The difference results in part from the fact that head spots are difficult to recognize on lightly colored chicks. However, because even in the dark chicks of the light strain the proportion showing head spots was lower (76 percent) than in dark chicks of the other populations, it seems probable that the genes causing light down may also tend to eliminate head spots. In the F_2 generation, the distribution of head spots was practically the same as in the unselected control population of 1937, both having head spots in about the same proportion of each color class and in about three-quarters of all chicks.

RELATION OF HEAD SPOTS TO SEX

In the control population, the light strain, and the F_2 generation, males comprised 71 percent of the dark chicks and females 61 percent of the light ones (table 3). Since head spots are found in over 90 percent of unselected dark chicks, but in less than 40 percent of the light ones (table 7), it follows that if all chicks in any population are considered, there must automatically be a preponderance of males among those with head spots, and of females among those without them. However, there is evidence that, apart from this spurious relationship, and regardless of down color, head spots are more frequent in males than in females. In the light strain and the unselected controls (table 7), there were 1,014 chicks of known sex classified as having down of medium color. The sex ratio in these—514 males : 500 females—was normal. In this population, the distribution of sexes and head spots was as follows:

	Males	*Females*
Chicks with head spots	288	225
Chicks without head spots	226	275

Application of the chi square test to this distribution yields a value for χ^2 of 12.34 and for P of <0.001. Since the probability of such a distribution occurring by chance is less than 1 in 1,000, it is apparent that among chicks bearing head spots the proportion of males is significantly greater than among chicks lacking them.

This contrasts with the situation in Rhode Island Red chicks where, as Byerly and Quinn (*1*) and Hays (*3*) have shown, over 82 percent of the chicks with black head spots are females. In that breed, however, the spot is quite different in color, size, and shape from those found in White Leghorns.

DISCUSSION

Since the introduction by Punnett and Pease (*9*) of the Cambar, a breed of fowls in which the sexes of the chicks are recognizable at hatching because the females are darker than the males, the colors and markings of the down feathers of chicks have been studied by several investigators. Hagedoorn (*2*), Lamoreux (*7*), Jaap (*5*), and Punnett (*8*) have established new "autosexing" breeds in which, as in the Cambars, identification of sex at hatching is facilitated by a light ground color or pattern in the down which accentuates the normal difference between males homozygous for barring and females hemizygous for that sex-linked character. Even in pure Barred Plymouth

Rocks there are differences in color between males and females. Jerome (*6*) was able to identify sex in that breed with an accuracy of 98 percent by considering differences in the head spot, the color of down, and the color of shanks and feet.

In White Leghorns, as in all these autosexing breeds and in Barred Rocks, the males are homozygous for barring and the females are hemizygous, but these conditions apparently do not cause corresponding differences in color. In fact, since males predominate among dark chicks and females tend to have light down (table 3), what difference does occur is exactly the opposite of that in Barred Rocks and in the autosexing Cambars, Barnevelders, Ancobars, Oklabars, and Legbars, where the males are light and the females dark. Apparently any effect of the barring gene is as effectively masked by dominant white in chicks as it is in adult White Leghorns. Identification of sex by color of the down is impossible in White Leghorns, except for the generalization that the darkest chicks are more likely to be males and the lightest ones to be females.

SUMMARY

From a stock of White Leghorns there were differentiated two strains, in one of which about 83 to 94 percent of the chicks had dark down, while in the other only 3 to 12.5 percent had dark down, the remainder grading as medium or light in color. Because this sharp difference between the strains was established in 2 years without deliberate selection for color, and was subsequently easily maintained, it is considered that only a few genes caused the difference between the dark and light strains.

In F_1 generations from reciprocal crosses between these two strains, the proportion of dark chicks was intermediate between those in the parent strains. However, among the F_1 progeny from dark dams there was a higher proportion of dark chicks (63.6 percent) than in F_1 chicks from light dams (24.6 percent).

It was shown that sex-linked genes were not primarily responsible for differences in down color. The tendency for the F_1 progeny from reciprocal crosses to resemble the dam's strain more than that of the sire is attributed to some kind of maternal influence, the basis for which is as yet unknown.

In an unselected control population, the proportions of dark, medium, and light chicks were 28, 59, and 13 percent respectively. In chicks of medium color, the proportions of males and females were about equal. Of the dark chicks, 71 percent were males; and of the light ones, 61 percent were females.

Color of down was shown to be quite unrelated to size at hatching, early growth, age at sexual maturity, viability, and ability to lay eggs. In weight at first egg, the darker chicks were consistently the heaviest, and the paler chicks the lightest, but it is not clear that these associations are significant.

The amount of riboflavin was highest in dark down, and lowest in light down, but it is considered that down color is not determined by that substance.

Dark spots in the occipital region of the head occurred in 99 percent of chicks in the dark strain, 36 percent of those in the light strain, and 76 percent of unselected control chicks. In all strains they were

most frequent in dark chicks and least so in light ones. They were more frequent in males than in females.

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