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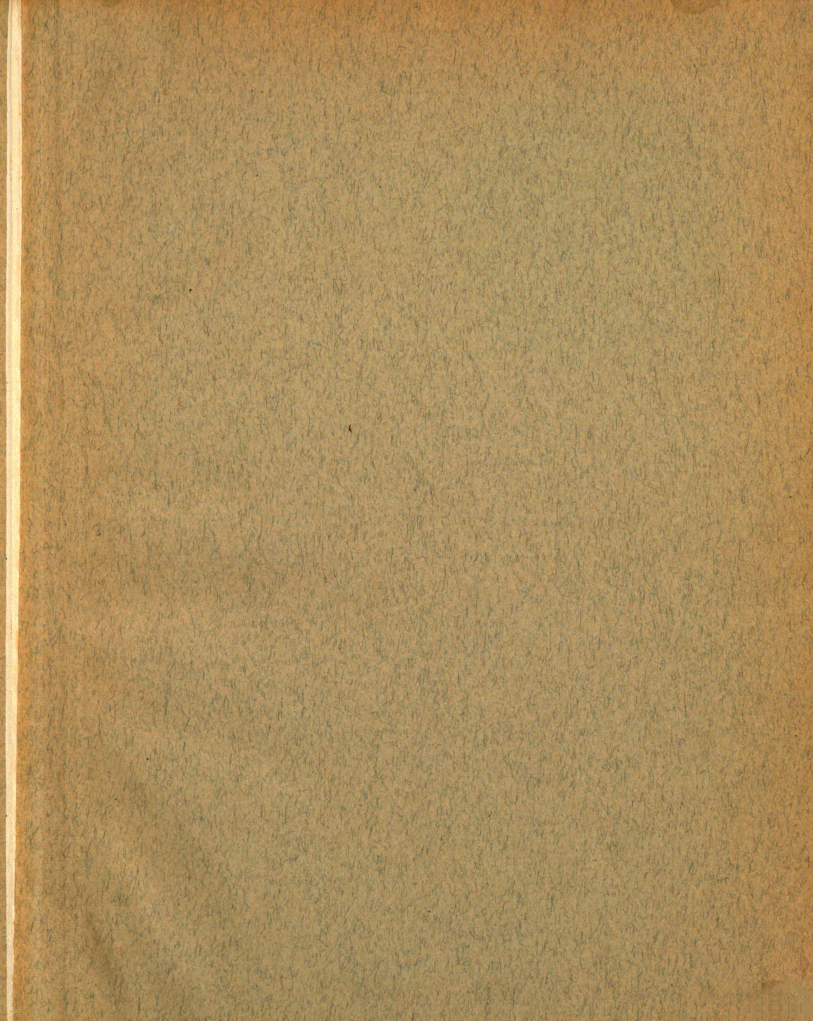


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VARIATIONS IN CERTAIN PHYSICAL  
CHARACTERISTICS OF EGGS  
FROM PUREBRED AND  
CROSS BRED PULLETS

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THESIS





VARIATIONS IN CERTAIN PHYSICAL CHARACTERISTICS  
OF EGGS FROM PUREBRED AND CROSS BRED  
PULLETS

By  
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## I. INTRODUCTION

Present Michigan egg grading standards are based in part on some of the following criteria: external shell texture, contour, porosity, yolk movement and egg weight. In the past it has generally been a common belief that environmental conditions were entirely responsible for these characters; but recently considerable evidence has been found that supports the opinion that they are hereditary.

The mode of inheritance of many of the foregoing characters is not known, nor are uniform methods of measuring certain criteria established. Whether cross breeding or so called pure breeding are best as methods for establishing the criteria mentioned is not known either. In view of the fact that cross breeding seems advantageous in the case of some quantitative characters, it seems desirable to measure the relative performance of cross bred and purebred progeny with respect to some of the "egg quality" characters.

## II. REVIEW OF LITERATURE

A review of the literature reveals some of the following criteria for measuring quality of eggs: texture; contour; porosity; yolk movement and egg weight. Some correlation of these criteria with practical Egg Grading Standards of the U. S. Department of Agriculture and Michigan Department of Agriculture is generally assumed, although they are not well established.

### Texture

Opinions of the significance of texture differs among research workers. Some define it as the shell's structural makeup, while others define it on the basis of external smoothness. Hays (12) used a system of grading shell texture in which he separated eggs into four groups on the variability of the external shell appearance. This method consists of classifying eggs as rough, ridged, sandy and normal. Normal eggs were considered as being smooth and free of any conspicuous ridges. Ridged eggs may or may not show sandy spots. Rough eggs exhibit mineral spots.

As to the relative variability in a homogenous group of pullet eggs, Fronda and Andrews (8) presented data showing that medium and good external shell texture represents 40 to 77 percent of all eggs laid throughout the year.

### Contour

Contour is a classification term used by Henderson (13) to describe ridges appearing on the shell. Closely related to contour is a condition known as wrinkled shell. Asmundson (4) noted this condition after operating on the hen's oviduct. Eggs laid by certain

hens after the isthmus was torn longitudinally and the tear closed with cat gut sutures had shells which were characteristically wrinkled. This substantiated work done by Pearl and Surface (14).

Curtis (7) showed that individual hen's eggs are quite variable among themselves, but that they resemble each other more closely than eggs of a random sample from the same strain. Eggs of the individual tend to be either uniform or variable in all characters while certain others may show a deviation in certain characters and uniformity in others.

#### Porosity

Porosity is a term that seems to be used to describe at least two characteristics of the egg shell. One condition described by Perry (15) is "apparent porosity" distinguished when an egg is held before the candle and is characterized by variable transmission of light through the shell resulting in translucent spots. This condition is popularly supposed to indicate holes or pores in the shell or at least thin spots. Almquist, Holst and Lorenz (3) cast doubt on this assumption. Perry (15) did not presume any relationship but justified his use of the term "apparent porosity" by stating that it is a distinct characteristic and therefore worthy of study. True porosity is not visible by the unaided eye and therefore it is not used in commercial grading of eggs. The criterion used in this work was "apparent porosity". It does not seem to be as transient in nature as Holst, Almquist, and Lorenz conclude.

It has been generally accepted that breaking strength of the egg's shell is a true measure of its porosity and that highly porous shell have a low breaking point.

Van Wagenen and Wilgus (18) observed a weaker condition in shells laid by Barred Rocks than in those laid by the Single Comb White Leghorn and Rhode Island Red breeds. This work was confirmed by Taylor and Martin (16) who noticed, while conducting a feeding experiment to determine some factors influencing thickness in egg shells, that individual differences in weight of egg shells between hens were great. Even in their control pens, where deficiency feeding had existed for six and one-half months, individuals were found to produce heavily shelled eggs, while others were producing rather thin shells. Among their Barred Rocks, which produced quite a number of thin shells, the average percent of shell failed to reach the average for the White Leghorn. The average percent of shell for the Barred Rock was 8.66 as compared to 9.13 for the White Leghorn. This difference was more than six times the probable error and significant.

#### Yolk Movement

Yolk movement is considered an essential criterion in estimating the viscosity of the albumen of eggs. Van Wagenen and Wilgus (18) studied the relationship between the score of the observed condition of the firm albumen and the candling quality, using 199 eggs. Yolk mobility was scored 1 for very slight mobility to 3 for very freely mobile yolks. In every case a significant correlation was found between the observed condition of the firm albumen, mobility of the yolk, yolk shadow mobility, and the candler's grade. Results indicated that the condition of the firm albumen is closely related to those factors in determining the candling quality of the egg. This work was in contrast to work by Almquist (1) who found no

correlation between the quality of firm albumen and apparent mobility of the yolk. He states that "since the yolk spins in a very fluid medium--the inner fluid layer of white--the manner in which the spin takes place refers to the anchorage of the yolk rather than the condition of the white".

Van Wagenen Hall and Wilgus (17) noted that the Rhode Island Reds and Barred Rocks did not differ significantly within the breeds with respect to the percentage of firm albumen.

#### Egg Weight

Funk and Kempster (10) reported a wide range of variation in egg weight and that egg weight is not definitely associated with the breed, but with individuals of the strain. In the breeds they worked with, egg weight ranked as follows: Rhode Island Red, Anconas, White Wyandotte, and White Leghorn. Hall (11) published data showing mean egg weight of 57.30 grams for Barred Rocks; 57.21 grams for White Wyandottes; and 56.75 for Rhode Island Reds. Atwood (5) noted that larger hens had a tendency to lay larger eggs and that these were of an average size for the breeds. Variations in mean egg weights were recorded by Fronda and Clemente (9) with individual weights ranging from 34.78 grams to 58.31 grams in a flock of Los Banos Cantonese fowl.

### III. EXPERIMENTAL

#### Object

The object of this study was to determine the significance of variations in certain physical characters among eggs laid by the  $F_1$  pullet progeny of the following matings: Single Comb White Leghorn; Barred Plymouth Rock; Dark Cornish x White Leghorn; Rhode Island Red; and White Cornish x Barred Rock.

#### Procedure

The method of scoring criteria was similar to that used by Perry (15); but revised and extended by Henderson (13). It consists of grades ranging from one to five.

#### Physical Characteristics

##### Shell Texture

In grading shell texture, eggs were segregated into five classes ranging from perfect to very poor and given numerical values. The range of this characteristic is illustrated in Fig. 1.

##### Contour

Contour is a term of classification used by Henderson (13) to describe ridges appearing on the surface of the shell structure and any other variation from the normal ellipsoidal curvature of the egg. In this study, a normal egg is graded 1; eggs with slightly pronounced ridges 2; and other degrees of variation are scored accordingly up to 5 for the most extreme variants. Fig. 2, is an illustration of the method used in scoring contour.



Fig. 1. Shell texture (Grades 1-5)

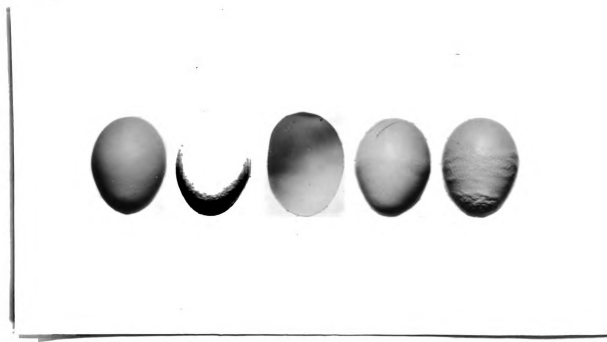


Fig. 2. Contour (Grades 1-5)

## Shell Porosity

Apparent porosity is a condition visible when an egg is held before a candle. Whether apparent porosity indicates actual openings in the shell is a controversial question. No attempt was made to demonstrate a relationship between apparent porosity and true porosity in this work. The condition is simply scored as it appears in degrees ranging from 1 to 5. An example of eggs graded 1 on porosity is illustrated in Fig. 3. An egg with few "apparent pores" and a good internal shell texture probably will permit light to penetrate to a lesser degree than one with more pores.

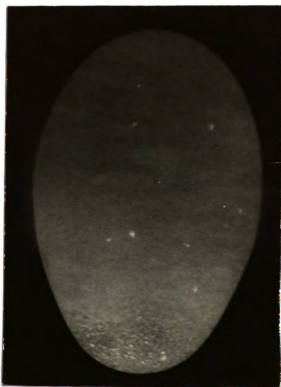


Fig. 3. Porosity (Grade 1)

Figs. 4 and 5. illustrates eggs graded 2 and 3 on porosity. A close comparison of the two reveals that Fig. 5 exhibits more and larger "pores" than Fig. 4.

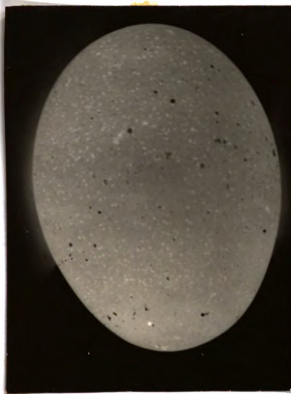


Fig. 4. Porosity (Grade 2)\*

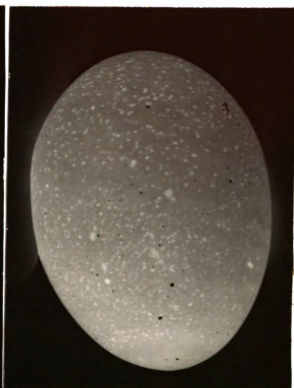


Fig. 5. Porosity (Grade 3)\*

Figs. 6 and 7 are illustrations of types of porosity in which the eggs were graded 4 and 5 respectively.

#### Yolk Movement

When determining the quality of the internal contents of eggs, the speed with which the yolk rotates is considered a criterion. In judging eggs in this work, the egg was rotated before the candle and the speed of the yolk's movement was estimated. It might be conceded that the intensity of the yolk shadow may influence one's estimate of yolk movement, but an experienced candler can easily distinguish this

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\*Black spots are on the external shell surface and not related to porosity.

condition. It is supposed to be indicative of a weak interior structure of the albumen or small percentage of thick albumen. A yolk imbedded in a firm sack of thick albumen was assumed to have very little movement from its center and was graded 1. Faster moving yolks were graded 2 and 3 depending upon their mobility. Those egg yolks which moved freely and rapidly were graded 4 and 5 respectively.

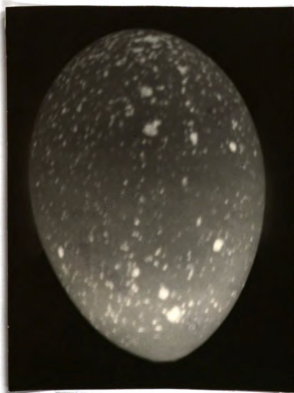


Fig. 6. Porosity (Grade 4)



Fig. 7. Porosity (Grade 5)

#### Egg Weight

Eggs were weighed on a balance accurate to one-tenth of a gram.

#### Analysis of Data

The data were analysed by a method of Analysis of Variance described by Baten (6). The influence of individual pullets is reduced

to unity by determining the mean value for the group of eggs laid by each individual.

### Results

The average scores for all characters observed are given in Table 1 by breeds. Data treated statistically by an analysis of variance for texture, contour, porosity, yolk, movement and egg weight between cross bred and purebred pullets are presented in Tables 2, 3, 4, 5, and 6.

Table 1. AVERAGE SCORES BY BREED FOR THE CHARACTERS STUDIED AMONG EGGS OF PUREBRED AND CROSS BRED PULLETS\*

| Characters                                 |         |         |          |               |        |
|--------------------------------------------|---------|---------|----------|---------------|--------|
| Breed                                      | Texture | Contour | Porosity | Yolk movement | Weight |
| Rhode Island Red                           | 2.37    | 1.99    | 3.83     | 2.10          | 58.72  |
| Barred Plymouth Rock                       | 2.76    | 2.31    | 4.04     | 2.21          | 55.76  |
| White Cornish<br>x<br>Barred Plymouth Rock | 2.34    | 1.98    | 3.92     | 1.87          | 53.04  |
| S. C. White Leghorn                        | 1.97    | 1.99    | 3.98     | 2.34          | 53.74  |
| Dark Cornish<br>x<br>White Leghorn         | 2.13    | 2.00    | 4.31     | 2.30          | 54.67  |

\*See Appendix Tables 1-5 for average individual scores by breeds.

### Variations Between Breeds

The results of the analysis of variance, designed to measure the difference in egg characteristics between purebred and cross bred pullets, are presented in Tables 2-7. The "F" value to reveal significance between any two means should attain a value of 2.56 at the 5 percent point. If an F value as great, or greater than this is found, one can assume that a difference does exist between breeds with 95 percent accuracy.

Table 2. ANALYSIS OF VARIANCE OF THE TEXTURE DATA FOR EGGS BETWEEN PUREBRED AND CROSS BRED PULLETS

| Source of Variance  | D. F. | S. S. | Mean Square | F.   |
|---------------------|-------|-------|-------------|------|
| Total               | 52    | 27.37 |             |      |
| Between breed means | 4     | 3.03  | .76         | 1.49 |
| Within breeds       | 48    | 24.34 | .51         |      |

The analysis of texture variance is presented in Table 2. The mean square between breed means only exceeds the mean square within breed means by .25 which shows that the difference between breeds is very small. The ratio or F value between means is 1.49. This value is less than the required value for significance by a whole number and certainly insignificant between breeds.

Table 3. ANALYSIS OF VARIANCE OF THE CONTOUR DATA FOR EGGS BETWEEN  
PUREBRED AND CROSS BRED PULLETS

| Source of Variation | D. F. | S. S. | Mean Square | F.   |
|---------------------|-------|-------|-------------|------|
| Total               | 52    | 10.78 |             |      |
| Between breeds      | 4     | .91   | .23         | 1.11 |
| Within breeds       | 48    | 9.87  | .21         |      |

The analysis of contour variance is presented in Table 3. All breeds observed show relatively the same degrees of contour deviation as illustrated in the mean square column. The difference between only exceeds the difference within by a margin of .02 and has an F value of 1.11 as great.

Table 4. ANALYSIS OF VARIANCE OF THE POROSITY DATA FOR EGGS BETWEEN  
PUREBRED AND CROSS BRED PULLETS

| Source of Variance  | D. F. | S. S. | Mean Square | F.  |
|---------------------|-------|-------|-------------|-----|
| Total               | 52    | 23.62 |             |     |
| Between breed means | 4     | 1.52  | .38         | .82 |
| Within breed means  | 48    | 22.10 | .46         |     |

The analysis of variance for the porosity data is given in Table 4. The variance within breeds is greater than the variance between breeds, as explained in the mean square column. The difference is an insignificant value of .82 shown in the F column.

Table 5. THE ANALYSIS OF VARIANCE OF THE YOLK MOVEMENT DATA FOR EGGS  
BETWEEN PUREBRED AND CROSS BRED PULLETS

| Source of Variance  | D. F. | S. S. | Mean Square | F.   |
|---------------------|-------|-------|-------------|------|
| Total               | 52    | 11.01 |             |      |
| Between breed means | 4     | 1.34  | .34         | 1.66 |
| Within breed means  | 48    | 9.67  | .24         |      |

In Table 5 is given the analysis of variance for the yolk movement data between breeds. There is a difference to be noticed, but this difference is not significant as shown by the ratio of between breeds to within breeds in the table.

It is noted that in no case did the F value reach or exceed the given value of F for error point of 5 percent. This indicates that characteristics measured are equally variable within breeds and not significantly important between breeds. It further indicates that in all breeds measured there are possibilities of equal individual potentialities.

Table 6. ANALYSIS OF VARIANCE OF EGG WEIGHT DATA AMONG PUREBRED AND  
CROSS BRED PULLETS.

| Source of Variance  | D. F. | S. S.  | Mean Square | F.     |
|---------------------|-------|--------|-------------|--------|
| Total               | 52    | 620.10 |             |        |
| Between breed means | 4     | 230.17 | 57.54       | 7.08** |
| Within breed means  | 48    | 389.93 | 8.12        |        |

\*\* Highly significant "F" value

In computing the analysis of variance of egg weights between the breeds, the average weight of all eggs laid by a pullet was considered to be representative of the individual pullet's production. There is a difference between the means of the representatives of at least two of the groups of pullets comprising the breeds. Therefore 58.72 is significantly greater than all the other mean weights. The mean weight (55.72 grams) for the Barred Plymouth Rock pullets is also significantly greater than the mean weight (53.04 grams) for the cross bred White Cornish x Barred Rock.

#### Variation Within Breeds

After showing that there is no significant difference in four of the characters measured between purebred and cross bred pullets, it remains to determine the nature of the variables within the breeds observed. From a study of the sums of the squares in the preceeding tables presenting texture, contour, porosity, and yolk movement, it is evident that the sums of squares are greater within in most cases than between - so much so that the difference within is almost equal to the difference between. To determine the nature of this difference five birds were selected from each breed and an analysis of variance was computed for each of these characters. It was found that five birds were just as accurate as all birds would have been and that it was not necessary to use them all to determine this variance. These five birds for each breed gives a fair representative sample of what one might expect from all the birds.

In the following tables data that are treated statistically for analyses of variances within breeds are presented in Table 7. Texture scores; in Table 8. contour scores; in Table 9. porosity scores; and in Table 10. yolk movement scores for all breeds.

Table 7. ANALYSES OF VARIANCES FOR TEXTURE OF EGGS PERTAINING TO BREEDS OF POULTRY - SHOWING THE F VALUES.

| Breed                                              | Source of Variance |        |                 |       |       |                |       |      | F Value               |
|----------------------------------------------------|--------------------|--------|-----------------|-------|-------|----------------|-------|------|-----------------------|
|                                                    | Total              |        | Between Pullets |       |       | Within Pullets |       |      |                       |
|                                                    | D.F.               | S.S.   | D.F.            | S.S.  | Var.  | D.F.           | S.S.  | Var. |                       |
| Rhode Island Red                                   | 130                | 142.7  | 4               | 57.94 | 14.49 | 126            | 84.76 | .67  | 21.6**                |
| S.C. White Leghorn                                 | 55                 | 54.84  | 4               | 4.23  | 1.06  | 51             | 50.61 | .99  | 1.07                  |
| <sup>1/</sup> Dark Cornish x White Leghorn         | 90                 | 90.62  | 4               | 37.03 | 9.27  | 86             | 53.54 | .62  | 14.95**               |
| Barred Plymouth Rock                               | 135                | 121.10 | 4               | 26.90 | 6.73  | 131            | 94.20 | .71  | 9.47**                |
| <sup>2/</sup> White Cornish x Barred Plymouth Rock | 171                | 155.4  | 4               | 56.20 | 11.24 | 166            | 99.20 | .60  | 18.40** <sup>1/</sup> |

\*\* Highly significant differences within breeds.

<sup>1/</sup> Single comb White Leghorn and Dark Cornish Cross

<sup>2/</sup> Barred Plymouth Rock and White Cornish Cross

Table 8. ANALYSES OF VARIANCE FOR CONTOUR OF EGGS PERTAINING TO BREEDS OF POULTRY - SHOWING THE F VALUES.

| Breed                                                          | Source of Variance |       |                 |       |      |                |       |      | F.<br>value |
|----------------------------------------------------------------|--------------------|-------|-----------------|-------|------|----------------|-------|------|-------------|
|                                                                | Total              |       | Between Pullets |       |      | Within Pullets |       |      |             |
|                                                                | D.F.               | S.S.  | D.F.            | S.S.  | Var. | D.F.           | S.S.  | Var. |             |
| Rhode<br>Island<br>Red                                         | 130                | 80.99 | 4               | 4.85  | 1.22 | 1.26           | 76.14 | .60  | 2.01        |
| S.C. White<br>Leghorn                                          | 55                 | 49.93 | 4               | 22.29 | 5.57 | .51            | 27.64 | .54  | 10.31**     |
| <sup>1/</sup><br>Dark Cornish<br>x<br>White Leghorn            | 90                 | 36.99 | 4               | 9.46  | 2.37 | .86            | 27.53 | .32  | 7.41**      |
| Barred<br>Plymouth<br>Rock                                     | 135                | 95.62 | 4               | 2.12  | .53  | 1.31           | 93.50 | .71  | .75         |
| <sup>2/</sup><br>White Cornish<br>x<br>Barred Plymouth<br>Rock | 155                | 86.84 | 4               | 5.71  | 1.43 | 1.51           | 81.13 | .54  | 2.66**      |

\*\* Highly significant differences within breeds

<sup>1/</sup> Single comb White Leghorn and Dark Cornish

<sup>2/</sup> Barred Plymouth Rock and White Cornish

Table 9. ANALYSES OF VARIANCES FOR POROSITY OF EGGS PERTAINING TO  
BREEDS OF POULTRY - SHOWING THE F VALUES

| Breed                                                          | Source of Variance |        |                 |       |       |                |        |      | F.<br>Value |
|----------------------------------------------------------------|--------------------|--------|-----------------|-------|-------|----------------|--------|------|-------------|
|                                                                | Total              |        | Between Pullets |       |       | Within Pullets |        |      |             |
|                                                                | D.F.               | S.S.   | D.F.            | S.S.  | Var.  | D.F.           | S.S.   | Var. |             |
| Rhode<br>Island<br>Red                                         | 130                | 127.54 | 4               | 73.94 | 18.49 | 126            | 53.60  | .43  | 43.00**     |
| S.C.<br>White<br>Leghorn                                       | 55                 | 97.43  | 4               | 64.44 | 16.11 | 51             | 33.99  | .67  | 24.04**     |
| <sup>1/</sup><br>Dark Cornish<br>x<br>White Leghorn            | 90                 | 56.62  | 4               | 22.30 | 5.58  | 86             | 34.32  | .40  | 13.95**     |
| Barred<br>Plymouth<br>Rock                                     | 135                | 142.12 | 4               | 40.11 | 10.03 | 131            | 102.01 | .78  | 12.86**     |
| <sup>2/</sup><br>White Cornish<br>x<br>Barred Plymouth<br>Rock | 155                | 209.08 | 4               | 60.82 | 40.21 | 151            | 48.26  | .32  | 15.53**     |

\*\* Highly significant differences within breeds

<sup>1/</sup> Single Comb White Leghorn and Dark Cornish Cross

<sup>2/</sup> Barred Plymouth Rock and White Cornish Cross

Table 10. ANALYSES OF VARIANCES FOR YOLK MOVEMENT OF EGGS PERTAINING TO BREEDS OF POULTRY - SHOWING THE F VALUES

| Breed                                                    | Source of Variance |        |                 |       |      |                |        |      | F<br>Value |
|----------------------------------------------------------|--------------------|--------|-----------------|-------|------|----------------|--------|------|------------|
|                                                          | Total              |        | Between Pullets |       |      | Within Pullets |        |      |            |
|                                                          | D.F.               | S.S.   | D.F.            | S.S.  | Var. | D.F.           | S.S.   | Var. |            |
| Rhode Island Red                                         | 130                | 82.50  | 4               | 8.83  | 2.21 | 126            | 73.67  | .58  | 3.81**     |
| S.C. White Leghorn                                       | 55                 | 51.72  | 4               | 10.85 | 2.71 | 51             | 40.87  | .80  | 3.38**     |
| <sup>1/</sup> Dark Cornish<br>x<br>White Leghorn         | 90                 | 83.14  | 4               | 10.56 | 2.63 | 86             | 72.64  | .84  | 3.13**     |
| Barred Plymouth Rock                                     | 135                | 102.53 | 4               | 4.65  | 1.16 | 131            | 97.88  | .75  | 1.54       |
| <sup>2/</sup> White Cornish<br>x<br>Barred Plymouth Rock | 155                | 119.59 | 4               | 15.90 | 3.99 | 151            | 103.69 | .69  | 5.77**     |

\*\* Highly significant differences within breeds

<sup>1/</sup> Single Comb White Leghorn and Dark Cornish Cross

<sup>2/</sup> Barred Plymouth Rock and White Cornish Cross

## IV. DISCUSSION

As to the criteria, texture, contour, porosity yolk movement, and egg weight, it seems apparent that only one criterion (egg weight) varies significantly between the  $F_1$  generation of purebred and cross bred pullets used in this study. From the analyses of variance within the breeds it is clear that all breeds vary significantly in some characters.

For egg weight between breeds, a significant value of 7.08 was obtained. This value was significant for two breeds. The Rhode Island egg weight was superior to all breed egg weights, while the Barred Rock was superior to the cross bred progeny of White Cornish and Barred Rock.

The values of 1.49 for texture, 1.11 for contour, 0.82 for porosity, and 1.66 for yolk movement were all insignificant between breeds. These values suggest a close relationship among individuals and among breeds of purebred and cross bred pullets. These values further substantiate the opinion that all breeds are equally variable for texture, contour (ridges), porosity, and yolk movement. Some breeds may vary in some characters while others are uniformly variable in all characters, as indicated in the analyses of variances for individual breeds.

From the Tables 6-10, analyses of variances within the breeds, it is to be noted that the cross bred progeny of each mating was uniformly variable in all characters observed, while the purebreds were only variable in certain characters.

Data were sufficient to show that intra individual variance is as equal between purebreds as between cross breeds. Data were

sufficient also, as evidenced in the statistical analyses of individual averages, to indicate that these characters are not associated with any particular breed, but with those individuals within the breed. Fig. 8, illustrates this very effectively. This pullet, No. 3223, a Barred Plymouth Rock, invariably laid eggs with an extremely poor shell texture, ridged, odd shaped, and in a highly porous condition; while another pullet, No. 3214, of the same breed laid eggs of better than normal condition, with respect to these same characters.



Fig. 8. These eggs were laid by a Barred Rock pullet No. 3223.

## V. CONCLUSIONS

From the data obtained by scoring eggs laid by purebred and cross bred pullets it is possible to draw the following conclusions:

1. The egg quality criteria texture, contour, porosity and yolk movement are equally variable between the strains of Single Comb White Leghorns, Rhode Island Reds, Barred Plymouth Rocks, White Cornish x Barred Plymouth Rocks and Dark Cornish x White Leghorns investigated in this study.

2. Egg shell texture in eggs of the Single Comb White Leghorn did not vary between individuals of the breed.

3. Porosity is variable within the breeds observed.

4. Yolk movement is relatively the same for each individual within the Barred Plymouth Rock strain.

5. Contour did not vary significantly within the Rhode Island Red and Barred Plymouth Rock breeds observed.

## VI. SUMMARY

Eggs laid by the  $F_1$  generation of purebred Single Comb White Leghorns, Rhode Island Reds, Barred Plymouth Rocks, cross bred White Cornish x Barred Rocks, and Dark Cornish x White Leghorns were scored for external shell texture, contour, porosity, and yolk movement. Egg weight was recorded from a balance graduated to one-tenth of a gram.

A method used by Perry (15), but revised and extended by Henderson (13) was used in scoring eggs for degrees of variance between breeds and within breeds.

A method of analysis of variance as given by Baten (6) was employed in computing results.

Variations between breeds, with respect to a scoring range of from 1-5, for texture, contour, porosity, and yolk movement were not significant. The mean values were as given in appendix tables I to V.

The mean weights of eggs in grams were as follows: Rhode Island Reds 58.72; Barred Rocks 55.76; Single Comb White Leghorns 53.67; White Cornish x Barred Rocks 53.04; and Dark Cornish x White Leghorn 54.67.

The differences between egg weights for the Rhode Island Red and Barred Rock, Single Comb White Leghorn, White Cornish x Barred Plymouth and Dark Cornish x White Leghorn were significant. The difference between the Barred Rock and the White Cornish x Barred Rock was also significant. The other breeds are not significant between themselves.

Significant differences were found within breeds for the following characters:

## Texture

Barred Plymouth Rock, Rhode Island Red, White Cornish x Barred Plymouth Rock, and Dark Cornish x White Leghorn.

## Contour

Single Comb White Leghorn, Dark Cornish x White Leghorn, and White Cornish x Barred Plymouth Rock.

## Porosity

Single Comb White Leghorn, Rhode Island Red, Barred Plymouth Rock, White Cornish x Barred Plymouth Rock and Dark Cornish x White Leghorn.

## Yolk Movement

Rhode Island Red, White Cornish x Barred Plymouth Rock, White Leghorn, and Dark Cornish x White Leghorn.

The following characters varied insignificantly within certain breeds:

## Texture

Single Comb White Leghorn

## Contour

Rhode Island Red and Barred Plymouth Rock

## Yolk Movement

Barred Plymouth Rock

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## APPENDIX I

In the following tables are given the data as taken and condensed for use in this investigation. These data are included here for comparisons and references to the foregoing computations; and for the benefit of other students interested in individual breed variations in egg characteristics among poultry.

## AVERAGE

Table 1. INDIVIDUAL CHARACTER SCORES FOR EGGS - RHODE

## ISLAND RED.

| Bird No. | Texture | Contour | Porosity | Yolk Movement |
|----------|---------|---------|----------|---------------|
| 3291     | 3.40    | 2.20    | 4.60     | 3.20          |
| 3293     | 2.33    | 1.33    | 3.66     | 1.17          |
| 3298     | 1.72    | 2.04    | 3.92     | 2.36          |
| 3299     | 2.24    | 1.71    | 3.52     | 2.38          |
| 3300     | 3.23    | 1.38    | 3.38     | 2.23          |
| 3301     | 3.00    | 1.66    | 3.00     | 1.66          |
| 3303     | 2.68    | 2.25    | 4.32     | 1.93          |
| 3305     | 2.18    | 2.53    | 4.12     | 1.94          |
| 3306     | 1.87    | 1.60    | 4.53     | 1.60          |
| 3309     | 1.90    | 2.24    | 3.81     | 2.14          |
| 3310     | 2.59    | 1.97    | 2.82     | 2.38          |
| 3311     | 1.25    | 1.25    | 4.25     | 2.25          |
| Average  | 2.37    | 1.89    | 3.83     | 2.10          |



Table 2. AVERAGE INDIVIDUAL CHARACTER SCORES FOR EGGS

## BARRED PLYMOUTH ROCK

| Bird No. | Texture | Contour | Porosity | Yolk Movement |
|----------|---------|---------|----------|---------------|
| 3201     | 2.23    | 2.41    | 4.53     | 1.82          |
| 3206     | 4.70    | 2.21    | 4.68     | 2.00          |
| 3214     | 1.71    | 1.43    | 3.29     | 2.43          |
| 3215     | 2.64    | 2.14    | 3.39     | 2.18          |
| 3219     | 2.88    | 2.03    | 3.70     | 2.48          |
| 3221     | 2.22    | 3.17    | 3.33     | 2.17          |
| 3222     | 1.79    | 2.11    | 4.45     | 1.92          |
| 3223     | 4.79    | 3.54    | 4.69     | 3.08          |
| 3228     | 1.86    | 1.71    | 4.33     | 1.86          |
| Average  | 2.76    | 2.31    | 4.04     | 2.21          |

Table 3. AVERAGE INDIVIDUAL CHARACTER SCORES FOR EGGS -  
WHITE LEGHORN BREED

| Bird No.      | Texture | Contour | Porosity | Yolk Movement |
|---------------|---------|---------|----------|---------------|
| 3312          | 1.33    | 1.00    | 3.33     | 1.66          |
| 3313          | 1.46    | 1.38    | 1.84     | 1.69          |
| 3314          | 2.00    | 2.00    | 4.33     | 2.50          |
| 3316          | 2.40    | 2.80    | 5.00     | 2.40          |
| 3322          | 2.07    | 1.96    | 3.86     | 2.71          |
| 3326          | 2.07    | 2.66    | 4.33     | 2.47          |
| 3332          | 2.25    | 1.75    | 4.86     | 3.00          |
| 3338          | 2.14    | 2.43    | 4.29     | 2.29          |
| Breed average | 1.97    | 1.99    | 3.98     | 2.34          |

Table 4. AVERAGE INDIVIDUAL CHARACTER SCORES FOR EGGS -  
DARK CORNISH AND WHITE LEGHORN CROSS

| Bird No.      | Texture | Contour | Porosity | Yolk Movement |
|---------------|---------|---------|----------|---------------|
| 3260          | 2.00    | 2.28    | 3.30     | 2.52          |
| 3262          | 2.48    | 2.10    | 4.52     | 2.61          |
| 3263          | 3.69    | 2.62    | 4.85     | 2.31          |
| 3264          | 1.67    | 1.83    | 4.67     | 1.67          |
| 3265          | 2.63    | 2.05    | 5.00     | 2.63          |
| 3267          | 1.50    | 1.50    | 4.45     | 1.90          |
| 3272          | 1.60    | 1.80    | 4.40     | 2.40          |
| 3273          | 2.00    | 1.80    | 4.40     | 2.30          |
| 3278          | 2.30    | 1.90    | 3.45     | 1.80          |
| 3285          | 1.83    | 2.33    | 4.33     | 2.17          |
| 3288          | 1.76    | 1.86    | 3.59     | 2.41          |
| Breed average | 2.13    | 2.00    | 4.3141   | 2.50          |



Table 5. AVERAGE INDIVIDUAL AND BREED CHARACTER SCORES FOR EGGS -  
WHITE CORNISH AND BARRED PLYMOUTH ROCK CROSS

| Bird No.      | Texture | Contour | Porosity | Yolk Movement |
|---------------|---------|---------|----------|---------------|
| 3230          | 1.38    | 1.44    | 4.63     | 1.69          |
| 3231          | 2.15    | 2.18    | 4.94     | 2.30          |
| 3235          | 2.00    | 1.33    | 3.33     | 1.00          |
| 3236          | 1.76    | 2.14    | 4.05     | 1.48          |
| 3238          | 2.00    | 2.33    | 4.66     | 2.80          |
| 3246          | 2.36    | 2.37    | 3.18     | 2.27          |
| 3249          | 2.25    | 2.08    | 4.03     | 2.13          |
| 3250          | 2.63    | 1.67    | 2.63     | 1.70          |
| 3251          | 3.31    | 2.03    | 3.88     | 2.41          |
| 3253          | 2.19    | 2.31    | 3.58     | 1.96          |
| 3257          | 3.00    | 2.00    | 3.25     | 1.75          |
| 3559          | 2.81    | 1.63    | 4.25     | 1.31          |
| Breed average | 2.34    | 1.98    | 3.92     | 1.87          |



Table 6. A COMPARISON OF FREQUENCY OF EGG WEIGHTS AND THE TOTAL  
FREQUENCY FOR THE FIVE BREEDS OF POULTRY

| Breed Distribution |                |                  |                               |                               |                        |
|--------------------|----------------|------------------|-------------------------------|-------------------------------|------------------------|
| Weight<br>grams    | Barred<br>Rock | White<br>Leghorn | Barred Rocks<br>White Cornish | Dark Cornish<br>White Leghorn | Rhode<br>Island<br>Red |
| 40-40.9            |                |                  |                               |                               |                        |
| 41-41.9            |                |                  | 1                             | 1                             | 1                      |
| 42-42.9            |                |                  | 2                             | 1                             | 3                      |
| 43-43.9            |                |                  | 4                             |                               | 2                      |
| 44-44.9            | 1              | 1                | 5                             |                               | 2                      |
| 45-45.9            | 1              |                  | 6                             |                               | 4                      |
| 46-46.9            |                | 2                | 8                             |                               | 4                      |
| 47-47.9            | 5              | 1                | 11                            | 3                             | 4                      |
| 48-48.9            | 2              |                  | 10                            | 6                             | 2                      |
| 49-49.9            | 7              | 2                | 15                            | 9                             | 5                      |
| 50-50.9            | 13             | 3                | 11                            | 10                            | 12                     |
| 51-51.9            | 21             | 6                | 19                            | 14                            | 10                     |
| 52-52.9            | 22             | 6                | 26                            | 19                            | 8                      |
| 53-53.9            | 18             | 7                | 28                            | 7                             | 10                     |
| 54-54.9            | 26             | 7                | 20                            | 6                             | 12                     |
| 55-55.9            | 35             | 12               | 17                            | 20                            | 12                     |
| 56-56.9            | 12             | 4                | 19                            | 7                             | 12                     |
| 57-57.9            | 30             | 6                | 10                            | 9                             | 12                     |
| 58-58.9            | 8              | 5                | 12                            | 11                            | 9                      |
| 59-59.9            | 13             | 4                | 6                             | 17                            | 17                     |
| 60-60.9            | 7              | 4                |                               | 6                             | 11                     |
| 61-61.9            | 6              | 1                | 2                             | 5                             | 15                     |
| 62-62.9            | 6              | 1                |                               | 6                             | 5                      |
| 63-63.9            | 3              | 1                |                               | 4                             | 10                     |
| 64-64.9            | 2              |                  |                               | 3                             | 20                     |
| 65-65.9            | 2              | 1                |                               | 4                             | 14                     |
| 66-66.9            |                |                  |                               | 2                             | 8                      |
| 67-67.9            |                |                  |                               |                               | 3                      |
| 67-67.9            |                |                  |                               |                               | 3                      |
| 68-68.9            | 1              |                  | 1                             |                               | 3                      |
| 69-69.9            | 1              |                  |                               |                               | 2                      |
| 70-70.9            |                |                  |                               |                               | 4                      |
| 71-71.9            |                |                  |                               |                               | 2                      |
| 72-72.9            |                |                  |                               |                               | 3                      |
| Total              | 242            | 74               | 235                           | 170                           | 241                    |

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