

THE SHAPE AND WEIGHT OF EGGS IN RELATION TO THE SEX OF CHICKS IN THE DOMESTIC FOWL¹

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REVIEW OF PREVIOUS WORK

A study of the causes that might affect the production of one sex or the other in the domestic fowl should have an important bearing on the practical aspects of the poultry industry and on current theoretical questions concerning sex determination. The senior author² has made a number of observations concerning the sex-ratio situation in the domestic fowl, including the following:

1. There is no apparent correlation between egg weight and sex ratio.

2. There is no apparent correlation between yolk weight and sex ratio.

3. There is no apparent correlation between yolk water-content and sex ratio.

The authors are not aware of any observations having been made concerning the relationship between the shape of the egg and the sex of the chick hatched from it. A solution of this problem is important in order that the result may be added to results already determined and also because of the prevailing opinion among many practical poultrymen that long eggs usually produce male chicks. The poultry office of the Animal Husbandry Division of the United States Department of Agriculture is continually receiving letters either stating that the longer eggs produce more males than the shorter ones or inquiring if such is not the case. The data presented in this study serve as an answer.

The data in this study also deal with the relationship between the weight of the egg and the sex of the chick hatched from it. It has been stated above that the senior author found no correlation to exist between egg weight and sex ratio. This observation was based upon the results

obtained in determining the sex of chicks from eggs laid during the first year of production by 45 Barred Plymouth Rock pullets mated to Brown Leghorn males. The sex was determined of all embryos that died from the twelfth day to hatching time as well as of all chicks that hatched. There was found to be no correlation between weight of egg and sex of chick.

On the other hand, in another study the senior author³ found a significant difference between the weights of eggs from which males were obtained and those from which females were obtained. This was based upon data used in a determination of growth rates in the sexes of pure-bred Barred Plymouth Rock chicks. The only egg weights taken into consideration were those producing the chicks on which growth rates were determined, the records for analysis being selected at the conclusion of the growth period. The weights of the eggs in which embryos died and the weights of the eggs producing chicks which died prior to the termination of the period of growth studied were not considered. From the sex standpoint there may have been a differential prenatal or a differential postnatal mortality, or both. The weights of the eggs producing the chicks which completed the growth test showed that the eggs which produced males were heavier than the eggs which produced females, 52.11 ± 0.41 and 50.05 ± 0.53 gm. The difference in mean weights is 2.06 ± 0.67 gm., a difference which is slightly more than three times its probable error and therefore barely significant.

The case in which there was established no correlation between egg weight and chick sex was with eggs laid throughout the first year of production

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² JULL, M. A. THE RELATION OF ANTECEDENT EGG PRODUCTION TO THE SEX RATIO IN THE DOMESTIC FOWL. *Jour. Agr. Research*, XXVIII: 199-224, 1924.

³ JULL, M. A. DIFFERENTIAL SEX GROWTH CURVES IN BARRED PLYMOUTH ROCK CHICKS. *Sci. Arg.* 4: 58-65, illus. 1923.

of each of 45 pullets, while the case in which there was a difference in the mean weights of eggs producing the two sexes was with eggs laid during the normal hatching season.

In view of the apparently different results obtained in the latter case, it was thought advisable to make additional studies, particularly with eggs laid during the normal hatching season.

EGG SHAPE IN RELATION TO CHICK SEX

The eggs of 24 Barred Plymouth Rock pullets laid between the middle of February and the last of April were measured carefully at the time of laying. The length and maximum breadth of each of 990 eggs were measured in millimeters, the measurements being recorded to hundredths of a millimeter. The sex of the chicks was determined by dissection at hatching time.

In Table I is shown the frequency distribution in terms of length in millimeters of the eggs producing males and those producing females. Of the 990 eggs, 512 produced males and 478 produced females. The mean length of the eggs producing males is 55.31 ± 0.06 mm. and the mean length of the eggs producing females is 55.42 ± 0.07 mm. The eggs producing females have a mean length slightly greater than that of the eggs producing males, but the difference is not at all significant since it is only 0.11 ± 0.09 , as shown in Table VIII. The variation in length, both absolutely and relatively, is quite small in each group of eggs producing males and females. In Table II the production of each pullet is considered separately and there is not a single case in which the mean length of eggs producing males and those producing females is significantly different. Moreover, among the 24 pullets there are 13 in which the mean length of eggs producing males is greater than the mean length of eggs producing females and 11 in which the reverse is the case. It can be said, therefore, that there is no relation between length of egg and the sex of the chick hatched from it.

The shape of an egg is determined by considering the length and breadth

in relation to each other. The length-breadth index was used as a measure of shape and was obtained by dividing one hundred times the breadth by the length. A long and narrow egg has a relatively low index, while a short and broad egg has a high index. Based on the assumption that long eggs usually produce a preponderance of males, it should be expected that eggs producing males would have a lower index than eggs producing females. The frequency distribution of shape index and the relative mean indexes of eggs producing males and females, respectively, are shown in Table III. The mean index of eggs producing males is 75.17 ± 0.09 and the mean index of eggs producing females is 75.09 ± 0.10 , the difference with its probable error being 0.08 ± 0.13 , as shown in Table VIII.

There is very little difference in respect to the relative and absolute amounts of variability between the groups of eggs producing the two sexes. In Table IV the mean indexes of eggs producing males and females, respectively, are shown for each pullet and in no case is the difference in the mean index significant. It is apparent, therefore, that there is no correlation between the relative length of an egg and the sex of the chick hatched from it. In other words, long and narrow eggs having relatively low indexes as compared with short, broad ones, are not likely to produce male chicks in any greater proportion than eggs with relatively high indexes.

EGG WEIGHT IN RELATION TO CHICK SEX

Eggs from two different sources were used in this study of egg weight in relation to the sex of chicks. In the first case eggs were obtained from 153 Barred Plymouth Rock females mated to Rhode Island Red males and in the second case from 58 Rhode Island Red females mated to Rhode Island Red males. The weights of 418 and 226 eggs in the former and latter cases, respectively, are taken into consideration, making a total of 644 eggs. The eggs were weighed daily as laid, the weights being recorded to hundredths of a gram.

TABLE I.—*Frequency distribution of egg length and the relative mean length of eggs producing males and females, respectively*

Egg length	Eggs producing—		
	Males	Females	Total
<i>Mm.</i>			
50.00 to 50.99	6	8	14
51.00 to 51.99	18	15	33
52.00 to 52.99	25	25	50
53.00 to 53.99	68	65	133
54.00 to 54.99	77	75	152
55.00 to 55.99	87	83	170
56.00 to 56.99	86	80	166
57.00 to 57.99	65	61	126
58.00 to 58.99	47	37	84
59.00 to 59.99	18	16	34
60.00 to 60.99	15	10	25
61.00 to 61.99		3	3
Total	512	478	990
Mean length	55.31±0.06	55.42±0.07	55.37±0.04
Standard deviation	2.18±0.05	2.17±0.05	2.17±0.03
Coefficient of variability	6.81±0.14	7.02±0.12	3.92±0.06

TABLE II.—*Mean egg length per bird for eggs producing males and females respectively*

Pullet No.	Eggs producing males		Eggs producing females		Difference
	Number	Mean length	Number	Mean length	
		<i>Mm.</i>		<i>Mm.</i>	<i>Mm.</i>
1	16	54.83±0.18	9	54.36±0.14	0.47±0.23
2	14	54.32±0.16	14	54.64±0.13	0.32±0.21
3	18	54.96±0.16	16	55.21±0.15	0.15±0.22
4	11	55.06±0.21	15	55.18±0.19	0.12±0.28
5	13	57.21±0.18	16	56.84±0.12	0.33±0.22
6	14	54.30±0.20	14	54.27±0.17	0.03±0.26
7	17	56.68±0.17	13	57.21±0.21	0.63±0.27
8	26	55.42±0.16	20	55.30±0.12	0.12±0.20
9	25	55.13±0.14	24	55.25±0.16	0.12±0.21
10	29	54.72±0.22	18	53.84±0.18	0.88±0.30
11	17	54.34±0.16	17	54.94±0.17	0.60±0.23
12	36	54.87±0.13	35	54.74±0.22	0.13±0.25
13	19	58.62±0.19	16	57.93±0.22	0.69±0.29
14	36	57.79±0.23	36	58.40±0.14	0.16±0.27
15	20	54.90±0.14	38	54.69±0.11	0.31±0.18
16	14	56.67±0.18	15	57.01±0.15	0.34±0.23
17	18	55.39±0.17	14	55.25±0.21	0.14±0.27
18	32	55.08±0.13	12	55.17±0.14	0.09±0.16
19	25	56.72±0.12	25	56.55±0.19	0.17±0.22
20	27	54.37±0.14	26	54.57±0.20	0.20±0.24
21	35	55.11±0.18	36	54.98±0.23	0.13±0.29
22	8	55.44±0.21	11	55.26±0.22	0.18±0.30
23	27	57.23±0.11	17	57.01±0.14	0.22±0.18
24	15	54.86±0.15	21	55.23±0.18	0.37±0.23
Total	512	55.31±0.06	478	55.42±0.07	0.11±0.09

TABLE III.—Frequency distribution of shape index and the relative mean indexes of eggs producing males and females, respectively

Length-breadth index	Eggs producing—		
	Males	Females	Total
63.00 to 63.99		1	1
64.00 to 64.99			
65.00 to 65.99	1	2	3
66.00 to 66.99	3	3	6
67.00 to 67.99	5	5	10
68.00 to 68.99	9	10	19
69.00 to 69.99	16	16	32
70.00 to 70.99	20	22	42
71.00 to 71.99	31	25	56
72.00 to 72.99	40	37	77
73.00 to 73.99	49	53	102
74.00 to 74.99	62	53	115
75.00 to 75.99	70	66	136
76.00 to 76.99	59	56	115
77.00 to 77.99	57	51	108
78.00 to 78.99	35	38	73
79.00 to 79.99	29	16	45
80.00 to 80.99	12	12	24
81.00 to 81.99	7	5	12
82.00 to 82.99	3	4	7
83.00 to 83.99	3	0	3
84.00 to 84.99	1	3	4
Total	512	478	990
Mean index	75.17±0.09	75.09±0.10	75.13±0.07
Standard deviation	3.20±0.06	3.28±0.07	3.24±0.05
Coefficient of variability	4.26±0.09	4.37±0.09	4.31±0.06

TABLE IV.—Mean egg length-breadth index per bird for eggs producing males and females, respectively

Pullet No.	Eggs producing males		Eggs producing females		Difference
	Number	Mean length-breadth index	Number	Mean length-breadth index	
1	16	75.38±0.56	9	73.83±0.62	1.55±0.83
2	14	76.47±0.37	14	75.74±0.41	0.73±0.55
3	18	75.22±0.77	16	77.59±0.38	2.37±0.86
4	11	73.62±0.54	15	71.69±0.60	1.93±0.81
5	13	77.76±0.41	16	77.48±0.27	0.28±0.49
6	14	76.33±0.32	14	77.28±0.40	0.95±0.51
7	17	78.79±0.24	13	78.02±0.36	0.77±0.43
8	26	81.03±0.28	20	80.82±0.22	0.21±0.36
9	25	74.03±0.19	24	74.47±0.27	0.43±0.33
10	29	76.15±0.16	18	77.00±0.14	0.85±0.21
11	17	75.13±0.31	17	74.20±0.24	0.93±0.39
12	36	76.59±0.29	35	77.16±0.14	0.57±0.32
13	19	72.25±0.48	16	71.94±0.71	0.31±0.86
14	36	76.05±0.22	36	75.87±0.13	0.18±0.25
15	20	72.74±0.26	38	73.31±0.15	0.57±0.30
16	14	73.42±0.27	15	72.67±0.29	0.75±0.40
17	18	74.13±0.23	14	73.13±0.33	1.00±0.40
18	32	74.51±0.14	12	74.30±0.41	0.21±0.43
19	25	75.93±0.20	25	77.01±0.26	1.08±0.33
20	27	69.55±0.18	26	69.64±0.15	0.09±0.23
21	35	70.94±0.12	36	70.79±0.17	0.15±0.21
22	8	77.92±0.49	11	77.20±0.38	0.72±0.62
23	27	77.33±0.19	17	76.49±0.31	0.84±0.36
24	15	74.46±0.27	21	74.01±0.16	0.45±0.31
Total	512	75.17±0.09	478	75.09±0.10	0.08±0.13

TABLE V.—*Frequency distribution and mean weights of eggs producing male and female chicks, respectively, that hatched*

BARRED PLYMOUTH ROCK FEMALES MATED TO RHODE ISLAND RED MALES

Egg weight	Eggs producing—		
	Males	Females	Total
<i>Grams</i>			
47.00 to 47.99.....		2	2
48.00 to 48.99.....	1	1	2
49.00 to 49.99.....	3	0	3
50.00 to 50.99.....	1	0	1
51.00 to 51.99.....	2	2	4
52.00 to 52.99.....	2	4	6
53.00 to 53.99.....	4	5	9
54.00 to 54.99.....	19	14	33
55.00 to 55.99.....	16	16	32
56.00 to 56.99.....	14	13	27
57.00 to 57.99.....	26	17	43
58.00 to 58.99.....	22	15	37
59.00 to 59.99.....	20	16	36
60.00 to 60.99.....	13	15	28
61.00 to 61.99.....	10	8	18
62.00 to 62.00.....	6	7	13
63.00 to 63.99.....	10	8	18
64.00 to 64.99.....	6	2	8
65.00 to 65.99.....	9	3	12
66.00 to 66.99.....	3	3	6
67.00 to 67.99.....	2	2	4
68.00 to 68.99.....	1	4	5
Total.....	190	157	347
Mean weight.....	58.64±0.19	58.53±0.21	58.58±0.14
Standard deviation.....	3.83±0.13	3.92±0.15	3.95±0.10
Coefficient of variability.....	6.53±0.22	6.70±0.25	6.74±0.17

TABLE VI.—*Frequency distribution and mean weights of eggs producing male and female chicks, respectively, that died in shell at hatching time*

BARRED PLYMOUTH ROCK FEMALES MATED TO RHODE ISLAND RED MALES

Egg weight	Eggs producing—		
	Males	Females	Total
<i>Grams</i>			
49.00 to 49.99.....		1	1
50.00 to 50.99.....	1	3	4
51.00 to 51.99.....	0	1	1
52.00 to 52.99.....	1	0	1
53.00 to 53.99.....	2	2	4
54.00 to 54.99.....	2	1	3
55.00 to 55.99.....	6	4	10
56.00 to 56.99.....	4	3	7
57.00 to 57.99.....	2	6	8
58.00 to 58.99.....	2	2	4
59.00 to 59.99.....	4	10	14
60.00 to 60.99.....	1	1	2
61.00 to 61.99.....	1	1	2
62.00 to 62.99.....	0	1	1
63.00 to 63.99.....	2	2	4
64.00 to 64.99.....	1	2	3
65.00 to 65.99.....	1	0	1
66.00 to 66.99.....		0	0
67.00 to 67.99.....		0	0
68.00 to 68.99.....		1	1
Total.....	30	41	71
Mean weight.....	57.56±0.44	57.82±0.43	57.71±0.31
Standard deviation.....	3.56±0.31	4.09±0.30	3.92±0.22
Coefficient of variability.....	6.18±0.54	7.07±0.53	6.77±0.38

TABLE VII.—Frequency distribution and mean weights of eggs producing male and female chicks, respectively, that hatched

RHODE ISLAND RED FEMALES MATED TO RHODE ISLAND RED MALES

Egg weight	Eggs producing—		
	Males	Females	Total
<i>Grams</i>			
46.00 to 46.99.....		1	1
47.00 to 47.99.....		0	0
48.00 to 48.99.....		0	0
49.00 to 49.99.....	1	1	2
50.00 to 50.99.....	3	0	3
51.00 to 51.99.....	4	2	6
52.00 to 52.99.....	1	5	6
53.00 to 53.99.....	8	4	12
54.00 to 54.99.....	10	9	19
55.00 to 55.99.....	14	13	27
56.00 to 56.99.....	6	8	14
57.00 to 57.99.....	9	6	15
58.00 to 58.99.....	8	10	18
59.00 to 59.99.....	13	10	23
60.00 to 60.99.....	13	8	21
61.00 to 61.99.....	7	5	12
62.00 to 62.99.....	11	7	18
63.00 to 63.99.....	2	7	9
64.00 to 64.99.....	5	2	7
65.00 to 65.99.....	3	2	5
66.00 to 66.99.....	1	0	1
67.00 to 67.99.....	3	0	3
68.00 to 68.99.....	0	0	0
69.00 to 69.99.....	1	0	1
70.00 to 70.99.....	1	2	3
Total.....	124	102	226
Mean weight.....	58.06±0.26	57.29±0.27	57.75±0.19
Standard deviation.....	4.28±0.18	4.11±0.19	4.21±0.13
Coefficient of variability.....	7.37±0.31	7.17±0.33	7.29±0.23

TABLE VIII.—Mean lengths, mean length-breadth indexes, and mean weights of eggs producing males and females, respectively

Item	Eggs producing—		Difference
	Males	Females	
Mean length.....mm.....	55.31±0.06	55.42±0.07	0.11±0.09
Mean length-breadth index.....	75.17±0.09	75.09±0.10	0.08±0.13
Mean weight Rock × Red, hatched.....gm.....	58.64±0.19	58.53±0.21	0.11±0.28
Mean weight Rock × Red, died in shell.....do.....	57.56±0.44	57.82±0.43	0.26±0.61
Mean weight Rock × Red, total.....do.....	58.49±0.17	58.45±0.19	0.04±0.25
Mean weight Red × Red, hatched.....do.....	58.06±0.26	57.29±0.27	0.77±0.37
Mean weight, all eggs.....do.....	58.24±0.14	58.01±0.16	0.23±0.21

Of the 418 eggs from the Barred Plymouth Rock females, 347 hatched and 71 died in shell at hatching time. Distinguishing the sex of the chicks at hatching time was readily done, since the sex-linked barring pattern of the female parents is transmitted to the sons only. The male chicks, therefore, had the characteristic white spot on the back of the head and yellow shanks. The female chicks were solid black in down color and had very dark-colored or black shanks. Table V shows for the 347 chicks that hatched, the frequency distribution and the mean

weights of the eggs producing males and females, respectively. The mean weight of the 190 eggs that produced males is 58.64 ± 0.19 gm. and the mean weight of the 157 eggs that produced females is 58.53 ± 0.21 gm. The difference in mean weight, with its probable error, is 0.11 ± 0.28 and, therefore, is of no significance. There is very little difference in respect to the amount of variability, either relatively or absolutely, in the groups of eggs producing the two sexes. The same situation prevails in respect to the 71 eggs whose chicks died in shell at hatching time,

as shown in Table VI. The mean weight of the 30 eggs producing males is 57.56 ± 0.44 gm. and the mean weight of the 41 eggs giving rise to females is 57.82 ± 0.43 gm. The difference, with its probable error, is 0.26 ± 0.61 and, therefore, is not significant. When the weights of the eggs that hatched and the weights of the eggs whose chicks died in shell at hatching time are taken into consideration, it is found that the mean weight of the eggs producing males is 58.49 ± 0.17 gm. and the mean weight of the eggs producing females is 58.45 ± 0.19 gm. as shown in Table VIII. The difference, with its probable error, is 0.04 ± 0.25 and, therefore, is of no significance.

From the Rhode Island Red females there were secured 226 eggs that hatched and on which the sex of the chicks was later recorded. The frequency distribution and mean weights of the eggs producing males and females, respectively, are shown in Table VII. The mean weight of the eggs producing males is 58.06 ± 0.26 gm. and the mean weight of the eggs producing females is 57.29 ± 0.27 gm. The difference, with its probable error, as shown in Table VIII, is 0.77 ± 0.37

and, therefore, is not significant. The relative and absolute amounts of variability in both groups are quite small, as shown in Table VII.

The mean weights of all eggs from the Barred Plymouth Rock and Rhode Island Red females producing males and females, respectively, are shown in Table VIII. The mean weight of all eggs producing males is 58.24 ± 0.14 gm. and the mean weight of all eggs producing females is 58.01 ± 0.16 gm. The difference, with its probable error, is 0.23 ± 0.21 and, therefore, is not significant.

CONCLUSIONS

As a result of this study, the following observations apply to eggs produced during the normal hatching:

There is no correlation between the absolute length of egg and the sex of the chicks hatched from it.

There is no correlation between the relative length or shape of egg and the sex of the chick hatched from it.

There is no correlation between weight of egg and the sex of the chick hatched from it.

