VARIATION IN PULSE RATE OF THE DOMESTIC FOWL AND THEIR PURE AND CROSSBRED PROGENY

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THESIS

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INTRODUCTION

One of the more important problems in the field of Poultry Husbandry is the measuring of the productive performance of the fowl. Many measurements have been attempted, among which are probable relationships between form and function, temperament of the fowl, etc. Criteria such as temperament are intangible, but if some precise physical character could be used as an index for measuring egg production, much labor could be saved in performance tests. The most reliable method known is the 12 month trap nest record which involves much time and labor.

It is thought that temperament is an expression of physiological efficiency. It has been shown by Totten (1940), in a previous investigation at this institution, that temperament is a very good index to egg production. Buchanan (1910) and Winchester (1939) have reported that metabolic rate is related to pulse rate. Therefore, it seems logical to suspect that pulse rate might be related to the productive performance of the fowl.

Poultrymen in general believe that the different breeds of poultry exhibit a difference in temperament. For instance, the Leghorn is a breed that is very excitable, and is said to have a nervous disposition, while the birds in the heavy class, such as Plymouth Rock and Cornish, are considered less nervous. If this is so and if temperament is an indication of metabolic rate, it may be that the different breeds might exhibit different pulse rates.

REVIEW OF LITERATURE

The pulse rate of the developing chick and of the adult fowl has been measured by several workers. Cohn (1925) and Barry (1940) concluded that the pulse rate of the developing chick embryo increased with age, that the acceleration rate is, at first, very rapid, but decreases as development progresses.

Bogue (1932) (1933) claimed to be the first to measure the pulse rate of the developing chicken embryo without opening the egg. He reported that his work confirmed that of Cohn (1925), and that the pulse rate of the chick rises sharply during, and immediately after hatching, but thereafter appears to remain constant for life. There was no obvious relation reported between the variations of the pulse rate and of the metabolic rate as observed during the development of the hen.

The pulse rate of the adult chicken was measured as early as 1909 by Buchanan (1909) (1910). She reported the mean pulse rate to be 369 per minute, and the variations in pulse rates between several species of birds and the hen was accounted for, in part by the difference in the heart weight - body weight ratio.

Winchester (1939) reported that the fluctuations of heat production were simultaneous with the fluctuations of the pulse rate. Again, Winchester (1940) reported the mean pulse rate of 29 New Hampshire hens to be 195 beats per minute

McNally (1940) reported the mean pulse rate of female White Leghorns and Rhode Island Reds to be 282 beats per minute. There was also a correlation between body weight and heart rate, which appears to be more fundamental than either breed or sex differences in breeds studied. The following table is a summary of previous recorded pulse rates of the domestic fowl. Table 1. Taken from McNally (1940).

Table 1. Previously recorded heart rates of the domestic fowl

Type of fowl	Heart Beats per minute	Authority
Adult cock.....	App. 320	Bogue (1933)
Adult cock.....	Ave. 333 (10)*	Stubel (1910)
Cock.....	Ave. 289±38.9 (4)*	Boas & Landauer(1933)
Fowl at rest...	300	Bogue (1932)
Hen when at rest	App. 330	Buchanan (1910)
Adult Hen.....	Ave. 286 (19)*	Stubel (1910)
New Hamp. hens.	Ave. 195 (29)*	Winchester (1940)
Hen.....	Ave. 200±18.7 (23)*	Boas & Landauer(1933)

* Number of birds studied.

The methods of measuring the pulse rates as used by the foregoing investigators are as follows: (1) Cohn (1925) and Barry (1940) measured the pulse rate by opening a

small hole in the large end of the egg and observing the pulsations, (2) The electrocardiograph was used by Bogue (1932), while (3) McNally (1940) used an electrocardiotachometer, which is similar to the electrocardiograph, (4) Buchanan (1910) used the electrical impulse of the heart and recorded the beat with a capillary electrometer, (5) A Western Electric 3A stethoscope was used by Winchester (1939).

No reports of a variation in pulse rate between purebred and crossbred or a correlation between egg production and pulse rate has been found.

PURPOSE

The objectives of this study were to determine the variation in pulse rates of pure and crossbred chickens; the correlation between pulse rate and egg production, and the influence of the dam on her progeny.

METHODS AND MATERIALS

Apparatus

The method of recording pulse rate included the use of a contact microphone, a preamplifier, and a Weston Electric recording machine, as shown in figure 1.

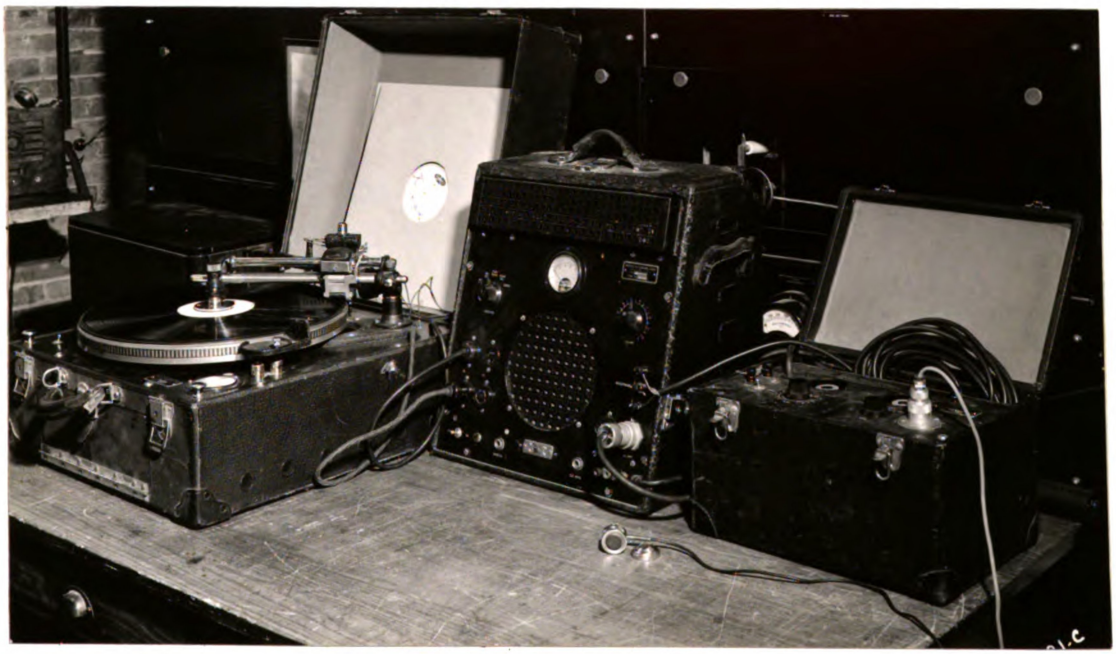

Figure 1. The apparatus used in recording pulse rates

The Shure Brothers Model 66A Piezoelectric microphone is shown in figure 2. The pulse beats were recorded on 16 inch wax records in duplicate 15 second intervals at the rate of 78 r.p.m. The count was made by revolving the record at the rate of 33 1/3 r.p.m.

Figure 2. The Sure Brothers Model 66A Piezoelectric contact microphone

Birds

The pulse rates of eight different "breeds" including both pure and crossbreds were measured. The breeding of the birds is as follows: (1) Dark Cornish (2) White Cornish (3) White Leghorn (4) Barred Plymouth Rock (5) Rhode Island Red (6) Dark Cornish, male X White Leghorn, female (7) White Cornish, male X Barred Plymouth Rock, female (8) Rhode Island Red X Leghorn, reciprocal cross.

Method

The pulse rates were measured on (1) March 25, (2) April 13, and (3) April 16, 1942. To insure some degree of uniformity, the birds were placed in holding crates at least 30 minutes prior to recordings. The technique of recording is illustrated in figure 3.

Figure 3. The position and method of holding the microphone

Results

The average count of the pulse beat during two

consecutive 15 second intervals is shown in table 2.

Table 2. Average pulse rate and number of birds

Dark Cornish	White Cornish	S.C.W. Leghorn	B.Ply. Rock	R.I.R.	D.C. X W.Leg.	W.C. X B.R.	R.I.R. X W.Leg.	
76	99	98	92	99	99	87	90	87
94	93	98	89	87	89	83	101	96
98	82	104	92	94	87	92	93	82
82	96	82	96	101	87	93	96	101
91	95	87	84		90	90	103	94
100	64	106	76		97	90	99	96
100		91	97		95	99	93	100
83		86	97		105	85	96	97
		89	93		80	73	92	96
		86	92		94	88	96	90
		93	93			80	95	97
		96	88			80	103	105
		92	98			98	98	92
		83	91			75	98	98
		90	93			86	95	102
		87	79			73	110	98
		97	101			92	98	95
		98	94			89	96	95
		89	84			80	90	102
		83	77			105	96	95
		101	93			90	95	88
		81	79			91	103	102
		93	87			95	100	104
		113	89				93	97
			87				98	84
			96				92	95
			94				94	103
			91				97	94
			87				95	93
			84				104	109
							96	88
							88	88
							99	99
							92	89
							94	92
							83	89
Mean of Breeds	90.5	88.2	92.6	89.8	95.3	92.3	87.6	95.7

Mean of Population = 92.5 S.D. = $\pm$7.59

It is evident that there is a considerable variation within breeds as well as between breeds. The mean pulse rate of the 177 birds measured is 92.5 with a S. D. of ± 7.59.

The eight breeds were combined and the data were tested by the method of analysis of variance. It can be seen in table 3 that there is a highly significant variation between breeds when the entire population is tested. The mean square between breeds is 120 times that within breeds. The "F" value need be only 2.92 for significance.

Table 3. Analysis of variance of pulse rates of 177 birds

Source of Variance	Degrees of Freedom	Sums of Squares	Mean Square	Standard Deviation
Total	176	10,152	57.7	7.59
Breeds	7	8,403	1200.0**	34.14
Within Breeds	169	1,749	10.0	3.16

** = highly significant

To determine significance of the variance in pulse rate between breeds, each breed was tested against all others until all breeds had been so tested. The "t" values are indicated in table 4. It can be noted in this table that, of the 28 possible combinations, there were

20 which demonstrated a significant variation in pulse rate. The remaining 8 combinations did not have significant values of "t".

Table 4. "t" values for pulse rate variations between breeds

Breeds	D.C.	W.C.	S.C.W. Leg.	B.P. Rock	R.I.R.	D.C. X W.Leg.	W.C. X B.R.	R.I.R. X W.Leg.
*D.C.		4.26	2.88	1.06	2.98	1.69	3.88	10.15
*W.C.			3.05	1.13	3.45	2.54	.44	5.59
S.C.W. Leg.				2.64	1.57	.26	5.46	4.17
B.P. Rock					16.89	2.29	2.51	8.61
*R.I.R.						1.78	4.50	.24
D.C. X W.Leg.							3.95	3.20
W.C. X *B.R.								10.66

* D.C. - Dark Cornish
W.C. - White Cornish
B.R. - Barred Plymouth Rock
R.I.R.- Rhode Island Red

Since Buchanan (1910) and Winchester (1940) showed that pulse rate is related to metabolic rate, it was surmised that pulse rate might be correlated with egg production. To test this, correlations were calculated of two classes of stock, crossbred pullets and purebred hens. In the case of the pullets, the egg production record for

the first 8 months of 1941-42 was used. The scatter of the pulse rates over the frequency chart can be noted in table 5. The correlation coefficient was found to be .0249±.117, which is not significant for these data.

Table 5. Correlation of pulse rate and egg production of Rhode Island Red X White Leghorn Crossbred Pullets

	Below 100.5	100.5 110.5	110.5 120.5	120.5 130.5	130.5 140.5	140.5 150.5	150.5 160.5	160.5 170.5	170.5 180.5	180.5 190.5	190.5 Above
105.5 110.5	1				1						
100.5 105.5	2	1	3	1		1	2	1			1
95.5 100.5	4	2	3	4	4		2	2	1	2	
90.5 95.5	1	1	1	2	3	6	3	1	1	2	
85.5 90.5			2	2	1	1	2		1		2
80.5 85.5				2							

Correlation Coefficient = .0249±.117

The egg production record for the year 1940-41 was used to test correlation coefficients of production with pulse rate for year old hens. The correlation coefficient was found to be -.218±.190 as shown in table 6. It is not significant.

During the collection of the data for this study,

Table 6. Correlation of pulse rate with first year egg production of purebred hens

PulseRate	EggProd.	PulseRate	EggProd.	PulseRate	EggProd.
98	130	101	170	87	159
98	166	94	213	96	208
104	161	84	180	94	190
82	205	77	156	91	172
87	133	93	143	87	169
106	177	79	216	84	216
91	188	87	196	99	123
79	150	89	176	87	157
		94	125	101	123

Correlation Coefficient = $-.218 \pm .190$

the question arose, "Is there a correlation between the pulse rate of a dam and her progeny?" The correlation coefficient was determined of 11 dams and their 46 progeny, and found to be $.232 \pm 299$ which is not significant. The dispersion of the pulse rates of the dam and progeny is shown in table 7.

Table 7. Pulse rates of dam and progeny

	Dam										
Pulse Rates	91	101	91	87	106	79	87	77	94	89	94
76								•			
85						•					
87				•							
88				•					•		
89					•				••		
90	•			•							
91											•
92			•	•			•		•	•	
93	•	•		•			•		•		
94				•							
95			••	•							
96	•		•	••							
97				•							
98			••	•		•					
99		•							•		
100				•							
101	•										
103	•		•	••							
104				•							
110			•								

DISCUSSION

The pulse rate of the domestic fowl has been measured by several investigators, and it has been shown that it ranges from 195 to 369 beats per minute. There are several physiological and environmental conditions which might cause such variations. In this investigation, the mean pulse rate of 8 different breeds was found to be 92.5 for a 15 second count or 370 beats per minute, with a S. D. of 7.59 for 15 seconds or 30.36 for one minute. This mean pulse rate appears to be slightly higher than that obtained by earlier workers. It is possible that the high rate obtained in this investigation may be due to excitement as a result of handling.

As previously mentioned, one objective of this study was to determine the relation between pulse rate and egg production, but from these data, there was no correlation between pulse rate and egg production of either pullets or hens. However, of the purebreds the highest pulse rate was that of the high producing Leghorns, while the lowest was that of the heavy weight, low producing White Cornish. The highest mean pulse rate recorded for a single breed was 382 for the Rhode Island Red X White Leghorn cross, and the lowest rate recorded was 340 for the White Cornish X Barred Plymouth Rock crossbreeds.

These data may not be adequate for purposes of determining the general relationship between pulse rate and egg production. It should be noted that a high pro-

portion of the birds used in the pulse rate - production correlation were of one breed. In the case of the pullets, the birds were all Rhode Island Red X White Leghorn crossbreds. From table 3, it is evident that the variation within breeds is relatively small. In the case of the hens, they consisted of 7 White Leghorns, 15 Barred Plymouth Rocks, and 4 Rhode Island Reds, all of which were selected for high egg production.

In this study, it has been found that 20 of the 28 combinations tested show a significant variation in pulse rate. In the instances of non-significant variation, in most cases the breeds were both of the heavy type, with the exception of the Rhode Island Red X White Leghorn combination. It is rather interesting to note that there is a significant difference in pulse rate of pure-bred Dark Cornish and White Leghorns, but the progeny of this cross did not differ significantly from either parental strain.

From the "t" values in table 4, it appears that pulse rate is a characteristic of the sample of breeds studied. This may imply inheritance in some fashion. In the case of the White Cornish and Barred Plymouth Rock, there is a strong indication that the White Cornish exerts the greatest effect because it does not exhibit a significant difference from the White Cornish X Barred Plymouth Rock crossbreds, while the Barred Plymouth does. There is still another condition present in the Rhode

Island Red X White Leghorn crossbreds. There is no significant variation between the Rhode Island Red and the White Leghorn purebreds, but there is a significant variation in pulse rate between the White Leghorn purebred and the Rhode Island Red X White Leghorn crossbred. In this instance the Rhode Island Red exerts the greatest effect on the progeny because there is no significant variation between the Rhode Island Red purebred and Rhode Island Red X White Leghorn crossbreds.

SUMMARY

1. A method of measuring the pulse rate of the domestic fowl has been noted and recorded.
2. The mean pulse rate and standard deviation of the 177 females studied are 92.5 and 7.59 respectively.
3. The following combinations of breeds were found to have significant variations of pulse rates.

a.	D. Cornish-W. Cornish	k.	W. Leghorn-W.C. X B.R.
b.	" -W. Leghorn	l.	" -R.I.R. X W.L.
c.	" -R. I. R.	m.	B.Ply.Rock-R. I. R.
d.	" -W.C. X B.R.	n.	" -R.I.R. X W.L.
e.	" -R.I.R. X W.L.	o.	" -D.C. X W.Leg.
f.	W. Cornish-W. Leghorn	p.	" -W.C. X B.R.
g.	" -R. I. R.	q.	R. I. R. -W.C. X B.R.
h.	" -W.C. X B.R.	r.	D.C. X W.L.-W.C. X B.R.
i.	" -R.I.R. X W.L.	s.	" -R.I.R. X W.L.
j.	W. Leghorn-B. Ply. Rock	t.	W.C. X B.R.-R.I.R. X W.L.

4. The following combinations of breeds were found to have a non-significant variation of pulse rates.

a.	D. Cornish-B.Ply.Rock	e.	W. Leghorn-R. I. R.
b.	" -D.C. X W.L.	f.	W. Leghorn-D.C. X W.L.
c.	W. Cornish-B.Ply.Rock	g.	R. I. R. -D.C. X W.L.
d.	" -D.C. X W.L.	h.	" -R.I.R. X W.L.

5. The correlation between pulse rate and egg production of hens and pullets is $-.218 \pm .190$ and $.0249 \pm 117$, respectively.
6. The correlation of the pulse rate between dam and progeny is $.232 \pm .299$.

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