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Horace Atwood

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A Study of the Time Factor in Egg Production

by
HORACE ATWOOD

AGRICULTURAL EXPERIMENT STATION
COLLEGE OF AGRICULTURE, WEST VIRGINIA UNIVERSITY
F. D. FROMME, Director
MORGANTOWN

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 T. B. Clark, B. S. Agr.
     Assistant in Poultry Husbandry

*In cooperation with the U. S. Department of Agriculture, Washington, D. C.

†In charge of the Lakin Sub-Station, Lakin, W. Va.

**In cooperation with the State Department of Agriculture, Charleston, W. Va.

‡In charge of the Reymann Memorial Farms, Wardensville, W. Va.

*A Study of the Time Factor in Egg Production**

by HORACE ATWOOD

WHEN a bird lays for several days in succession the first egg is usually the heaviest. Generally there is a gradual decrease in the weight of the eggs toward the end of the series, the last egg being the lightest. Then, after the bird has ceased to lay for one or more days, another series of eggs is started beginning with a heavy egg, and so on. A series of eggs so laid is called a cycle or clutch.

The first egg of a cycle usually is laid relatively early in the day and the remainder of the eggs in the cycle generally are laid later and later respectively on following days. An example of an egg cycle showing the weights of the eggs and the time of laying is shown in Table 1.

**TABLE 1.—Weight of Eggs and Time of Laying for One Cycle by Bird No. 124.
(August, 1926)**

Date of Laying	Time of Laying	Weight of Eggs in Grams	Interval
Aug. 1	did not lay	none	-----
Aug. 2	9 a. m.	55.7	-----
Aug. 3	11 a. m.	53.6	26 hours
Aug. 4	1 p. m.	53.4	26 hours
Aug. 5	3 p. m.	51.5	26 hours
Aug. 6	did not lay	none	-----

It is evident from Table 1 that the normal laying period for this bird during the time under consideration was 26 hours.

The length of the interval from the laying of one egg to the laying of another in the same cycle probably closely depends upon the activity of the physiological processes associated with egg production. If this be true the intervals may be used as a measure of the activity of the processes, and an understanding of these intervals may prove

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to be of importance in connection with feeding and breeding experiments.

Source and Method of Handling Data

During August, 1926, 172 White Leghorns in their first laying year were trapped hourly on the hour beginning at 8 a. m. and ceasing at 5 p. m. Particular care was taken to record all eggs laid during each interval. The birds laid during the month 3,516 eggs,—an average production of 20.44 eggs each.

In handling the data all eggs laid during any hourly interval were considered as though they were laid at the expiration of that interval, and in this discussion only those intervals have been considered when eggs were laid on consecutive days.

Correlations and deviations have been computed by the method proposed by Phillips,* and the probable error of the mean has been calculated from the customary formula.

The following discussion is a summary of the results obtained from the statistical examination of the data.

Cycles Consisting of Two Eggs Only

During the month 139 birds laid 485 two-egg cycles. The mean interval between the time of laying the first egg and the time of laying the second egg was one day plus $4.033 \pm .031$ hours, or practically 28 hours. The standard deviation of the intervals was $1.022 \pm .022$ hours.

Cycles Consisting of Three Eggs

During the month 137 birds laid a total of 355 three-egg cycles. The mean length of the intervals and the standard deviation of the intervals are given in Table 2.

TABLE 2.—Mean Length of Intervals and Standard Deviation of Intervals in Three-Egg Cycles

Period between	Mean Interval (One Day Omitted)	Standard Deviation of Intervals
First and second eggs	$2.479 \pm .035$ hours	$.968 \pm .025$
Second and third eggs	$3.208 \pm .032$ hours	$.886 \pm .022$
All intervals	$2.844 \pm .025$ hours	$.996 \pm .018$

The mean interval between the second and third eggs was materially longer than the interval between the first and second eggs. Also the mean of all the intervals in the three-egg cycles was slightly

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more than one hour shorter than the mean of the intervals in the two-egg cycles, showing that egg production moves at a faster pace in the longer cycles.

Cycles Consisting of Four Eggs

During the month 82 birds laid a total of 137 four-egg cycles. The mean length of the intervals and the standard deviation of the intervals are given in Table 3.

TABLE 3.—Mean Length of Intervals and Standard Deviation of Intervals in Four-Egg Cycles

Period between	Mean Interval (One Day Omitted)	Standard Deviation of Intervals
First and second eggs	1.664±.058 hours	1.012±.041
Second and third eggs	1.548±.065 hours	1.125±.046
Third and fourth eggs	2.569±.061 hours	1.052±.043
All intervals	1.927±.039 hours	1.159±.027

In the four-egg cycles the shortest mean interval was between the second and third eggs, and the longest mean interval was between the last two eggs in the cycles. It is to be observed also that the mean of all the intervals is smaller than in the two-egg or three-egg cycles.

Cycles Consisting of Five Eggs

During the month 36 birds laid 46 five-egg cycles. Table 4 records the mean intervals and the standard deviation of these intervals.

TABLE 4.—Mean Length of Intervals and Standard Deviation of Intervals in Five-Egg Cycles

Period between	Mean Interval (One Day Omitted)	Standard Deviation of Intervals
First and second eggs	1.478±.124 hours	1.426±.100
Second and third eggs	0.913±.109 hours	1.099±.077
Third and fourth eggs	1.109±.102 hours	1.026±.072
Fourth and fifth eggs	2.435±.162 hours	1.824±.115
All intervals	1.484±.071 hours	1.437±.051

In the cycles consisting of five eggs the greatest mean interval was between the last two eggs in the cycles, and the intervals between the second and third eggs and between the third and fourth eggs were significantly shorter than the intervals at either extremity of the cycles. The standard deviations of all intervals were somewhat greater than in the case of the four-egg cycles.

Cycles Consisting of Six Eggs

During the month 17 birds laid 21 six-egg cycles. The mean intervals and the standard deviation of these intervals are recorded in Table 5.

TABLE 5.—Mean Length of Intervals and Standard Deviation of Intervals in Six-Egg Cycles

Period between	Mean Interval (One Day Omitted)	Standard Deviation of Intervals
First and second eggs	1.619±.116 hours	.785±.082
Second and third eggs	1.191±.133 hours	.906±.094
Third and fourth eggs	-.238±.340 hours	2.307±.240
Fourth and fifth eggs	0.667±.205 hours	1.392±.145
Fifth and sixth eggs	2.810±.128 hours	.871±.091
All intervals	1.210±.251 hours	1.705±.178

Agreeing with the results obtained in the shorter cycles, the longest mean interval was between the last two eggs in the cycles, and the shortest intervals were between the eggs in the middle of the cycles. Also in these cycles the mean of all intervals was shorter than in the cycles consisting of a smaller number of eggs.

The standard deviations indicate that there was greater variability in the length of the intervals toward the center of the cycles than at either extremity. Why this should be so is not apparent.

Cycles Consisting of Seven Eggs

During the month six birds laid six cycles consisting of seven eggs each. Table 6 gives the mean intervals and the standard deviation of these intervals.

TABLE 6.—Mean Length of Intervals and Standard Deviation of Intervals in Seven-Egg Cycles

Period between	Mean Interval (One Day Omitted)	Standard Deviation of Intervals
First and second eggs	1.833±.130 hours	.473±.092
Second and third eggs	2.000±.275 hours	1.000±.195
Third and fourth eggs	0.500±.741 hours	2.693±.524
Fourth and fifth eggs	-2.333±1.014 hours	3.682±.717
Fifth and sixth eggs	1.500±.264 hours	.957±.186
Sixth and seventh eggs	3.000±.159 hours	.577±.112
All intervals	1.083±.293 hours	2.607±.208

In the cycles consisting of seven eggs the longest mean interval

was between the last two eggs in the cycles, and agreeing with the results obtained with the shorter cycles, the shortest mean intervals were found in the middle of the cycles, the interval between the fourth and fifth eggs being less than twenty-four hours. Also agreeing with the results obtained with the six-egg cycles, there was greater variability in the length of the intervals toward the center of the cycles than at either extremity.

Cycles Consisting of Eight or More Eggs

As the number of cycles consisting of eight or more eggs is too small to give reliable averages of the intervals between the various eggs in the cycles, the mean of all the intervals in these longer cycles has been computed and the results are presented in Table 7. Also for purposes of comparison the means of all intervals and standard deviations of intervals in the shorter cycles are brought together in this table.

TABLE 7.—Mean Length of Intervals and Standard Deviation of These Intervals in Cycles Containing Two or More Eggs

Length of Cycle	Number of Birds	Number of Cycles	Mean Length of Intervals in Hours	Standard Deviation of Intervals
2 eggs	139	485	$24+4.033\pm.031$	$1.022\pm.022$
3 eggs	137	355	$24+2.844\pm.025$	$.996\pm.013$
4 eggs	82	137	$24+1.927\pm.039$	$1.159\pm.027$
5 eggs	36	46	$24+1.484\pm.071$	$1.437\pm.051$
6 eggs	17	21	$24+1.210\pm.251$	$1.705\pm.173$
7 eggs	6	6	$24+1.083\pm.293$	$2.607\pm.208$
8 eggs	3	4	$24+.571\pm.211$	$1.657\pm.149$
9 eggs	1	1	$24+.750\pm.733$	$3.072\pm.518$
10 eggs	3	3	$24+.407\pm.103$	$.823\pm.076$
11 eggs	2	2	$24+.700\pm.291$	$1.926\pm.295$
26 eggs	1	1	$24+.160\pm.079$	$.731\pm.070$

Table 7 shows that as the cycles became longer the mean interval between the laying of one egg and the laying of the next egg in the cycle became shorter. For cycles consisting of two eggs only, the mean interval was approximately 28 hours, and as the cycles became longer there was a reasonably uniform decrease in the length of the intervals until in the one cycle consisting of 26 eggs the interval was approximately 24 hours.

A study of the results shows that the mean interval between the last two eggs in the cycles was greater than any other mean interval.

Also, at or about the center of the cycles the mean intervals were shorter than at either end, indicating that egg production is speeded up after the cycle has been started and that after the middle of the cycle has been reached this acceleration is succeeded by a slackening or retardation.

Effect of Bird Age on Length of Intervals

During August, 1927, as well as during August of the preceding year the average interval between the laying of successive eggs was determined for each of 132 birds that laid during each month. The unweighted mean interval for August, 1926, was found to be one day plus $2.6761 \pm .0539$ hours, and for August, 1927, the interval was one day plus $3.7008 \pm .0506$ hours. The difference between these two mean intervals, $1.0247 \pm .0739$ hours, apparently represents the mean additional time required by the older birds at that particular season of the year to produce an egg after a cycle has been started. The standard deviation of the intervals was practically the same in both instances, being $.918 \pm .038$ for the pullets and $.862 \pm .036$ when they were one year older.

Correlation of Intervals at Different Ages

It is interesting to determine whether the average length of interval between the laying of successive eggs is a persistent character of a bird or merely temporary in its nature. To throw light on this question the correlation between the average intervals for each bird at the two different ages was calculated and was found to be $+.578 \pm .039$. This correlation is positive and significant and indicates that the interval between the laying of successive eggs is a reasonably definite and fixed character.

Correlation of Mean Intervals and Annual Egg Production

If a close relationship should exist between the average interval for a few cycles and the number of eggs that a bird will lay in a year, it would afford information from which the future productivity of a bird could be predicted. The sum was obtained of all of the intervals in hours between eggs laid on consecutive days in all cycles for each bird in the test for the month of August, 1926. This sum divided by the number of intervals gave the average duration of each interval for each bird for the month. The average interval for each bird was then correlated with the number of eggs laid by each bird for the pullet year and the coefficient was found to be $-.413 \pm .043$. The coefficient

is negative and significant and shows that the shorter the average interval for August, the better the egg production for the year.

The mean of the 172 average intervals was found to be one day plus $2.814 \pm .048$ hours, and the standard deviation of these intervals was $.923 \pm .048$.

TABLE 8.—Correlation Table Showing Distribution of Egg Production and Intervals between Successive Eggs in Cycles for August, 1926

	TIME INTERVALS - HOURS																									TOTAL
	.11-.30	.31-.50	.51-.70	.71-.90	.91-1.10	1.11-1.30	1.31-1.50	1.51-1.70	1.71-1.90	1.91-2.10	2.11-2.30	2.31-2.50	2.51-2.70	2.71-2.90	2.91-3.10	3.11-3.30	3.31-3.50	3.51-3.70	3.71-3.90	3.91-4.10	4.11-4.30	4.31-4.50	4.51-4.70	4.71-4.90	4.91-5.10	
2																										1
3																										1
4																										1
5																										4
6																										1
7																										4
8																										1
9																										1
10																										1
11																										3
12																										2
13																										1
14																										3
15																										7
16																										3
17																										9
18																										21
19																										29
20																										25
21																										21
22																										7
23																										5
24																										3
25																										1
26																										172
27																										
28																										
29																										
30																										
TOTAL	1	1	1	5	4	3	2	8	7	13	22	16	8	19	8	10	6	8	5	5	4	3	1	5		172

$$r = -.420 \pm .041$$

Correlation of Average Intervals and Monthly Egg Production

The coefficient of correlation was computed also between the average time interval for the month of August for each bird and the egg production of each bird for that month. It was found to be $-.420 \pm .041$. This coefficient also is negative and significant and shows that the shorter the average time interval between the laying of successive eggs in the cycles for August, the better the egg production for that month. The data used in calculating this coefficient are shown in Table 8. (See page 9).

Summary and Conclusions

When a bird lays for several days in succession the first egg of the cycle or clutch generally is laid relatively early in the forenoon. The remainder of the eggs is laid later and later on succeeding days, the last egg of the cycle being laid relatively late in the afternoon. Then the bird ceases to lay for one or more days, and when a new cycle is started, again the first egg is laid early in the forenoon, and so on. The length of the interval between the laying of successive eggs is fairly uniform for any particular bird.

The data examined apparently justify the following conclusions:

The longer the cycle, the shorter are the intervals between the laying of successive eggs.

The interval between the laying of the last two eggs in a cycle is usually greater than any other interval in the cycle.

The intervals between the laying of eggs at or about the middle of the cycles are shorter than the intervals at either extremity.

As the birds become older the intervals between the laying of successive eggs become longer.

The shorter average intervals between the laying of successive eggs are usually associated with the more prolific layers.

APPENDIX

Time of Laying Used to Check Trap Nest Records

The high degree of regularity with which birds lay later and later in the day on succeeding days affords means by which trap nest records may be checked with a high degree of accuracy when the time of laying is recorded for each day. For example, suppose that the records of egg production and time of laying for a bird were as follows: 8:00 a. m., 10:00 a. m., 11:00 a. m., 12:00 m. and 1:00 p. m. If on the day following the last record an inspector should trap that particular bird at 9:00 a. m. he would know quite definitely that the record for the preceding day was wrong and that either a mistake had been made or the record had been intentionally falsified.

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