

shown, for example, that this number represents about the average number of oocytes to which any appreciable addition of yolk is being made at any given instant of time.

4. Applying this method to records of one, two and three year old hens many interesting and novel points regarding ovarian activity, as expressed in ovulation, may be made out. The long period secular cycles of production appear much more clearly and precisely than in flock mass statistics. The steady diminution in maximum rate of fecundity per unit of time after the first spring cycle in the bird's life is very strikingly shown in the great majority of cases.

This method of measuring fecundity opens the way to the attacking in the individual of a number of problems which hitherto have only been amenable to indirect, statistical treatment. Such, for example, are the questions of relation of size of egg to rate of fecundity, the relation between fertility (in the fowl readily measured by hatching quality of eggs) and fecundity. There are many other interesting biological problems relating to reproduction in birds, the analysis of which will certainly be aided by the method here discussed.

The complete paper describing the method and illustrating it fully by examples will shortly be published elsewhere, probably as a bulletin of the Maine Agricultural Experiment Station.—RAYMOND PEARL.

ON THE RHYTHM OF EGG PRODUCTION.

The subject matter of this paper presents some points of an investigation still in progress.

The term *rhythm* of egg production is used rather than *rate*, in order to emphasize the rhythmical character of egg extrusion. Although true that the observed rhythm is by no means regular, still each hen often tends to produce eggs according to a fairly characteristic rhythm. Superimposed on the daily rhythm, are evidences of other rhythms having a beat measured by months or years. Of course, from another standpoint egg production is a more or less continuous process.

The Rhythm as Shown by the Time of Day the Egg is Laid:—The time of day at which the eggs have been collected from the trap nests has been recorded at half-hour intervals, and as they are collected at least every hour and a half, the time collected represents approximately the time when the egg was dropped. This data has not yet been reduced, but some interesting facts are easily observed on inspection. Most hens lay for a period of several days and then skip one. The first day of a series the hen lays early in the morning. The time she lays the next day depends largely on the character of her particular rhythm. If the rhythm is such that she lays only every other day, she usually lays

about the same time each day, i. e. 10, 0, 11, 0, 10, 0, 11. If she lays two days out of three, the first egg is laid during the morning and the second during the afternoon, i. e. 10, 3, 0, 10, 2, 0, 9, 1, 5, 0.

As the period lengthens, the number laid in the morning increases until the larger proportion are laid before noon. Thus: 8, 9, 10, 10, 10, 10, 9, 10, 9, 5, 11, 11, 5, 11, 11, 2, 2, 4, 0. There is however, much variation.

Types of Rhythm:—As a working basis, we may assume an egg a day as a standard rhythm, and although this rhythm is rarely reached for extended periods we may refer the observed rhythm to it. Some hens lay every other day, or, we may say, a 1-2 rhythm, others 2-3, i. e. 2 days out of 3, others 3-4, and so on. Occasionally the series may be repeated without the intervention of a zero day.

None of these types are characteristic of any one hen. Many individuals, however, seem to centre about a particular rhythm, e. g. 2-3. While these individuals may fall to the 1-2 type, they do not often, except in the spring, exceed the 3-4 type. While little stress can be laid on this point, it is interesting to note this tendency particularly in certain individuals.

Rhythm and High Egg Production: Pearl found on the basis of winter egg production that his birds fell into three classes, viz. high, mediocre and zero producers. The dividing line between the high and mediocre producers came at about 30 eggs. Our statistics are in essential agreement with this statement. Observation, however, shows great variation in the number of eggs laid by birds in the over 30 class. Broodiness, age and time at which laying commences in the fall all influence the number of eggs laid. But aside from these factors, birds of the same age, beginning to lay at approximately the same time, and which do not become broody, do not lay at the same rate.

Here are two full sisters, hatched the same day, one of which, after making due allowance for the advantage gained by a two weeks' start of the better bird, laid 43 (36) against 69. The records show that one bird laid only about every other day, while the second laid about 5 days out of 6. The rhythm, then, is an important factor in determining the absolute number of eggs laid.

Rhythm and Very High Egg Production: The curve of the winter egg production of our flock does not slope evenly to the base line, but forms a shoulder at 70-80 eggs. This shoulder I take to be an indication, from a genetic standpoint, of a group of individuals differing genotypically in their capacity for egg production from the remainder of the high class. The existence of this group must be due in part to the high frequency pullets.

The Inheritance of Egg Rhythm:—This is a subject on which we have little data. Full sisters, however, may lay at different rates so that if rhythm is inherited it indicates segregation.

Factors that Modify Rhythm:—Various causes may interfere with the normal rhythm, such as environment, season, method of management, and internal factors, as broodiness.

The Rhythm Independent of the Formation and Growth of an Egg:—One of the most interesting things in connection with the rhythm of egg production as observed by Pearl is the existence of hens which never lay an egg, but which visit the nests according to a very definite rhythm. We are able to add to this record, for we find the hours of such visits fall into the same sort of rhythm as normal hens. These facts point strongly to the existence of some mechanism other than the formation and deposition of an egg which controls the extrusion of the egg. It is interesting to note that if one of these hens is removed from the nest before she is ready to leave, she returns and persists in doing so until, shall we say, she thinks she has laid her egg.

Laying hens often visit the nest at the proper day and hour, but fail to lay. Such hens usually lay the day previous and the day after in regular routine, though at times they may pay two or more such non-productive visits in succession. One hen laid well during the winter, and then stopped producing eggs although continuing to visit the nest in about the same rhythm as when laying.—H. D. GOODALE.

THE CONSTITUTION OF THE WHITE LEGHORN BREED.

The paper presented data which demonstrated that the White Leghorn breed of fowls carries factors for barred plumage pattern and for black pigmentation, but that the appearance of barring is held in check by inhibiting factors for which the White Leghorn is homozygous. Another factor possessed by the White Leghorn was shown to be an inhibitor for the mesodermal pigmentation of the Silky fowl, a factor which appears to be heterozygous in the female and homozygous in the male.

These data were used as a plea for the formulation of a *scientific standard* for the description and classification of breeds of poultry. Such a standard, it was assumed, would be based, not on the appearance, but on the breeding value of the stock, and would be represented symbolically. It was argued that a standard of this sort would foster race-purity, if carried far enough, standardize accepted breeds in all countries and through this means, throw open to poultrymen a world of possibilities for the production of new breeds or the improvement of old.—PHILIP B. HADLEY.

INBREEDING, ITS EFFECT ON VIGOR AND EGG LAYING.

I have not yet had time to fully analyze our records bearing on this question, but a brief statement of the results so far as they have been studied will no doubt be of interest.

1. From different matings where the son was bred to the mother, the pullet offspring showed a lower average egg yield than others not inbred.

2. There was greater variability in production from the inbred pullets; that is there was a wider range between the highest and lowest individual records, than was the case with those not inbred.

3. The vigor of the laying stock as shown by the mortality records was lowest in the inbred stock.

4. The vigor of the offspring as shown by the mortality records of the chicks was lowest in the inbred stock.

5. There was a lower fertility of eggs in the inbred stock.

So far as fixing the character of egg production is concerned, inbreeding proved a failure.

It may be true that inbreeding tends to uniformity of type, that it discourages variability of type, but our experiments with fowls gave results in egg production exactly the opposite. An inbred pullet, for example, laid 291 eggs in a year, the most remarkable layer produced at the station except one, but the same mating that produced this phenomenal layer produced the poorest layer in the flock.

It is probably true that most of our breeds of poultry, as well as of live stock, were largely inbred in the making. It may be open to doubt whether this was not largely due to circumstances or to the fact that in the making of new breeds there was not at hand two or more families unrelated by blood line from which to draw upon rather than to the merit of the system itself.

The evil effects of inbreeding may not be apparent in the form or beauty of the fowl but it will show in reduced vigor and lower breeding power. It may show in the egg yield, in the fertility of the eggs, and in the vigor or mortality of the chicks, but not necessarily in type or prize winning qualities. The explanation may be that productive qualities are more closely related to vigor than is shape or type.

I might add that in all my experiments with heavy layers, with one or two exceptions, a high record hen has never been secured by inbreeding or line breeding, and so far as I have gone the average result from inbreeding was lower than from outbreeding.—JAMES DRYDEN.

INHERITANCE STUDIES.

SEX LIMITATION AND THE BARRING FACTOR.

The presence of a factor for barring in the plumage pattern of many of our com-