

tain characteristics are linked with the factors for sex.

2. Spangling in the Silver Spangled Hamburg follows the sex-linked mode of inheritance.

3. Spangling is inherited as a unit character independently of characters that are connected with different degrees of pigmentation.

4. Spangling is a unit character which segregates independently, and it may appear on the buff background inherited from the Brown Leghorn as well as on the white background of the Hamburg, as may be seen in different individuals of the F₂ generation. This would indicate the independent segregation of spangling as a definite unit.

5. The factor for spangling is independent of a factor or factors for mottling which seems to have a complicated form of inheritance.

6. The black cocks which transmit spangling, although adequate experimental data are lacking, would seem to be best explained by assuming the presence of multiple factors for black which may have a cumulative effect and conceal the spangled pattern.

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PRELIMINARY REPORT OF RESULTS OF AN EXPERIMENT ON CLOSE INBREEDING IN FOWLS.¹

It seems unnecessary at this time to review current ideas as to the effects of inbreeding. Briefly stated the consensus of present opinion seems to be that the continued mating of closely related individuals serves as a method of quickly fixing desirable traits in a breed, but that it also tends to accentuate faults, and commonly leads to deterioration of the stock, gauged by lowered fertility, weakened vitality and the like. Many practical experiments in inbreeding have been made by the breeder in his effort to improve his stock during the past several decades, and it is almost a truism that considerable inbreeding has been practiced in the establishing of practically every prominent breed of live stock. On the other hand, while they have not attracted such general attention, the failures have far exceeded the successes—so much so, in fact, that most breeders are afraid to practice very close breeding, preferring the slower but, in their opinion, safer method of hunting for animals with the desired traits in unrelated lines. According to common experience inbreeding is a sharp but double-edged tool.

Laboratory experiments likewise have

given conflicting results. In some cases inbreeding appears to have produced deterioration; in other experiments, particularly where proper selection has been practiced, no such effect has been noticed. While it may not be the whole story, the most probable cause of defects arising from inbreeding is that in the shuffling of factors in successive generations there is always the danger of loss of some which are of vital importance to the animal. On the other hand, since there is no crossing out with other stock there is no chance of replacing any such which may have been lost out of the germ plasm. The end result depends upon the effectiveness of conscious selection together with the chance results of the large amount of unconscious and uncontrolled selection which must occur, and this accounts for the inconstancy of results.

The experiment here briefly described was devised to eliminate one of these factors, namely conscious selection of any factors of vital importance to the subject. The plan has been to base the selection of individuals for carrying on the stock entirely upon a character which in no way, so far as we could judge, was associated with the animal's fertility or vitality. Rhode Island Red fowls were chosen as subjects for the experiment and plumage color as a basis of selection. The conduct of the experiment has been essentially as follows:

In February, 1913, twelve pullets from the University flock were placed in a pen with an entirely unrelated cockerel. The pullets varied in age from ten to eleven months and were more or less related, being descended from four hens and a cockerel used as foundation stock in 1910. The cockerel used was approximately eleven months old.

In following years, in order to carry on the experiment it was necessary to make a certain amount of selection on the basis of number of progeny, birds for this purpose being selected only from the progeny of single hens which had matured ten or more pullets and at least two cockerels during the season. Between these families, or fraternities, selection was now made on the following basis:

1. Individual pullets were judged on the basis of the color of the back, both surface and undercolor, "perfect" back color, according to the Standard of Perfection, being adjudged 100 and all pullets rated on this basis. In case of equality in back color, color of other parts was taken into consideration in prescribed order. No attention was paid to defects in other respects.

2. The ten highest scoring pullets were selected from each of the two lots ranking highest in the requirements of

¹Presented with the permission of the Director of the Wisconsin Agricultural Experiment Station.

plumage color outlined above. The first of these constituted the "winning line," to be used for continuance of the experiment; the other was designated the "second line" and was saved each year for comparison with the winning line and as a reserve in case of emergency.

The higher scoring of the two cockerels in each of the two lines saved was bred to his ten sisters each season, the other cockerel in each line being saved for substitution in case of necessity.

The winning line and second line were housed separately, but otherwise received similar treatment. With each line each season were put as checks two entirely unrelated Rhode Island Red pullets, known not to have inbred pedigrees, thus making a total of 12 pullets in each house. Record of egg production by individuals is kept from the time the pullets begin to lay, only those eggs laid from March 1 to May 14, however, being incubated. While other records have been kept, we shall in the present account confine ourselves almost entirely to seasonal egg production and to hatchability of the eggs. No attempt will be made to present details, but a simple statement will be made of the general results, which we shall substantiate later in a full report on the experiment.

EGG PRODUCTION has been divided more or less arbitrarily into four seasons, (1) the WINTER SEASON, Nov. 1, to Feb. 28, (2) the HATCHING SEASON, March 1 to May 14, (3) the SUMMER SEASON, May 15 to Aug. 31, and (4) the FALL SEASON, Sept. 1 to Oct. 31. While to date we have complete records for only two full years, we have records for four hatching seasons and for three of each of the other seasons. This is a short period on which to base conclusions of weight, but there has been a decrease in average egg production of the inbred birds even in this short time which is not paralleled by the checks carried under precisely the same conditions except as to breeding. The checks also, it is true, show a slight decrease in certain seasons, which may be due to difference in conditions, or to other variables, and an equal decrease would have to be deducted from the effect to be attributed to inbreeding; but even with this deduction the decrease of the inbred lines is still in excess and seems to be significant.

FERTILITY shows no change in the inbred hens significantly different from that of the checks.

HATCHABILITY. It is in hatchability that the greatest difference between the experimental and the check pullets is to

be seen. For present purposes we need consider only the average number of chicks hatched per hen, although the records will ultimately be considered in more detail. The following table² gives the average per cent. of fertile eggs per hen which hatched in the successive years of the experiment, both for the inbred birds and the controls. It should be borne in mind that in the first year the original stock was not yet inbred and no extra birds as checks were added. While there is considerable fluctuation in the hatchability of the checks, which was unaccountably low in 1914, it is evident that this is very different from the surprisingly consistent decrease shown by the inbred birds.

PER CENT FERTILE EGGS HATCHED.

| | 1913 | 1914 | 1915 | 1916 |
|----------------|------|------|------|------|
| Inbred pullets | 67 | 49 | 41 | 18 |
| Checks | 67 | 31 | 56 | 64 |

In conformation, weight and general appearance the females of the inbred lines appear to be up to normal, while the males generally give the appearance of being somewhat lacking in vigor. As to color, it is difficult to say what the effect of the intense selection has been, except that the selected stock is generally very good in color of back, and often in other parts. Since selection for color as well as other qualities has been going on in the general University flock during the same period, comparison with these birds does not prove anything.

²The figures here given are based on preliminary first calculations; it may be that slight changes will be made when they are carefully checked, but such changes will not be enough to affect sensibly the general results.

Summing up we may say in a word that the inbred birds appear to show some decrease in egg production and an unmistakable lowering of hatchability of eggs, which probably means lower vitality of embryos. The extent of this decrease and its apparent decisiveness have been an unexpected surprise to us, but we cannot help feeling it is in large part, at least, at direct result of the method of breeding. We realize that the experiment as yet has made no real analysis of the factors at work, but hope by continuing the investigation to be able ultimately to contribute something to that phase of the question as well.

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