

Studies in Broiler Production

1. Performance of Breeds and Breed Crosses of Broiler Parents

V. BUVANENDRAN

Central Poultry Research Station, Kundasale, Ceylon

(Received January, 1968)

INTRODUCTION

AN ideal chick for broiler production should have a rapid growth rate combined with other characters such as quick feathering, meat-type conformation, good livability and white flesh and feathers. However, in view of the difficulty of incorporating into one strain all the desired broiler qualities, it is often necessary to resort to cross breeding. One of the popular crosses used in broiler production is the White Cornish $\times$ White Plymouth Rock, the Cornish males being crossed with the White Rock hens to produce commercial broiler chicks. White Rock is used as the dam line in the cross because it has moderate egg production and hatchability with good growth rate. The Cornish breed also has a good growth rate, but its outstanding characteristic is its meat type conformation.

A broiler breeder, producing the chicks for commercial broiler production will therefore have to maintain the two breeds as pure lines and apply selection pressure within the lines for the traits he wishes to improve. However, a limited broiler chick market raises a practical problem for the breeder, since he has to maintain a large number of Cornish females right through the year for his selection programme but cannot use them in propagation except for 2 or 3 weeks of the year (i.e. to propagate the line). It was therefore decided to compare the performance of the two pure breeds and the reciprocal crosses to examine the feasibility of using the pure White Cornish chicks and chicks of the reciprocal cross, White Rock $\times$ White Cornish in broiler production. Since growth rate is the most important single factor contributing to profit in broilers, attention was paid chiefly to this character in this experiment.

MATERIALS AND METHODS

Parent females of the two breeds—White Cornish and White Rock hatched on the same date were divided into two samples. One sub-population was mated with males of its own breed and the other with

males of the other breed. This method of mating permitted the production of pure-bred Cornish (C) and White Rock Chicks (R) and cross bred chicks ($C \times R$ and $R \times C$) simultaneously. In subsequent discussions, abbreviations for the crosses will be used and the male side in each case will be listed first.

On the day of hatching, all chicks were sexed and 20 males and 20 female chicks from each pure breed and cross selected at random were wing-banded. The chicks were brooded together under an infra red brooder and fed a starter ration. At the end of 4 weeks of age they were transferred to Californian type grower cages, each cage accommodating 5 chicks. The males and females of each of the 4 groups (2 pure breeds and 2 crosses) were housed in separate cages and a finisher ration given from the 5th to 12th week of age. Individual chick weights to the nearest gram and feed consumption for each group were recorded weekly.

RESULTS AND DISCUSSION

The mean 10 week body weights are presented by breeds and crosses in Table 1. The cross utilizing Cornish on the male side of the cross is superior to the reciprocal and the better parental mean in both males and females. The significance of the differences are shown in Table 2.

TABLE 1.—Mean 10 week body weight in grams

Breed or Cross			Males	Females
R	..	..	1388.1 $\pm$ 47.7	1243.9 $\pm$ 24.9
C	..	..	1474.5 $\pm$ 39.7	1369.0 $\pm$ 38.8
$C \times R$	..	..	1536.9 $\pm$ 32.5	1388.2 $\pm$ 25.6
$R \times C$	..	..	1402.3 $\pm$ 33.6	1320.1 $\pm$ 23.2

TABLE 2.—Significance of difference between means in body weight

Comparison	Sex	Difference in weight (g)		t values
Breeds vs.	M	..	—38.3	1.01
Crosses	F	..	—47.7	1.08
$C \times R$ vs. $R \times C$	M	..	134.6	2.93*
	F	..	68.2	2.03*
$C \times R$ vs. Pure breeds	M	..	105.6	2.20*
	F	..	81.8	2.05*
$C \times R$ vs. C	M	..	62.4	1.22
	F	..	19.3	0.37

*P < 0.05

**P < 0.01.

PERFORMANCE OF BREEDS AND CROSSES OF BROILER PARENTS

The combined cross means for males and females were not significantly higher than the combined parental means (breeds vs. crosses). The C × R cross mean was significantly higher than the combined parental mean for both males and females but was not significantly superior to the better Cornish parent. These results show that a heterotic effect on 10-week body weight was present in the C × R cross but not in the reciprocal.

The food conversion ratios calculated for the 6-week period from 4 to 10 weeks of age for the four groups are shown in Table 3. These values were calculated by dividing the total feed consumed by the absolute weight gain during this period. The C × R cross had the lowest feed conversion in both males and females while the reciprocal cross males had a conversion ratio intermediate to that of the two pure breeds. The females of this cross had a conversion rate inferior to that of the two pure breeds. The data on feed conversion could not be tested for statistical significance as feed consumption figures were obtained on a group basis.

Differences in growth rate among the reciprocal crosses can be explained as being due to maternal or sex linked effects. Yao (1961) found evidence of maternal effects on 10-week body weight in diallel crosses between inbred lines of poultry and Thomas *et al.* (1958) have reported the existence of sex linked effects on 8 and 10-week body weights. Cock and Morton (1963) have reported the presence of both maternal and sex linked effects on adult body size.

TABLE 3.—Food conversion ratios between 4—10 weeks of age

				Males	Females
R × R	..	..	..	2.92	3.63
C × C	..	..	..	3.02	3.17
C × R	..	..	..	2.81	2.99
R × C	..	..	..	3.22	3.72

In the present experiment the difference in weight between the reciprocal cross males was 134.6 ± 46.2 grs. or 9.59 per cent. of the mean weight of R × C. In females however, the difference was smaller being 68.2 ± 33.7 grs. or 5.17 per cent. of R ± C. The data so far, in that they show a large difference in males and a smaller but still significant difference in females suggest a strong maternal and a weak sex-linked effect.

Approximate estimates of maternal and sex linked effects may be obtained using the procedure of Cock and Morton (1963). In poultry (unlike mammals), the female is the heterogametic sex while the male has two sex chromosomes. If we designate the sex

chromosomes of the Cornish and White Rock by C and R and the maternal environments provided by their females by M_1 M_2 respectively, then the sex chromosomes and maternal environment of the progeny of the two reciprocal crosses will be as shown below.

Parents					
	♂	♀	♂	♀	
	C	R	R	C	
Sex chromosomes	.. CC	R	RR	C	
Maternal environment	.. —	M_2	—	M_1	
Progeny F_1					
	♂	♀	♂	♀	
Sex Chromosomes	.. CR	C	CR	R	
Maternal environment of dam	.. M_2	M_2	M_1	M_1	

The difference in reciprocal F_1 males is due purely to differences in maternal effects while the difference in females is due to both maternal and sex chromosome effects. These two effects can be easily estimated by subtraction knowing $C \times R - R \times C$ for both males and females. The effects estimated by the different comparisons for weights at different ages are shown in Table 4.

TABLE 4.—Mean difference in body weight between reciprocal crosses and estimate of maternal and sex linked effects

<i>Effect estimated</i>	$C \times R - R \times C$				<i>X estimated as a % effect</i>
	$\delta\delta$ M		♀♀ X—M		
<i>Age (weeks)</i>	<i>grs.</i>	<i>as % of R × C</i>	<i>grs.</i>	<i>as % of R × C</i>	
6 ..	57.8	8.14	42.7	6.44	+ 1.70
8 ..	78.5	7.64	22.0	2.20	+ 5.44
10 ..	134.6	9.59	68.2	5.17	+ 4.42
12 ..	126.8	7.07	69.7	4.56	+ 2.51
Mean effect ..	—	8.11	—	—	+ 3.54

M = Effect of substituting an M_2 (Rock) for an M_1 (Cornish) maternal environment.

X = Effect of substituting a C (Cornish) for an R (Rock) sex chromosome.

PERFORMANCE OF BREEDS AND CROSSES OF BROILER PARENTS

The average estimates of maternal and sex linked effects are shown in the bottom line of Table 4. The smaller White Rock breed, has the superior maternal effect while the Cornish breed has the larger sex-link effect. However, the maternal influence is nearly twice as strong as the sex-link effect.

The sex-link effect can easily be explained on the basis that birds of the Cornish breed carry genes for large body weight on their sex chromosomes. The mechanism of the maternal effect however, is not so clear. It may perhaps depend on the different nutritional environments provided to the embryos by the dams of the two breeds. One way in which maternal environment may operate is through differences in egg size. It is known that egg size influences the size of the embryo at hatching and that this effect is continued for a few weeks of the post embryonic period (Merritt and Gowe, 1965). However, in the present experiment, the weight of the chicks of the two reciprocal crosses were very similar at hatching (39.5 and 40.0 grs.) and hence egg weight differences cannot account for any significant portion of the maternal effect. Perhaps a qualitative difference in the nature of the environment provided by the egg as suggested by Cock and Morton (1963) seems to be a more likely cause of the maternal effect.

SUMMARY

The growth rates of the chicks of White Cornish and White Rock breeds and their reciprocal crosses were compared. A heterotic effect was observed in Cornish $\times$ White Rock crosses but not in the reciprocal. The males and females of the C $\times$ R cross were significantly superior to the reciprocal males and females but the differences between males were considerably larger than that between females. This difference is explained as being due to maternal and sex-linked effects.

ACKNOWLEDGMENTS

The author wishes to express his appreciation of the technical assistance given by Miss L. S. Salgado.

REFERENCES

- COCK, A. G., and MORTON, J. R. (1963). Maternal and sex-linked effects on size and conformation in domestic fowl. *Heredity*, 18, 337-350.
- MERRITT, E. S., and GOWE, R. S. (1965). Post embryonic growth in relation to egg weight. *Poult. Sci.*, 44, 477-480.
- THOMAS, C. H., BLOW, W. L., COCKERHAM, C. G. and GLAZENER, E. W. (1958). The heritability of body weight, gain, feed consumption and feed conversion in broilers. *Poult. Sci.*, 37, 882-869.
- YAO, T. S. (1961). Genetic variation in the progenies of the diallel crosses of inbred lines of chicken. *Poult. Sci.*, 40, 1048-1059.