

A COMPARISON OF THE EFFECTS OF SEX-LINKED EARLY AND  
LATE FEATHERING ON GROWTH AND FEATHERING  
OF CHICKS TO TWELVE WEEKS OF AGE

by

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## INTRODUCTION

In recent years much emphasis has been placed upon the desirability of producing early feathering chicks. From the standpoint of the broiler grower it is extremely important that chickens grow and feather rapidly during the first few months of their life. A well feathered bird facilitates dressing and presents a neat, attractive carcass. Chickens which are not well feathered at market age present a more serious problem in preparation for cooking. If there are too many pinfeathers the carcass appears untidy and poorly dressed. The poultry packer has placed a discriminatory price against the so-called "bare backs," influencing the more progressive poultry breeders to develop strains of heavy breeds which are well feathered at the broiler age. The importance of early feathering has been increased by recent advances in poultry nutrition and breeding which provide for the production of market-size broilers at young ages. This tendency has attained greater significance in the past few years due to an enormously increased consumer demand. Early feathering also offers some protection from chilling in the advent of cool temperatures. There is some feeling that early feathering chicks attain a greater body weight at 12 weeks than do late feathering chicks.

Rapid improvement of the feathering condition in broilers has been accomplished by production of stock known to be well feathered at broiler age, and by the utilization of such strains for the conversion of heavy breeds into early feathering types. It is known that the major differences in feathering are inherited in a simple manner which makes the fixing of the early feathering trait a relatively easy procedure. In the production of early feathering breeds, investigators have found that the incorporation

of the gene for sex-linked early feathering largely eliminates the problem of poor feathering in broilers.

In view of the interest manifest among progressive poultry breeders, the poultryman selling breeding stock of heavy breeds which lack the early feathering trait is most likely in the future to find discrimination of the market against his stock.

However, some commercial broiler producers adhere to the production of late feathering chicks. While acknowledging the fact that early feathering chicks have the advantage at the beginning, some producers claim that at market age the late feathering chick is more desirable from the standpoint of mature plumage. It is their thought that the early feathering bird, having attained its first set of plumage, begins to molt and secure the second set at market age. Thus, the early feathering bird, according to their claim, has more pinfeathers at this stage than a late feathering bird which is maturing its first set of plumage.

The chief interests in this research were the determination of the differences in body weight and the actual feathering condition of early and late feathering strains of broilers at market age.

#### REVIEW OF LITERATURE

It is well established that the rate of feathering in chickens is controlled by genetic factors, although the physiologic mechanisms involved in the expression of these factors have not been determined. Serebrovsky (1922), reporting upon a cross between Barred Plymouth Rocks and Russian Orloffs, first described a genetic factor for the rate of feathering at one to one and one-half months of age and gave evidence that the gene involved

was carried on the sex chromosome. The allelomorphic pair of genes involved was the late feathering characteristic of most of the heavier breeds, and the early feathering found in the smaller Mediterranean breeds. Later, Warren (1925) confirmed the findings of Serebrovsky and demonstrated by crossing White Leghorn males and Jersey Black Giant females that late feathering is controlled by a sex-linked dominant gene. The  $F_1$  females were early feathering and the  $F_1$  males were late feathering. Both sexes were late feathering in offspring from the reciprocal cross. He found that an examination at 12 days of age would permit a correct classification by recording those showing tail feathers as early feathering and those lacking them at that time as late feathering.

Danforth (1929) observed that differences in the time at which feathers first appear in young chicks and also that the rate at which feathers grow after having made their appearance tend to be associated with breeds. He observed that feathering in American and Asiatic Classes was in general more or less retarded, while the Mediterranean and other of the smaller breeds were on the whole precocious in this respect.

Martin (1929) found that Barred Plymouth Rock chicks show sex dimorphism with respect to rate of feather growth, the females feathering more rapidly than the males. Sexual dimorphism in rate of feathering has also been observed by Jaap and Morris (1937), Radi and Warren (1938), Hays and Sanborn (1942), and Darrow and Warren (1944).

Warren (1933) described another type of feathering, "retarded," which behaves as a simple autosomal recessive factor. Its presence reduces the number of secondaries present in the day-old chick and inhibits the appearance of tail feathers for several weeks. A recessive multiple allele

of this factor, reported by Jones and Mutt (1946), was found to prevent manifestation of the sex-linked type of early feathering characteristic of White Leghorns. This factor, called "tardy," causes slow development of the tail, secondary feathers in the wing, and contour feathers over the body. Similarly to the early feathering gene, this gene controls the rate of feathering through the growing period, but is not discernible in the adult.

By selection, Radi and Warren (1938) established two strains of late feathering Rhode Island Reds which as broilers differed genetically in the degree of feathering. Their results indicated that this genetic difference was primarily dependent on the presence of autosomal modifying factors. This observation was confirmed by Hays and Sanborn (1942) who showed that a dominant autosomal gene exerts a cumulative effect with the recessive sex-linked gene for early feathering to produce complete feathering over the back at eight weeks and to essentially eliminate sex-dimorphism in rate of feathering.

The number of well developed secondaries in day-old chicks was found by Barrow (1941) to be indicative of the degree of feathering to be expected at six weeks of age. Barrow and Warren (1944) found that the degree of development of tail feathers at 10 days was highly correlated with feathering at six weeks.

Several investigators have observed an association between early feathering and rapid growth in body size. Martin (1929) reported that the rate of feather development over the back of Barred Plymouth Rocks was closely related to rate of growth with the heaviest chicks feathering most rapidly. Gericke and Platt (1932) found a correlation coefficient of  $+ .8120 \pm .109$  between weight and feathering at eight weeks of age.



Glazener and Jull (1946) discovered that chicks having six or more secondaries at hatching time were heavier at ten weeks of age than were those with five or less secondaries, and that the birds which were best feathered at eight weeks were the heaviest birds at ten weeks of age. Jaap and Morris (1937) obtained significant correlation coefficients between weight and feathering at eight weeks. They also concluded from a covariance analysis that sex was relatively more important than any other heritable factor influencing the rate of feathering. They further concluded that when there are both poor and well feathered individuals in a population at eight weeks of age, 49 percent of the variability is not inherited, also, that one would expect to make much more rapid progress selecting for weight than for feathering from observations taken the eighth week after hatching. In four lots of New Hampshire chicks, Warren and Payne (1945) found those with early feathering to be consistently heavier at 12 weeks of age than were the ones with late feathering.

It is of some interest that the late feathering birds used in studies by Doone, Davidson, and Reineke (1950) showed more rapid early growth than the early feathering strain. In a large group of Rhode Island Red chicks hatched in the spring of 1950 a study by Hays (1951) produced evidence that the presence or absence of the sex-linked gene for early feathering had no effect on body weight in early growing stages. However, an autosomal gene was found to be associated with rapid growth.

## STOCK AND MANAGEMENT

The stock used in this study consisted of 496 chicks hatched on May 29, 1951 from several broiler strains. Of these chicks, 100 were of a commercial White Plymouth Rock broiler strain and 130 were of a commercial New Hampshire broiler strain. These commercial strains have attained high national rankings in the Chicken-of-Tomorrow Contests and were found to be approximately 50 and 60 percent early feathering, respectively. Crossbred males known to be heterozygous for the early feathering sex-linked gene were mated with females of the Kansas State College strain of White Plymouth Rocks to produce 175 chicks used in this study. A similar male was mated with White Leghorn females to produce 37 chicks. For purposes of comparison, 14 White Leghorn chicks were included. The remainder of the total was comprised of chicks known only to be of the last two groups mentioned.

The term "early" is applied to birds having the sex-linked recessive gene for early feathering as found in the Leghorn. The chick expresses this factor by being well covered with feathers at an early age.

Standard procedures for pedigrees chicks were followed with the chicks being removed from the incubator on the twenty-second day. After being classified as "early" or "late," they were moved to a battery room and brooded there for three weeks by standard methods of management. At the end of the third week, they were placed under electric hovers in a large permanent brooder house. Throughout the experiment, all chicks were reared together and fed the following "high efficiency" broiler ration:



<u>Ingredients</u>	<u>Amount per 100 lbs.</u>
Ground yellow corn	61 lbs.
Dehydrated alfalfa meal	1
Meat scraps (50% protein)	2.5
Fish meal	2.5
Soybean oil meal (14% solvent-extracted)	30
Calcium carbonate	1
Steamed bone meal	1.5
Sodium chloride	0.5
Manganese sulphate	25 gm
Cholesterol (DB)	40
Ca-Pantothenate	1
Riboflavin	5
Prot-A	100
Aurofac	115
Choline chloride (25%)	36
Macin	5

The chicks received no grain but were reared on the above mash diet throughout the experiment. Feed was placed in the hoppers in the morning. The hoppers were allowed to be partially emptied by late afternoon, at which time they were filled sufficiently to supply adequate feed until the next morning. As the chicks grew, larger hoppers and more space within the brooder house were utilized.

Through the use of automatic water fountains the chicks were provided with a fresh supply of water at all times.

#### EXPERIMENTAL METHODS

Differences in degree of body feathering are not readily discernible in the adult and only the extreme variations can be distinguished at broiler ages; therefore, a critical study of each chick was made during the early growing period. Each chick was described at 1 day, 10 days, 6 weeks, and 8 weeks of age.

It was believed that descriptions of the rate of feathering in live birds older than six weeks of age would be subject to considerable variation and human error; therefore, an actual feather count was deemed to be more accurate and advisable. To obtain an actual feather count, approximately 40 birds, including representatives of each strain and cross being studied, were killed and skinned at the ages of 6, 8, 10, and 12 weeks and the pelts were preserved for further study. Care was taken to insure that the birds killed from each strain and cross were paired according to sex and with respect to the two types of feathering being considered. A total of 38,810 individual feathers were classified according to their stage of maturity.

All birds still alive at 12 weeks of age were taken to a commercial poultry processing plant where they were dressed and then were graded according to the number of pinfeathers present immediately after mechanical picking and before any manual removal of pinfeathers.

Body weights were recorded in grams at the ages of 8 and 12 weeks.

The classifications and descriptions of feathering which were used during the course of this study are listed below.

#### Classification of Live Chicks

The following descriptions were used in describing the feathering condition of birds in the live state at the age of 1 day, 10 days, 6 weeks, and 8 weeks:

One-Day Descriptions. The chicks were removed from the incubator on the twenty-second day at which time they were dry and well fluffed out. At this age they could be easily handled and accurately classified for

feathering.

All chicks were classified into two groups in an endeavor to predict and study the rate of feathering. Chicks that had sheaths of primary feathers in the wing longer and larger in diameter than those of their covert feathers and which exhibited six or more well developed secondary feather sheaths were classified as early feathering. Chicks classified as late feathering were those that had coverts about the same diameter and length as the primaries and had few, if any, poorly developed secondary feather sheaths.

Ten-Day Descriptions. The widest differences in tail and wing feather development between early and late feathering chicks are apparent at the 10- to 12-day age. The ten-day age was selected for the second description to verify the classifications made at one-day of age.

At this age the early feathering chicks were easily recognized by the presence of well developed tail feathers and primary and secondary feathers of equal length. Chicks originally classified as late feathering possessed no well developed tail feathers and the secondaries were definitely shorter than the primaries. The ten-day descriptions proved the original one-day classifications to be greater than 98 percent accurate.

Five arbitrary scores as to the development of the feathers in the wing, tail, and humeral tract were established in an effort to determine if slight variations within each group were indicative of the degree of feathering at broiler age.

Six-Week Descriptions. In an effort to establish a trend in the rate of feathering six weeks of age was chosen as a time for the first description of body feathering in the growing broilers. It is at this age that

the greatest variation in degree of feathering over the back is expressed. This is probably because the back tract is the last one to attain its complement of feathers; a region which attracts the concern of commercial broiler growers.

All chicks were scored for the degree of back feathering, utilizing the following five scores which are illustrated in Plate I:

- 1 — No fully developed feathers, but having a few poorly developed feathers or pinfeathers
- 2 — Few well developed feathers extending down the median line of the back region
- 3 — Several rows of well developed feathers in the back region
- 4 — A fair covering of feathers over the back region
- 5 — Back region completely covered.

Eight-Week Descriptions. At eight weeks of age the differences in the body feathering condition between early and late feathering individuals were not easily ascertained. However, to establish the trends for each group, the birds were scored for their over-all feathering condition. In order to obtain a relatively uniform quantitative determination of the degree of feathering, a simple arbitrary scoring system was used. In estimating the feathering of a bird by this system, each one was scored as good, medium, poor, or very poor.

#### Classification of Dorsal Tract Feathers on Felts

At 6, 8, 10, and 12 weeks of age a random sampling of approximately 40 chicks paired to include individuals representing both sexes and both types of feathering were killed and skinned.

EXPLANATION OF PLATE I

The standards for back scores established for chicks at six weeks of age.

The distribution of these scores among the population studied was as follows:

<u>Score</u>	<u>Percentage</u>
1	10
2	12
3	13
4	25
5	40

## PLATE I





The skinning of the birds was accomplished in such a manner as to procure pelts retaining the feather tracts as intact as possible and with a minimum loss of the original number of feathers.

The pelts were then tightly stretched and stapled to sections of fiberboard. Each pelt was covered by a layer of salt in order to facilitate its drying. After a drying period of approximately one week, the pelts lost their moisture, thus the skin became dry, stiff, and brittle allowing the pelts to be handled with ease.

Inasmuch as the feathering over the back region receives the most attention from the poultry producer and the poultry packer, it was deemed advisable to concentrate this study upon that specific region. The greater portion of the dorsal tract of each pelt was selected as the area for detailed study.

The limits of the part of the dorsal tract studied were defined in the following manner: A line was drawn on the underside of each pelt between the dorsal and femoral tracts in order to establish the lateral boundaries. The anterior boundary of the area considered was determined by drawing a line parallel with the forward edge of the femoral tract on each side. Throughout this investigation, the enclosed area described is referred to as the dorsal tract and is illustrated in Plate II.

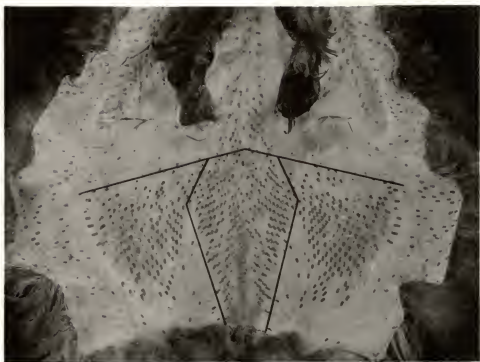
Every feather was plucked from the dorsal tract of each pelt and was scored according to its stage of maturity into one of the following five classifications which are illustrated in Plate III:

Mature — possessing a dry, clear shaft without a feather sheath

EXPLANATION OF PLATE II

The underside of a chicken pelt illustrating the manner in which the limits of the dorsal tract area were defined.

## PLATE II



- Intermediate (1) — possessing a feather sheath less than  $\frac{1}{4}$  the total length of the feather, and appearing practically mature except for the presence of pigment in the pulp
- Intermediate (2) — quite immature and with a feather sheath between  $\frac{1}{4}$  and  $\frac{1}{2}$  the total feather length
- Intermediate (3) — advanced slightly beyond the pinfeather stage with a feather sheath greater than  $\frac{1}{2}$  the total feather length
- Pinfeather — entirely enclosed within a feather sheath.

#### Classification of Dressed Birds

When the chickens were 12 weeks old, the remaining stock was commercially dressed and classified on the line immediately after mechanical picking. In order to maintain uniformity in the dressing procedure and avoid variations in the amount and efficiency of manual pinning it was felt that the classifications would be more accurate if made as the birds came from the mechanical picker.

Three arbitrary classifications were used in scoring the dressed carcasses according to the number of pinfeathers prevalent. The dressed birds were classified as good, medium, or poor.

EXPLANATION OF PLATE III

The maturity classifications established for dorsal tract feathers.

- First row — Mature
- Second row — Intermediate (1), less than  $\frac{1}{4}$  sheathed
- Third row — Intermediate (2),  $\frac{1}{4}$  to  $\frac{1}{2}$  sheathed
- Fourth row — Intermediate (3), greater than  $\frac{1}{2}$  sheathed
- Bottom row — Pinfeather





## RESULTS

## Relationship of Feathering to Growth

The weights of all chicks in the experiment at 8 and 12 weeks were recorded to the nearest five grams.

The data summarized in Table 1 show no differences between the mean weights of early and late feathering chicks of either sex at eight weeks. The data also show that at 12 weeks of age the early feathering females averaged  $1,196.6 \pm 19.20$  grams and the late feathering females  $1,119.3 \pm 29.85$  grams. The difference in the mean weight between the early and late feathering females was  $77.3 \pm 35.49$  grams or approximately 0.17 pounds, a significant figure.

The early males averaged  $1,437.0 \pm 27.45$  grams at 12 weeks, and the late males averaged  $1,440.8 \pm 12.66$  grams. The difference of  $3.8 \pm 30.22$  grams was not significant.

## Comparison of Body Feathering of Early and Late Feathering Chicks

The ten-day descriptions were practically 99 percent in agreement with the one-day descriptions which classified each chick as either early or late feathering.

The arbitrary scoring system used at 10 days in an effort to make a more detailed classification seemed to be of little value as the chicks matured.

It was found that chicks having the best back feathering scores (4 or 5) at six weeks became satisfactorily feathered. These scores are illustrated in Plate I.

Table 1. Relation of the type of feathering to chick weight. <sup>1</sup>

Age, weeks	Early feathering		Late feathering		Difference
	Chicks, no.	Mean weight, gm	Chicks, no.	Mean weight, gm	
Females					
8	121	777.9 ± 12.02	57	749.8 ± 17.12	28.1 ± 20.92
12	102	1196.6 ± 19.20	41	1119.3 ± 29.85	77.3 ± 35.49* <sup>2</sup>
Males					
8	108	894.0 ± 16.20	111	902.2 ± 13.93	8.2 ± 21.36
12	86	1437.0 ± 27.45	91	1440.8 ± 12.66	3.8 ± 30.22

<sup>1</sup> In this table and in all succeeding tables where there is a comparison of early and late feathering chicks the data for the White Leghorns have been omitted because they did not include late feathering chicks.

<sup>2</sup> Throughout this thesis, statistical significance is denoted as follows: \* -- statistically significant at the 5 percent level ( $P < .05$ )  
\*\* -- statistically significant at the 1 percent level ( $P < .01$ )

The various strains did not differ significantly in the distribution of six-week body scores. It was of interest to note that the White Leghorns also had, in general, the same scores as the early feathering heavy breeds and crossbreeds. Strain differences did appear among the scores for the late feathering females.

The scores for body feathering at eight weeks of age indicated no difference between the strains among the females but did show significant differences between strains among the males. The detailed data are given in Tables A and B of the Appendix.

An analysis of the six-week body feathering scores showed a larger proportion of the early feathering chicks with a high score while the late feathering chicks received a larger proportion of the low scores. Of the early feathering females, 93.7 percent obtained a score of 4 or 5 in contrast to 27.9 percent for the late feathering females. The chi-square value on the distribution of the scores was 113.40, a highly significant figure.

Of the early male chicks, 79.7 percent scored 4 or 5 compared to 30 percent for the late male chicks. This difference was also highly significant with a chi-square value of 76.55.

As the chicks matured these differences maintained their significance with 92.9 percent of the early females and 72.3 percent of the early males being classified as possessing good feathering at eight weeks compared to 58.9 percent of the late females and 25.9 percent of the late males. Again, the chi-square values of 34.50 and 63.68, respectively, were highly significant. These data are summarized in Table 2.

Table 2. Relation of the type of feathering to body classifications.

Body score	Female chicks				Male chicks			
	Early		Late		Early		Late	
	no.	percent	no.	percent	no.	percent	no.	percent
	:	:	:	:	:	:	:	:
6-week classifications								
1	1	0.6	8	13.1	4	3.1	35	29.2
2	5	3.2	15	24.6	8	6.3	29	24.2
3	4	2.5	21	34.4	14	10.9	20	16.6
4	37	23.6	14	23.0	40	31.3	25	20.8
5	110	70.1	3	4.9	62	48.4	11	9.2
Total	157		61		128		120	
8-week classifications								
V. Poor	0	0.0	4	7.2	1	0.8	20	17.9
Poor	2	1.4	5	8.9	4	3.4	26	23.2
Medium	8	5.7	14	25.0	28	23.5	37	33.0
Good	130	92.9	33	58.9	86	72.3	29	25.9
Total	140		56		119		112	

Comparison of Body Feathering Scores to Dorsal Tract  
Feather Maturity Classifications

The scores given for body feathering at six weeks of age had a direct relationship with the actual feathering condition of the chicks at 6, 8, 10, and 12 weeks of age as determined by the count and maturity classifications given the feathers present in the dorsal tract.

The chicks given the score of 1 at six weeks had no feathers mature in the dorsal tract while of those present 25.43 percent were pinfeathers. Those scoring 5 had 25.13 percent of their feathers mature with only 7.99 percent being pinfeathers.

This trend was also present when the six-week body score was compared to the maturity of the feathers at 8, 10, and 12 weeks.

At 12 weeks of age the chicks which received a score of 1 at six weeks had 14.65 percent of their feathers mature and 8.86 percent were pinfeathers while those which had a six-week score of 5 showed 39.37 percent of their feathers mature and only 4.71 percent were pinfeathers. These data for each age and maturity classification are given in detail in Table 3. The portion of Table 3 concerning the maturity classifications at 12 weeks of age are represented graphically in Fig. 1.

Figure 1 shows a remarkable relationship between 6-week body scores and 12-week feather counts. Chicks with the lowest body scores had the lowest proportion of mature feathers and the highest proportion of pinfeathers when skinned six weeks later.

Table 3. Relation of scores for body feathering at 6 weeks of age to maturity classifications of dorsal tract feathers counted at 6, 8, 10, and 12 weeks of age. <sup>1</sup>

Maturity Classification	Percentage distribution of feathers on the basis of the maturity classification when counted.				
	Body scores at 6 weeks				
	1	2	3	4	5
	6-week classifications				
Mature	0.00	0.48	0.00	8.10	25.13
Intermediate (1)	14.10	18.34	33.59	33.09	32.64
Intermediate (2)	16.03	28.36	36.77	29.73	23.05
Intermediate (3)	44.44	33.99	17.05	13.32	11.19
Pinfeather	25.43	18.83	12.59	15.76	7.99
	8-week classifications				
Mature	1.28	3.77	7.83	20.00	37.46
Intermediate (1)	8.16	27.90	33.04	29.03	28.64
Intermediate (2)	19.52	27.67	26.09	31.46	18.56
Intermediate (3)	44.64	25.21	21.30	13.20	10.15
Pinfeather	26.40	15.45	11.74	6.31	5.19

<sup>1</sup> The maturity classifications are described and illustrated in Plate III.



Table 3. (concl.)

Maturity Classification	Percentage distribution of feathers on the basis of the maturity classification when counted.					
	Body scores at 6 weeks					
	1	2	3	4	5	
	10-week classifications					
Mature	0.00	9.38	16.86	31.47	36.28	
Intermediate (1)	8.53	28.27	26.36	25.11	26.88	
Intermediate (2)	38.27	26.03	32.02	17.85	19.24	
Intermediate (3)	26.84	14.24	9.71	8.53	7.50	
Pinfeather	26.36	22.08	15.05	16.99	10.10	
	12-week classifications <sup>1</sup>					
Mature	14.65	22.71	33.42	32.28	39.37	
Intermediate (1)	32.73	27.41	28.70	28.22	25.31	
Intermediate (2)	33.63	31.44	23.90	20.03	22.25	
Intermediate (3)	10.13	10.30	9.72	13.82	8.36	
Pinfeather	8.86	8.14	4.26	5.65	4.71	

<sup>1</sup> These data are shown graphically in Fig. 1.

Variations in feather counts attributable to body score at six weeks when considering the maturity of the feathers at 6, 8, and 10 weeks of age are difficult to evaluate in terms of percentage figures. Therefore, a point system was devised to permit simultaneous expression of the effects of age and six-week score on feather tract counts. Each feather in the dorsal tract of the chicks skinned was given a point value according to its stage of maturity as follows:

<u>Classification</u>	<u>Point score</u>
Mature	5
Intermediate (1)	4
Intermediate (2)	3
Intermediate (3)	2
Pinfeather	1

Using this system each chick was given a total point score by the addition of the values given to each feather in the dorsal tract. A high point score represented a large number of feathers with a high degree of maturity. An average score was computed for the birds represented in each one of the five groups with regard to body feathering at six weeks of age.

These average point scores are presented graphically in Figure 2 in order to clearly demonstrate the relation of the six-week body scores to the actual feathering condition of the broiler chicks up to market age.

It is shown in Figure 2 that the higher the score for feathering at six weeks, the greater the maturity of the feathers at that and succeeding ages as indicated by the larger point scores.

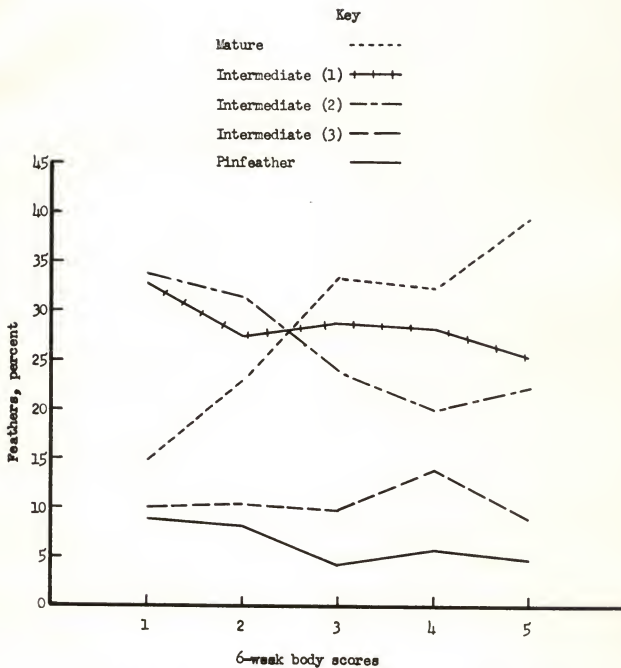


Fig. 1. A comparison of the 6-week body feathering score with the maturity of the feathers in the dorsal tract at 12 weeks.

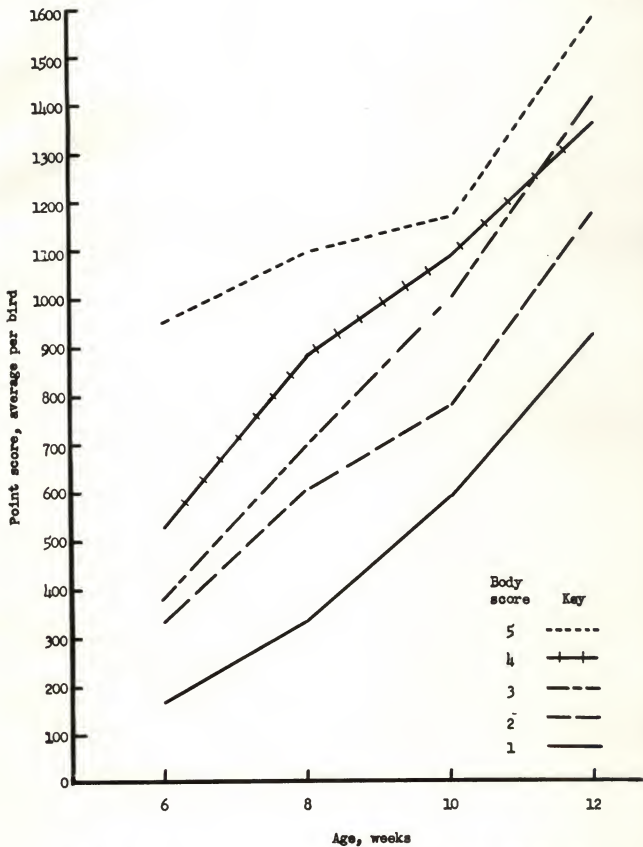


Fig. 2. A comparison of the point scores for maturity of feathers in early and late feathering birds.

Comparison of Dorsal Tract Feather Maturity Classifications  
of Early and Late Feathering Chicks

Individual chicks exhibited varying degrees of body feathering. The early feathering chicks displayed a greater number of feathers in providing for a more complete coverage of their bodies. The mean number of feathers of the early females at six weeks of age was  $190 \pm 16.43$  and that of the late feathering females was  $101 \pm 15.16$ . The difference in the mean number of feathers was  $89 \pm 22.35$ , a highly significant figure. At eight weeks of age the mean number of feathers was  $293 \pm 20.59$  and  $210 \pm 26.90$ , respectively. This difference of  $83 \pm 33.88$  feathers was significant. These differences were not present at 10 and 12 weeks.

The early males averaged  $243 \pm 17.08$  feathers at six weeks and  $402 \pm 20.13$  at 12 weeks. The late males averaged  $129 \pm 20.60$  and  $329 \pm 13.0$ , respectively. The differences of  $114 \pm 26.75$  and  $73 \pm 24.02$  were highly significant. The differences noted between 6 and 12 weeks of age were also significant. These data are presented in detail in Table 4. Early feathering males consistently possessed more feathers than did late feathering males. However, there were no significant differences in the total number of feathers attributable to early or late feathering in the female chicks after the age of eight weeks.

To determine if there was any difference in the number of mature feathers and pinfeathers prevalent in the early and late feathering chicks a statistical analysis of the data was made. This analysis revealed the fact that no difference in the number of pinfeathers existed between the early and late feathering females. The analysis further showed that the average number of pinfeathers was  $30.5 \pm 5.76$  on the early feathering males

Table 4. A comparison of the average number of feathers in the dorsal tract of early and late feathering chicks.

Age, weeks	Early feathering		Late feathering		Difference
	Chicks, no.	Feathers, mean no.	Chicks, no.	Feathers, mean no.	
Females					
6	12	190 $\pm$ 16.43	9	101 $\pm$ 15.16	89 $\pm$ 22.35**
8	7	293 $\pm$ 20.59	7	210 $\pm$ 26.90	83 $\pm$ 33.33*
10	11	311 $\pm$ 14.04	7	310 $\pm$ 14.42	1 $\pm$ 20.12
12	9	394 $\pm$ 11.72	8	374 $\pm$ 19.88	20 $\pm$ 23.07
Males					
6	9	243 $\pm$ 17.08	7	129 $\pm$ 20.60	114 $\pm$ 26.75**
8	7	250 $\pm$ 20.56	7	196 $\pm$ 22.42	54 $\pm$ 30.41*
10	10	310 $\pm$ 14.38	9	262 $\pm$ 11.80	48 $\pm$ 18.60*
12	8	402 $\pm$ 20.13	8	329 $\pm$ 13.10	73 $\pm$ 24.02**

at 10 weeks and  $63.8 \pm 5.26$  on the late feathering males. The difference of  $33.3 \pm 7.80$  feathers was highly significant. At 12 weeks of age the early feathering males averaged  $16.1 \pm 3.39$  pinfeathers compared to  $31.2 \pm 4.66$  for the late males. The difference of  $15.1 \pm 5.76$  was significant. These data are presented in Table 5 and similar data for mature feathers are given in Table 6.



Table 5. A comparison of the number of pinfeathers in the dorsal tract of early and late feathering chicks.

Age, weeks	Early feathering		Late feathering		Difference Feathers, mean no.
	Chicks, no.	Feathers, mean no.	Chicks, no.	Feathers, mean no.	
Females					
6	11	18.5 ± 6.20	9	18.3 ± 4.27	0.2 ± 7.53
8	7	12.0 ± 5.15	7	20.9 ± 2.75	8.9 ± 5.83
10	9	39.2 ± 6.40	7	66.4 ± 18.67	27.2 ± 19.74
12	9	21.2 ± 2.27	8	16.7 ± 3.28	4.1 ± 3.91
Males					
6	7	27.3 ± 5.91	7	21.3 ± 4.99	6.0 ± 7.73
8	7	28.7 ± 4.83	7	40.0 ± 16.33	11.3 ± 17.03
10	10	30.5 ± 5.76	9	63.8 ± 5.26	33.3 ± 7.80**
12	8	16.1 ± 3.39	8	31.2 ± 4.66	15.1 ± 5.76*

Table 6. A comparison of the number of mature feathers in the dorsal tract of early and late feathering chicks.

Age, weeks	Early feathering		Late feathering		Difference
	Chicks, no.	Feathers, mean no.	Chicks, no.	Feathers, mean no.	
Females					
6	11	33.9 ± 9.96	9	0.0 ± <u>1</u>	33.9 <u>1</u>
8	7	92.7 ± 15.82	7	31.7 ± 13.34	61.0 ± 20.69*
10	9	109.7 ± 11.77	7	85.9 ± 15.33	23.8 ± 19.33
12	9	116.8 ± 12.30	8	129.0 ± 21.08	17.8 ± 24.41
Males					
6	7	30.9 ± 12.72	7	0.0 ± <u>1</u>	30.9 <u>1</u>
8	7	47.4 ± 14.96	7	3.1 ± 3.15	44.3 ± 15.29*
10	10	85.8 ± 27.48	9	18.4 ± 10.59	67.4 ± 29.45*
12	8	115.9 ± 13.78	8	69.9 ± 7.33	70.9 ± 15.08**

1 Inasmuch as these values are zero a statistical treatment is not possible. Obviously the differences are significant.

The average number of feathers classified into each of the maturity classifications for early and late feathering chicks at 6, 8, 10, and 12 weeks of age are also presented in graphic form in Figures 3 and 4. The summarized data are presented in Tables C and D of the Appendix with the original data for each chick studied given in Tables E through H of the Appendix.

Since the average number of feathers per chick varied considerably, it is of interest to note the proportionate distribution of the various maturity classifications and how they changed as the chicks matured.

The early feathering females exhibited 37.2 percent of their dorsal tract feathers as mature whereas the late females ~~exhibited~~ this figure with 34.5 percent when both groups were 12 weeks of age. The percentages of pinfeathers at the same age were 5.4 and 4.5, respectively.

The males present an entirely different picture with the early feathering males being consistently better with respect to feather maturity at all ages studied. At 12 weeks of age only 4.0 percent of the dorsal tract feathers of the early males were pinfeathers while that percentage for the late males was 9.5. This difference is exemplified further when the presence of 36.3 percent mature feathers for the early males is compared to 21.0 percent for the late males.

Figures 5 and 6 prepared from the summarized data presented in Table D of the Appendix clearly demonstrate the comparisons of the proportionate maturity of feathers from the early and late feathering females and males.

Feather  
Classifications

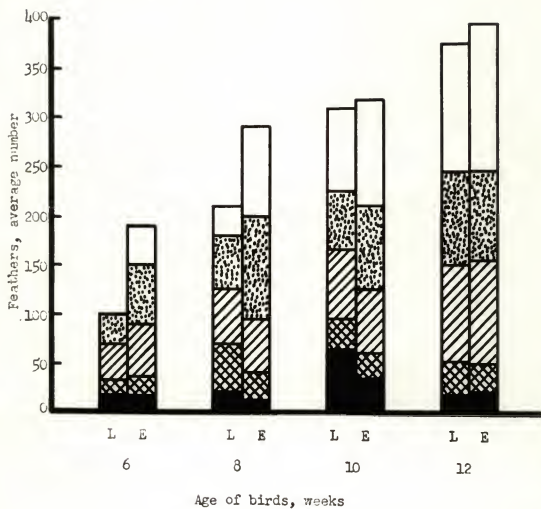
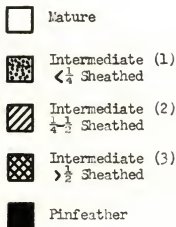


Fig. 3. A comparison of the degree of maturity of feathers in the dorsal tract of late feathering (L) and early feathering (E) pullets, based upon an actual count of feathers.

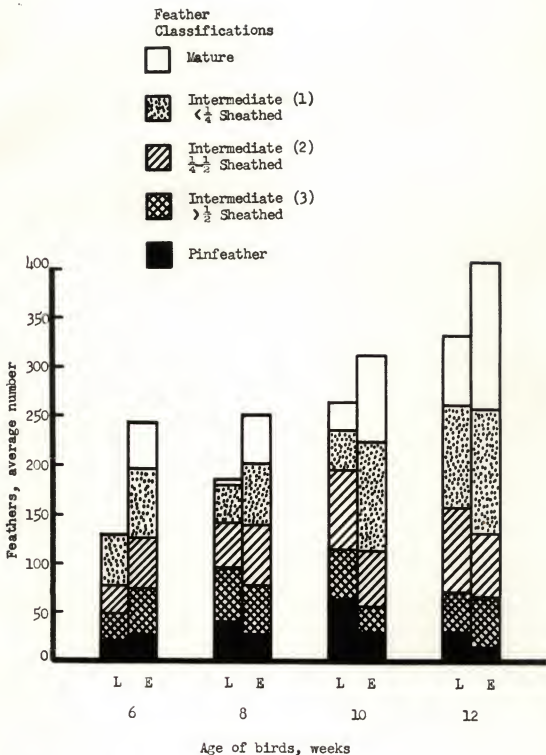


Fig. 4. A comparison of the degree of maturity of feathers in the dorsal tract of late feathering (L) and early feathering (E) cockerels, based upon an actual count of feathers.

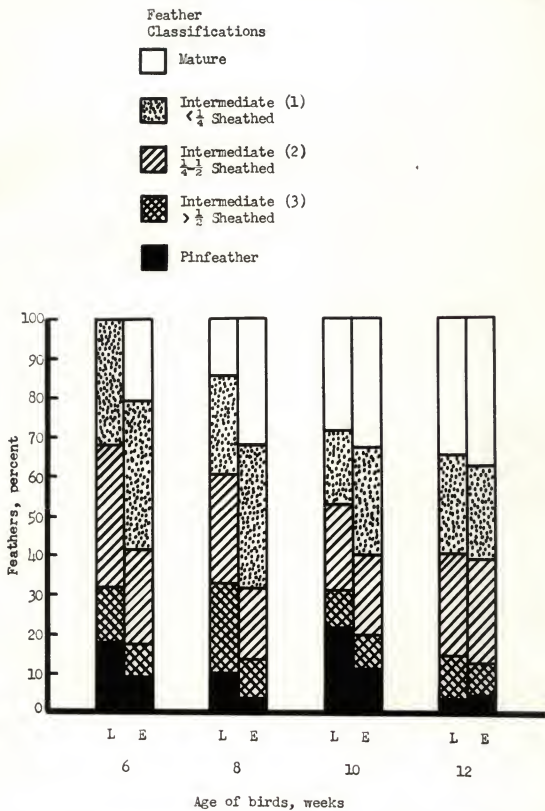


Fig. 5. A comparison of the degree of maturity of feathers in the dorsal tract of late feathering (L) and early feathering (E) pullets, based upon the proportionate number of feathers.

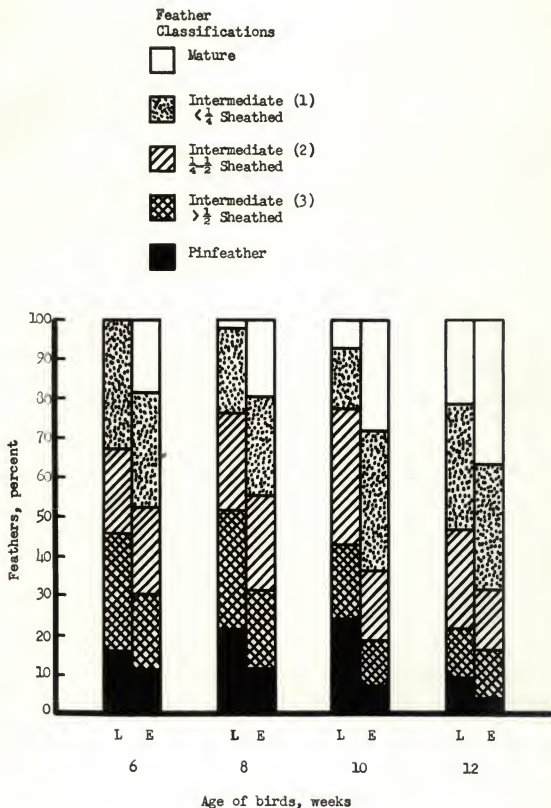


Fig. 6. A comparison of the degree of maturity of feathers in the dorsal tract of early feathering (E) and late feathering (L) cockerels, based upon the proportionate number of feathers.



Relation of the Type of Feathering to the  
Classifications of the Dressed Carcasses

Inasmuch as the six-week body score for feathering was a direct indication of the maturity of feathers up to 12 weeks it was only natural to assume that such a relationship would also exist with reference to the scores of the dressed carcasses at 12 weeks.

From the results summarized in Table 7 it may be inferred that such is the case. While 65.0 percent of those scored as 1 at six weeks provided poor appearing carcasses only 28.3 percent of those scoring 5 did likewise. On the other hand, 25.7 percent of those which had a score of 5 at six weeks were classified as good whereas only 15 percent of those which had scored 1 were good when dressed.

Table 7. Relation of scores for body feathering at 6 weeks of age to scores of carcasses dressed at 12 weeks of age.

Dressed score	Percentage distribution of chicks on the basis of the dressed score at 12 weeks of age.				
	Body scores at 6 weeks				
	1	2	3	4	5
Good	15.0	14.2	23.3	32.8	25.7
Medium	20.0	42.9	43.3	32.8	46.0
Poor	65.0	42.9	33.4	34.4	28.3

It was found that 30.3 percent of the early feathering female chicks provided a good carcass compared to 24.0 percent of the late female chicks and that 22.3 percent of the early females were classified as poor carcasses because of excessive pinfeathers while the percentage for the late females was 32.0.

It is evident from the data presented in Table 8 that the males exhibited a similar trend. It should be mentioned that a statistical analysis of the data indicated a chi-square value of 2.13 for the females and 3.79 for the males, both figures being nonsignificant. However, out of six birds which presented an extremely poor carcass, four were late feathering. Although not statistically different, the percentages show that in both sexes the proportion of carcasses graded down because of pinfeathers was higher in late feathering birds than in early feathering ones and does indicate a practical significance to the broiler grower.

Table 8. Relation of the type of feathering to the scores of dressed carcasses at 12 weeks of age.

Dressed score	Female chicks				Male chicks			
	Early		Late		Early		Late	
	no.	percent	no.	percent	no.	percent	no.	percent
Good	23	30.3	6	24.0	11	17.2	16	22.2
Medium	36	47.4	11	44.0	29	45.3	21	29.2
Poor	17	22.3	8	32.0	24	37.5	35	48.6
Total	76		25		64		72	

## DISCUSSION

The small differences in mean weight between the early and late feathering chicks obtained in this study seem to be quite low when compared to those of several workers. This difference in the results may be accounted for by the fact that the studies by Gericke and Flatt (1932) and Warren and Payne (1945) were primarily nutritional with various diets being tested. In this study a single "high efficiency" broiler ration was used, hence the growth response to various levels of protein were eliminated. Furthermore, this study utilized several breeds which may have tended to minimize variations peculiar to a particular strain. The absence of significant differences in body weight between early and late feathering individuals as reported by Hays (1951) was also noted in this investigation.

It was interesting to note that there were few consistent differences in feathering among breeds and strains in this study. Early feathering heavy breeds were comparable to the pure White Leghorns with regard to feathering. Most of the strain differences which did become apparent were found among the late feathering chicks.

Since the greatest variation in the degree of body feathering is expressed at six weeks of age, it seemed quite logical to expect the early feathering chicks to receive a larger proportion of the high scores. Furthermore, as the rate of growth of most feathers seemed to be about equal, the differences between the feathering condition of early and late feathering chicks was probably a matter of the time at which the feather emerged from the skin. This fact is illustrated by the direct relationship

which continued to exist between the six-week body scores and later classifications.

Since the early feathering chicks began feather growth at an earlier age, it was apparent that they should possess a greater number of feathers during the earliest stages of growth. This difference was maintained at all ages studied. The late feathering females approached the feathering condition of the early females after 10 weeks. Female chicks usually feather out more rapidly and possess better feathering than males. This may be due to some physiological difference between the two sexes such as the difference existing in the hormone complex.

It should be mentioned that the inconsistent results of the data for late feathering males at 10 weeks is attributable to a nonrandom selection of chicks that were skinned. The method of selection practiced resulted by chance in a high proportion of the poorly feathered males. This tended to accentuate the differences between the early and late chicks at that age. This may be especially noticed in Tables 3 and 5.

There was practically no feather picking noticed among the flock studied, although all chicks were raised together as a single group. Practically all picking which was observed was suffered by the late feathering chicks.

Throughout this study the early feathering chicks had a distinct advantage in producing a high proportion of feathers with a greater degree of maturity.

It was believed that an actual count of the feathers present was the most accurate measure possible of the feathering condition present. The feather counts proved to be quite indicative of the true feathering condition

however, the labor and time involved do not seem to make it practical.

From the standpoint of the producer, the problem resolves into which of the two groups provide him with a more appealing market bird.

From a casual examination of the underside of the pelts from 12-week males it was readily apparent that the late males possessed many more pin-feathers. This was expressed by a large amount of pigment being present within the feather follicles. It is clearly shown in Plate IV that the early feathering male at this age showed a small amount of pigment, indicating a high degree of maturity of the feathers present. Thus, the early feathering males provided a better carcass since mature feathers leave no pigment in the skin when plucked. These differences were not noticeable to any extent within the females of the same age.

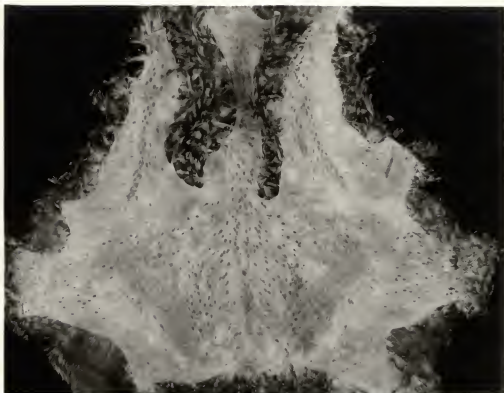
It is of interest to note that in the dressed carcass comparisons the early feathering chicks commanded a greater share of the favorable scores and a lower proportion of the poor scores. The differences were not great but when multiplied by a large volume of birds such as the broiler growers produce, they should provide convincing evidence that the possession of early feathering is beneficial. Therefore, it is inferred that early feathering chicks should be preferred to late feathering ones.

EXPLANATION OF PLATE IV

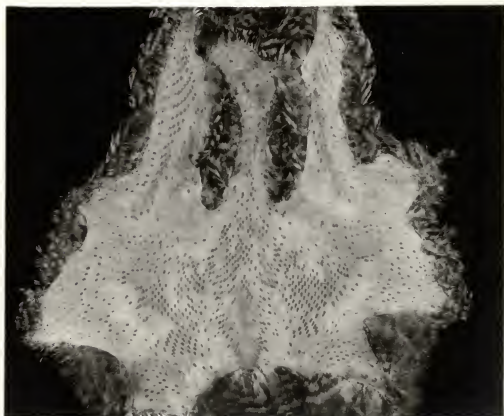
(a) The pelt of an early feathering male 12 weeks of age showing a high proportion of mature feathers as indicated by the lack of pigment in the skin.

(b) The pelt of a late feathering male 12 weeks of age demonstrating a high proportion of pinfeathers (and a low proportion of mature feathers) by the presence of a large amount of pigment in the skin.





(a)



(b)



## SUMMARY AND CONCLUSIONS

An experiment was conducted to study the differences in body weight and the actual feathering condition of early and late feathering strains of broilers up to market age.

The data presented indicate no significant differences in body weight between early and late feathering chicks at eight weeks of age. However, it demonstrated that a barely significant difference of 0.17 pound existed in the favor of early feathering females at 12 weeks of age, while no apparent differences existed in the males at this age.

The results of the detailed feather studies were as follows:

1. No significant differences were found to exist in the distribution of the scores for body feathering at 6 weeks of age among the early feathering strains studied. Even the White Leghorns fitted into the analysis. However, significant strain differences did appear among the late feathering females.
2. A highly significant difference in the scores for body feathering was noted between early and late feathering chicks at 6 weeks and again at 8 weeks of age.
3. The scores for body feathering at 6 weeks of age were in direct relationship to the maturity classifications of the dorsal tract feathers at 6, 8, 10, and 12 weeks of age. These scores also proved to be quite indicative of the appearance of the birds when dressed 6 weeks later.
4. At 8 weeks of age the distribution of the body feathering scores of the strains studied showed no differences in the females but a significant difference among the early feathering males and a highly significant difference among the late feathering males.

5. Early feathering females possessed a significantly larger number of feathers in the dorsal area than did the late feathering females until after 8 weeks of age. At 10 and 12 weeks this difference was decreased.

6. Early feathering males exhibited a significantly larger number of feathers in the dorsal tract than did the late feathering males throughout the period of investigation.

7. It was found that the early feathering females had fewer pinfeathers and more mature feathers than late feathering females through 8 weeks of age. However, late feathering females were nearly as good as early feathering females with respect to feathering at 12 weeks.

8. A significantly larger number of mature feathers was noted in the early feathering males than in late feathering ones throughout the experiment. The proportionate number of pinfeathers was higher in late feathering males at all ages observed.

9. A larger percentage of the early feathering broilers provided better dressed carcasses but the difference did not prove to be statistically significant. However, the most poorly dressed carcasses usually proved to be from late feathering birds.

10. At no time were the late feathering individuals superior to the early feathering ones, thus making it seemingly desirable to have all broiler stocks possess the sex-linked gene for early feathering.

## ACKNOWLEDGMENTS

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## APPENDIX

Table A. A comparison of the scores for body feathering of early and late feathering chicks at 8 weeks of age.

Stocks used	Number of chicks	Body scores			
		G	M	P	VP
<b>Early females</b>					
White Plymouth Rocks	31	30	1	0	0
New Hampshires	34	31	2	1	0
Heavy crosses	30	32	5	1	0
Heavy-Leghorn crosses	24	24	0	0	0
White Leghorns	4	4	0	0	0
Total	131	121	8	2	0
<b>Late females</b>					
White Plymouth Rocks	11	9	2	0	0
New Hampshires	16	8	7	1	0
Heavy crosses	21	9	5	3	4
Heavy-Leghorn crosses	3	3	0	0	0
Total	51	29	14	4	4
<b>Early males</b>					
White Plymouth Rocks	13	8	3	2	0
New Hampshires	27	13	11	2	1
Heavy crosses	44	36	8	0	0
Heavy-Leghorn crosses	21	20	1	0	0
White Leghorns	6	6	0	0	0
Total	111	83	23	4	1
<b>Late males</b>					
White Plymouth Rocks	25	4	10	6	5
New Hampshires	27	1	6	9	11
Heavy crosses	41	11	17	10	3
Heavy-Leghorn crosses	10	9	1	0	0
Total	103	25	34	25	19



Table B. A comparison of the scores for body feathering of early and late feathering chicks at 6 weeks of age.

Stocks used	Number of chicks	Body scores				
		1	2	3	4	5
<b>Early females</b>						
White Plymouth Rocks	34	0	1	1	5	27
New Hampshires	37	1	1	0	13	22
Heavy crosses	48	0	3	3	14	28
Heavy-Leghorn crosses	25	0	0	0	2	23
White Leghorns	5	0	0	0	0	5
Total	149	1	5	4	34	105
<b>Late females</b>						
White Plymouth Rocks	13	0	2	4	5	2
New Hampshires	18	0	4	9	4	1
Heavy crosses	25	8	8	7	2	0
Heavy-Leghorn crosses	5	0	0	1	0	4
Total	61	8	14	21	11	7
<b>Early males</b>						
White Plymouth Rocks	14	1	1	2	6	4
New Hampshires	29	2	1	4	9	13
Heavy crosses	47	1	4	4	17	21
Heavy-Leghorn crosses	24	0	0	1	5	18
White Leghorns	7	0	0	0	2	5
Total	121	4	6	11	39	61
<b>Late males</b>						
White Plymouth Rocks	28	9	8	5	4	2
New Hampshires	30	14	5	5	4	2
Heavy crosses	42	10	13	8	9	2
Heavy-Leghorn crosses	11	0	0	1	5	5
Total	111	33	26	19	22	11

Table C. A comparison of the degree of maturity of feathers in the dorsal tract of early and late feathering chicks, based upon an actual count of feathers.\*

Maturity Classi- fication **	6 weeks		8 weeks		10 weeks		12 weeks	
	Feathers, mean no.		Feathers, mean no.		Feathers, mean no.		Feathers, mean no.	
	Early	Late	Early	Late	Early	Late	Early	Late
Females								
Mature	38.9	0.0	92.7	31.7	102.6	85.9	146.8	129.0
I (1)	61.8	31.9	105.6	51.0	84.1	58.7	91.4	93.1
I (2)	55.3	36.5	53.7	57.3	62.6	72.0	105.3	97.8
I (3)	16.8	14.2	28.6	48.7	25.9	26.7	29.7	37.5
Pin	17.3	18.3	12.0	20.9	36.1	66.4	21.2	16.8
Total	190.1	100.9	292.6	209.6	311.3	309.7	394.4	374.2
Males								
Mature	44.9	0.0	47.4	3.1	85.8	18.4	145.8	69.1
I (1)	69.8	41.7	63.1	40.3	110.3	40.1	126.1	104.3
I (2)	53.1	28.0	61.1	46.3	56.1	89.5	63.6	83.6
I (3)	48.2	38.1	49.9	56.6	26.9	50.5	50.1	40.8
Pin	27.0	21.3	28.7	40.0	30.5	63.8	16.1	31.2
Total	243.0	129.1	250.2	186.3	309.6	262.3	401.7	329.0

\* These data are represented in Figs. 3 and 4 and as percentages in Table D, with the original data given in Tables E to H.

\*\* These classifications are described and illustrated in Plate III.

Table D. A comparison of the degree of maturity of feathers in the dorsal tract of early and late feathering chicks, based upon the proportionate number of feathers.\*

Maturity Classi- fication **	6 weeks		8 weeks		10 weeks		12 weeks	
	Feathers, percent		Feathers, percent		Feathers, percent		Feathers, percent	
	Early	Late	Early	Late	Early	Late	Early	Late
	:	:	:	:	:	:	:	:
Females								
Mature	20.5	0.0	31.7	15.1	33.0	27.7	37.2	34.5
I (1)	32.5	31.6	36.1	24.3	27.0	19.0	23.2	24.9
I (2)	29.1	36.2	18.3	27.3	20.1	23.2	26.7	26.1
I (3)	8.8	14.1	9.8	23.3	8.3	8.6	7.5	10.0
Pin	9.1	18.1	4.1	10.0	11.6	21.5	5.4	4.5
Males								
Mature	18.5	0.0	19.0	1.7	27.7	7.0	36.3	21.0
I (1)	28.7	32.3	25.2	21.6	35.6	15.3	31.4	31.7
I (2)	21.9	21.7	24.4	24.8	18.1	34.1	15.8	25.4
I (3)	19.8	29.5	19.9	30.4	8.7	19.3	12.5	12.4
Pin	11.1	16.5	11.5	21.5	9.9	24.3	4.0	9.5

\* These data are represented in Figs. 5 and 6 and as average numbers in Table C, with the original data given in Tables E to H.

\*\* These classifications are described and illustrated in Plate III.

Table 2. A comparison of the maturity of feathers in the dorsal tract of early and late feathering birds at 6 weeks of age.

Type of feathering	Sex	Breed*	W.B.	Number of feathers, dorsal tract					Total
				Maturity classifications					
				M	I-1	I-2	I-3	F	
Early	Female	W.R.	1301	40	79	87	5	18	229
		W.R.	1319	3	42	48	5	12	110
		N.H.	1355	7	73	69	17	34	200
		N.H.	1402	93	90	53	6	12	254
		H.C.	1064	47	69	24	24	23	187
		H.C.	1082	3	66	31	21	17	138
		H.C.	1081	33	58	61	17	25	194
		H.C.	1128	18	47	62	16	30	173
		H.C.	1156	49	62	87	15	17	230
		L.C.	1518	80	68	41	20	16	225
		L.C.	1540	94	83	76	7	3	263
Leg.	1494	87	55	63	23	35	263		
Late	Female	W.R.	1234	0	26	72	8	6	112
		W.R.	1270	0	32	74	22	12	140
		N.H.	1434	0	41	25	22	25	113
		N.H.	1448	0	61	20	0	15	96
		H.C.	1117	0	31	69	29	26	155
		H.C.	1160	0	30	6	9	44	89
		H.C.	1190	0	16	15	11	21	63
		H.C.	1194	0	4	0	2	0	6
		L.C.	1469	0	47	48	25	16	136
Early	Male	W.R.	1295	3	102	71	75	33	284
		N.H.	1343	0	40	76	47	10	173
		N.H.	1362	35	60	49	44	41	229
		H.C.	1084	2	39	22	61	51	175
		H.C.	1132	24	65	61	110	28	288
		H.C.	1230	83	120	62	39	10	314
		L.C.	1470	69	93	38	16	18	234
		L.C.	1532	103	61	54	23	40	281
		L.C.	1533	86	48	45	19	12	210
		Leg.	1489	97	84	23	32	15	256
Late	Male	W.R.	1241	0	43	46	18	21	128
		W.R.	1276	0	12	29	36	5	82
		N.H.	1429	0	0	0	15	42	57
		N.H.	1431	0	31	12	19	32	94
		H.C.	1071	0	154	36	12	17	219
		H.C.	1231	0	4	25	135	7	171
		L.C.	1465	0	48	48	32	25	153

\* W.R. = White Plymouth Rock  
 N.H. = New Hampshire  
 H.C. = Heavy cross

L.C. = Heavy-Leghorn cross  
 Leg. = White Leghorn

Table F. A comparison of the maturity of feathers in the dorsal tract of early and late feathering birds at 8 weeks of age.

Type of feathering	Sex	Breed	W.D.	Number of feathers, dorsal tract					Total
				Maturity classifications					
				M	I-1	I-2	I-3	P	
Early	Female	W.R.	1289	85	91	99	52	42	369
		W.R.	1327	145	58	93	23	7	326
		N.H.	1359	123	82	51	8	1	265
		N.H.	1397	124	120	27	18	12	301
		H.C.	1124	21	107	48	43	8	227
		H.C.	1199	69	124	18	11	6	228
		L.C.	1511	82	157	40	45	8	332
	Leg.	1498	145	53	61	27	16	302	
Late	Female	W.R.	1233	48	19	47	38	12	164
		W.R.	1264	50	50	90	18	16	224
		N.H.	1417	12	64	80	99	33	288
		N.H.	1459	0	67	62	66	20	215
		H.C.	1108	12	85	64	77	28	266
		H.C.	1116	3	15	10	27	20	75
		L.C.	1499	97	57	48	16	17	235
Early	Male	W.R.	1330	2	15	40	51	53	161
		W.R.	1691	34	81	22	67	16	220
		W.H.	1350	38	73	70	47	34	262
		N.H.	1394	76	40	135	26	16	293
		H.C.	1060	8	49	81	44	32	214
		H.C.	1127	59	102	51	49	25	286
		L.C.	1471	115	82	29	65	25	316
	Leg.	1493	144	57	70	16	17	304	
Late	Male	W.R.	1254	0	78	34	47	43	202
		W.R.	1268	0	0	12	37	49	98
		N.H.	1414	0	0	18	103	21	142
		N.H.	1432	0	0	2	115	52	169
		H.C.	1149	0	88	101	64	20	273
		H.C.	1223	0	37	113	24	69	243
		L.C.	1466	22	79	44	6	26	177

Table G. A comparison of the maturity of feathers in the dorsal tract of early and late feathering birds at 10 weeks of age.

Type of feathering	Sex	Breed	W.B.	Number of feathers, dorsal tract					Total
				Maturity classifications					
				M	Y-1	Y-2	I-3	P	
Early	Female	W.R.	1285	135	76	34	75	64	384
		W.R.	1298	63	142	72	17	62	356
		W.R.	1306	40	58	30	52	63	243
		N.H.	1348	104	88	76	35	24	327
		N.H.	1383	126	87	81	7	29	330
		H.C.	1135	117	74	52	6	28	277
		H.C.	1145	129	60	65	4	43	301
		H.C.	1227	145	95	65	8	16	329
		L.C.	1509	128	71	83	30	24	336
		L.C.	1530	25	93	68	24	18	228
		L.C.	1541	117	81	63	27	26	314
		Leg.	1495	170	62	45	19	22	318
Late	Female	W.R.	1244	96	32	53	29	102	312
		W.R.	1267	94	69	78	47	40	328
		N.H.	1428	135	66	22	2	28	253
		N.H.	1444	97	32	48	25	159	361
		H.C.	1058	31	80	105	25	23	264
		H.C.	1100	30	76	95	52	73	326
Early	Male	W.R.	1310	87	138	59	48	42	374
		W.R.	1318	100	105	53	7	5	270
		N.H.	1341	74	127	71	49	22	343
		N.H.	1390	61	120	81	47	55	364
		H.C.	1072	89	128	75	11	8	311
		H.C.	1083	50	96	50	14	44	254
		H.C.	1113	48	102	46	21	45	262
		H.C.	1217	130	102	44	37	40	353
		H.C.	1229	105	88	29	17	36	275
		L.C.	1478	114	97	53	18	8	290
Leg.	1491	149	72	56	32	8	317		
Late	Male	W.R.	1251	49	25	173	23	41	311
		W.R.	1269	0	22	116	70	85	293
		N.H.	1449	0	0	97	111	65	273
		N.H.	1461	0	53	83	64	55	255
		H.C.	1103	2	72	111	36	70	291
		H.C.	1216	0	13	99	32	67	211
		H.C.	1170	9	74	62	45	88	278
		H.C.	1195	14	74	35	43	53	219
		L.C.	1505	92	28	30	31	50	231



Table II. A comparison of the maturity of feathers in the dorsal tract of early and late feathering birds at 12 weeks of age.

Type of feathering	Sex	Breed	W.D.	Number of feathers, dorsal tract					Total
				Maturity classifications					
				M	I-1	I-2	I-3	P	
Early	Female	W.R.	1305	168	70	95	24	20	377
		W.R.	1317	160	73	90	48	25	396
		N.H.	1373	205	95	116	10	25	451
		N.H.	1396	92	110	140	42	24	408
		H.C.	1066	154	118	120	19	14	425
		H.C.	1122	153	79	64	31	20	347
		H.C.	1179	101	112	152	20	26	411
		H.C.	1188	115	89	63	45	30	342
		L.C.	1474	173	77	108	28	7	393
	Leg.	1486	158	63	132	30	17	400	
Late	Female	W.R.	1245	168	46	97	22	8	341
		N.H.	1446	176	91	70	22	17	376
		N.H.	1415	28	117	127	36	27	335
		H.C.	1065	52	79	117	16	27	291
		H.C.	1076	138	87	125	16	10	426
		H.C.	1181	144	120	100	42	7	413
		L.C.	1497	162	105	61	29	28	385
Early	Male	W.R.	1292	134	174	58	54	18	438
		W.R.	1325	150	132	50	46	13	391
		N.H.	1300	210	146	53	76	19	504
		N.H.	1408	171	97	46	17	37	368
		H.C.	1110	174	126	108	32	4	444
		H.C.	1171	111	146	37	69	12	375
		H.C.	1198	87	98	102	72	14	373
		L.C.	1477	130	90	55	35	12	322
		Leg.	1552	100	85	69	43	17	314
Late	Male	W.R.	1259	74	73	113	43	40	343
		W.R.	1261	70	139	65	45	30	349
		N.H.	1443	69	57	119	48	50	343
		N.H.	1454	29	102	69	40	22	262
		H.C.	1063	100	94	82	57	29	362
		H.C.	1074	61	96	90	25	35	307
		H.C.	1153	63	170	95	36	6	370
		L.C.	1503	87	103	36	32	30	296



A COMPARISON OF THE EFFECTS OF SEX-LINKED EARLY AND  
LATE FEATHERING ON GROWTH AND FEATHERING  
OF CHICKS TO TWELVE WEEKS OF AGE

by

PHILLIP EDWARD PLUMART

B. S., University of Illinois, 1950

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AN ABSTRACT OF A THESIS

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The purpose of this experiment was to compare sex-linked early and late feathering stocks of broilers at market age with respect to their actual feathering condition and body weight.

The chicks used in the study consisted of stock from commercial broiler strains and crossbreds from the Kansas State College flocks. Each chick was classified according to its feathering condition at 1 day, 10 days, 6 weeks, and 8 weeks of age. Body weights were recorded at 8 and 12 weeks of age.

Paired samples of chicks representing each sex and type of feathering were killed and skinned at 6, 8, 10, and 12 weeks of age. Each feather in the dorsal area of the skins studied was plucked and classified according to its degree of maturity. The classifications used in describing each of the 38,810 feathers studied included fully mature feathers, pinfeathers, and three intermediate grades.

All birds which were still alive at the end of the 12-week period were commercially dressed and classified according to the number of pinfeathers present after mechanical picking and before any manual removal of pinfeathers.

The difference in the mean weight between the early and late feathering females at 12 weeks of age was  $77.3 \pm 35.49$  grams or approximately 0.17 pound, a significant figure, while no apparent differences existed in the males at this age. No significant differences existed in either sex at eight weeks of age.

Few consistent differences in feathering among strains were noticed in this study. Early feathering heavy breeds were comparable to the White Leghorns with regard to feathering. The slight strain differences noted

were confined to the late feathering chicks.

The early feathering chicks possessed a greater number of feathers during the earliest stages of growth. A highly significant difference in the scores for body feathering was noted between early and late feathering chicks at 6 weeks and again at 8 weeks of age.

The scores for body feathering at 6 weeks of age were in a direct relationship to the maturity classifications of feathers in the dorsal tract at 6, 8, 10, and 12 weeks of age. These scores also proved to be quite indicative of the appearance of the birds when dressed six weeks later.

The data proved that the early feathering birds had a lower proportion of pinfeathers and a higher proportion of mature feathers than the late feathering ones except that the late feathering females were nearly as good as early feathering females in this respect at 12 weeks of age.

A larger percentage of the early feathering birds provided better dressed carcasses at 12 weeks. At no time were the late feathering individuals superior to the early feathering ones, thus making it seemingly desirable to have all broiler stocks possess early feathering.