

**BEHAVIOR PATTERNS OF CHICKENS**  
"  
**FROM HATCHING TO 10 WEEKS OF AGE**

by

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## INTRODUCTION

Methods of improving the productive level of broilers are constantly being sought by those connected with the poultry industry. Advancements in genetics, nutrition and disease control have contributed much to the progress made in the past. Improvements in management practices have also contributed to a larger and more efficient production.

There is a dearth of information concerning the development of behavior patterns in young chickens. Possible reasons for the lack of experimentation in this area might be attributed to the time involved in the collection of data, the large amount of individual variation found in behavioral patterns and the lack of appropriate statistical methods for the analysis of data.

Information on behavior patterns in growing chickens should be valuable in providing a better understanding of social relationships within a flock. Knowledge of these relationships could provide reasons for certain management procedures now employed in rearing chickens and give insight to new ones which might be applied.

The present experiment was designed to study the emergence and changes in behavior patterns in male and female chickens from divergent growth lines under different flocking situations. Other information sought concerned variation in growth, feed consumption and water consumption.



## REVIEW OF LITERATURE

### Social Organization

Social organization in flocks of chickens was first described in 1922 (Schjelderup - Ebbe cit. by Masure and Allee, 1934). His observations on the social organization and behavior in flocks has been substantiated by Sanctuary (1929) and Masure and Allee (1934).

Guhl (1953) and Wood-Gush (1955) have reviewed studies on social and individual behavior patterns. Briefly, it has been found that agonistic behavior was greater among males than among females. In flocks where the sexes were intermingled, two peck-orders were formed, one among males and the other among females. Once the social order was formed and peck-rights established, changes in the social hierarchy were infrequent. It has been shown by Masure and Allee (1934), however, that the peck orders among females were more stable than those among males.

Several studies (Allee et al., 1939; Collias, 1943; Marks et al., 1960) have been conducted to determine factors which influence the social rank achieved in a flock by birds of the same sex and genetic background. These studies indicate that age and physical factors such as comb size, state of health, molt and fatigue were important. Body weight appeared to be important only when the other factors were equal. It also appeared that various hormones had an indirect influence on the social behavior of chickens (Allee et al., 1940).

### Methods of Determining Social Rank

Relative aggressiveness may be measured by several techniques other than by peck-order rank. Collias (1943) suggested the use of initial paired encounters. According to this procedure two strange chickens from each of two flocks were placed in a neutral pen and their dominance-subordinance relationships determined. Each bird in one flock met each bird in the other flock and the number of initial paired encounters won was considered to be indicative of the relative aggressiveness of an individual. Guhl (1953) compared results obtained from this technique with actual peck-order rank and obtained highly significant correlation coefficients that ranged from  $+0.50$  to  $+0.89$ .

McBride (1958) and Siegel (1960) have presented modifications of the paired encounter technique. McBride used panels against which all individuals were tested. The panels consisted of chickens with a wide range of aggressiveness. Siegel followed the procedure of Collias (1943) more closely in that members of one flock met those of another flock in initial paired encounters. It was found that eight encounters per bird were sufficient to obtain a reliable estimate of relative aggressiveness, thus resulting in a considerable saving of time. He pointed out further that no bird should have more than one paired encounter per day and that pairings should be made at random.

Komai et al. (1959) provided a method whereby percentages were used in the estimation of social rank within a flock in those instances when dominance-subordinance relationships between all flockmates had

not been obtained. The formula used was:

Percentile social rank =  $(A + B)/2$  where A was the percentage of birds that individual X dominated and B was 100% minus the percentage of birds that dominated X.

#### Genetic Basis of Behavior

Although the role of genetics in the behavior of chickens has been questioned for some time, only recently has it received much experimental attention. Conditional behavior is difficult to partition out completely in discussing the inheritance of behavioral patterns; thus, the concept of imprinting (Lorenz, 1935; Hess, 1959) is probably an area where genetics and behavior interact.

Potter (1949) noted differences in aggressiveness among seven breeds of chickens. Siegel (1959) found highly significant differences between inbred lines of White Plymouth Rocks for percentage of initial paired encounters won. An incross was intermediate in aggressiveness to the two inbred lines from which it originated thus showing no evidence of heterosis for this characteristic. Komai et al. (1959) reported heritability estimates of .30 and .34 for aggressiveness whereas Siegel (1960) obtained a higher estimate of .57 based on one generation of selection in divergent directions for aggressiveness.

Guhl et al. (1960) found significant differences between F<sub>2</sub> generation lines selected in opposite directions for aggressiveness. The mean heritability estimate for four filial generations was 0.20.

They also found in four of the nine body weight comparisons made between lines that the birds from the highly aggressive line were significantly heavier than those from the lowly aggressive line.

#### Ontogeny of Behavior

The development of behavior involves the ontogeny of the various systems in an individual. The behavior of a chick should be viewed as the result of its genetic background in its particular environment.

Kuo (1932) devised a procedure which enabled the observation of embryonic behavior. The method consisted of removing parts of the egg shell and outer shell membrane prior to incubation. Embryonic movement began with the lifting of the head on the third day of incubation. This was followed by lateral turning of the head on the fourth day and mouth and beak movements on the fifth and seventh days, respectively. Movements in the head region preceded those in the trunk and tail regions.

In the early stages of a bird's life a highly specialized and limited form of learning takes place. This has been called imprinting by Lorenz (1935). Hess (1959) found that the amount of effort exerted by the subject was the major factor which influenced the strength of imprinting, and that this form of learning took place during a very critical period in the subject's life. This critical period was found to be prior to the onset of fear reaction.

Two-way selection experiments for imprintability were also conducted by Hess (1959). He found significant differences in the  $F_1$  generation

between ducks whose parents were highly imprintable and those whose parents were considered non-imprinters. The offspring from imprintable parents were easily imprinted while those of less imprintable parents were difficult to imprint.

Smith (1957) demonstrated that young chicks learn from one another. Also, chickens become imprinted to each other prior to the age when the fear reaction has become developed sufficiently to interfere with socialization (Guiton, 1959). Fear reactions according to Rattner and Thompson (1962) reach a maximum at 7-10 days.

Guhl (1958) has presented the most comprehensive study on the development of behavior patterns in domestic chickens. His findings, based on a series of experiments with small numbers indicate that there is a sequence in which behavior patterns appear. The general sequences appear to be escape (fear), frolicking, sparring, aggressive pecking, avoidance and fighting. Males showed agonistic behavior earlier than females and there was a disproportionate pecking frequency between sexes in flocks when males and females were intermingled.

Guhl (1958) found that the escape reaction was common by the third day after hatching and was mainly in the form of running. Frolicking and an incipient agonistic interaction appeared during the first week and led to sparring which appeared during the second week. The earliest aggressive peck was delivered late in the second week while the first avoidance in response to an aggressive action was noted during the fifth week. Fighting was observed during the sixth week but usually ended with no decision. Guhl indicated further that there was

considerable variation among individuals and among flocks with regard to the age when these behavior patterns became evident.

#### Water Consumption

Heywang (1941) measured the annual water consumption of hens maintained at Glendale, Arizona, where the mean yearly temperature was 69.4° F. The annual water consumption per hen for replicate flocks of White Leghorns were 18.2 and 18.3 gallons, whereas for replicate flocks of Rhode Island Reds it was 19.8 and 19.9 gallons. The amount of water loss from evaporation during the period of this experiment was 26.1 gallons.

Barott and Pringle (1947) found that chicks drank 1.6 grams of water per gram of feed on the ninth day post-hatch. On the eighteenth day post-hatch 1.5 grams of water per gram of feed was consumed (Barott and Pringle, 1949). When the age period ranged from 18 to 32 days (Barott and Pringle, 1950), the ratio between water and feed was noted to be 1.7:1.

Eley and Hoffman (1949) measured the average daily water consumption of 120 Barred Rocks x New Hampshire crossbred chicks in each of three trials. They found in Trial 1 that the average daily water consumption on a per bird basis from 8 to 12 weeks of age was 128 ± 4 grams. In trials 2 and 3 consumption was measured from 9 to 13 weeks and the respective mean values were 176 ± 6 and 178 ± 4 grams. Ross et al. (1954) divided White Rocks into low, medium, and heavy weight groups and measured water consumption during the fourth and fifth weeks of

life. They found that the water to feed ratio was relatively constant (2 grams of water per gram of feed) for the three groups of chickens regardless of the amount of feed consumed or feed efficiency.

Medway and Kare (1959) using Single Comb White Leghorns found that grams of water consumed per gram of feed eaten from 1 to 32 weeks of age ranged from 2.1 to 2.6 for all ages except the 32 week-old pullets which consumed 3.6 grams of water per gram of feed. They felt that the increase in water consumption was due to water loss in the egg.

#### Genetic Aspects of Growth

Asmondson and Lerner (1933) found genetic differences with respect to rate of growth in strains of White Leghorn chickens and concluded that these differences were determined by multiple gene factors. Jaap and Morris (1937) quantitatively determined the relative importance of some of the sources of variation in growth. They found that variety, sex, sire, and dam accounted for 82 percent of the variance in growth with the remaining 18 percent being caused by size of egg, time hatched, and physiological differences due to environmental responses.

Brunson et al. (1956) indicated the approximate percentage of total variation in body weight due to genetic differences were 41 percent for additive genic effects, 2 percent for non-additive genic effects and 10 percent for sex-linked effects. Goodman and Jaap (1960) also found that the additive variance was high for body weight.

Goodman and Godfrey (1956) summarized heritability estimates for body weights according to age and methods of estimation. The average

of the estimates was 0.30 and they concluded that individual selection would be the most effective method of selecting for improvements of body weight in broilers.

Siegel (1962) in a two-way selection experiment for large and small body weight at 8 weeks of age found that one generation of selection resulted in highly significant differences between lines. Differences between lines became progressively larger with each subsequent generation of selection. Additive genetic variance accounted for approximately 30 percent of the total variation. Non-additive genetic effects were unimportant.

#### Rearing Sexes Separately and Intermingled

Few experiments have been conducted in which comparisons were made of body weights within sexes when males and females were reared separately and intermingled. Results have been inconclusive. Smith et al. (1954) used a total of 6000 broiler-type chickens in two trials and found that weights were not influenced by separation of sexes. Wisman et al. (1961) found that males were slightly lighter and females slightly heavier when reared separately rather than intermingled; however, they concluded that greater labor income favored intermingled rearing rather than separate rearing of sexes.



## MATERIALS AND METHODS

### Experiment I

Chicks used in this experiment consisted of progeny from pedigree matings of F<sub>2</sub> generation White Rocks which had been selected in divergent directions for body weight at eight weeks of age (Siegel, 1962). Upon hatching, chicks were sexed and assigned to three flocks (A, B, C) by systematic randomization. Compositions of the flocks were:

- A. 15 high weight and 15 low weight males,
- B. 15 high weight and 15 low weight females,
- C. 7 high weight, 8 low weight males and  
8 high weight, and 7 low weight females.

Thus Flock A consisted of males, Flock B of females and sexes were intermingled in Flock C.

Floor space allowances were 1.3 square feet per chick started. Feeder space allowances on a per chick started basis were 2.4 linear inches to five weeks of age and 4.0 linear inches thereafter. Drinking facilities consisted of a one gallon waterer to one week of age and one two gallon waterer thereafter. The circumference of the one gallon waterer was 28.3" and of the two gallon waterer 37.7".

Infra red heating lamps, placed 18" from the litter, were used continuously for heat during the first four weeks. From four to six weeks the heating lamps were used only at night. Continuous illumination of 30 foot candles of light was provided by placing in each pen one 150 watt bulb 40" above the litter. A starting ration was fed until five weeks of age and a finisher was fed thereafter (Table 1).

Water consumption in each pen was measured daily and converted to grams of water consumed per bird per day. To minimize water wastage while being measured the waterer was placed over a large open galvanized pan while its contents were transferred to a graduated cylinder. Litter which had accumulated in the waterer was removed and placed on a petri dish and weighed. After a 24-hour air drying period the petri dish and its contents were reweighed and the difference was considered to be water absorbed by the litter. In addition to the correction for litter absorption of water a correction was made for loss by evaporation.

Body weights, in grams, were obtained weekly for each bird. Feed consumption data were also obtained on a weekly basis.

Oxygen consumption was determined from a random sample of 2 birds from each line within each flock at 50 days of age according to a modification of the method of Charkey and Thornton (1959). The 16 birds were fasted for a period of 12 hours before the oxygen consumption determinations were made.

Observations of individual and social behavioral patterns were obtained daily for 70 days. The behavioral characters observed and how they were determined are given below.

1. Resting - A chick was considered to be resting when it had the appearance of being asleep or was inactive over a period of time (Plate 1).

2. Scratching - A chick was considered to be scratching when it scraped the litter with its claws.

3. Stretching - A chick was considered to be stretching when the limbs and/or body were extended giving the impression that a strain was being placed on the muscles.

4. Preening - An individual was considered to be preening when it used its beak to groom and smooth its feathers (Plate 2).

5. Running - An individual was considered to be running when it moved swiftly and smoothly over the floor (Plate 3). This form of behavior would occur spontaneously in one individual and was frequently mimicked by some of its flockmates.

6. Frolicking - A chick was considered to be frolicking when it ran with its wings flapping or raised (Plate 4).

7. Threat-avoidance - The aggressor, bird X, attempted to peck another individual, Y, which submitted; however, no physical contact was made between the two chickens.

8. Peck-Avoidance - The aggressor, bird X, made physical contact with individual Y and resulted in the submission of bird Y.

9. Avoidance - The submission of bird Y to bird X when no visible aggressive act was made by bird X.

10. Fighting - Birds X and Y face each other with necks extended, and with a circular motion both individuals have physical contact one with another.

11. Sparring - Chick X faced chick Y as when fighting; however, no physical contact was made between birds.

All observations were made by the same individual who wore a white T-shirt during the observation period which commenced at 6:00 a.m. A

**Explanation of Plates**

**Plate 1 - Group of birds resting**

**Plate 2 - Individual bird preening**

Plate 1



Plate 2



**Explanation of Plates**

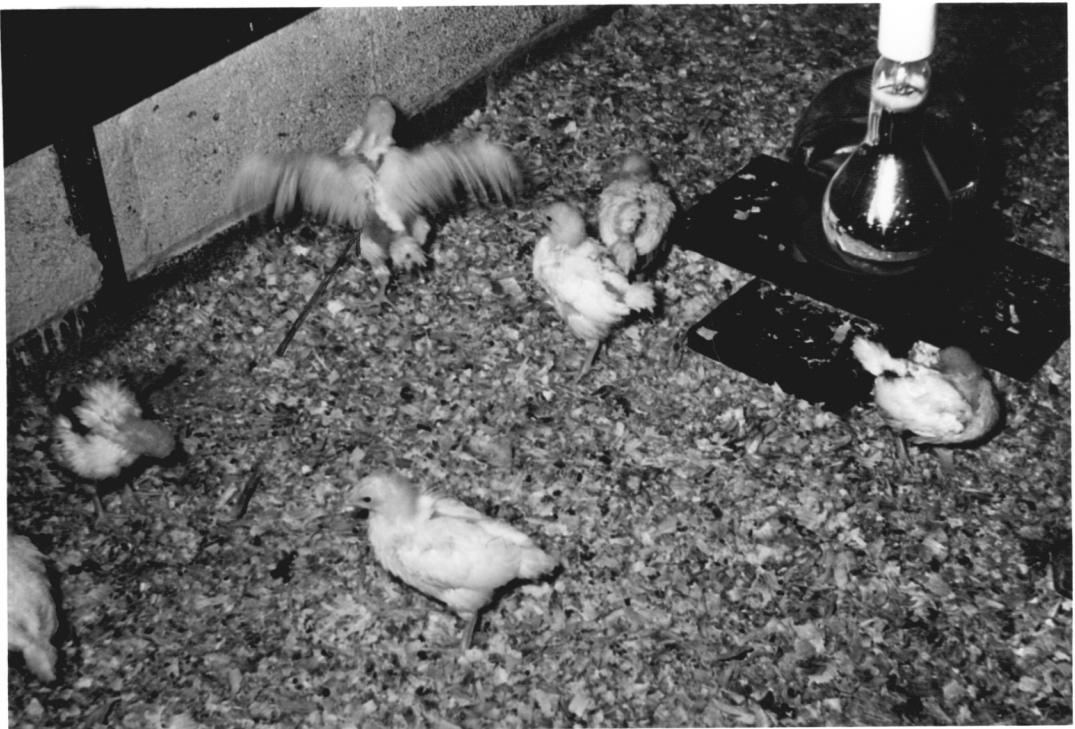
**Plate 3 - Individual bird running**

**Plate 4 - Individual bird frolicking**

Plate 3



Plate 4



diagrammatic scheme of the pens is given in Figure 1. Pens were encompassed with a four foot canvas baffle which restricted the birds' view of the outside of the pen to the upper portion of the observer's body. The order in which the flocks were observed each day was determined at random. Each flock was then observed for 25 minutes per day. Prior to the collection of data, an adjustment period of five minutes was allowed to enable the birds to become adjusted to the observer.

Data, on an individual bird basis, were obtained with the aid of a battery powered tape recorder. Codes, utilizing dyes of various colors, were placed on the backs and/or sides of the birds to facilitate identification of individual members of each flock. When a behavioral pattern was observed a number corresponding to the color code was recorded.

All behavior patterns with the exception of scratching, preening, and resting were recorded each time they occurred. Scratching, preening, and resting were not recorded more than once for an individual during a single observation period.

Peck-orders were obtained for each flock using several methods. In addition to obtaining dominant-subordinate relationship from direct flock observations, paired encounters between flockmates were obtained. Paired encounters were obtained by placing both individual in an exhibition cage 24" x 24" x 27" and observing the dominance-subordinate relationship. In Flock B and among females in Flock C, data on the dominance-subordinate relationship were not complete. To complete the social hierarchy of these flocks the method of percentile social rank scores outlined by Komai (1959) was used.



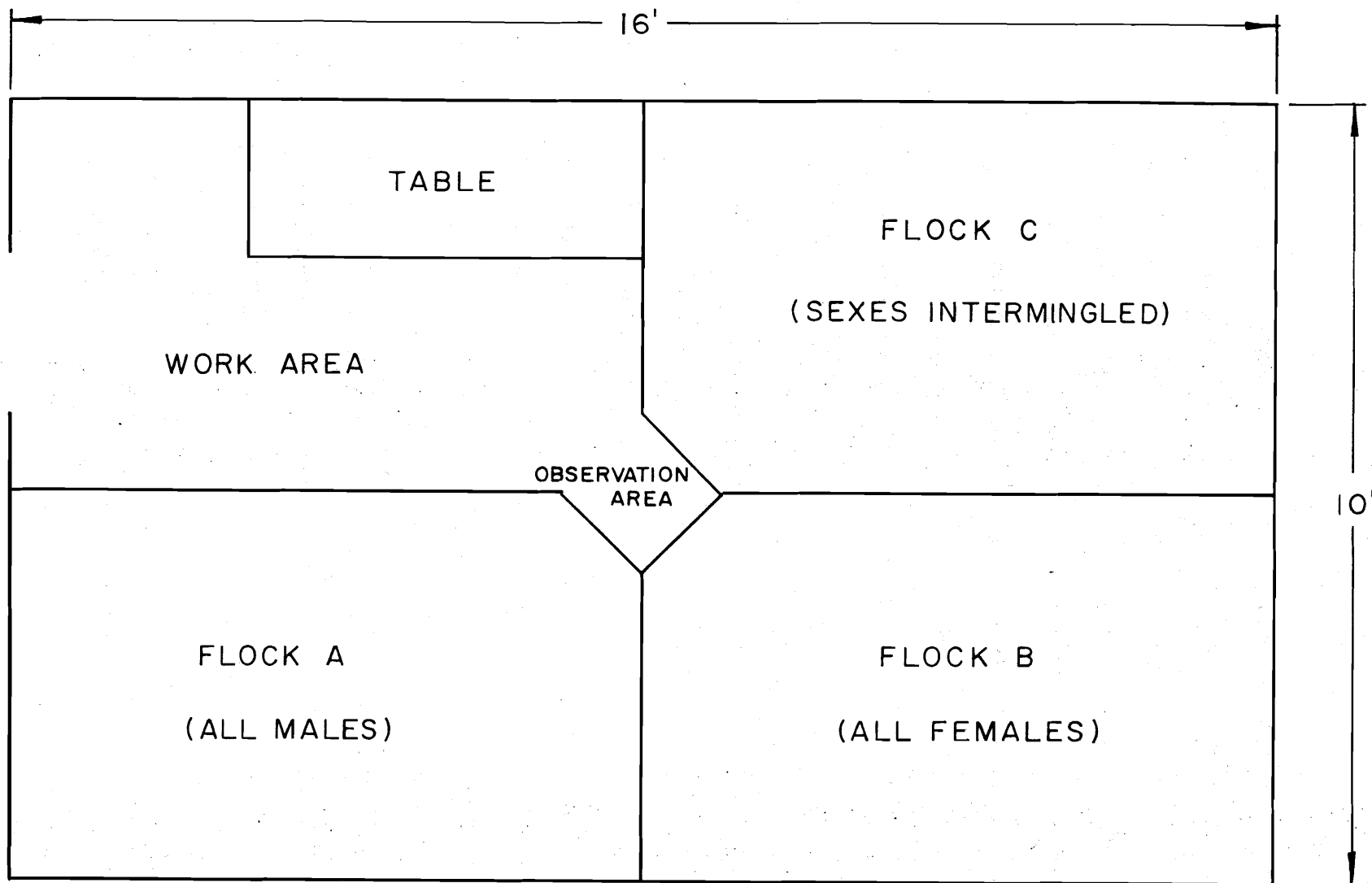


Figure 1. Diagrammatic scheme of pen layout.

Data pertaining to resting, stretching, scratching, preening, running, and frolicking were analyzed according to analysis of variance. The main variables considered in the analysis of the data for each of these behavioral patterns were line (L), method of rearing (SI), and sex (S). These variables were considered as fixed effects, and a factorial analysis was conducted so that interactions between them could be tested for statistical significance. The method of expected numbers, as outlined by Snedecor (1946), was used to adjust for disproportionate subclass numbers. In addition to analyses of variance of the data, least squares polynomial equations were fitted with the aid of a 650 digital computer for each of the behavior patterns in time.

#### Experiment II

In Experiment II the general experimental procedures were the same as those in Experiment I. Only those instances where the experiments differed will be given. Compositions of the flocks were:

- A - 6 high weight and 6 low weight males,
- B - 6 high weight and 6 low weight females,
- C - 3 high weight and 3 low weight males, and  
3 high weight and 3 low weight females.

Although the same pens were used the smaller number of chicks resulted in changes in feeding, watering, and floor allowances. The floor space allowance per chick started were 3.2 square feet. Feeder space allowances on a per chick started basis were 6 linear inches to four weeks of age and 10 linear inches thereafter.

Data on individual behavioral patterns were obtained on alternating days.

Oxygen consumption was not determined in this experiment.

Table 1. Calculated approximate analysis and ingredients of the ration.

<u>Calculated (%)</u>	<u>Ration A (to 6 wks.)</u>	<u>Ration B</u>
Crude protein	22.00	18.00
Crude fat	4.00	4.00
Crude fiber	4.00	4.00
Prod. energy cal./lb.	1260.00	985.00
 <u>Ingredients</u>		
Wheat flour middlings (pounds)	50.00	100.00
Yellow corn meal	1039.50	1175.00
Ground oats	30.00	
Corn gluten meal	60.00	80.00
Alfalfa meal, 17% crude protein	50.00	70.00
Soybean oil meal, 50% crude protein	570.00	347.00
Feather meal	30.00	50.00
Animal fat, stabilized	50.00	60.00
Fish meal	50.00	60.00
Fish solubles	15.00	
Riboflavin supplement		2.00
Ground limestone	7.00	20.00
Defluorinated rock phosphate	35.00	20.00
Iodized salt	6.00	6.00
Vitamin A feeding oil		1.50
D-activated animal sterol	2.00	1.00
Vitamin B <sub>12</sub> supplement, 6 mgs./lb.		1.00
Antibiotic feed supplement	.75	.75
Choline chloride, 25%	2.00	3.50
Butylated hydroxytoluene	.25	.25
Trace mineral mix <sup>1</sup>	2.50	2.50
<b>Totals</b>	<b>2000.00</b>	<b>2000.50</b>

<sup>1</sup> Contained the following as percentages: 3.4 manganese, 1.2 zinc, .35 iron, .25 copper, .12 iodine, .02 cobalt, 1.2 magnesium and 28.0 calcium.

## RESULTS

### Experiment I

In the subsequent presentation of results on behavior patterns references to the tables of means will be given; however, the reader should refer to Table 2 for a summary of the analyses of variance of the data presented in the tables of means.

#### Resting

Means for the number of observation periods in which a chicken was observed to be resting from hatching to ten weeks of age are presented in Table 3. The mean number of periods a chicken was observed to be resting in flocks where sexes were reared separately was 12.9, whereas in the intermingled flock the mean was 10.8. The difference of 2.1 was highly significant. Each male was observed to be resting an average of 10.2 periods whereas the respective value for females was 14.2. The difference between means for the sexes was highly significant.

Table 3. Mean numbers of observation periods each bird was observed to be resting by line, sex and method of rearing; Experiment I.

Method of rearing sexes	Males			Females			Wt. $\bar{x}$
	HL <sup>1</sup>	LL <sup>2</sup>	Combined	HL <sup>1</sup>	LL <sup>2</sup>	Combined	
Separate	9.9	10.8	10.4	16.7	14.0	15.4	12.9
Intermingled	10.6	9.0	9.7	13.4	9.9	11.8	10.8
Wt. $\bar{x}$	10.1	10.2	10.2	15.6	12.7	14.2	12.2

<sup>1</sup>High weight line.

<sup>2</sup>low weight line.

Table 2. Analyses of variance of data on resting, stretching, scratching, preening, running and frolicking; Experiment I.

Source of variation	Df	M.S.					
		Resting	Stretching	Scratching	Preening	Running	Frolicking
Between lines (L)	1	45.4	461.0**	97.2*	105.5	18.4	0.0
Separate vs. intermingled (SI)	1	90.1**	29.6	2.7	6.0	145.5*	66.4
Between sexes (S)	1	351.6**	335.2**	59.4	2.8	59.7	680.2
L x SI	1	14.9	4.0	2.4	111.6	8.5	210.9
L x S	1	51.3*	85.1	0.1	50.5	271.7**	1071.6*
SI x S	1	50.8*	154.9*	115.5*	5.8	7.9	5.7
L x SI x S	1	4.2	73.9	14.0	15.7	21.1	201.6
Error	82	11.6	34.9	21.9	55.6	32.6	248.9

\*\* P = .01.

\* P = .05.

The L-S interaction was significant with the mean values for males from both lines being essentially the same, whereas the mean number of periods that high-line females rested was much larger than the respective value for the low-line females. The SI-S interaction for resting was also significant. The difference between the mean for females maintained in the all-female flock and the mean for those intermingled with males was 3.6 while the difference between the mean for males maintained separately from the mean of those intermingled with females was only 0.7.

Differences between lines, the L-SI interaction and the L-SI-S interaction were not significant.

The mean number of chickens in the low line group observed to be resting when measured over time is illustrated in Figure 2. Resting declined rapidly after hatching until about three weeks of age. It then increased until about the eighth week, after which it declined in all groups except the females in Flock B. The general response for birds in the high line group was similar to those illustrated and is not shown in Figure 2.

### Stretching

Means for the number of times each bird was observed to stretch from 0 to 10 weeks of age are presented in Table 4. Chickens in the high and low weight lines stretched an average of 22.9 and 18.5 times, respectively. The difference between lines of 4.4 stretches per bird was highly significant. The mean number of stretches for males was 22.6 times and for females 19.0 times with the difference of 3.6 being highly

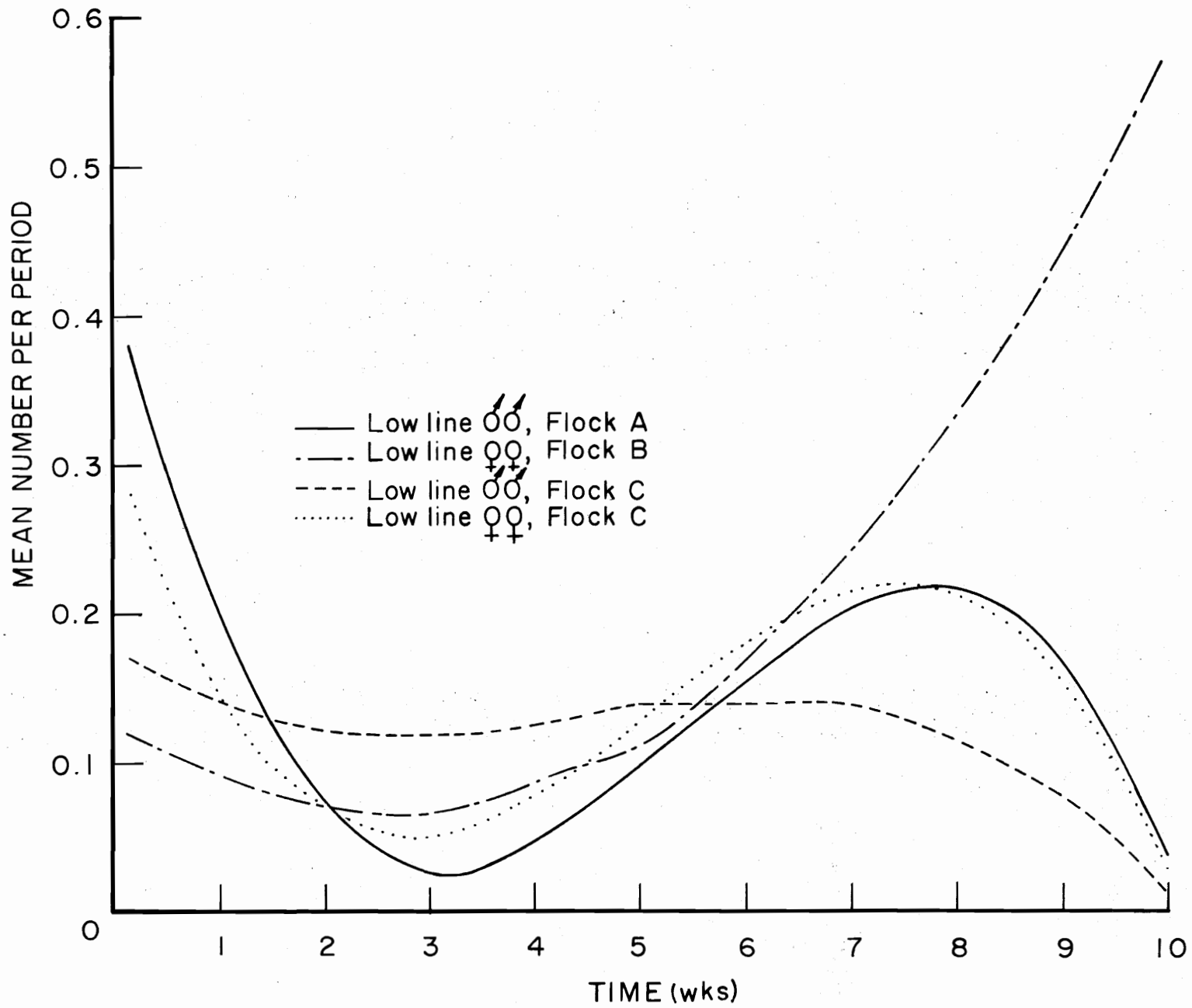


Figure 2. Polynomial curves (cubic) for resting.



significant. Differences between flocks where sexes were maintained separately and intermingled were not significant.

Table 4. Mean number of stretches per bird by line, sex and method of rearing; Experiment I.

Lines	Method of rearing sexes						Wt. $\bar{x}$
	Separate		Intermingled		Wt. $\bar{x}$		
	M <sup>1</sup>	F <sup>2</sup>	M <sup>1</sup>	F <sup>2</sup>	M <sup>1</sup>	F <sup>2</sup>	
High	24.1	21.4	29.6	17.5	25.9	20.4	22.9
Low	18.6	17.3	21.1	18.1	19.5	17.6	18.5
Wt. $\bar{x}$	21.4	19.4	25.1	17.7	22.6	19.0	20.8

<sup>1</sup>Males.

<sup>2</sup>Females.

The only significant first order interaction was the SI-S interaction. Males in flocks where sexes were intermingled stretched more than those in the all-male flocks, while the opposite relationship existed for females.

The mean number of stretches per bird over time in both high and low weight lines are illustrated in Figure 3. Stretching increased from hatching to about five weeks of age and declined thereafter. Other groups which are not illustrated in figure followed a similar pattern.

#### Scratching

The mean number of scratches to ten weeks of age for chickens in the high and low weight lines were 11.3 and 9.3, respectively (Table 5). The mean difference of 2.0 scratches between lines was highly significant.

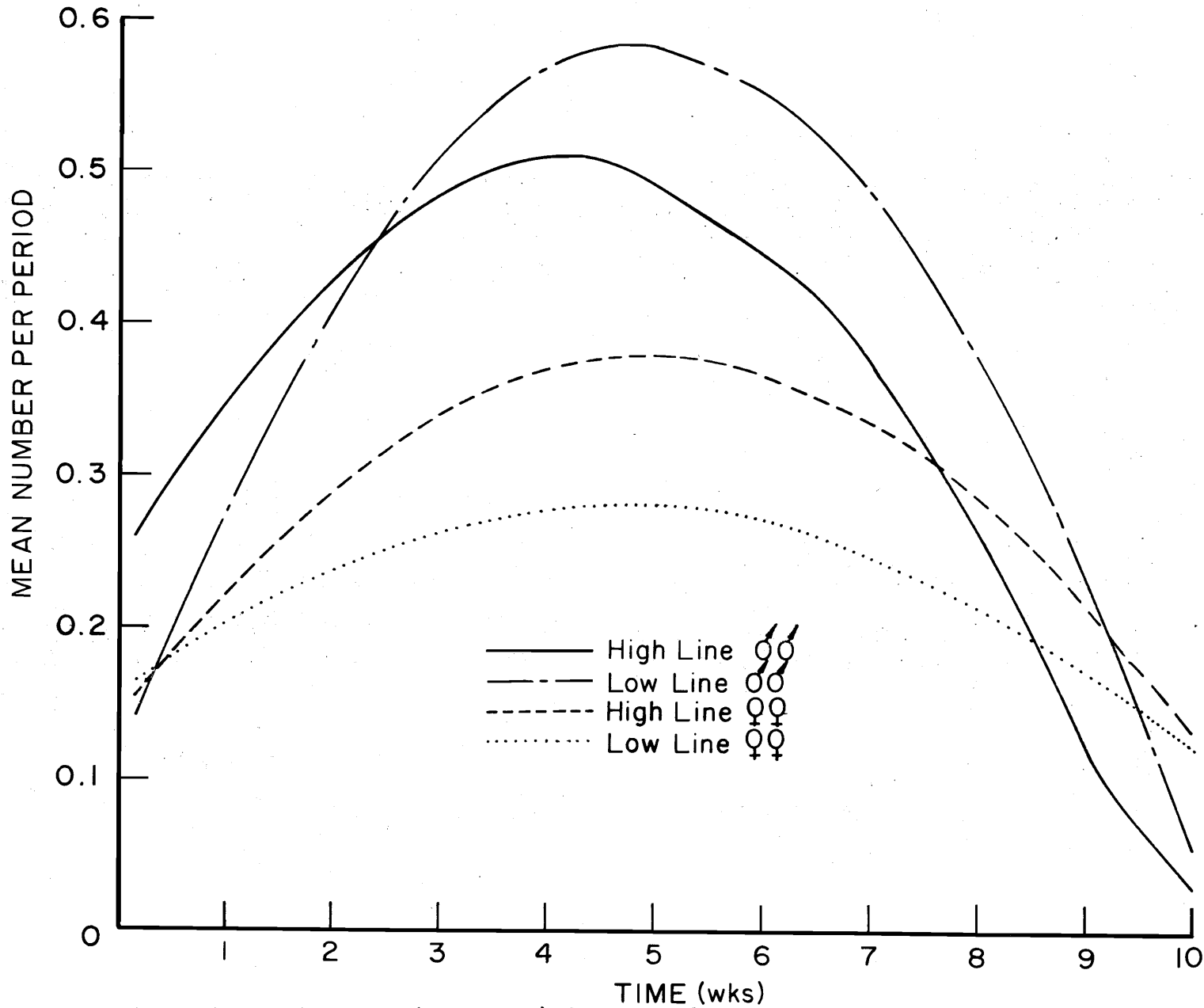


Figure 3. Polynomial curves (quadratic) for stretching.

Table 5. Mean number of observation periods each bird was observed to be scratching by line, sex and method of rearing; Experiment I.

Lines	Method of rearing sexes						Wt. $\bar{x}$
	Separate		Intermingled		Wt. $\bar{x}$		
	M <sup>1</sup>	F <sup>2</sup>	M <sup>1</sup>	F <sup>2</sup>	M <sup>1</sup>	F <sup>2</sup>	
High	10.0	12.7	11.5	11.1	10.5	12.1	11.3
Low	7.6	11.4	10.2	7.4	8.5	10.1	9.3
Wt. $\bar{x}$	8.8	12.1	10.8	9.4	9.2	11.2	10.3

<sup>1</sup>Males.  
<sup>2</sup>Females.

Differences between sexes and between flocks where sexes were maintained separately and intermingled were not significant with regard to scratching. However, females maintained in all-female flocks scratched more frequently than those intermingled with males, whereas the opposite relationship was noted for males. This relationship is illustrated by the significant SI-S interaction. Other first order interactions were not significant.

To illustrate the frequency of scratching in time values for males within each line are presented in Figure 4. Scratching increased from hatching until the birds were about three weeks of age after which it declined to a very low level. At about nine weeks it began to increase again. A similar time-trend relationship was found for the other group which is not illustrated in Figure 4.

#### Preening

No significant differences existed between lines, sexes or method

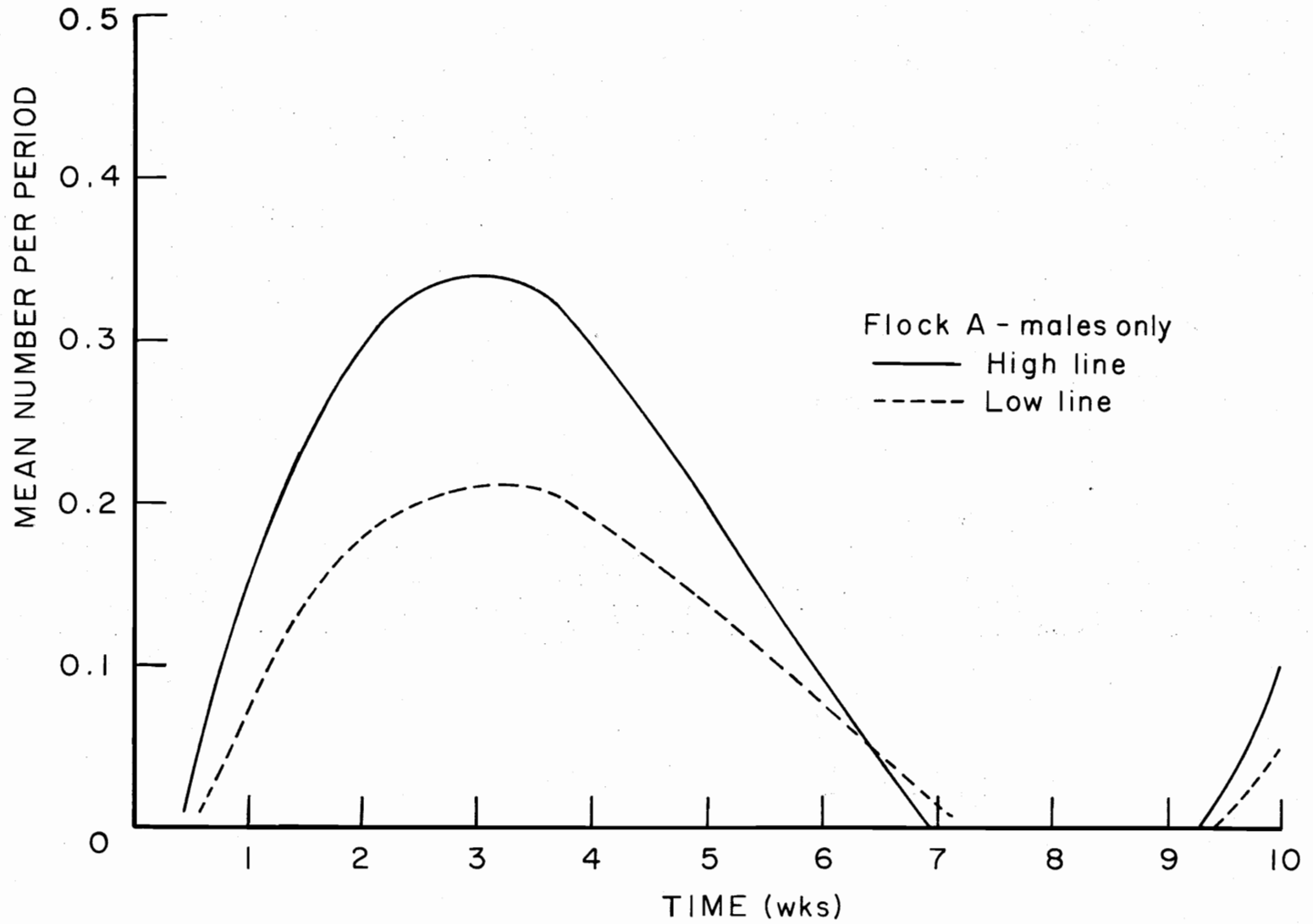


Figure 4. Polynomial curves (cubic) for scratching.

of rearing for preening. Interactions between main variables were not significant.

Preening increased in a linear fashion as the birds became older (Figure 5). The two groups of individuals shown in Figure 5 were representative of the changes which occurred in all groups when this factor was measured in time.

Running

The means for number of runs per individual from 0 to 10 weeks of age are presented in Table 6. Differences between lines and sexes were not significant, whereas the difference between the method of rearing sexes was significant. Individuals maintained in sex-separated flocks were observed to run an average of 9.8 times while the average value for those in flocks where sexes were intermingled was 7.1

Table 6. Mean number of runs per bird by line, sex, and method of rearing; Experiment I.

Sex	Line	Method of rearing sexes		Wt. $\bar{x}$
		Separate	Intermingled	
Male	High	7.6	7.2	7.5
	Low	13.1	9.4	11.8
Female	High	10.6	6.9	9.3
	Low	7.8	4.8	6.8
Wt. $\bar{x}$		9.8	7.1	8.9

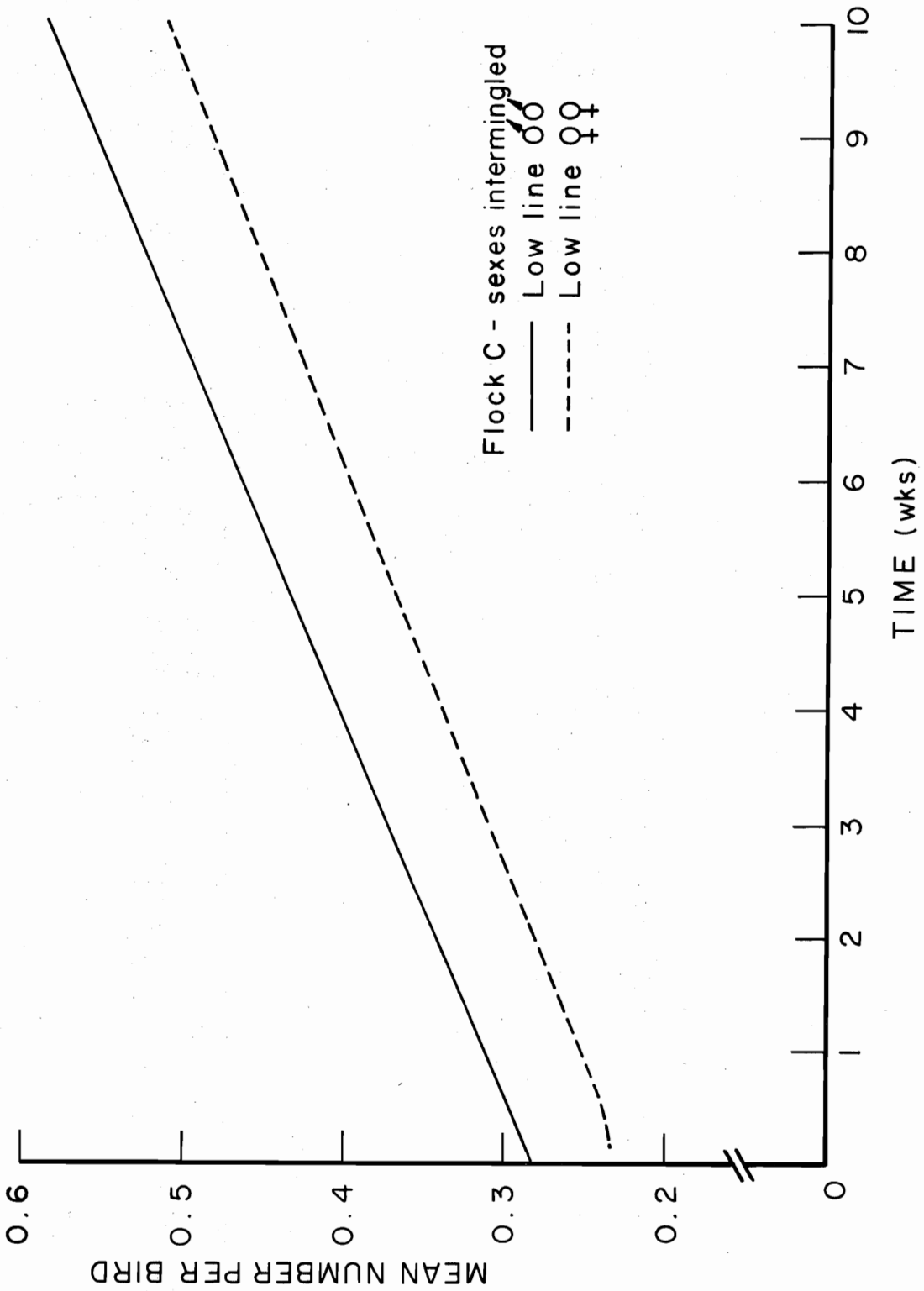


Figure 5. Linear regression lines for preening.

The only significant interaction was the L-S interaction. Males from the low weight line ran more frequently than males from the high weight line, whereas females from the high line ran more frequently than those from the low line.

Running declined as the birds became older (Figure 6). The groups of individuals shown in Figure 6 were illustrative of the changes which occurred in all groups when this factor was measured in time.

### Frolicking

No significant differences were found between sexes, lines, or method of rearing sexes for frolicking. The L-S interaction was the only interaction which was significant. Males from the low line frolicked more frequently than those from the high line, whereas females from the high line frolicked more than those from the low line (Table 7).

Table 7. Mean number of frolics per bird by line and sex; Experiment I.

Sex	Lines		Wt. $\bar{x}$
	High	Low	
Males	22.4	29.4	25.8
Females	23.8	16.9	20.4
Wt. $\bar{x}$	23.1	23.2	23.1

Frolicking values of both high and low line males which were maintained in the all-male flock were used to demonstrate changes which

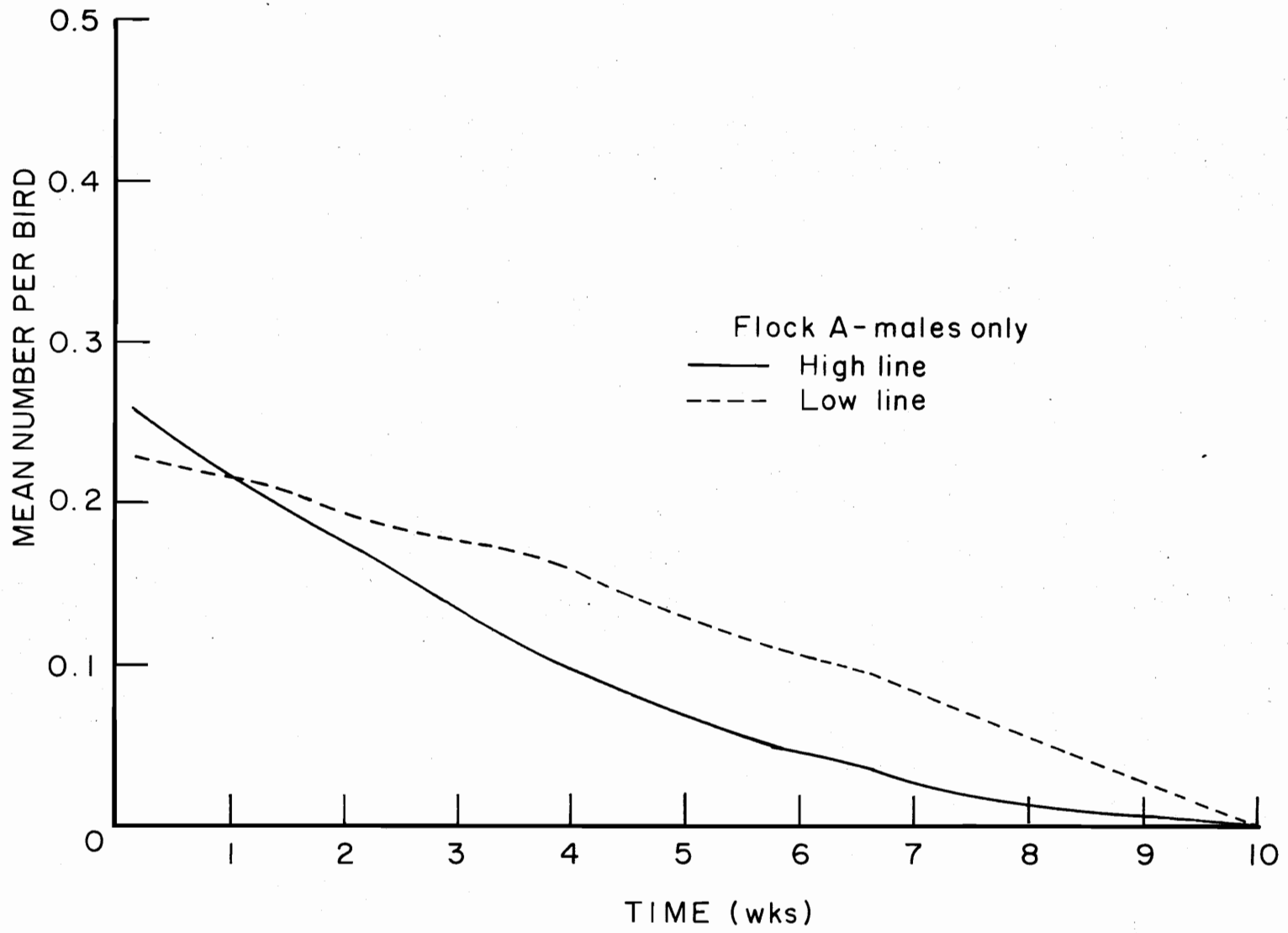


Figure 6. Polynomial curves (quadratic) for running.



occurred in time for this factor (Figure 7). The frequency of frolicking increased until about the fifth week after which it declined rapidly. By 10 weeks of age this behavioral pattern had practically disappeared.

#### Agnostic Behavior

Data obtained on peck-avoidances, threat-avoidances, avoidances without visible aggressive acts, fights, and spars were analyzed according to the method of asymptotic simultaneous confidence intervals outlined by Marks et al. (1960). Since these were social behavior patterns each individual was classified into three categories for analysis. These categories were initiates, recipients, and the combination of the two. An initiate was considered to be the individual that performed the aggressive act while a recipient was the individual who was the receiver of the act. Combined involvement was the total number of interactions which an individual was involved in for a particular pattern. Avoidances were not broken down into these categories because the definition of it given in Materials and Methods precluded such a classification.

Peck-Avoidances: Although considerable overlapping occurred between the groups compared for the number of pecks initiated, certain differences did exist (Table 8). The high weight males maintained in the all-male flock differed significantly from the low weight females which were maintained either in the all-female flock or in the flock where sexes were intermingled. Differences among the other groups were not significant.

The results obtained for recipients of pecks were not always similar to those found for initiates of pecks. Low line males reared in the

Table 8. Comparisons between lines within sexes within methods of rearing for peck-avoidances, threat-avoidances, avoidances, fights, total encounters and spars; Experiment I.

Method of rearing sexes	Sex	Line	Peck-avoidances			Threat-avoidances			Avoidances
			Init. <sup>1</sup>	Recip. <sup>2</sup>	Comb. <sup>3</sup>	Init. <sup>1</sup>	Recip. <sup>2</sup>	Comb. <sup>3</sup>	
Separate	Males	High	43 <sup>b</sup>	15 <sup>a</sup>	58 <sup>b</sup>	14 <sup>a</sup>	7 <sup>a</sup>	21 <sup>ab</sup>	5 <sup>a</sup>
		Low	25 <sup>ab</sup>	53 <sup>b</sup>	78 <sup>b</sup>	14 <sup>a</sup>	21 <sup>a</sup>	35 <sup>b</sup>	5 <sup>a</sup>
	Females	High	10 <sup>ab</sup>	9 <sup>a</sup>	19 <sup>a</sup>	0 <sup>a</sup>	1 <sup>a</sup>	1 <sup>a</sup>	0 <sup>a</sup>
		Low	3 <sup>a</sup>	4 <sup>a</sup>	7 <sup>a</sup>	1 <sup>a</sup>	0 <sup>a</sup>	1 <sup>a</sup>	0 <sup>a</sup>
Intermingled	Males	High	16 <sup>ab</sup>	8 <sup>a</sup>	24 <sup>a</sup>	4 <sup>a</sup>	3 <sup>a</sup>	7 <sup>a</sup>	0 <sup>a</sup>
		Low	24 <sup>ab</sup>	18 <sup>ab</sup>	42 <sup>ab</sup>	3 <sup>a</sup>	3 <sup>a</sup>	6 <sup>a</sup>	0 <sup>a</sup>
	Females	High	9 <sup>ab</sup>	11 <sup>a</sup>	20 <sup>a</sup>	0 <sup>a</sup>	1 <sup>a</sup>	1 <sup>a</sup>	0 <sup>a</sup>
		Low	1 <sup>a</sup>	13 <sup>a</sup>	14 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>

Any 2 numbers on the vertical which do not have the same superscript are significantly different at the 5 percent level.

<sup>1</sup>Initiates.

<sup>2</sup>Recipients.

Table 8. (Continued)

Method of rearing sexes	Sex	Line	Fights			Total encounters			Spars		
			Init. <sup>1</sup>	Recip. <sup>2</sup>	Comb. <sup>3</sup>	Init. <sup>1</sup>	Recip. <sup>2</sup>	Comb. <sup>3</sup>	Init. <sup>1</sup>	Recip. <sup>2</sup>	Comb. <sup>3</sup>
Separate	Males	High	15 <sup>a</sup>	28 <sup>ab</sup>	43 <sup>bc</sup>	72 <sup>b</sup>	55 <sup>ab</sup>	127 <sup>b</sup>	76 <sup>bc</sup>	84 <sup>ab</sup>	160 <sup>b</sup>
		Low	51 <sup>b</sup>	38 <sup>b</sup>	89 <sup>c</sup>	90 <sup>b</sup>	117 <sup>b</sup>	207 <sup>bc</sup>	140 <sup>c</sup>	131 <sup>b</sup>	271 <sup>c</sup>
	Females	High	8 <sup>a</sup>	4 <sup>a</sup>	12 <sup>ab</sup>	18 <sup>a</sup>	14 <sup>a</sup>	32 <sup>a</sup>	28 <sup>ab</sup>	19 <sup>a</sup>	47 <sup>a</sup>
		Low	0 <sup>a</sup>	4 <sup>a</sup>	4 <sup>a</sup>	4 <sup>a</sup>	8 <sup>a</sup>	12 <sup>a</sup>	8 <sup>a</sup>	16 <sup>a</sup>	24 <sup>a</sup>
Intermingled	Males	High	3 <sup>a</sup>	7 <sup>ab</sup>	10 <sup>ab</sup>	23 <sup>a</sup>	8 <sup>a</sup>	31 <sup>a</sup>	37 <sup>ab</sup>	30 <sup>a</sup>	67 <sup>a</sup>
		Low	19 <sup>ab</sup>	11 <sup>ab</sup>	30 <sup>ab</sup>	46 <sup>ab</sup>	32 <sup>a</sup>	78 <sup>ab</sup>	33 <sup>ab</sup>	33 <sup>a</sup>	66 <sup>a</sup>
	Females	High	3 <sup>a</sup>	5 <sup>a</sup>	8 <sup>ab</sup>	12 <sup>a</sup>	17 <sup>a</sup>	29 <sup>a</sup>	25 <sup>a</sup>	24 <sup>a</sup>	49 <sup>a</sup>
		Low	0 <sup>a</sup>	2 <sup>a</sup>	2 <sup>a</sup>	1 <sup>a</sup>	15 <sup>a</sup>	16 <sup>a</sup>	10 <sup>a</sup>	14 <sup>a</sup>	24 <sup>a</sup>

Any 2 numbers on the vertical which do not have the same superscript are significantly different at the 5 percent level.

<sup>1</sup>Initiates.

<sup>2</sup>Recipients.

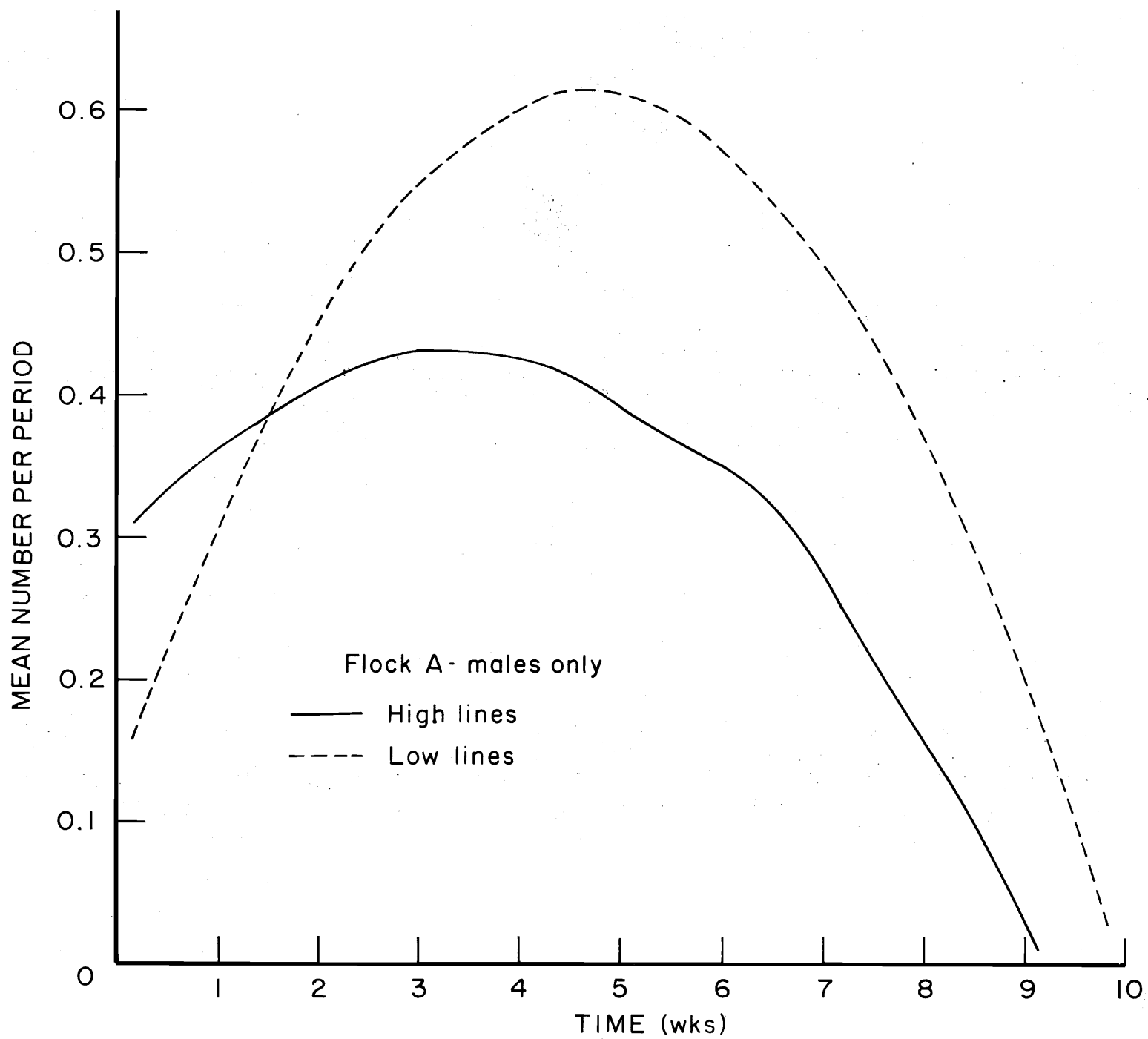


Figure 7. Polynomial curves (quadratic) for frolics.

all-male flock received significantly more pecks than any of the other groups with the exception of the low line males intermingled with chickens from both sexes and lines. This latter group did not differ significantly, however, from the other groups.

When initiates and recipients were combined, values for males in both lines maintained in the all-male flock were significantly greater than those for all other groups with the exception of the low line males in the sex-intermingled flocks. Differences between the other groups were not significant.

Threat-Avoidances: There were no significant differences between groups for either threats initiated or for the recipients of the threats (Table 8). When initiates and recipients of threats were combined certain differences, although only slight, did become apparent. Overlapping of the confidence intervals made the determination of clear-cut differences difficult. Generally, as shown in Table 8, males in the all-male flocks had more total involvement than the females in both the intermingled and all-female flocks. Values for males in the sex-intermingled flocks were lower than those in the all-male flock but differences were not consistently significant.

Avoidances: The number of avoidances which were observed were extremely low and no significant differences were found between any of the comparisons (Table 8).

Fights: As shown in Table 8, males from the low lines maintained in the flock where sexes were separated initiated significantly more fights than any other group except the low line males reared in the

flock where sexes were intermingled. This latter group did not, however, differ significantly from any of the groups.

With regard to recipients of fights, the low line males reared in the flock where the sexes were maintained separately were recipients significantly more times than any of the female groups regardless of the method of rearing used. Males from both lines intermingled with females and the high weight males maintained in flocks where sexes were reared separately did not, however, differ significantly from any of the female groups.

Confidence intervals between groups when initiates and recipients were combined showed that males from the low line maintained in the all-cockerel flock were involved in significantly more fights than birds in any of the other groups with the exception of the high-line males in the all-cockerel flock. The confidence interval for this latter group, however, overlapped with the confidence intervals of four other groups which in turn overlapped with the remainder of the groups.

Total Encounters: The total number of initiates, recipients and the combined values for peck-avoidances, threat-avoidances and fights were pooled and classified as encounters. Agnostic behavior was greatest in the all-male flock. Males from the two lines maintained in an all-male flock did not differ significantly from one another with regard to the initiation of agnostic behavior. These groups differed significantly from all other groups with the exception of the males from the low line maintained in the flock where sexes were intermingled. Differences between females maintained in the all-female flock and in sex-intermingled

flock were not significant. Although the values for males intermingled with females were greater they were not significantly different from any of the female groups.

With regard to recipients of agnostic behavior, the low line cockerels in the all-male flock were recipients significantly more times than any other group. The sole exception was the high-line males maintained as members of the same flock. This latter group, however, did not differ significantly from any of the other groups.

When initiates and recipients were combined the total number of encounters for each line of males in the all-male flock was significantly greater than those of any other group with the exception of the males from the low line in the intermingled flock. This latter group, however, did not differ significantly from the intermingled males from the high line or any of the female groups.

Spars: There was no significant differences (Table 8) among lines in the all-male flock with regard to initiates of spars. However, males from low line maintained in this flock initiated significantly more spars than any of the other groups tested. The males from the high line maintained in the all-male flock differed significantly from the females maintained in flocks where sexes were separated. Differences between female groups, whether intermingled with males or maintained separately, were not significant.

Differences between lines and sexes within the intermingled flock were not significant for recipients of spars, nor did high and low line birds maintained in an all-female flock differ significantly from the

groups in the intermingled flock. The same was true for males from the high line in the all-male flock. The low line cockerels in this all-male flock, however, were significantly different from all of the other groups except their flockmates from the high line.

When the initiates and recipients of spars were combined, clear-cut differences became apparent. Males from the low line in the all-cockerel flock sparred significantly more than birds in any of the other groups. The high line males in the same all-cockerel flock while sparring significantly less than their low line flockmates sparred more than birds in the other groups. No significant differences were noted between the other groups which included females from both lines in all female and in sex-intermingled flocks and males in the sex-intermingled flock.

#### Encounters Between and Within Lines Within Flocks

Comparisons of peck-avoidances, threat-avoidances, fights and spars were made between and within lines for each flock. Asymptotic simultaneous confidence intervals were computed for all groups and the results are presented in Table 9. No significant differences were found between any of the groups for either peck-avoidances, threat-avoidances, or fights. When these social interactions were pooled into total encounters certain relationships became apparent. Agnostic behavior appeared greatest in the all-male flocks and lowest among females in the flock where the sexes were intermingled. Although significant differences were found between certain groups located in different flocks, there were, however, no significant differences between the various groups within a particular flock.



Table 9. Comparisons of behavior patterns between and within lines by sex and method of rearing; Experiment I.

Method of rearing sexes	Sex	Line <sup>1</sup>	Peck-avoidances	Threat-avoidances	Fights	Total encounters	Spars <sup>2</sup>
Separate	Male	H H	8 <sup>a</sup>	0 <sup>a</sup>	10 <sup>a</sup>	18 <sup>ab</sup>	35 <sup>ab</sup>
		H L	8 <sup>a</sup>	14 <sup>a</sup>	5 <sup>a</sup>	27 <sup>ab</sup>	41 <sup>ab</sup>
		L H	35 <sup>a</sup>	7 <sup>a</sup>	18 <sup>a</sup>	60 <sup>b</sup>	50 <sup>b</sup>
		L L	17 <sup>a</sup>	7 <sup>a</sup>	32 <sup>a</sup>	56 <sup>b</sup>	86 <sup>b</sup>
	Females	H H	7 <sup>a</sup>	0 <sup>a</sup>	4 <sup>a</sup>	11 <sup>ab</sup>	43 <sup>ab</sup>
		H L	4 <sup>a</sup>	0 <sup>a</sup>	4 <sup>a</sup>	8 <sup>ab</sup>	23 <sup>ab</sup>
		L H	2 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	2 <sup>a</sup>	20 <sup>ab</sup>
		L L	1 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	1 <sup>a</sup>	15 <sup>ab</sup>
Intermingled	Male	H H	3 <sup>a</sup>	2 <sup>a</sup>	2 <sup>a</sup>	7 <sup>ab</sup>	2 <sup>ab</sup>
		H L	5 <sup>a</sup>	2 <sup>a</sup>	1 <sup>a</sup>	8 <sup>ab</sup>	5 <sup>ab</sup>
		L H	3 <sup>a</sup>	1 <sup>a</sup>	4 <sup>a</sup>	8 <sup>ab</sup>	2 <sup>ab</sup>
		L L	7 <sup>a</sup>	2 <sup>a</sup>	8 <sup>a</sup>	17 <sup>ab</sup>	2 <sup>ab</sup>
	Female	H H	2 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	2 <sup>a</sup>	0 <sup>a</sup>
		H L	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
		L H	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	1 <sup>a</sup>
		L L	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>	1 <sup>a</sup>

Any 2 numbers on the vertical which do not have the same superscript are significantly different at the 5 percent level.

<sup>1</sup>H H high line over high line.  
H L high line over low line.

L H low line over high line.  
L L low line over low line.

<sup>2</sup> no decision

Sparring appeared to be greatest within the sex-separated flocks and lowest where males and females were intermingled in the same flock. Differences between groups within flocks were not significant.

#### Correlations Between Peck-Orders and Spars, Frolics and Runs

Mann-Whitney U tests (Siegel, 1956) were conducted to determine if there were differences between lines for rank in the peck-order. Values of U were computed on a within sex basis in the flock where sexes were intermingled, whereas in sex-separated flocks one U value was obtained for each flock. Birds from the high line ranked significantly higher in the social hierarchy than low line birds in three comparisons and approached significance in a fourth. The three peck-orders where the birds from the high line were in the significantly higher positions were the males in the sex intermingled flock, the females in the same flock and the females in the all-female flock. The peck-orders on a within-sex basis are presented in Table 10.

Rank correlations (Siegel, 1956) were calculated on an individual bird basis between rank in the social order and rank for number of spars, frolics, and runs. None of the correlations was significant (Table 11) although they were positive in most instances.

#### Development of Various Behavior Patterns in Time

The various behavior patterns as measured in time were previously presented for each pattern individually but not collectively. Curves for resting, stretching, scratching, preening, running, frolicking, sparring and total encounters in time have been calculated for males

Table 10. Peck-orders listed in decending order for each flock; Experiment I.<sup>1</sup>

Flock A	Flock B	Flock C	
(all males)	(all females) <sup>2</sup>	(males) <sup>2</sup>	(females) <sup>2</sup>
H12	H1	H1	H19, H21
H6, H15	H7	L11	H20
H4	H13, L22	H5, H6, H7	H23
H11, H1	H12	H4	H22, L26
L28, L30	H8, H14	H8	L27
H9	H11	H9, L12, L15	H18
H5	L28	L10	H17
L16, L23	H5	L3, L13	H16
H2, H4, L25	L21	H2	L29
H10, L26	H3, H9		L28
H8, H13, L18	H15, L17		L24
L22	L25, L30		
L29	L27		
L27, H3	L23, L26		
H7	H19		
L24			

<sup>1</sup>Letter denotes line, high (H) or low (L); number denotes individual within line.

<sup>2</sup>Significant U values.

Table 11. Rank correlations between peck-orders and runs, frolics and spars within each flock; Experiment I.

Method of rearing sexes	Flock	Sex	Runs	Frolics	Spars
Separate	A	Males	.11	.22	.32
	B	Females	-.05	.38	.42
Intermingled	C	Males	.01	.11	-.12
		Females	.09	.54	.46

in the low line which were maintained in the all-male flock and the results are shown in Figure 8.

At hatching the chicks spent much time resting with other forms of behavior consisting of preening, running and frolicking. Resting was at its peak at hatching, after which it declined rapidly until about 3 to 4 weeks of age. It then increased until 7 to 8 weeks of age and then declined again, resulting in a significant cubic effect.

In contrast, preening increased linearly with time over the 10-week period. Running declined in a quadratic manner over time and had disappeared by the tenth week. As running declined, frolicking increased until the third to fourth week and then declined rapidly until it disappeared completely at about 9 weeks. The trend in time was quadratic.

Scratching was first observed during the first week. It increased rapidly reaching a peak about the third week and then declined until it had almost disappeared by 7 weeks; then at 9 weeks when running and frolicking disappeared, scratching began to appear again.

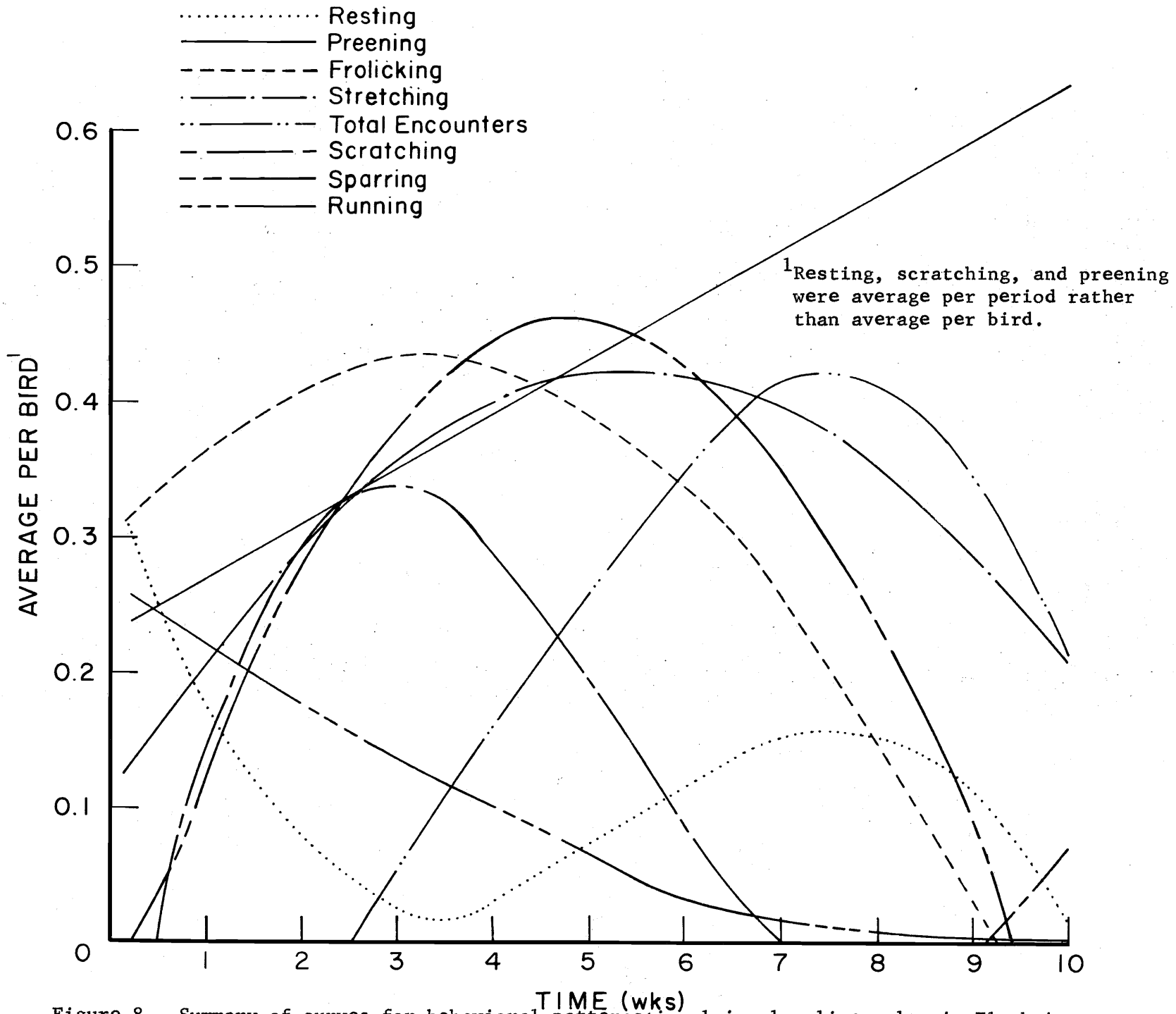


Figure 8. Summary of curves for behavioral patterns involving low line males in Flock A.

The equation for stretching was cubic when measured over time. It increased rapidly during the first few weeks, plateaued between 4 and 7 weeks and then declined so that at 10 weeks it was about half of its peak level.

Sparring was observed at a very early age and peaked between the fourth and fifth weeks. Sparring then declined at approximately the same rate as it increased and disappeared during the ninth week. Between the second and third week other agnostic factors came into being. They rose rapidly and replaced sparring by the seventh week. At about the eighth week, they began to decline.

#### Body Weights

Body weight data were analyzed on a within-sex basis according to the method of weighted squares of means (Goulden, 1952) to adjust for unequal subclass numbers. Since method of rearing sexes was significant in only two of 22 analyses and the L-SI interaction was significant in only one of 22 analyses (Table 12), they were attributed to chance and the means for method of rearing were pooled and weighted values are presented in Table 13.

Differences in body weights between the high and low lines were highly significant at hatching for males and females. This difference between lines persisted and increased throughout the ten-week experimental period.

#### Water and Feed Consumption

Cumulative values for water and feed consumption and the ratio of water to feed consumed at weekly intervals were presented in Table 14

Table 12. Analyses of variance of body weight data; Experiment I.

Sex	Source of variation	df	1 da.	1 wk.	2 wk.	3 wk.	4 wk.	5 wk.
			M.S.	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )
Males	Between lines (L)	1	274**	35**	140**	510**	1732**	2900**
	Separate vs. intermingled (SI)	1	22	6*	6	2	8	1
	L x SI	1	1	6*	14	44	24	24
	Error	41	18	1	4	14	79	79

Sex	Source of variation	df	6 wk.	7 wk.	8 wk.	9 wk.	10 wk.
			M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )
Males	Between lines (L)	1	3277**	4854**	5270**	7231**	8996**
	Separate vs. intermingled (SI)	1	24	151	93	115	255
	L x SI	1	3	28	190	115	272
	Error	39	80	104	125	188	232

Sex	Source of variation	df	1 da.	1 wk.	2 wk.	3 wk.	4 wk.	5 wk.
			M.S.	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )
Females	Between lines (L)	1	164**	21**	112**	483**	1255**	2246**
	Separate vs. intermingled (SI)	1	26	9**	10	13	33	3
	L x SI	1	0	3	10	31	85	3
	Error	41	19	1	3	9	22	61

Sex	Source of variation	df	6 wk.	7 wk.	8 wk.	9 wk.	10 wk.
			M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )
Females	Between lines (L)	1	3303**	4750**	7008**	6944**	6552**
	Separate vs. intermingled (SI)	1	1	4	1	18	11
	L x SI	1	1	4	1	17	582
	Error	38	69	145	152	212	184

\*\* P = .01.

\* P = .05.

Table 13. Means and standard deviations of body weights by lines within sexes; Experiment I.<sup>1</sup>

Age (wks.)	Males			Females		
	High line (gm.)	Low line (gm.)	Diff. (gm.)	High line (gm.)	Low line (gm.)	Diff. (gm.)
0	41 <sup>†</sup> 4	36 <sup>†</sup> 4	5**	40 <sup>†</sup> 4	36 <sup>†</sup> 4	4**
1	92 <sup>†</sup> 11	76 <sup>†</sup> 9	76**	82 <sup>†</sup> 7	69 <sup>†</sup> 12	13**
2	164 <sup>†</sup> 17	131 <sup>†</sup> 23	33**	149 <sup>†</sup> 17	119 <sup>†</sup> 19	30**
3	289 <sup>†</sup> 25	224 <sup>†</sup> 46	65**	257 <sup>†</sup> 26	193 <sup>†</sup> 33	64**
4	470 <sup>†</sup> 37	348 <sup>†</sup> 71	122**	403 <sup>†</sup> 38	300 <sup>†</sup> 53	103**
5	634 <sup>†</sup> 75	468 <sup>†</sup> 99	166**	546 <sup>†</sup> 44	406 <sup>†</sup> 102	140**
6	840 <sup>†</sup> 82	651 <sup>†</sup> 100	189**	695 <sup>†</sup> 63	520 <sup>†</sup> 101	175**
7	1032 <sup>†</sup> 91	799 <sup>†</sup> 113	233**	846 <sup>†</sup> 110	636 <sup>†</sup> 131	210**
8	1230 <sup>†</sup> 102	970 <sup>†</sup> 122	260**	1028 <sup>†</sup> 81	768 <sup>†</sup> 155	260**
9	1450 <sup>†</sup> 123	1147 <sup>†</sup> 152	303**	1177 <sup>†</sup> 92	910 <sup>†</sup> 180	267**
10	1639 <sup>†</sup> 129	1298 <sup>†</sup> 176	341**	1319 <sup>†</sup> 79	1064 <sup>†</sup> 180	255**

\*\* P = .01.

<sup>1</sup>Flocks were pooled.



Table 14. Cumulative mean water and feed consumption and water:feed ratio, by flocks:  
Experiment I.<sup>1</sup>

Periods (in wks.)	Flock A (all males)			Flock B (all females)			Flock C (males & females)			Mean water:feed ratio
	water <sup>1</sup>	feed <sup>1</sup>	ratio	water <sup>1</sup>	feed <sup>1</sup>	ratio	water <sup>1</sup>	feed <sup>1</sup>	ratio	
0-1	.40	.15	2.67	.37	.15	2.47	.43	.15	2.80	2.64 <sup>a</sup>
0-2	.99	.40	2.48	.93	.39	2.38	1.02	.40	2.55	2.47 <sup>ab</sup>
0-3	1.89	.78	2.42	1.74	.72	2.42	1.90	.76	2.50	2.44 <sup>ab</sup>
0-4	3.00	1.35	2.22	2.88	1.16	2.48	3.09	1.29	2.40	2.37 <sup>ab</sup>
0-5	4.74	2.07	2.29	4.25	1.81	2.35	4.42	1.94	2.28	2.31 <sup>bc</sup>
0-6	6.48	2.93	2.21	5.67	2.52	2.25	5.83	2.72	2.18	2.21 <sup>bc</sup>
0-7	8.24	3.81	2.16	6.77	3.25	2.08	7.38	3.55	2.08	2.11 <sup>bc</sup>
0-8	10.41	4.78	2.18	8.48	4.07	2.08	9.13	4.47	2.04	2.10 <sup>c</sup>
0-9	12.62	5.87	2.15	10.11	4.97	2.03	10.96	5.47	2.00	2.06 <sup>c</sup>
0-10	14.88	7.00	2.13	11.86	5.88	2.02	13.10	6.49	2.02	2.06 <sup>c</sup>

Any 2 numbers on the vertical which do not have the same superscript are significantly different at the 5 percent level.

<sup>1</sup>lbs. per bird.

and Figure 9. Analysis of variance of the water to feed ratios (Table 15) showed highly significant differences among weeks but no significant difference among flocks. The Duncan (1955) multiple range test for differences between mean weekly water:feed ratios was applied and showed that the ratios at the earlier ages were significantly higher than those at the older ages. The water:feed ratios from 0 to 1 week of age were 2.67:1, 2.47:1, and 2.80:1 for Flock A, Flock B and Flock C, respectively. As birds in the flocks became older the ratio decreased and by the tenth week the ratio was 2.13:1 for Flock A and 2.02:1 for Flock B and 2.02:1 for Flock C.

Oxygen Consumption

Oxygen consumption did not differ between the high and low line males and females involved in this experiment (Table 16). The mean values in l./kg./hr. for birds in the high line were .789 for males and .777 for females while the respective values in the birds in the low line were .708 and .884. The sexes separated vs. sexes intermingled and the line-treatment interaction were not significant with regard to oxygen consumption.

Table 15. Analysis of variance of water: feed ratios; Experiment I.

Source of variation	df	M.S.
Among flocks	2	.002
Among weeks	9	.012**
Error	18	.002

\*\* P = .01.

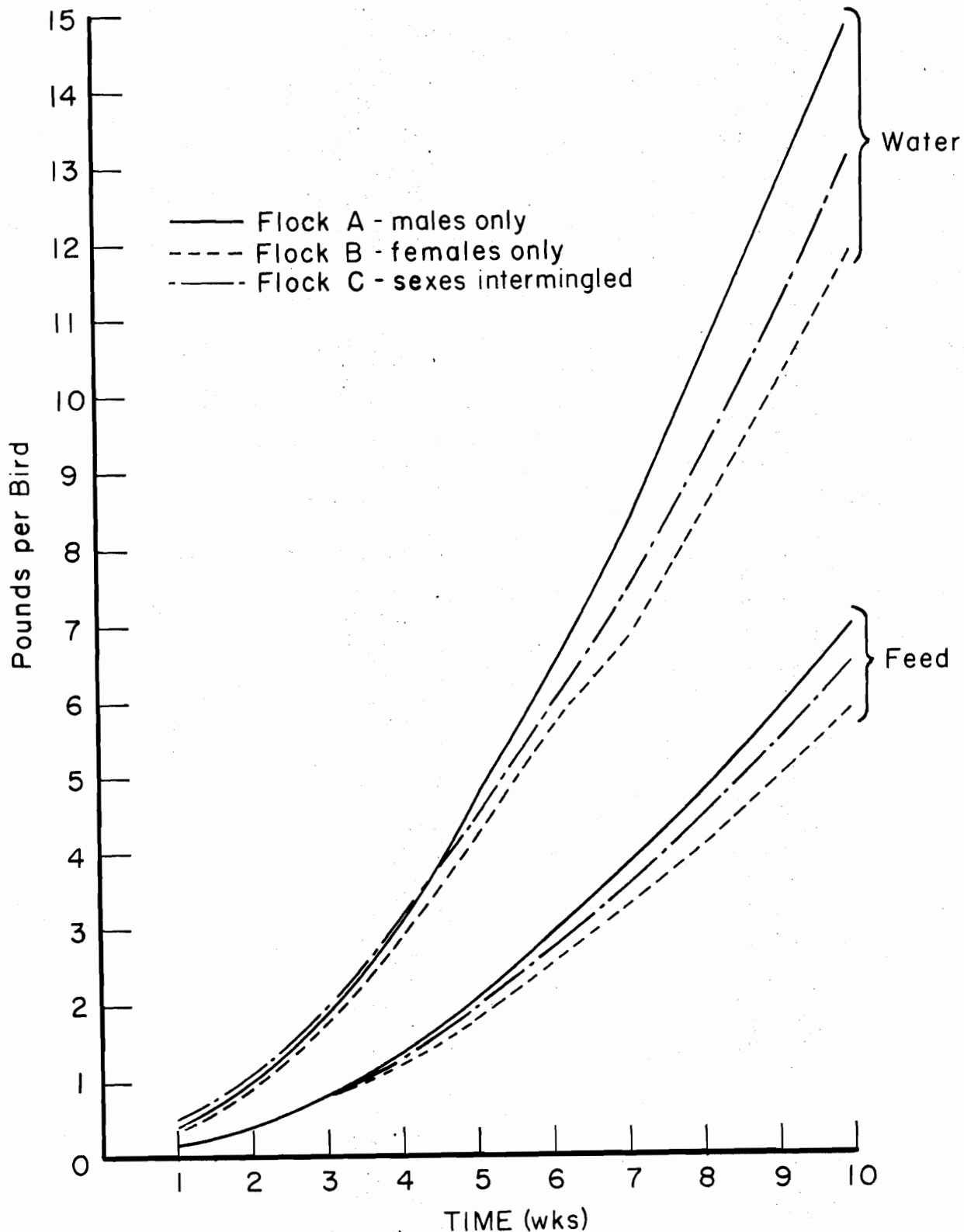


Figure 9. Cumulative feed and water consumption by flocks; Experiment I.

Table 16. Analysis of variance of oxygen consumption of birds at 50 days of age.

Source of variation	df	M.S.	
		Males	Females
Between lines (L)	1	.01331	.02296
Separate vs. intermingled (SI)	1	.00428	.00001
L x SI	1	.01098	.00492
Error	4	.02166	.03680

### Experiment II

Analyses of variance of resting, stretching, scratching, preening, running, and frolicking data obtained in Experiment II are present in Table 17. Tables of means will be given during the subsequent presentation of results; however, the reader should refer back to Table 17 for the various analyses of variance of the data.

#### Resting

Means of the number of observation periods a chicken was observed to be resting from hatching to ten weeks of age are presented in Table 18. The mean number of periods each male and female was observed to be resting was 23.6 and 26.4, respectively. The difference of 2.8 was significant. Also significant was the SI-S interaction. The mean for females in the all-female flock was 2.5 larger than the mean for females intermingled in a flock with males, whereas the mean for males maintained separately was 5.2 less than the mean for those intermingled with females.

Table 17. Analyses of variance of data on resting, stretching, scratching, preening, running and frolicking; Experiment II.

Source of Variation	Df	M.S.					
		Resting	Stretching	Scratching	Preening	Running	Frolicking
Between Lines (L)	1	40.0	882.2**	19.0	17.7	0.6	116.1
Separate vs. Intermingled (SI)	1	3.9	512.0**	55.6	9.2	12.0	15.2
Between Sexes (S)	1	67.6*	73.0	23.6	0.2	0.1	41.8
L x SI	1	7.0	271.9*	8.8	93.6**	48.0	451.6*
L x S	1	3.5	1.4	123.1*	2.2	48.7	0.0
SI x S	1	81.7*	320.4*	15.7	10.9	0.0	138.3
L x SI x S	1	2.7	0.0	0.0	3.6	54.2	148.9
Error	26	11.4	43.1	17.0	6.6	32.8	68.2

\*\* P = .01.

\* P = .05.

Table 18. Mean number of observation periods each bird was observed to be resting by sex and method of rearing; Experiment II.

Method of rearing sexes	Sex		Wt. $\bar{x}$
	Males	Females	
Separate	22.3	27.2	24.7
Intermingled	27.5	24.7	25.8
Wt. $\bar{x}$	23.6	26.4	25.7

Table 19. Mean number of stretches per bird by line, sex and method of rearing; Experiment II.

Method of rearing sexes	Males			Females			Wt. $\bar{x}$		
	HL <sup>2</sup>	LL <sup>2</sup>	Combined	HL <sup>1</sup>	LL <sup>2</sup>	Combined	HL <sup>2</sup>	LL <sup>2</sup>	Combined
Separate	33.7	26.8	30.3	34.4	28.1	31.3	34.1	27.5	30.8
Intermingled	38.0	19.0	33.2	25.5	6.5	16.0	31.7	9.6	22.9
Wt. $\bar{x}$							33.3	23.1	

<sup>1</sup>High weight line.

<sup>2</sup>Low weight line.

### Stretching

The mean number of times each bird was observed to stretch from 0 to 10 weeks of age were 33.3 and 23.1 in the high and low lines, respectively (Table 19). This difference was highly significant. Differences between flocks where sexes were maintained separately and intermingled were also highly significant, with the respective values for separate and intermingled flocks being 30.8 and 22.9. There was no significant difference between sexes in this experiment.

The L-S and the L-SI-S interactions were not significant. In contrast, the L-SI and the SI-S interactions were. Birds from the low line maintained in flocks where sexes were separated stretched an average 17.9 more times than their counterparts in flocks where sexes were intermingled, while birds from the high line in the flock where sexes were separated stretched only 2.4 more times per bird than their counterparts in the intermingled flock.

With regard to the SI-S interaction, females in the flock where sexes were intermingled stretched less than those in the all female flock whereas the males reacted in the opposite manner to the two types of flocking.

### Scratching

No significant differences were found for scratching between lines, sexes, or method of rearing. The only significant interaction was the L-S interaction. As shown in Table 20, males from the low line scratched more than males from the high line, whereas females from low line scratched less than females from the high line.

Table 20. Mean number of observation periods each bird was observed to be scratching by line and sex; Experiment II.

Sex	Line		Wt. $\bar{x}$
	High	Low	
Male	10.4	16.1	13.0
Female	15.5	13.8	14.7
Wt. $\bar{x}$	14.7	13.2	13.9

### Preening

Differences between lines, sexes and method of rearing were not significant for preening. None of the first or second order interactions was significant with the exception of the L-SI interaction. Mean values which illustrate this significant interaction are presented in Table 21. Chickens from the low line that were maintained in flocks where sexes were separated preened more than those in flocks where sexes were intermingled. In contrast, chickens from the high line in flocks where sexes were maintained separately preened less than those in flocks where sexes were intermingled.

### Running

No significant differences were found between lines, sexes, or method of rearing for running nor were the interactions significant.

### Frolicking

Differences in frolicking between lines, sexes, and method of rearing were not significant. The L-SI interaction was the only



Table 21. Mean number of observation periods each bird was observed to be preening by line and method of rearing; Experiment II.

Method of rearing sexes	Line		Wt. $\bar{x}$
	High	Low	
Separate	13.3	16.8	15.0
Intermingled	15.6	11.8	14.1
Wt. $\bar{x}$	14.0	15.6	14.6

significant interaction involving main effects. This interaction is illustrated in Table 22. In sex-separated flocks, birds from the low line frolicked 8.5 times more than those from high line, whereas in the flock where sexes were intermingled the chickens from high line frolicked 3.9 more times than those from the low line.

Table 22. Mean number of frolics per bird by line and method of rearing; Experiment II.

Method of rearing sexes	Line		Wt. $\bar{x}$
	High	Low	
Separate	12.8	21.3	17.1
Intermingled	21.7	17.8	20.1
Wt. $\bar{x}$	17.3	20.4	18.0

Agnostic Behavior

Total Encounters: Peck-avoidances, threat-avoidances, avoidances without visible aggressive acts and fights were pooled for analysis because of the low frequency of each type of behavior. The pooled values for social interactions were divided into the same three categories used in Experiment I. These were initiates, recipients, and combined. According to the asymptotic simultaneous confidence intervals which were determined for these data (Table 23 and 24); no significant differences were found between any of the groups.

Table 23. Comparisons between lines within sexes within method of rearing for total encounters and spars; Experiment II.

Method of rearing sexes	Sex	Line	Total encounters			Spars		
			Init. <sup>1</sup>	Recip. <sup>2</sup>	Comb.	Init. <sup>1</sup>	Recip. <sup>2</sup>	Comb.
Separate	Males	High	0 <sup>a</sup>	4 <sup>a</sup>	4 <sup>a</sup>	12 <sup>ab</sup>	10 <sup>ab</sup>	22 <sup>a</sup>
		Low	12 <sup>a</sup>	8 <sup>a</sup>	20 <sup>a</sup>	43 <sup>b</sup>	45 <sup>b</sup>	88 <sup>b</sup>
	Females	High	6 <sup>a</sup>	7 <sup>a</sup>	13 <sup>a</sup>	8 <sup>a</sup>	8 <sup>a</sup>	16 <sup>a</sup>
		Low	2 <sup>a</sup>	1 <sup>a</sup>	3 <sup>a</sup>	17 <sup>ab</sup>	17 <sup>ab</sup>	34 <sup>a</sup>
Intermingled	Males	High	11 <sup>a</sup>	2 <sup>a</sup>	13 <sup>a</sup>	37 <sup>ab</sup>	12 <sup>ab</sup>	49 <sup>ab</sup>
		Low	3 <sup>a</sup>	6 <sup>a</sup>	9 <sup>a</sup>	11 <sup>ab</sup>	22 <sup>ab</sup>	33 <sup>a</sup>
	Females	High	0 <sup>a</sup>	3 <sup>a</sup>	3 <sup>a</sup>	6 <sup>a</sup>	10 <sup>ab</sup>	16 <sup>a</sup>
		Low	4 <sup>a</sup>	7 <sup>a</sup>	11 <sup>a</sup>	7 <sup>a</sup>	18 <sup>ab</sup>	25 <sup>a</sup>

Any 2 numbers on the vertical which do not have the same superscript are significantly different at the 5 percent level.

<sup>1</sup>Initiates.  
<sup>2</sup>Recipients.

Table 24. Comparisons of total encounters between and within lines by sex and method of rearing; Experiment II.

Method of rearing sexes	Sex	Line <sup>1</sup>	Total encounters
Separate	Males	H H	0 <sup>a</sup>
		H L	0 <sup>a</sup>
		L H	4 <sup>a</sup>
		L L	8 <sup>a</sup>
	Females	H H	5 <sup>a</sup>
		H L	1 <sup>a</sup>
		L H	2 <sup>a</sup>
		L L	0 <sup>a</sup>
Intermingled	Males	H H	0 <sup>a</sup>
		H L	5 <sup>a</sup>
		L H	1 <sup>a</sup>
		L L	0 <sup>a</sup>
	Females	H H	0 <sup>a</sup>
		H L	0 <sup>a</sup>
		L H	1 <sup>a</sup>
		L L	1 <sup>a</sup>

Any 2 numbers on the vertical which do not have the same superscript are significantly different at the 5 percent level.

<sup>1</sup>H H high line over high line      L H low line over high line  
H L high line over low line      L L low line over low line

Spars: The comparisons involving spars were presented in Table 23. Males from the low line maintained in all-male flocks initiated a significantly greater number of spars than females from the low line maintained in the sex-intermingled flock and high line females maintained in either the all female or the sex intermingled flock. There were no significant differences among male groups regardless of method of rearing. Also the confidence intervals for the females in the low line maintained in an all-female flock overlapped with the male group as well as the female groups.

With regard to recipients of spars there were only two groups which were significantly different from each other. These were the males from the low line maintained in the all-male flock and the females from the high line maintained in the all-female flock. The former group had the largest and the latter the smallest value for all groups. When initiates and recipients were combined the males from the low line maintained in the all-cockerel flock differed significantly from all other groups except the males from the high line which were in the sex intermingled flock. Differences among the other groups were not significant.

#### Correlations Between Peck-Orders and Spars, Frolics and Runs

Rank correlation coefficients (Siegel, 1956) were calculated between peck-orders and runs, frolics, and spars (Table 25). The only significant correlation (+.65) was with spars in the all-male flock. The other correlations although predominately positive were not significant.

Table 25. Rank correlations between peck-orders and runs, frolics and spars within each flock; Experiment II.<sup>2</sup>

Method of rearing sexes	Flock	Sex	Runs	Frolics	Spars
Separate	A	Males	.30	.28	.65*
	B	Females	.05	-.34	.16
Intermingled	C	Males	.40	.14	.54
		Females	.76	.12	.46

\* P = .05.

#### Body Weight

Body weight data were analyzed on a within sex basis according to the method of weighted squares of means (Goulden 1952). Since as shown in Table 26 the methods of rearing sexes was not significant in any of the 22 analyses, sexes were pooled for presentation in Table 27. Significant or highly significant differences between lines with females from the high line being heavier than those in the low line were found throughout. The difference which was present at hatching increased throughout the ten-week experimental period. Males followed a similar pattern although differences between lines were not significant at one and two weeks of age.

#### Water and Feed Consumption

An error was made when the feed consumption data were obtained at the conclusion of the seventh week; therefore, the feed consumption data were reliable for only the first seven weeks. Water to feed ratios

Table 26. Analyses of variance of body weight data; Experiment II.

Sex	Source of variance	df	1 da.	1 wk.	2 wk.	3 wk.	4 wk.		
			M.S.	M.S.	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )		
Males	Between lines (L)	1	59**	278	23	101**	254**		
	Separate vs. intermingled (SI)	1	11	13	1	1	3		
	L x SI	1	6	35	1	5	34		
	Error	12	4	20	2	6	10		
Sex	Source of variance	df	5 wk.	6 wk.	7 wk.	8 wk.	9 wk.	10 wk.	
			M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	
Males	Between lines (L)	1	700**	979**	1366**	1766**	3055**	3113**	
	Separate vs. intermingled (SI)	1	1	1	46	5	91	158	
	L x SI	1	50	27	28	26	194	156	
	Error	26	26	43	68	101	107	174	
Sex	Source of variance	df	1 da.	1 wk.	2 wk.	3 wk.	4 wk.	5 wk.	
			M.S.	M.S.	M.S.	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	
Females	Between lines (L)	1	50**	125**	920**	35*	100**	219**	
	Separate vs. intermingled (SI)	1	26	52	5	1	1	1	
	L x SI	1	4	117	659*	14	30	38	
	Error	14	2	20	133	5	11	21	
Sex	Source of variance	df	6 wk.	7 wk.	8 wk.	9 wk.	10 wk.		
			M.S. (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	df (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	df (x10 <sup>2</sup> )	M.S. (x10 <sup>2</sup> )	
Females	Between lines (L)	1	359**	569**	1	555**	1	474*	
	Separate vs. intermingled (SI)	1	29	58	1	61	1	37	
	L x SI	1	57	39	1	88	1	1	
	Error	35	35	34	13	46	11	82	10

\*\* P = .01.

\* P = .05.

Table 27. Means and standard deviations of body weights by lines within sexes<sup>1</sup>; Experiment II.

Age (Wks)	Males			Females		
	High line (gm.)	Low line (gm.)	Diff. (gm.)	High line (gm.)	Low line (gm.)	Diff. (gm.)
0	31±2	29±2	2**	31±2	28±1	3**
1	60±4	54±2	6	60±4	56±4	4*
2	145±11	120±10	25	130±10	120±9	10*
3	264±19	208±22	56**	226±22	202±17	24*
4	410±26	335±29	75**	346±28	308±30	38**
5	598±42	458±46	140**	501±40	438±40	63**
6	778±48	599±65	179**	642±50	560±54	82**
7	958±122	746±83	212**	778±40	669±60	109**
8	1152±74	913±102	239**	936±52	832±66	104**
9	1343±78	1078±102	265**	1094±67	958±86	136**
10	1520±112	1262±117	258**	1236±58	1106±101	130*

\*\* P = .01.

\* P = .05.

<sup>1</sup>Flocks were pooled.

were not calculated because of this error. Cumulative values for water consumption at weekly intervals from 0 to 10 weeks and feed consumption from 0 to 7 weeks were presented in Table 28. Feed and water consumption increased each week with water consumption being considerably greater than feed consumption.

Table 28. Cumulative mean water consumption and feed consumption by flocks; Experiment II.

Periods (in wks.)	Flock A		Flock B		Flock C	
	<u>(all males)</u>		<u>(all females)</u>		<u>(males &amp; females)</u>	
	water <sup>1</sup>	feed <sup>1</sup>	water <sup>1</sup>	feed <sup>1</sup>	water <sup>1</sup>	feed <sup>1</sup>
0-1	.33	.15	.35	.13	.31	.18
0-2	.95	.40	.93	.36	.89	.44
0-3	1.85	.79	1.73	.73	1.75	.76
0-4	3.08	1.33	2.73	1.30	2.85	1.29
0-5	4.48	2.50	3.95	2.29	4.17	1.95
0-6	6.19	2.86	5.39	2.76	5.74	2.72
0-7	7.77	3.80	6.79	3.66	7.23	3.69
0-8	9.69		8.41		8.95	
0-9	12.09		10.43		10.82	
0-10	14.36		12.36		12.86	

<sup>1</sup> lbs. per bird.



## DISCUSSION

The experiments reported here were concerned with the development of behavior patterns of chickens from one day until ten weeks of age. Although many studies have been conducted on imprinting (Hess, 1959) and on behavior during peck-order formation and at older ages (Guhl, 1953 and Wood-Gush, 1955), there is a dearth of information concerning the behavior of young chickens.

Data were obtained on the emergence of various behavior patterns, their sequence in development and changes in time. The development of structural and physiological mechanisms during the period studied could have a profound influence on the behavior of chickens in requiring adaptation to these changes. Also, it is difficult to determine if the development of certain patterns are due to changes in heredity, environment or a combination of the two. The general area of behavioral genetics has recently been reviewed by Fuller and Thompson (1960), while Guhl (1961) has reviewed the relationship between gonadal hormones and social behavior.

The study reported here considered sex, line and method of rearing (sexes separate and intermingled) as hereditary and environmental sources of variation. Since, in behavioral studies, differences between birds are large (Guhl, 1958 and Siegel, 1959), data, for each form of behavior investigated, were obtained on an individual bird basis. Although main variables were similar in both of the experiments reported here, it should be remembered that Experiment I and II differed in that flock

sizes varied and that they were conducted during different seasons. It was felt that by investigating differences within these situations a broader picture of the emergence and changes of behavior patterns in time would be obtained. Previous work by Wood-Gush (1955) and Guhl (1958) have given some indication that certain behavior patterns appear in sequence but that there is much over-lapping. Many of the forms of behavior observed in this experiment have not been previously reported for chickens and thus cannot be substantiated from previous experimentation.

Resting, with the chicks being located in groups, was observed to be most prevalent during the first few days. This grouping may be considered to be allelomimetic, a general type of behavior which Scott (1958) defined as a situation in which two or more individuals do the same thing, with some degree of mutual stimulation. This, however, would not necessarily be the sole reason for resting at very early ages. Another possible explanation is that the thermo-regulatory mechanisms in the birds were not fully developed at these ages (Lamoreux and Hutt, 1939) and that the grouping during resting and sleeping was primarily for warmth. No significant differences in resting were found between lines or method of rearing in either experiment. Differences between sexes, however, were significant in both experiments with females resting more than males. Also the SI-S interaction was significant in both experiments with the females resting more in the all-female flocks than in the intermingled flocks, whereas an inconsistent effect of flocking was observed for the males. If males rested less than the females and

if part of the effect was allelomimetic then this interaction would be expected.

Chicks were observed to stretch during the first week. Stretching increased in time until the chicks were 4 to 5 weeks of age after which it declined. Highly significant differences for stretching were found between lines with chicks in the high line stretching more than those in the low line. This difference was observed in both experiments and would indicate that there were genetic factors influencing this pattern. Also the SI-S interaction was significant in both experiments. Males in the flocks where sexes were intermingled stretched a greater number of times than those in the all-male flocks. In contrast, females in the intermingled flocks stretched less than those in all-female flocks. Although no ready explanation is offered for this consistent interaction, it was probably not a spontaneous activity since it frequently followed a period in which the birds were inactive. The observer, however, did not notice any specific stimulus which resulted in a stretching response.

Scratching, a displacement reaction in adult chickens (Wood-Gush, 1954), increased during the first few weeks and then declined rapidly, only to start to increase again during the ninth week. The decline occurred when total encounters were rising and then reappeared when total encounters began to decline. The relationship may be meaningful but further experimentation should be conducted before reaching even tentative conclusions. In both experiments, chicks in the high line were observed to scratch more than those in the low line; however, the difference between lines was significant only in Experiment II. This

would suggest that there might be some genetic influence on the frequency of this behavior pattern.

Results obtained from this study indicate that neither lines, sexes, or method of rearing had any significant influence on preening. The only significant interaction between main effects was the L-SI interaction in Experiment I and this might have been a chance occurrence.

Preening increased in a linear manner as the chicks became older. Both lines were early feathering and thus juvenile feathers began to appear at very early ages. It has been well documented (Jull, 1952) that during the first 10 weeks of life juvenile and post-juvenile plumage rapidly replace down and juvenile feathers. Since the amount of feather coverage increased during this period it would be logical to also assume that preening would increase in time.

Running, an escape reaction, was observed in all groups during the first week. This substantiated the finding of Guhl (1958) that running occurred very early in a bird's life. Running decreased with time and was probably replaced by other escape responses. No significant differences between sexes or lines were found in either experiment. Method of rearing, however, was significant in Experiment I and not significant in Experiment II, although the error terms for the experiments were very similar (32.6 and 32.8). In the first experiment chicks reared in flocks where sexes were maintained separately ran more than those reared in the intermingled flock. This may suggest that the mixing of the sexes reduces this type of behavior. Since comparisons of this

type were not available from the literature, the influence of method of rearing on running cannot be ascertained at this time.

Frolicking appeared to occur spontaneously. One chick would frolic and almost immediately others would mimic the pattern. Those that mimicked the pattern, however, would not necessarily frolic in the same direction as the chick that frolicked initially.

Possible reasons for frolicking have been offered by Guhl (1958). He felt that this activity was caused by disturbances such as the filling of feed troughs and the turning on of lights. The writer concurs with this reasoning although the specific disturbances differed. For example, when the flocks reported here were frightened by unusual noises, the chicks restrained from their existing activity for a short time. Then, one individual would spontaneously frolic being followed by some of its flockmates.

Differences in frolicking between lines, sexes and method of rearing were not significant in either experiment. There was in each experiment a significant interaction; the L-S in Experiment I and the L-SI in Experiment II. No explanation for their occurrence are offered at this time.

Changes in the frequency of frolicking in time were of considerable interest. Frolicking was first observed during the first week and appeared to replace running. Frolicking increased during the first 3 weeks after which it declined. Sparring started somewhat later than frolicking, increased at a much faster rate and surpassed frolicking when the chicks were about 25 days of age. Sparring reached its peak

about one week later and then declined. The data obtained here on the emergence of frolicking and sparring are consistent with the report of Guhl (1958). They do not, however, confirm his observation that frolicking led to sparring by the second week. Instead they indicate that this occurred about one week later than Guhl stated. The multitude of differences between Guhl's experiment and mine precludes any explanation for this small inconsistency in results.

Results of total encounters indicate that males were more aggressive than females and were consistent with the previous reports of Masare and Allee (1934), Allee et al. (1939), Collias (1943) and Guhl (1958). Encounters appeared to be greater among males in the all-male flock than among males that were intermingled with females. The fewest numbers of encounters within the age period studied occurred in the all-female flocks. The results obtained here and those of Guhl (1953) show that in small flocks of males peck-orders were formed about the eighth to ninth week, whereas among females they were established at a later age. Since encounters form the final basis for peck rights the age at which the peck-orders were established provide an explanation for the lower number of total encounters among females in the experiments reported here.

It is of interest that although chicks from low line, maintained in the all-male flocks, were involved in the largest number of encounters when a stable peck-order was developed they were relegated to the lower social positions. These findings that birds in the lower social positions have a greater number of interactions were in agreement with the results obtained with older birds (Marks et al., 1960).

In both experiments birds from the high weight line were significantly heavier than those from the low line. These differences were consistent with previous reports of weight differences between lines (Siegel, 1962 and Siegel and Wisman, 1962).

Method of rearing sexes whether it be separate or intermingled showed no significant difference with regard to body weights. Females, however, were slightly heavier and males slightly lighter when reared separately as compared to their respective sexes in intermingled flocks. These results substantiate those of Smith et al. (1954) and Wisman et al. (1961).

Oxygen consumption did not differ between sexes or lines. The lack of a line effect is consistent with the unpublished results obtained at this station that showed no significant difference in oxygen consumption of F<sub>2</sub> and F<sub>3</sub> generation birds from these same two lines. They do not agree with the results of Ross et al. (1954) who reported that slower growing chickens consumed more oxygen per gram of body weight than rapid growing chickens.

Water and feed consumption increased with time. The ratio of water:feed declined indicating that feed consumption increased more rapidly than water consumption. These results are consistent with those of Ross et al. (1954) and Medway and Kare (1959). The water:feed ratio in these experiments, however, were somewhat higher than those reported by Barott and Pringle (1947, 1949 and 1950).

### SUMMARY AND CONCLUSIONS

A study was conducted to determine the age at which certain behavior patterns first appeared and the changes that occurred in the frequency of these patterns in time. These patterns were studied in male and female chickens from lines maintained under different flocking situations. Also obtained were data pertaining to body growth, feed consumption, water consumption and oxygen consumption.

Resting, stretching, scratching, preening, running, frolicking and sparring were first observed during the first week posthatch. Changes of these patterns were different in time and graphic illustrations were presented of equations fitted for each.

Agnostic encounters between birds were observed to replace sparring which was subplanting frolicking. Encounters increased in time until peck-orders were established.

Differences between birds from the high and low lines were not significant for resting, preening, running, and frolicking. Chickens from the high line stretched and scratched significantly more than those from the low lines, and they ranked higher in the peck order in three of the four groups tested.

Females rested significantly more than males whereas males stretched significantly more than females. Differences existed between sexes in agnostic behavior with males being involved in more total encounters than females. Differences between sexes for other behavioral patterns were not significant.



Resting was greatest in the all-female flocks, whereas running was greatest in the flocks containing all-males. Agnostic behavior was significantly greater in the all-male flock than in either the all-female flocks or the flocks where sexes were intermingled. Methods of rearing sexes did not appear to influence the other behavior patterns.

Birds from the low line maintained in the all-male flocks sparred significantly more than either sexes or lines maintained in flocks where sexes were intermingled or in the all-female flocks. Males from the high line maintained in all-male flocks while sparring significantly less than their low line flock-mates sparred more than birds in the other groups.

Chickens in the all-male flocks had a consistently greater number of total encounters than those in other flocks. Birds from the low line maintained in all-male flocks had a greater number of total encounters than any other group tested; however, when peck-orders were established birds from this group ranked in the lower social positions.

Males were significantly heavier than females and birds in the high line were significantly heavier than birds in the low line; however, no definite effect was noted in body weights between the methods of rearing used in the two experiments.

The results obtained on water and feed ratios show that as birds approached 10 weeks of age a ratio of approximately two to one was maintained in each flock.

No significant difference was found between lines or between sexes for oxygen consumption.

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## ABSTRACT

An experiment was conducted to determine the ontogeny of behavior patterns. Measurements were obtained under various flocking conditions for male and female chickens from lines selected in divergent directions for body weight. Data were also obtained on feed and water consumption and growth.

Behavioral patterns that appeared during the first week of life were resting, stretching, scratching, preening, running, frolicking and sparring. Behavioral patterns which appeared subsequently were threat-avoidances, peck-avoidances, avoidances and fights.

Significant differences were found between lines for stretching, scratching and peck-order rank. Birds from the high weight line stretched and scratched more and ranked higher than those from the low line. Agnostic behavior, however, was greater among birds from the low line. Differences between lines for other patterns were not significant.

Females rested significantly more than males, whereas the relationship between sexes was reversed for stretching and agnostic behavior. Differences between sexes for other behavior patterns were not significant.

Agnostic behavior was greater in the all-male flocks than in either the sex-intermingled or all-female flocks. Resting was greatest in the flocks containing all-females whereas running was greatest within the flocks containing all-males. Methods of rearing sexes did not appear to influence the other behavioral traits.



Males were significantly heavier than females and birds in the high line were significantly heavier than the low line birds. Method of rearing had no significant effect on body weight.

Water and feed consumption increased with time; however, the rate of increase for water consumption was less than that for feed consumption.