BREED DIFFERENCES AMONG CHICKENS AS RELATED TO COMPATIBILITY WHEN REARED TOGETHER

by

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INTRODUCTION AND REVIEW OF LITERATURE

Although the field of social behavior among animals has not received a great amount of attention until recent years, many of the vertebrate animals, with the possible exception of amphibians, have been observed to exhibit some form of social organization. Such behavior is not so notable, if it exists at all, in the invertebrates except for the social insects, although Howard (1955) observed fighting in the grain beetle, Tenebrio molitor, and found evidence of the possible formation of a dominance hierarchy. The social organization of animals is characterized by agonistic behavior which includes both aggressive and submissive behavior. Aggression may be expressed by fighting and bluffing, and the opposite is expressed by submissive, avoidance and escape reactions.

The common domestic chicken has long been a favorite animal of scientists in the study of animal nutrition, genetics and other related fields, but the study of the social behavior of these animals has been neglected until relatively recently. The pioneer work was initiated by the observations of Schjelderup-Ebbe in Europe during the second decade of the present century. Investigations by American scientists did not begin until some 20 years later (Sanctuary, 1932); (Masure and Allee, 1934).

Schjelderup-Ebbe (1935) first discovered the dominance order in chickens in 1913 and noted that in small flocks of birds (less than 25) there is a hierarchy of dominance formed which remains fairly constant over long periods of time. This dominance hierarchy has commonly become known among students of animal behavior as a peck-order. In small flocks of chickens a straight-line hierarchy is commonly the case, whereas in larger flocks there are many triangle and quadrangle relationships.

The straight-line hierarchy is characterized by one member of the flock dominating all others and being dominated by none in return, and one individual is dominated by all and dominates none in return. A triangle relationship exists in a situation in which B dominates C, C dominates D and D dominates B. Whether a straight-line hierarchy exists or a hierarchy complicated by triangles, the relationship between any two individuals is characterized by unidirectional dominance, that is, if B pecks C, C does not peck B in return. The term peck-right describes this type of relationship.

Masure and Allee (1934) found that a different type of relationship existed in pigeons in which there was bidirectional pecking. It is the number of pecks delivered by each individual which determines which one is dominant--the one delivering the greater number of pecks being the dominant individual. The term peck-dominance is used to describe this type of relationship. Doves (Bennett, 1939), canaries (Shoemaker, 1939) and shell parakeets (Masure and Allee, 1934) also maintain a peck-dominance type of social organization.

For the study of social behavior, flocks of more than 25 individuals constitute a large flock in so far as the total number of possible pair relationships is concerned. This number is determined by the formula $N^2-N/2$. Guhl (1953) found evidence of a peck-order in a flock of 96 White Rock pullets, but in such a large flock the peck-order tended to be less stable due to the large number of individuals each bird must learn to recognize--either as a superior or a subordinate.

The tendency in small flocks is toward a straight-line peck-order (Guhl, 1945). Collias (1944) stated that triangle relationships tend to straighten out in time, but such a claim seems to lack experimental

verification. Usually the males do not peck the females, and vice versa, except in young chicks, and a separate peck-order exists for each sex in a mixed flock. When chickens are reared together, a peck-order is usually established by the seventh or eighth weeks among males and by the tenth week among females (Guhl, 1953). When adult birds are introduced into a pen as strangers to each other, dominant-subordinate relationships between each bird and each of its flockmates are soon established. This may be done by fighting or by some birds submitting to others without a contest.

When two birds meet in an initial contest, there are several factors which may determine the possible outcome of the encounter (Collias, 1943). Among these are:

1. Sex -- the males usually being dominant over females.

2. Familiarity with the surroundings -- a bird fights best in its home territory and among flockmates.

3. The physiological condition of the bird as regards to male hormones -- the size of the comb being used as an indicator of the amount of androgens present in the body.

4. Body weight and general state of health -- the heavier, healthier bird having a better chance to win.

5. State of molt -- molting birds tend to be less aggressive in initial encounters.

6. Psychology of success -- the social rank of the bird in its home flock is indicative of its chance of dominating its opponent.

The basis of agonistic behavior in chickens, as in other vertebrate animals, is both psychological and physiological. After the peck-order has been established, it is maintained by social inertia--aggression tends

to lessen and be replaced by those factors which make for memory of flockmates, and each bird's relationships with its flockmates. The physiological factor can be subdivided into neural and chemical (hormonal) factors. The neural factors are responsible for the motor patterns associated with various emotional or social expressions. Chemical and neural factors are actually inseparable in their action, the former usually being relatively slow and sustained in character and the latter acting more rapidly and often are of shorter duration (Collias, 1944). It is now generally thought that the neural mechanisms of behavior are inherent parts of the individual, and the degree of expression of behavior through these mechanisms is regulated by the quantity of certain chemicals in the body. Fisher (1956) demonstrated this by the application of certain chemicals to specific areas of the brain, and recording the results on electroencephalographs as well as making the usual visual observations of behavior. Breneman (1940) was able to induce crowing in very young chicks by the injection of testosterone propionate. Guhl (1957) injected androgens into chicks and got results which suggested that the neural patterns for crowing are present at an early age but that in the absence of androgens could not be expressed. Even though a peck-order was formed in these treated birds at least a week earlier than in the normal controls, fighting was still not induced at as early an age as crowing. This suggests that the neural mechanism responsible for fighting develops much later than that for crowing. Allee, et al. (1955) state that aggressive behavior can be induced in young chicks when treated with testosterone propionate.

The significance of the peck-order to the flock must be recognized

in its effect on the individual and on the flock as a whole. On the individual basis, the higher-ranking birds have precedence at the feed hoppers, water fountain, and roosting area (Guhl, et al., 1945). Sanctuary (1932) observed that those hens of higher rank tend to produce more eggs than those low in the peck-order. In general, the high-ranking birds tend to possess a greater freedom of the pen. Among cocks, Guhl and Warren (1946) noted that the higher-ranking birds had a greater freedom to mate and consequently sired more chicks than low-ranking cocks. This does not imply that the most aggressive males are necessarily the most fertile as the opposite might be true.

Guhl and Allee (1944) attempted to compare the efficiency of a well-organized flock with that of flocks kept in a continuous state of flux. They concluded that the well-organized flocks showed less aggressive behavior, consumed more feed, gained more weight and laid more eggs than the flock in which reorganization was continually occurring.

Observations of multibreed flocks by Potter (1949) suggest that previous experience with a member of another breed may influence subsequent behavior toward strange birds of that breed. She employed a number of multibreed flocks involving seven different breeds of hens, and staged initial pair-contests between the various breeds. A statistically significant difference was noted in the degree of dominance between certain breeds. That the recognition of individuals of other breeds as individuals may not be as notable as the recognition of them as a breed type was evident in Potter's work.

Potter and Allee (1953) conducted experiments with various breeds of chickens to determine the extents of individual and breed recognitions. The evidence here suggested also that a hen may respond to a member of

another breed on the basis of breed recognition rather than of individual recognition.

That there are breed differences in aggressive behavior was evidenced by the work of Holabird (1955). He observed and compared a flock of Light Brahmas with flocks of five other breeds and found statistical differences between certain combinations of these breeds as related to various types of interactions. Hale (1956) conducted experiments with different breeds of chickens to test the hypothesis that behavioral responses are based on breed recognition rather than on individual recognition. He made predictions, based on previous experiences of the birds, as to the outcome of initial pair-contests, and the expected results occurred in a high percentage of the contests. Three types of tests were employed: (a) pair-contests between birds having had previous experience with the other's breed, (b) maintenance of small multibreed flocks, and (c) morphological modification of dominant birds of another breed, or of strangers belonging to the breed winning paired inter-breed contests. He concluded that behavioral responses based on breed recognition without discrimination of individuals established a situation in which a single brief experience with one member of another breed had a profound influence upon subsequent reactions to other individuals of that breed encountered within the memory span.

Further evidence of breed differences is demonstrated in the reaction to treatment with male hormones. Allee, et al. (1955) injected low-ranking hens of six common breeds with testosterone propionate and noted that some breeds responded more to this treatment than did others. Since relatively few birds in each breed were treated, individual differences

may have been highly important and partially overshadowed the apparent breed differences.

All of these experiments were with adult birds and did not determine whether rearing in multibreed groups or in single-breed groups would influence the results. One might anticipate that early experience may be a factor in breed recognition. Young chicks may not react to strain differences.

The purpose of the present study was to determine if there were differences in the social behavior of different breeds and/or strains of chickens as regards the development of behavior from the time of hatching to maturity and to obtain some information on the compatibility of the breeds under study. The experiment was conducted as part of a more extensive project carried on by the Department of Poultry Husbandry at Kansas State College.

THE BIRDS AND THEIR TREATMENT

Six strains of chickens, involving four breeds, were used in this experiment. The experiment was begun with 16 birds from each of five of the strains and 15 from the other strain for a total of 95 birds. Of this number, 82 survived to the end of the experiment. The birds used were as follows: Dirksie White Leghorns, Ghostley White Leghorns, Honegger White Leghorns, Parmenter Rhode Island Reds, Berry Black Australorps and Kansas State College White Plymouth Rocks. These breeds were chosen because it was thought that they might represent a good sample in the range of variability of aggressiveness between the breeds, and strains of White Leghorns.

Since there were three strains of White Leghorns used in this experiment and each of the other breeds was represented by only one strain, the term strain will be employed hereafter to designate each group. This is merely for the sake of convenience and both the strain and breed names will be used when referring to the White Leghorns and only the breed name when referring to the other three breeds.

Hatching eggs were obtained from the commercial breeders of each strain with the exception of those of the White Plymouth Rocks which were supplied from the stock at Kansas State College. The birds were cared for by the personnel of the poultry farm at Kansas State College from the time of hatching until the termination of the experiment; the birds were kept at the poultry farm throughout the entire study period. Handling of the birds was under the supervision of members of the Department of Poultry Husbandry at Kansas State College. The chicks were sexed when four days old by a professional sexer, and only females were used in this experiment.

In so far as this could be accomplished, the birds were reared and cared for just as would be done by the poultryman and under similar conditions. This was desirable in order that any information which might be gained from this study could be of use to the poultryman under the conditions of which his birds would be maintained. Since this was the case, the animals were not in a controlled environment such as might be desired in some types of research work.

Numbered metal wing bands were employed to identify each individual bird. In order to distinguish between the various strains during observation, the chicks were marked on the saddle and wings with dyes except where the color of the feathers made this unnecessary. Redyeing of the

feathers was necessary at frequent intervals during the course of the experiment.

Observations were made from April 5, 1956 to February 9, 1957 (Table 1).[1] Observations on the multistrain flock were terminated on December 22, 1956; the remainder of the time was used to conclude the staging of initial pair-contests. Approximately 200 hours were spent in actual observation time on the multistrain flock and over 19,000 pecks and threats were recorded. Even though many peck-rights were unknown, this number of interactions was thought to be a reasonable sample of the birds' activities.

During the early course of the experiment no attempt was made to distinguish between individuals within a strain. To facilitate speed and ease in recording observations, a symbol was used to represent each group.

The birds were weighed at irregular intervals throughout the course of the experiment. Weights were in grams until the birds became quite large and then were taken to the nearest tenth of a pound. The number of birds from each strain feeding at any one time was recorded at the beginning of each observation period and at fifteen-minute intervals thereafter.

The chicks were housed in the basement of the feed barn from the fourth day until 30 days of age. A fairly constant temperature was maintained in this part of the building although minor fluctuations did occur. The lights were on 24 hours a day. Within the building the chicks were kept in a "Million-Dollar Hen" brooder. This brooder is 68 inches by 34 inches, about one-third being a warming area and the other two-thirds serving as an area in which the birds can move about more freely. This latter part contained a feed trough on each side and a waterer on one end.

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[1] All tables are in the appendix.

The birds could move about freely in this area until they reached a size at which crowding became evident.

Observations were made from about three feet away from the brooder. Since the brooders were stacked four high, the observations were handicapped somewhat by the angle at which the birds were viewed--the brooder above preventing a direct bird's-eye view. Since the warming area was very low and partially enclosed by canvas flaps, no activity could be observed in this area. The time of observation varied from day to day but was always between 8:00 A. M. and 5:00 P. M. while the birds were in the brooder. (Later in the experiment some observations were made during the early morning twilight hours.) Interruptions were rather frequent and were caused by noises on the floor above and by people entering the house to care for other birds. It was while making the feed counts that interruptions were most disturbing, and some feeding data were invalidated as a result.

At 30 days of age the birds were moved from the brooder to a floor pen in the north brooderhouse. This house was rectangular with 10 pens, each 10 feet by 10 feet, partitioned off on either side of a central passageway. The pens were separated from each other by boards from the floor up to one foot high, and by one-inch mesh chicken wire on to the ceiling. This was also the construction on the side facing the central passageway. There was a hover type brooder in the pen in which the temperature was thermostatically controlled and the brooder could be raised and lowered as desired. There was a window on the south side which supplied adequate lighting during the daylight hours and could be opened and closed as weather conditions demanded. Two feed troughs, each 42

inches long, and an automatic waterer were employed in each pen. Crushed corn cobs were put on the concrete floor to absorb droppings and facilitate cleaning of the pens.

All observations were made from outside the pen. At the beginning of each observation period the brooder was raised so the entire pen area could be viewed. The observer had to enter the pen in order to do this, but the little amount of disturbance caused usually waned by the time the observer was situated to start recording observations. Activity within the pen was usually greatest just after the brooder was raised. When there was to be more than one observation period in one day, the brooder was raised at the beginning of the first and not lowered until the end of the last period of that day.

People moving about in the house caused some disturbance in the flock, but this was rather infrequent other than the regular times when feed was being put into the troughs.

The birds were transferred to House No. 14 at 83 days of age. The pen utilized in this house measured 15 feet by 15 feet. No other chickens were housed in this building at the time. Coarse sand was kept on the concrete floor to absorb droppings. Three 16-inch feed troughs, one for mash and two for mixed grain, were arranged on the floor with adequate space between them for the birds to feed freely. Water was provided by two 10-quart pails placed on a single stand. Light was provided by windows along the south wall. An elevated roost extended across the north side.

Observations were made from within the house, and the pullets became quite accustomed to the observer and apparently were not affected by his

presence. In order to obtain a maximum of data in a minimum of time, many observations were made between 5:30 A. M. and 7:00 A. M. at which time the birds were thought to be most active. Also there were some times when two observers were working at the same time with each observing "one-half" of the house. There were seldom any intrusions in this house during the observation periods which made the situation ideal.

Eight birds from each strain were selected at random from the flock, when the pullets were 153 days old (Table 1), to make a total of 48 birds. These birds were moved to the old mating house and kept as a multibreed unit for the remainder of the experiment. At that time, birds which were the same age and from the same hatching stock, but which had been on the range as a single unit, were used to make up additional flocks. Two of these additional flocks were like the one just described, and in addition there were six single-strain flocks of 24 pullets each. It was from four of these single-strain flocks that the birds were chosen for the initial pair-contests. The three mixed-strain flocks and the six single-strain flocks were used in an experiment conducted by the Department of Poultry Husbandry to study the effects which the mixing of strains might have on the production of meat and eggs.

All birds were debeaked at the time the flocks were formed. Observations were continued until the birds were 272 days of age. The physical structure of the pens in the old mating house left much to be desired and made observations from within the pen necessary. Two cylindrical, hanging feeders were suspended from the ceiling and water was supplied in 10-quart pails placed on the floor.

During the course of the experiment the following data were recorded:

number of birds feeding at a time, frolicking, sparring, threatening, pecking and fighting. These data were later analyzed on the basis of the number of activities per bird per hour. The explanation of each of these terms is given below.

1. Feeding: Only those birds actually picking up feed were counted. Birds standing passively at the feeder were not counted.

2. Frolicking: Spontaneous running and wing-flapping for which there is no apparent external stimulus. This may involve only one bird although such behavior seems to be contagious.

3. Sparring: A sort of play fighting in which two birds come face to face, assume a fighting posture and make pecking attempts or actually deliver some weak pecks but with no apparent avoidance on the part of either bird.

4. Threatening: A threat consists of raising the head or displaying some type of aggression toward another bird, but making no attempt to deliver a peck.

5. Pecking: A peck is a blow delivered about the head of another bird or an attempted delivery which fell short or missed its mark. Picking feathers and pecking at feed or foreign matter about the beak are not considered pecks. (For the sake of convenience, both pecking and threatening will be referred to hereafter as pecks, because both are acts of aggression.)

6. Fighting: A fight involves at least two individuals, each taking an active aggressive attitude toward the other. Fights do not always end in a decision as the birds may just cease fighting and wander away from each other.

Initial paired-encounters were staged between individuals of some of the four strains which were maintained in single-strain flocks. These encounters were staged over a period of time from November 28, 1956, to February 9, 1957. Only one strain of White Leghorns, Dirksies, was used in these contests. Ten birds were chosen at random from each of the following single-breed flocks: Rhode Island Reds, White Plymouth Rocks, Dirksie White Leghorns, and Black Australorps. Although all four breeds were reared together until five months of age, they had been in single-breed flocks for nearly three months, and the individuals of each flock, as a result, were strangers to those in other flocks.

Following the technique devised by Collias (1943), each of the ten birds of each breed met each of the 30 birds from the other three breeds in a neutral area. These initial pair-encounters were staged in order to obtain further measurements in levels of aggressiveness. Collias (1943), Guhl (1953) and others have used this technique to help determine the relative aggressiveness of chickens and found that there was a significant correlation between the number of flockmates pecked and the number of initial pair-encounters won. No intrabreed encounters were staged. The encounters were staged in wire exhibition cages about two feet square. This small area was employed to bring about an interaction in a minimum amount of time.

The two birds were placed in the cage simultaneously facing away from each other. Some times feed was placed in the cage to stimulate activity. The winner of each encounter was determined by fighting, pecking, threatening or by avoiding. An avoidance was characterized by one bird assuming a submissive attitude toward the other bird which made no apparent threat.

The encounters were staged by only one person, and the exact action which decided the winner might have been missed while going to the pens for other birds. If there was no decision within 15 or 20 minutes, the birds were separated and rematched at a later time. Encounters were scheduled so that no bird was involved in more than two rounds per day, and there was a time lapse of at least two hours between each round. No type of control, such as intentionally matching winners with winners or losers with losers, was employed.

RESULTS

The Behavior of the Flock as A Unit

When observations were begun at the beginning of the second week, frolicking and sparring behavior were already present. Plate I[2] shows that the rate of frolicking for the entire flock, when analyzed on the basis of the number of frolicks per bird per hour, did not go beyond 2.9 at any time. The high peak reached during the fifth week can be attributed to the fact that the birds were moved from close confinement in the brooder to the floor pen where there was ample space for frolicking.

Sparring activity, when summarized on the same basis as frolicking, was very infrequent throughout the twelve weeks it was recorded, and at no time did it surpass the rates of frolicking (Plate I). Instead of showing a rise in rate as did the frolicking when the birds were moved, sparring frequency showed a decline although such decline was negligible.

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[2] All plates are in the appendix.

Both sparring and frolicking activity dropped sharply in frequency during the tenth week and continued to drop until the thirteenth week at which time these activities were no longer recorded.

No aggressive behavior, i. e., pecks or fights, showed up until the fifth week and was negligible until the eleventh week (Plate I). Weeks ten and eleven were characterized by very little activity of any kind; even feeding activity was infrequent at these times. It should be noted that as the pecks increased in frequency, sparring and frolicking decreased. Pecks showed a gradual increase in frequency until the fourteenth week at which time they leveled off to a fairly constant rate. The variations during the later weeks of the study might be attributed to changes in weather conditions or to the times of day at which the observations were made.

The feeding activity as presented in Plate I, shows variations from week to week, but this also might be due to changing weather conditions or the times of day at which observations were made. The low point at the tenth week coincides with the slumps in other activity rates. It was at the thirteenth week that the birds were moved to a larger house which had three feed troughs instead of two. This might explain the sudden upsurg in feeding frequencies at that time. With more space per bird for feeding, the friction between individuals was lessened and the birds had greater opportunities to feed. The decline in feeding activity which started at the sixteenth week is unaccounted for, but might be due to the birds having less time to feed as the rate of pecking activity increased.

It is of interest to note that during nearly 200 hours of observation time, only 53 fights were observed (Table 8). The first fight was

recorded in the seventh week, and most of the fights occurred between this and the thirteenth week. Fifteen was the greatest number of fights recorded for any one week, and this was during the ninth week. This was during the height of the peck-order formation period (Guhl, 1953). This small number of fights made analysis of this activity impossible on a statistical basis, but the greatest number involved the White Plymouth Rocks, with fewer involving the Dirksie White Leghorns, Ghostley White Leghorns, and the Black Australorps, and the least involving the Honegger White Leghorns and Rhode Island Reds.

Differences Between Strains

To test the significance of the differences between the six different strains in regards to the frequencies of frolicking, sparring, pecking, and feeding, the following formula was employed:

$$t = \frac{\bar{d}}{\sqrt{\frac{\leq d^2 - \bar{d} \leq d}{n(n-1)}}}$$

This is the method of paired comparisons which was devised by "Student" (1925), in which "d" is the difference between pairs (strains) in weekly performance, and $\bar{d}$ is the mean difference over sets of weeks (n).

Frolicking. The rates of frolicking were analyzed on the basis of the number of frolicks per bird per hour for each strain. These rates are shown graphically by weeks for each strain in Plate II, and in tabular form in Table 2. Table 3 gives the mean rates for each strain for an eight-week period and makes 15 comparisons between the strains in rates of frolicking. When testing the significance of the differences between the strains, it seemed justifiable to omit the last four weeks of data due to

the low rate to which this activity had suddenly declined, since all of the strains showed a similar decline. After the rates fell to such low points, they became rather meaningless in presenting strain differences.

It can be seen from Table 3 that of the 15 strain comparisons, ten were statistically significant. Eight of these were highly significant ($P = 0.01$). The Black Australorps were the most active in frolicking, and Plate II shows that this strain was not surpassed in the rate of frolicking after the fourth week. The lowest rate of frolicking was among the Honegger White Leghorns, although this strain was not consistentently the lowest from week to week (Plate II).

Sparring. Sparring activity was analyzed on the same basis as frolicking using only the first eight weeks of data and omitting the last four weeks. The interstrain comparisons and mean rates of sparring for this eight-week period are given in Table 5. The number of sparrings observed is presented for each strain by weeks in Table 4, and Plate II gives these rates in graphic form. Both interstrain and intrastrain sparring are included with no separation of the two being made.

Nine of the 15 interstrain comparisons showed significance; six of these were highly significant ($P = 0.01$). The highest mean rate was among the Rhode Island Reds and the lowest among the Honegger White Leghorns. During the eighth and ninth weeks, the Rhode Island Reds showed much higher sparring rates than any other strain.

Pecking. Strain differences become evident when the rates of pecking are analyzed for each strain. Plate III shows that from weeks 11 to 22 there was much variation in pecking rates. Both interstrain and intrastrain pecks are included in the analysis of these rates. The number of

observed pecks is presented in Table 6. It can be seen from this table that pecking was negligible until about the eleventh week. Because of the low rates and the lack of any appreciable difference between strains, the analysis presented in Table 7 includes only weeks 11 to 22.

Only one of the 15 strain comparisons shown in Table 7 lacks statistical significance. Of the 14 which show significance, all but one were highly significant (P = 0.01). Some strains showed much variation in pecking rates from week to week, but two strains, Honegger White Leghorns and Rhode Island Reds, showed a minimum of variation. These two strains were also the lowest in pecking rates with the Rhode Island Reds being significantly lower than the Honegger White Leghorns.

The White Plymouth Rocks and Ghostley White Leghorns displayed the highest rates of pecking with the former being more active than the latter, but there was no statistical difference between the two strains (Table 7). On Plate III the lines representing these two breeds cross several times.

Fighting. A grand total of only 53 fights were observed during nearly 200 hours of observation time. This small number made statistical analysis on a strain basis all but impossible. No fights were observed until the seventh week and more than half of the total number observed occurred during this and the following two weeks (Table 8). Some of the fights occurred between birds of the same strain as well as between birds of different strains. The White Plymouth Rocks were involved in the greatest number of fights observed, and the Rhode Island Reds in the least.

Feeding. The data on the number of birds of each strain feeding at a time were analyzed in two different parts. One analysis included weeks two to nine and the other included weeks 15 to 22. This was done in order

to determine if there was any difference in the rates of feeding of the various strains in the pre-peck-order period and the post-peck-order period. The peck-order in small flocks of pullets usually is established by the tenth week (Guhl, 1953) and it is thought that in a larger flock, such as used in the present study, it would be established somewhat later.

Plate IV shows little separation among most of the lines during weeks 10 to 14 except for the Rhode Island Reds. Before and after this period the six lines tend to separate more. Feeding rates for the 21 weeks of observation represented on Plate IV are given in tabular form in Table 9.

Out of 15 strain comparisons (Table 10), only one shows any significant difference in the rates of feeding during the pre-peck-order period, and this is barely significant ($P = 0.05$). This difference was between the Ghostley White Leghorns and the Honegger White Leghorns; the former being more active in feeding than the latter. All of the remaining strain comparisons lacked statistical differences in feeding rates during the pre-peck-order period.

Table 11 gives the strain comparisons in feeding rates from week 15 to week 22. Four of these strain comparisons in feeding rates showed statistical differences and each of the four involved the Rhode Island Reds. It can be seen in Plate IV that this strain was much lower than any of the other strains during the later weeks of the experiment.

Growth Rates. The body weights and percentages of gain are given for each of the strains in Table 12. From this table it would appear that the Rhode Island Reds were not suffering unduly from this low rate of feeding. There were no single-strain control flocks maintained during this period of time. Because of this it was not determined if any variations in body

weight gains reflected the social statuses of the strains or whether the differences were due to strain differences in development.

Peck-Rights. Table 13 gives the number of peck-rights within and between the strains which were known and the number of possible peck-rights for each strain in the flock of 82 birds. Similar data are given in Table 14 for the reduced flock of 48 birds. The data for both flocks are further summarized in Table 15. The per cent of initial pair-encounters won by each of four of the strains is also given in this table.

From Table 15 it can be seen that not all of the possible interstrain peck-rights were known in either the flock of 82 pullets (2792 possible) or the flock of 48 pullets (960 possible). In each flock a smaller percentage of peck-rights was known for the Black Australorps than for any of the other strains.

It can be noted that after the flock was reduced to 48 birds and moved, there was a change in the per cent of relationships in which each strain was dominant. Some relationships between individuals which were known in the larger flock were not observed in the reduced flock and some new relationships were observed. The Black Australorps and White Plymouth Rocks changed positions in regards to the per cent of known interstrain relationships in which they were dominant, but the Australorps, as a strain, were still dominant to the White Plymouth Rocks. Other changes can also be noted, but they are not great enough to be of any significance. The Rhode Island Reds were very definitely at the bottom of the peck-order in each of the flocks.

Initial Pair-Encounters. The results of the initial pair-contests were quite surprising as regards the Rhode Island Reds and Black Australorps

(Table 16). Out of 300 encounters, the Rhode Island Reds won 200 and lost only 100. Ninety of these wins were from the Black Australorps with only ten loses with this strain. It should be noted that the birds used in these initial pair-encounters were not the same individuals used in the ontogenetic study, but were of the same hatching stock and the same age. The Rhode Island Reds were lowest in the ontogenetic peck-order and the Black Australorps were at the top. In contrast, the Australorps won only 85 encounters and lost 215. Other than between these two breeds, the only major differences in the number of wins was between the White Plymouth Rocks and the Black Australorps with the latter winning only 29 of the 100 contests between these two breeds. There were no essential differences between the other breeds with each winning about as many contests as it lost.

Out of the 600 initial pair-encounters staged, only 53, or 9 per cent, were settled by actual fighting. Thirty-four per cent were decided by pecks, 44 per cent by threats and 13 per cent by avoidance or submission. This general pattern held true for each of the four breeds tested except that the White Leghorn breed won as many by pecks as by threats. These findings do not follow too closely those of Collias (1943), but differences may be due to the interbreed encounters; Collias used all of the same breed.

DISCUSSION

There is a hint that frolicking, sparring and pecking might be different developmental stages in the aggressive behavior complex (Guhl, unpublished data). From Plate I it can be seen that at no time did the sparring

rate go as high as did the frolicking rate. This suggests that sparring requires a stronger, or at least a different, stimulus than frolicking. Frolicking may be spontaneous, but this activity on the part of one bird often stimulates others to frolic also. This should not be taken to imply that seeing a bird frolic is the only external stimulus for frolicking. Just what the stimuli are which initiate the various types of behavior in chickens is not well known.

When two frolicking birds come together, whether by chance or otherwise, some other stimulus comes into play and sparring is often the response. In this "play fighting" type of behavior, the birds might actually become aggressive toward each other. Even though aggressive behavior is exhibited, no dominance order can be formed until one bird avoids the other. It would appear, then, that aggressive behavior develops at about the same time that sparring is accompained by pecking and gives way to fighting behavior.

Since avoidance plays a major role in the formation of a peck-order, it should be given more consideration. The bird which assumes a low rank in the ontogenetic peck-order might do so because it displayed avoiding behavior at a slightly earlier age than another bird. If such were the case, it might be that the low-ranking bird is not necessarily the least aggressive.

In the present study pecking was first observed in the fifth week and fights were first observed during the seventh week. As the rates of frolicking and sparring declined, the rates of pecking increased. Frolicking and sparring were replaced by pecking almost entirely by the thirteenth week (Plate I).

The greatest number of fights for any week was observed during the

ninth week, and even then the total number observed was only 15 fights in the entire flock. These fights occurred at the time when dominance relationships were being established (Guhl, 1953). The heterogeneity of the flock and the large number of individuals might have been factors responsible for the low number of fights which were observed.

The sudden upsurge in the rate of frolicking during the fifth week took place following the removal of the birds from the brooder to the floor pen. This suggests that space is an important factor in frolicking activity. Since no similar rise was observed in sparring rates at this time, space may not be as important a factor in this activity as in frolicking. This suggestion is only tentative as it is not supported by adequate evidence.

In regards to the feeding activity of the flock as a whole, the sudden rise in feeding rates occurred at the time the birds were moved to a larger house which contained three feeders instead of two as was the case in the pen from which they were moved. The low point at the tenth week might suggest that at the time the peck-order relationships were being established, the birds had less time to feed or were disturbed more often during feeding. The slump in all activity at this time does not lend too much support to this idea. The only explanations given for the other fluctuations are the possible effects of weather changes or the times of day at which observations were made. Siegel and Guhl (1956) used photoelectric systems to measure the diurnal rhythms in activity rates of White Leghorn cockerels and found that the rates of activities varied with the time of day. The greatest amount of activity occurred in the morning hours with the least occurring in the afternoon and evening.

Relatively little is known about the compatibility of different breeds of chickens in a multibreed flock. Potter's (1949) work with multibreed flocks involved mature hens which were not reared together. Other experiments in the study of interbreed compatibility were also conducted with adult birds (Potter and Allee, 1953; Hale, 1956; Fisher and Hale, 1957; Holabird, 1955; and Allee, et al., 1955).

That the development of behavior patterns in one strain of chickens differs from that of other strains when reared in multistrain flocks is suggested by the present study. One breed or strain may show a high rate of activity in one type of behavior, and low in another.

It would appear that there is very little, if any, relationship between the frequencies of frolicking and sparring and the frequency of pecking. The Rhode Island Reds which displayed the highest rate of sparring showed the least amount of pecking throughout the entire observation period. The White Plymouth Rocks, however, were comparatively high in both frolicking and sparring and showed the highest frequency of pecking (Tables 3, 5, and 7).

Even though many of the strain comparisons showed statistical significance in differences in rates of frolicking and sparring, only one of these comparisons in the rate of feeding showed any significant difference between strains during the first nine weeks. This would suggest that prior to the time the peck-order is formed, each strain has equal opportunity to feed irrespective of their rates of activities. However, after pecking activity reached its height, four of the fifteen comparisons showed significant differences in feeding rates. These same four comparisons showed significant differences in pecking rates also with the strain

pecking the most being the strain feeding more often in each comparison. The indication here is that the strains which are most active in pecking have precedence at the feed hoppers.

The Rhode Island Reds showed a low percentage of gain in body weight from the twelfth to the fifteenth week as compared to the flock mean (Table 12). On to the twenty-second week, the rate of growth of this strain was on a par with that of the flock as a whole. It was during the eleventh and twelfth weeks that pecking activity began to increase rapidly, and during the twelfth week the Rhode Island Reds started feeding at a much lower rate than the rest of the flock. One might conclude from the foregoing observations that the Rhode Island Reds were adversely affected by the low rank they were assuming and by their infrequencies of visiting the feeders during the time of peck-order formation, but that they later became adjusted to the situation and were able to maintain good growth rates even under adverse circumstances.

Guhl (1953) found that birds low in the peck-order had a tendency to leave the roost early in the morning and feed before the other birds of the flock descended from the roost. These low-ranking birds would also remain and feed after the others had gone to roost in the evening, but were observed to feed less during the daytime while their flockmates were about the feeders. Such was not observed, but such a situation might have been the case with the Rhode Island Reds in the present experiment. These low-ranking Rhode Island Reds had a tendency to feed rapidly while at the feeders which could have compensated for the infrequency of feeding.

Being a phlegmatic breed, the Rhode Island Reds might have been capable of utilizing their feed to greater advantage and thus have been

able to maintain their growth rates on a minimum of nourishment. Whatever the adjustment might have been, these birds apparently were able to adjust themselves, either psychologically or physiologically, to the low social position in the flock. However, the peck-order formation period did appear to be a crucial time in the development of these low-ranking birds.

The initial pair-encounters between members of four of the breeds maintained in single-breed flocks gave quite striking results concerning breeds. The Rhode Island Reds which were at the bottom of the ontogenetic peck-order won more encounters than any other breed. These birds won 90 per cent of their encounters with the Black Australorps which were at the top of the peck-order. Potter (1949) observed that Rhode Island Red hens won more encounters than any other of six different breeds excepting White Leghorns. In the multibreed dominance-order, the White Leghorns ranked first with Games and Rhode Island Reds ranking second and third respectively with no significant differences between the latter two breeds. Potter's work suggested that the breed high in the peck-order had a better chance of winning a high number of encounters than those low in the peck-order.

When the Rhode Island Reds became mature, the avoidance or submissive behavior of this breed might have become overshadowed by aggressive behavior. Helabird (1955) found that the Rhode Island Reds showed a relatively higher percentage of peck-order violations than any of four other breeds and were surpassed only by Light Brahmas; this difference was not significant.

Since all the strains in the multistrain flock of the present study were reared together, the evidence suggested that the age at which the different strains become mature may be a factor in social rank obtained.

If the Rhode Island Reds matured later than the other strains, they might have been forced to accept a lower position in the dominance hierarchy than if they had been allowed to reach maturity before being mixed with other strains. The birds used in the initial pair-encounters were nearly eight months old when the staging of the encounters was begun. They had been laying for nearly three months and could be considered as mature individuals.

This certainly suggested that the Rhode Island Reds are not necessarily the least aggressive of the strains under study but were held in a low position in the flock by social inertia. After a bird assumes a low rank in a flock, the phenomenon of social inertia serves to maintain it at that level even though it may at a later time become physiologically capable of climbing on the social ladder. A controlled experiment in which birds of these same strains were maintained in single-strain flocks until mature and then mixed might shed much light on the matter.

The Black Australorps show a reverse situation from that observed with the Rhode Island Reds. The Australorps were the most active of all the strains in frolicking rates, intermediate in sparring and pecking rates, but dominated more flockmates (of the number possible to dominate) than any other strain in the ontogenetic peck-order. This, and their low level of success in the initial pair-encounters suggested a passive dominance. Relatively little aggressive action appears to be necessary for this strain to exert their dominance over flockmates, but when later confronted with a strange bird in a neutral area, they give way very readily. This might suggest that a bird can be highly dominant without displaying aggressiveness. This is hinted at in instances in which the most dominant bird in a

flock delivers fewer pecks than many of its subordinates (Guhl, 1953).

Again the phenomenon of avoidance might be considered. That the Black Australorps developed avoidance or submissive behavior later than some of the other strains might be a possibility. If so, avoidance behavior might be overshadowing aggressiveness in adult birds of this strain.

Something about releasers should be mentioned here. The stimuli which evoke aggressiveness or avoidance are not well understood, but they are undoubtedly highly complex. It was noted that between some birds employed in the initial pair-encounters, neither member of the pair presented the proper releaser(s) for any type of agonistic behavior on the part of the other bird. It is suggested that a given strain can stimulate the release of behavior patterns in one strain but not in another. Much work is necessary in order to develop this idea further.

According to Hale (1956), if a bird recognized a member of another breed as a breed type more than on an individual basis, certain results may be predicted in initial pair-encounters. Theoretically, if such recognition be the case, if a bird of one breed loses a fight to a member of another breed, it would tend to avoid other birds of that breed which it might meet in subsequent encounters. The latter encounters would have to be staged within the memory span of the birds for such recognition of breeds to occur. The evidence from the present experiment is not adequate to confirm such a theory. However, there were some outstanding observations in which such a theory might have been operating. Two Black Australorps won all ten of their encounters with the White Leghorns, and one lost all ten; two more individuals lost nine of the ten contests.

There were other examples which do suggest that the factor of breed recognition may have been operating in these initial pair-encounters. An error in sampling might have been the causative factor in the results of the initial pair-encounters. By chance the most aggressive individuals from the Rhode Island Red flock, and the least aggressive individuals from the Black Australorp flock might have been selected.

That there are differences in behavior between breeds and strains of chickens is suggested by this study. The effects which such differences might have on the production of eggs and on body weights are being evaluated in another phase of the experiment by Mr. Dale Tindell of the Department of Poultry Husbandry. It might be that the Black Australorps are ideal dominants since they show a tendency to dominate a large number of flockmates with a minimum of aggressive action. As for the Rhode Island Reds, they may represent the ideal subordinate breed. The data on body weights (Table 12) suggested that individuals of this breed of pullets were able to maintain good body weights while at the bottom of the social scale.

This experiment does not propose to answer the problems, if there are real problems, connected with the rearing and maintaining of pullets in multibreed flocks. It does, however, suggest that certain breeds, when mixed, might be more compatible than others. The findings in the present study along with those of Mr. Tindell, suggest possible approaches to the study of interbreed compatibility in future experimental work.

SUMMARY

Ten out of 15 interstrain comparisons showed statistically significant differences in mean rates of frolicking, and 9 out of 15 showed significant

differences in rates of sparring.

Fourteen of the 15 interstrain comparisons showed significant differences in the mean rates of pecking from week 11 to week 22.

A grand total of 53 fights was observed from the second to the twenty-second week. This number was too small to be subjected to statistical analysis on a strain basis.

Before the period of peck-order formation, only one of the 15 strain comparisons in feeding rates showed any significant difference. After the peck-order formation period four of the 15 comparisons showed significant differences.

Growth rates appeared to be affected very little by the social status of a strain except for the Rhode Island Reds which were affected some during the peck-order formation period. The percentage of gain of this strain was low during this period as compared to the flock mean.

Peck-rights were known for 84 per cent of the possible pair relationships. The Black Australorps and White Plymouth Rocks shared the top ranks in the peck-order and the Rhode Island Reds were at the bottom of the order.

Ranking by strains based on results of initial pair-encounters differed from those based on rank in the peck-order. Two strains out of six showed marked differences in aggressiveness. These differences may have been due to sampling, to the effects of breed recognition on initial encounters, or effects due to strain differences in maturation rates of agonistic behavior.

The results of this experiment do not answer the problems which might accompany the rearing and maintenence of mixed-strain flocks, but

do suggest possible approaches to the study of interstrain compatibility in future experimental work.

ACKNOWLEDGMENT

To Dr. A. M. Ouhl, major professor, who not only gave technical assistance and moral support throughout the course of this study, but who also rendered assistance in the handling of the birds, grateful appreciation is hereby expressed.

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LITERATURE CITED

Allee, W. C., D. Foreman, E. M. Banks and G. H. Holabird.
Effects of androgen on dominance and subordination in six common breeds of Gallus gallus. Physiol. Zool., 28: 89-115. 1955.

Bennett, M. A.
The social hierarchy in ring doves. Ecology, 20: 337-357. 1939.

Breneman, W. R.
Variations in the reactions of chicks to different methods of administration of androgen. Endocrinology, 24: 55-62. 1940.

Collias, N. E.
Statistical analysis of factors which make for success in initial encounters between hens. Amer. Nat., 77: 519-538. 1943.

Collias, N. E.
Aggressive behavior among vertebrate animals. Physiol. Zool., 17: 83-123. 1944.

Fisher, A. E.
Maternal and sexual behavior induced by intracranial chemical stimulation. Science, 124: 228-229. 1956.

Fisher, A. E. and E. B. Hale.
Stimulus determinants of sexual and aggressive behavior in male domestic fowl. Behavior, 10: 309-323. 1957.

Guhl, A. M.
Some observations and experiments on social behavior in the domestic fowl. Trans. Kans. Acad. Sci., 47: 337-341. 1945.

Guhl, A. M.
Social behavior of the domestic fowl. Kans. Agri. Exper. Sta. Tech. Bull. No. 73. 1953. 48p.

Guhl, A. M.
The ontogeny of social behavior. (In press). 1957.

Guhl, A. M. and W. C. Allee.
Some measurable effects of social organization in flocks of hens. Physiol. Zool., 17: 320-347. 1944.

Guhl, A. M., N. E. Collias and W. C. Allee.
Mating behavior and the social hierarchy in small flocks of White Leghorns. Physiol. Zool., 18: 365-390. 1945.

Guhl, A. M. and D. C. Warren.
Number of offspring sired by cockerels related to social dominance in chickens. Poultry Sci., 25: 460-472. 1946.

Hale, E. B.
Breed recognition in the social interaction of domestic fowl. Behavior, 10: 240-253. 1956.

Holabird, C.
Social organization in flocks of Light Brahma hens as compared with other breeds. Physiol. Zool., 28: 239-255. 1955.

Howard, R. S.
The occurrence of fighting behavior in the grain beetle, Tenebrio molitor, with the possible formation of a dominance hierarchy. Ecology, 26: 281-285. 1955.

Masure, R. H. and W. C. Allee.
The social order in flocks of the common chicken and the pigeon. Auk, 51: 306-327. 1934.

Potter, Jane H.
Dominance relations between different breeds of domestic hens. Physiol. Zool., 22: 261-280. 1949.

Potter, Jane H. and W. C. Allee.
Some effects of experience with breeds of Gallus gallus on behavior of hens toward strange individuals. Physiol. Zool., 26: 147-161. 1953.

Sanctuary, W. C.
A study of avian behavior to determine the nature and persistency of the order of dominance in the domestic fowl and to relate these to certain physiological reactions. Thesis for M. S. Degree, Mass. State College, Amherst. (unpublished). 1932.

Schjelderup-Ebbe, T.
Social behavior in birds. Chap. XX in Murchison's Handbook of Social Psychology. Worcester, Mass. Clark University Press. 1935.

Schoemaker, H. H.
Effects of testosterone propionate on behavior of the female canary. Proc. Soc. Exper. Biol. and Med., 41: 299-302. 1939.

Siegel, P. B. and A. M. Guhl.
The measurement of some diurnal rhythms in the activity of White Leghorn cockerels. Poultry Sci., 35: 1340-1345. 1956.

"Student".
New tables for testing the significance of observations. Metron, 5: 105-108; 114-118. 1925.

APPENDIX

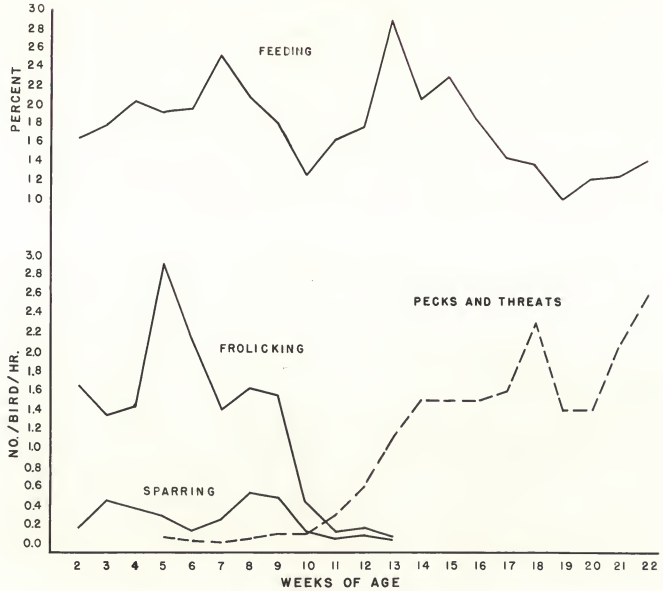
EXPLANATION OF PLATE I

Graphs of mean weekly rates of activities for multi-strain flock of pullets.

Feeding is expressed as the mean per cent of the flock feeding at one time.

Frolicking, sparring and pecks and threats are expressed as the mean numbers of each activity per bird per hour.

PLATE I


PERCENT
30
28
26
24
22
20
18
16
14
12
10
FEEDING
NO./BIRD/HR.
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
PECKS AND THREATS
FROLICKING
SPARRING
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
WEEKS OF AGE

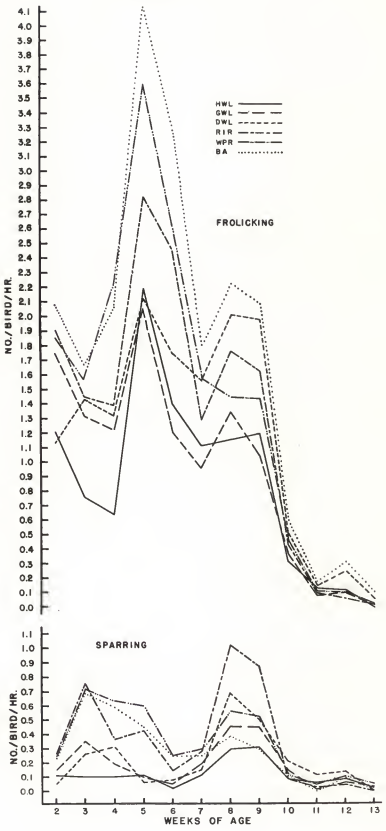
EXPLANATION OF PLATE II

Graphs of mean weekly rates of frolicking and sparring for each of six strains of pullets maintained in multi-strain flock expressed as the number of activities per bird per hour.

Legend

HWL	Honegger White Leghorns
GWL	Ghostley White Leghorns
DWL	Dirksie White Leghorns
RIR	Rhode Island Reds
WPR	White Plymouth Rocks
BA	Black Australorps

PLATE II


HWL
GWL
DWL
RIR
WPR
BA
FROLICKING
NO./BIRD/HR.
SPARRING
NO./BIRD/HR.
WEEKS OF AGE

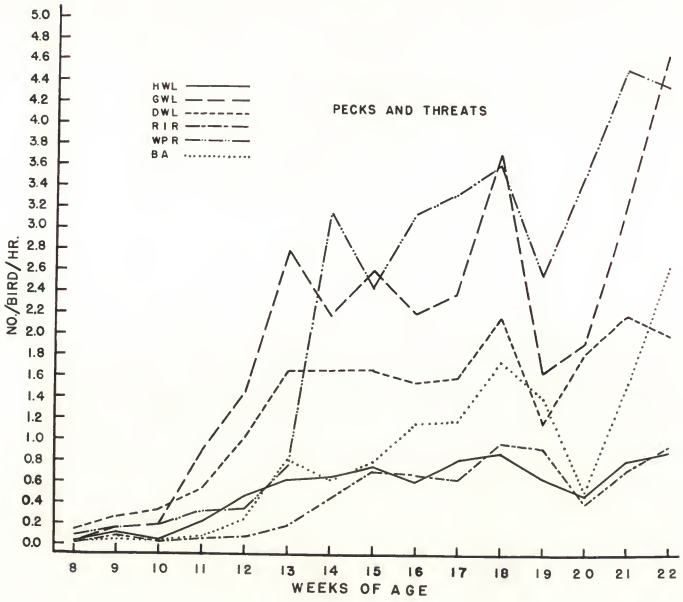
EXPLANATION OF PLATE III

Graph of mean weekly rates of pecks and threats for each of six strains of pullets maintained in multi-strain flock expressed as the number of activities per bird per hour.

Legend

HWL	Honegger White Leghorns
GWL	Ghostley White Leghorns
DWL	Dirksie White Leghorns
RIR	Rhose Island Reds
WPR	White Plymouth Rocks
BA	Black Australorps

PLATE III


PECKS AND THREATS
HWL
GWL
DWL
RIR
WPR
BA
NO./BIRD/HR.
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
WEEKS OF AGE

EXPLANATION OF PLATE IV

Graph of mean weekly rates of feeding for each of six strains of pullets maintained in a multi-strain flock expressed as the per cent of each strain feeding at one time.

Legend

HWL	Honegger White Leghorns
GWL	Ghostley White Leghorns
DWL	Dirksie White Leghorns
RIR	Rhode Island Reds
WPR	White Plymouth Rocks
BA	Black Australorps

PLATE IV

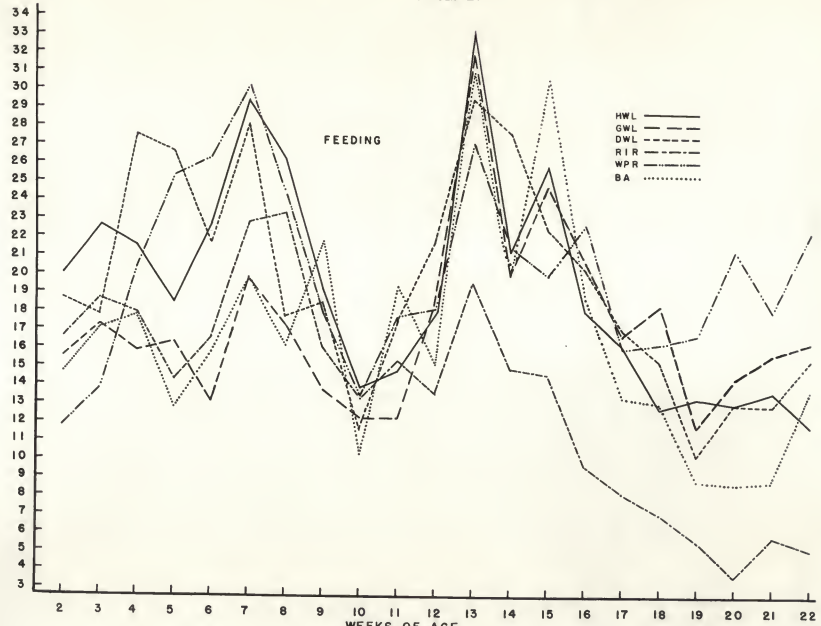


Table 1. Calendar

Date	Age (days)	Week	Treatment of birds
1956 Apr. 5			Chicks hatched
Apr. 9	4	1	Chicks sexed; males removed from flock; females moved to brooder in feed barn
Apr. 10	5	1	Weighed pullets
Apr. 12	7	2	First observation of flock
May 5	30	5	Pullets moved to floor pen in north brooder house; weighed birds
May 7	32	5	First observation in floor pen
June 6	62	9	Put numbered upright wing badges on wings; weighed birds; began observations on individual basis
June 27	83	12	Moved pullets to house no. 14; weighed birds
June 29	85	13	First observation in house no. 14
July 10	96	14	Frolicking and sparring no longer recorded
July 18	104	15	Weighed birds
Aug. 8	126	18	Weighed birds
Aug. 30	148	22	Last observation in house no. 14
Sept. 3	153	22	Made up new flock of 48 pullets; weighed; debeaked; excess birds disposed of
Sept. 5	154	22	New flock moved to old mating house; First observation of flock
Nov. 28	238	34	Began staging initial pair-encounters
Dec. 22	262	38	Flock observations terminated
1957 Feb. 9	311	45	Finished staging initial pair-encounters; experiment terminated

Table 2. Mean rates of frolicking per bird per hour for six strains of pullets by weeks.

Week	Strain					
	BA	WPR	GWL	DWL	HWL	RIR
2	2.08	1.86	1.75	1.13	1.21	1.91
3	1.67	1.57	1.31	1.43	0.76	1.45
4	2.07	2.26	1.22	1.32	0.63	1.39
5	4.48	3.60	2.10	2.15	2.19	2.83
6	3.28	2.61	1.21	1.75	1.40	2.45
7	1.78	1.58	0.96	1.57	1.12	1.29
8	2.23	1.45	1.35	2.02	1.16	1.77
9	2.09	1.44	1.05	1.98	1.20	1.63
10	0.58	0.46	0.35	0.48	0.32	0.43
11	0.17	0.12	0.08	0.15	0.13	0.10
12	0.32	0.11	0.10	0.25	0.12	0.06
13	0.11	0.02	0.02	0.06	0.00	0.02

NOTE: The following strain abbreviations will be used in all of the tables of the appendix.

BA Black Australorps
WPR White Plymouth Rocks
GWL Ghostley White Leghorns
DWL Dirkzie White Leghorns
HWL Honegger White Leghorns
RIR Rhode Island Reds

Table 3. Comparisons by strains of their mean rates of frolicking from week two to week nine inclusive.

Strain comparisons I : II	Means I	Means II	Difference	P-value
WPR : DWL	2.05	1.67	0.38	0.01
WPR : HWL	2.05	1.21	0.84	0.01
WPR : GWL	2.05	1.36	0.69	0.02
WPR : RIR	2.05	1.84	0.21	NS*
WPR : BA	2.05	2.43	0.38	NS
GWL : DWL	1.36	1.67	0.31	NS
GWL : BA	1.36	2.43	1.07	0.01
GWL : RIR	1.36	1.84	0.48	0.01
GWL : HWL	1.36	1.21	0.15	NS
BA : DWL	2.43	1.67	0.76	0.03
BA : RIR	2.43	1.84	0.59	0.01
BA : HWL	2.43	1.21	1.22	0.01
DWL : RIR	1.67	1.84	0.17	NS
DWL : HWL	1.67	1.21	0.46	0.01
RIR : HWL	1.84	1.21	0.63	0.01

* NS = Not statistically significant

Table 4. Mean rates of sparring per bird per hour for six strains of pullets by weeks.

Week	Strain					
	BA	WPR	GWL	DWL	HWL	RIR
2	0.23	0.23	0.15	0.05	0.11	0.24
3	0.72	0.73	0.35	0.27	0.10	0.73
4	0.59	0.64	0.19	0.32	0.10	0.37
5	0.45	0.60	0.10	0.06	0.11	0.43
6	0.24	0.25	0.05	0.08	0.02	0.14
7	0.25	0.30	0.19	0.15	0.11	0.58
8	0.39	0.57	0.46	0.68	0.29	1.01
9	0.30	0.53	0.45	0.50	0.31	0.87
10	0.11	0.12	0.14	0.21	0.05	0.09
11	0.01	0.05	0.02	0.12	0.06	0.03
12	0.10	0.11	0.07	0.14	0.09	0.05
13	0.00	0.05	0.03	0.00	0.02	0.00

Table 5. Comparisons by strains of their mean rates of sparring from week two to week nine inclusive.

Strain comparisons I : II	Means I : II	Difference	P-value
WPR : DWL	0.46 0.26	0.20	0.04
WPR : HWL	0.46 0.14	0.32	0.01
WPR : GWL	0.46 0.24	0.22	0.01
WPR : RIR	0.46 0.55	0.09	NS*
WPR : BA	0.46 0.40	0.04	NS
GWL : DWL	0.24 0.26	0.02	NS
GWL : BA	0.24 0.40	0.16	0.04
GWL : RIR	0.24 0.55	0.31	0.01
GWL : HWL	0.24 0.14	0.10	0.01
BA : DWL	0.40 0.26	0.14	NS
BA : RIR	0.40 0.55	0.15	NS
BA : HWL	0.40 0.14	0.26	0.02
DWL : RIR	0.26 0.55	0.29	0.01
DWL : HWL	0.26 0.14	0.12	NS
RIR : HWL	0.55 0.14	0.41	0.01

* NS = Not statistically significant

Table 6. Number of observed pecks per strain by weeks.

Week	Strain BA	WPR	GWL	DWL	HWL	RIR	Total	No. hrs. observed	No.of birds	Mean/ bird/ hour
3	0	0	1	0	1	0	2	5.5	93	<0.01
4	0	0	0	0	0	0	0	2.0	90	0.00
5	0	5	0	1	2	1	9	2.5	88	0.04
6	4	0	2	0	1	0	7	4.0	88	0.02
7	0	4	1	2	0	0	7	7.0	87	0.01
8	5	11	5	16	4	1	42	9.0	87	0.05
9	11	22	24	35	18	8	118	10.5	87	0.10
10	5	28	33	43	8	6	123	10.5	87	0.10
11	10	49	145	73	35	11	323	11.0	86	0.30
12	47	67	291	179	96	14	694	13.5	86	0.60
13	52	43	167	86	37	10	395	4.0	86	1.10
14	35	155	114	80	34	21	439	3.5	86	1.50
15	179	473	546	323	160	127	1808	14.0	86	1.50
16	269	592	476	293	133	127	1890	14.5	85	1.50
17	216	460	420	238	142	89	1565	11.5	83	1.60
18	432	680	864	436	205	181	2794	15.5	83	2.30
19	101	136	111	68	44	50	510	4.5	83	1.40
20	105	550	372	310	93	63	1493	13.0	83	1.40
21	434	923	801	483	210	139	2990	17.0	82	2.10
22	85	105	140	52	27	21	430	2.0	82	2.60
Total	1288	3243	2994	1968	806	692	11001	175.0	--	0.91

Table 7. Comparisons by strains of their mean rates of pecking from week 11 to week 22 inclusive.

Strain comparisons I	II	Means I	II	Difference	P-value
WPR	DWL	2.68	1.58	1.10	0.01
WPR	HWL	2.68	0.66	2.02	0.01
WPR	GWL	2.68	2.46	0.22	NS*
WPR	RIR	2.68	0.57	2.11	0.01
WPR	BA	2.68	1.06	1.62	0.01
GWL	DWL	2.46	1.58	0.88	0.01
GWL	BA	2.46	1.06	1.40	0.01
GWL	RIR	2.46	0.57	1.89	0.01
GWL	HWL	2.46	0.66	1.80	0.01
BA	DWL	1.06	1.58	0.52	0.01
BA	RIR	1.06	0.57	0.49	0.01
BA	HWL	1.06	0.66	0.40	0.01
DWL	RIR	1.58	0.57	1.01	0.01
DWL	HWL	1.58	0.66	0.92	0.01
RIR	HWL	0.57	0.66	0.09	0.03

* NS = Not statistically significant

Table 8. Number of birds observed in fights per week by strains.

Week	Strain						Total no. birds involved	Total no. of fights
	BA	WPR	GWL	DWL	HWL	RIR		
7	1	7	3	3	0	0	14	7
8	1	8	0	2	1	0	12	6
9	3	11	3	5	4	4	30	15
10	2	0	1	3	0	0	6	3
11	0	0	0	0	0	0	0	0
12	5	4	0	1	2	0	12	6
13	0	0	1	3	0	0	4	2
14	1	0	1	0	0	0	2	1
15	1	2	3	2	0	0	8	4
16	1	0	0	0	0	1	2	1
17	0	0	0	0	0	0	0	0
18	0	2	2	0	0	0	4	2
19	0	0	0	0	0	0	0	0
20	0	1	2	1	0	0	4	2
21	0	0	1	4	1	0	6	3
22	0	2	0	0	0	0	2	1
Totals	15	37	17	24	8	5	106	53

Table 9. Mean percentages of each strain feeding at a time by weeks.

Week	Strain					
	BA	WPR	GWL	DWL	HWL	RIR
2	15	12	16	19	20	17
3	17	14	17	18	23	19
4	18	20	16	28	22	18
5	13	25	16	27	18	14
6	16	26	13	22	23	17
7	20	30	20	28	29	23
8	16	24	17	18	26	23
9	22	18	14	18	19	16
10	10	13	12	12	14	13
11	19	18	12	17	15	15
12	15	18	18	22	18	14
13	32	27	31	30	33	20
14	19	21	19	28	21	15
15	31	20	25	22	26	15
16	19	23	21	20	18	8
17	13	16	17	17	16	8
18	13	16	18	15	13	7
19	9	17	12	10	13	6
20	9	21	14	13	13	4
21	9	18	16	13	14	6
22	14	22	16	15	12	5

Table 10. Comparisons by strains of their mean rates of feeding from week two to week nine inclusive.

Strain comparisons I : II	Means I	Means II	Difference	P-value
WPR : DWL	1.69	1.78	0.09	NS*
WPR : HWL	1.69	1.80	0.11	NS
WPR : GWL	1.69	1.29	0.40	NS
WPR : RIR	1.69	1.47	0.22	NS
WPR : BA	1.69	1.37	0.32	NS
GWL : DWL	1.29	1.78	0.49	NS
GWL : BA	1.29	1.37	0.08	NS
GWL : RIR	1.29	1.47	0.18	NS
GWL : HWL	1.29	1.80	0.51	0.05
BA : DWL	1.37	1.78	0.41	NS
BA : RIR	1.37	1.47	0.10	NS
BA : HWL	1.37	1.80	0.43	NS
DWL : RIR	1.78	1.47	0.31	NS
DWL : HWL	1.78	1.80	0.02	NS
RIR : HWL	1.47	1.80	0.33	NS

* NS = Not statistically significant

Table 11. Comparisons by strains of their mean rates of feeding from week 15 to week 22 inclusive.

Strain comparisons I : II	Means I	Means II	Difference	P-value
WPR : DWL	1.53	1.25	0.28	NS*
WPR : HWL	1.53	1.25	0.28	NS
WPR : GWL	1.53	1.39	0.14	NS
WPR : RIR	1.53	0.59	0.94	0.02
WPR : BA	1.53	1.17	0.36	NS
GWL : DWL	1.39	1.25	0.14	NS
GWL : BA	1.39	1.17	0.22	NS
GWL : RIR	1.39	0.59	0.80	0.01
GWL : HWL	1.39	1.25	0.14	NS
BA : DWL	1.17	1.25	0.08	NS
BA : RIR	1.17	0.59	0.58	NS
BA : HWL	1.17	1.25	0.08	NS
DWL : RIR	1.25	0.59	0.66	0.01
DWL : HWL	1.25	1.25	0.00	NS
RIR : HWL	0.59	1.25	0.66	0.01

* NS = Not statistically significant

Table 12. Number of peck-rights within and between strains which were known as compared with the number of possible peck-rights in a flock of 82 pullets. Fractions give the actual number of known peck-rights (numerator) and the possible number (denominator). Percentages facilitate comparisons.

Strain	No.	Strain														% of known
		BA		WPR		GWL		DWL		HWL		RIR		Total		
		No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	
BA	16	74/120#	62	98/192	52	152/240	63	144/208	70	151/240	63	118/176	67	663/1056	63	90
WPR	12	17/192	09	57/66#	86	147/180	82	137/156	88	162/180	90	111/132	84	574/840	68	82
GWL	15	19/240	08	25/180	14	103/105#	98	109/195	56	181/225	80	162/165	98	496/1005	49	54
DWL	13	11/208	05	3/156	92	77/195	39	71/78#	89	153/195	78	136/143	95	380/897	42	48
HWL	15	6/240	03	2/180	01	32/225	14	20/195	10	75/105#	71	144/165	87	204/1005	20	25
RIR	11	24/176	14	1/132	01	0/165	00	0/143	00	1/165	01	50/55#	91	26/781	03	03
Total	82	77/1056	07	129/840	15	480/1005	41	410/897	46	648/1005	64	671/781	86	2343/2792	84	--

These intrastrain data not included in tatals

Table 13. Number of peck-rights within and between strains which were known as compared with the number of possible peck-rights in a flock of 48 pullets. Fractions give the actual number of known peck-rights (numerator) and the possible number (denominator). Percentages facilitate comparisons.

Strain	No.	Strain																% of known
		BA		WPR		GWL		DWL		HWL		RIR		Total				
		No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	
BA	8	7/28#	25	21/64	33	18/64	28	20/64	31	33/64	52	24/64	38	116/320	36	66
WPR	8	4/64	06	17/28#	63	44/64	69	31/64	48	42/64	66	48/64	75	169/320	53	87
GWL	8	17/64	27	2/64	03	27/28#	96	26/64	41	37/64	58	62/64	97	144/320	45	58
DWL	8	24/64	38	2/64	03	29/64	45	23/28#	82	34/64	53	64/64	100	153/320	48	63
HWL	8	4/64	06	2/64	03	14/64	22	11/64	17	23/28#	82	54/64	84	85/320	27	37
RIR	8	12/64	19	0/64	00	0/64	00	0/64	00	0/64	00	27/28#	96	12/320	04	05
Total	48	61/320	19	27/320	08	105/320	33	88/320	28	146/320	46	252/320	79	697/960	71	—

These intrastrain data were not included in totals.

Table 14. Percentages of intrastrain peck-rights for each of six strains of pullets as compared to the percentages known and the numbers possible for flocks of 82 and 48 pullets, and the percentages of initial pair-encounters won by each of four of the strains.

Strain	Flock of 82 pullets			Flock of 48 pullets			% initial pair-encounters
	% of possible	% of known	% known	% of possible	% of known	% known	
BA	63	90	70	36	66	55	28
WPR	68	82	84	53	87	92	52
GWL	49	54	90	45	58	78	--
DWL	42	48	88	50	63	75	52
HWL	20	25	85	27	37	72	--
RIR	3	3	89	4	5	82	66

Table 15. Results of initial pair-encounters between individuals of single-breed flocks. The figures represent the number of encounters won out of a possible 100 by each of the breeds listed at the left from each of the breeds listed across the top.

Breed	RIR	WPR	DWL	BA	Total wins
RIR	*	58	52	90	200
WPR	42	*	44	71	157
DWL	48	56	*	54	158
BA	10	29	46	*	85
Total	100	143	142	215	600

* No intrabreed encounters were staged.

Table 16. Mean body weights and percentages of gain for six strains of pullets maintained in a mixed-breed flock. Weights are in grams.

Age (days)	Week	Interval (days)	Strain												Mean total	
			HWL		GWL		DWL		WPR		BA		RIR			
			Wt.	% gain	Wt.	% gain	Wt.	% gain	Wt.	% gain	Wt.	% gain	Wt.	% gain	Wt.	% gain
5	1	--	48	--	50	--	49	--	49	--	48	--	48	--	49	--
30	5	25	226	371	253	406	240	390	263	437	258	438	266	454	251	412
62	9	32	623	176	688	172	620	158	704	168	777	201	721	171	689	175
83	12	21	850	36	970	41	858	38	1032	47	1094	41	1046	45	975	42
104	15	21	1042	23	1175	21	1054	23	1274	23	1353	24	1202	15	1183	21
126	18	22	1158	11	1361	16	1199	14	1532	20	1564	16	1445	20	1377	16
153	22	27	1373	19	1549	13	1458	22	1935	26	1829	17	1703	18	1641	19
Total		148		2706		2958		2876		3849		3710		3448		3249

BREED DIFFERENCES AMONG CHICKENS AS RELATED TO COMPATIBILITY WHEN REARED TOGETHER

by

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Previous experiments concerned with the study of the interbreed behavior of mixed-breed flocks of chickens have been done with adult birds. The purpose of this experiment was to study the possible effects which rearing together might have on the compatibility of a mixed-breed flock of pullets. This experiment was part of a more extensive project conducted by the Department of Poultry Husbandry at Kansas State College.

Six strains of pullets, involving four breeds, were used in this study. The strains used, and the number of individuals in each, were as follows: Black Australorps (16), White Plymouth Rocks (16), Rhode Island Reds (16), Ghostley White Leghorns (16), Dirksie White Leghorns (15), and Honegger White Leghorns (16). The birds were reared together and maintained under the standard procedures practiced at the Kansas State College Poultry Farm.

The following activities were recorded during the periods of observation of the flock which started April 5, 1956, and ended February 9, 1957: frolicking, sparring, pecking, fighting and feeding. The frequencies of these activities were summarized on a mean per bird per hour basis by weeks. Paired comparisons of the rates of activities of the six strains made and the mean differences between strains were tested for statistical significance. Interbreed initial pair-encounters were staged between adult individuals of four of the strains which were of the same hatching stock and the same age, but which were maintained in single-breed flocks.

Significant differences were observed for some of the strain comparisons in each of the four types of activities analyzed. Some of these differences were between the same strains in more than one activity. The

frequencies of frolicking and sparring appeared to have little, if any, relationship to the frequencies of pecking and feeding. There was a relation between the frequency of pecking and the frequency of feeding, for one strain at least, which showed that the more aggressive strains had precedence at feeding.

The number of fights observed was too small to treat statistically, but the greatest number occurred during the time of peck-order formation. The strains which were observed to fight most were highest in the peck-order and vice versa.

There was some indication that during the peck-order formation period growth rates might have been influenced by social status and frequency of feeding. The efficiencies in meat and egg production of these strains is being presented in another phase of the experiment which was conducted by Mr. Dale Tindell of the Department of Poultry Husbandry.

In the staged initial pair-encounters between adult individuals of four strains maintained in single-strain flocks, the strain lowest in the ontogenetic peck-order won the most encounters, and the strain highest in the peck-order won the least encounters. This is partially explained on the basis of breed recognition and differences in maturity rates of the different breeds, but the real meaning in such results was not determined.