BREEDING FOR AGGRESSIVENESS IN THE FOWL

by

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B. S., Kansas State College
of Agriculture and Applied Science, 1948

A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Poultry Husbandry

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1949

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INTRODUCTION AND REVIEW OF LITERATURE

Modern studies of social behavior among birds date from the work of Schjelderup-Ebbe (1922, 1935). These initial studies of the social organization were concerned mainly with the so-called peck-order in the domestic fowl. Schjelderup-Ebbe's original description of social behavior in chickens has been essentially verified, among others, by Sanctuary (1932), by Masure and Allee (1934), and by Murchison in his 1935 series of papers. Recent studies by Allee et al. (1945), have expanded the interest and popularity of the chicken in behavior studies.

This avian hierarchy is based on what has been called peck-rights, in which the relative social position of the hen is determined by the number of birds she dominates. The truly dominant bird pecks all of its flockmates without being pecked in return and the lowest ranking bird is pecked by all. Variations from a straight line peck-order may be caused by pecking triangles (for example, bird A pecks bird B, bird B pecks C, and C pecks A). The trend in small flocks is to form a straight line peck-order, while larger flocks involve triangles or deviations from the straight line pattern.

The severity of the peck, when given, varies widely. Blood may be drawn from the comb; feathers may be plucked; or, on the other hand, the peck may be light. The attack is often aimed at the comb or the top of the head; but, as the subordinate usually dodges the blow, it frequently lands on the neck or even

on the back or shoulders or not at all. Under these conditions the superior hen often renews the attempt to deliver an effective blow. The fowl are usually close together when pecking, but threats may be given from a distance of two feet or more. It appears that there is most tension between birds that rank close to each other in the peck-order, particularly between those which occupy positions near the top. In a well organized flock, birds of high rank in the peck-order seem to tolerate birds of low rank. Some individuals react strongly to being pecked. They may retreat to the other end of the pen, the roost, or the top of the nest boxes. The individual also may hide in some corner, stand still with head held low, or even crouch low with wings half lifted and tail depressed, squatting, as a hen will do for a cock.

Aggressive action has been found to occur among vertebrates from fishes to primates, (Collias, 1944, and Allee, 1945). The manner in which aggressiveness is expressed may vary from species to species.

There are many indications that high social rank may be associated with definite survival value for individuals in the upper portion of the social order, as contrasted with those in the lower portion of the social organization. It has been shown by Masure and Allee (1934) and Collias (1944) that birds ranking high in the social order have precedence to food and display greater freedom of the pen. Guhl and Allee (1944) demonstrated that continual readjustment in flocks of chickens

increased the social activity. The hens in an unstable organization also consumed less food; declined in body weight; produced fewer eggs; and showed smaller comb size than did birds in well organized flocks.

Guhl and Warren (1946) observed that normal and healthy males, when in competition, vary greatly in the number of offspring which they sire. The results indicated that the number of offspring sired by each of the cockerels was related to his relative dominance. In all cases studied the dominant male completed more matings, fertilized a higher percentage of eggs, and sired a larger number of viable chicks than did his subordinate males. These males when later introduced singly into the same pen of pullets showed little difference in the rates at which they mated.

From a practical standpoint it seems reasonable to conclude that a manager of flocks should keep these groups as stable as possible. In doing so the tension of the group is held at a minimum and there will be less interference during feeding and other activities. Experiments demonstrate that when strangers are introduced into an organized group the tension and social activity increase until the social position of the new individual is determined. Culling has no effect on the general social behavior of the hens retained. However, Sanctuary (1932), demonstrated that when birds ranking low in the peck-order were removed and penned as a separate group they were later equal to the more aggressive group in rate of production.

There are indications that in flocks of very aggressive chickens, such as the Leghorns, the foregoing social factors are more pronounced than in flocks composed of the heavy breeds of fowl. If it were possible to breed for lack of aggressiveness, certain problems in poultry husbandry might become less concerting. Contrariwise, if breeding should inadvertantly result in increased aggressiveness in the strain, some of the social phenomena which may affect production and fertility might be accentuated.

Through many years of selection no scientific evidence has been published which shows any direct heritable difference in aggressiveness within a strain. There have been papers published demonstrating the effects of physiological and psychological factors on aggressiveness. Physiological effects include mainly hormonal influence, as there are several lines of evidence to indicate that tendencies for aggressive domination or submission may be strongly effected by certain hormones (Allee, Collias, and Lutherman, 1939).

According to Schjelderup-Ebbe (1935); Shoemaker (1939); Allee, Collias, and Lutherman (1939), factors which make for dominance between members of the same sex and species of birds have been reported to include the following:

1. Other things being equal, the stronger bird usually wins.

2. One bird acts as though intimidated by the appearance of a strange and apparently unfrightened individual and so gives

way without fighting.

3. Both birds act as though frightened, but one recovers more rapidly and so wins the contact reaction.

4. An individual which is normally aggressive and victorious may be temporarily out of condition (tired, ill or molting severely) when it meets a newcomer, and so loses when it might, from other relations, be expected to win.

5. Mature hens usually dominate immature chickens.

6. The location of the first contact is important; birds, like many mammals, fight better in their home territory.

7. Even in quarters strange to both members of a contact pair a bird wins more readily if surrounded by others with which it has associated.

8. Old birds brooding their young fight more fiercely than they would at other times.

Aggressive behavior and the factors which make for success in the initial encounters between hens have been analyzed by Collias (1943). Collias staged two-hundred paired-contacts in a neutral pen using moderately inbred White Leghorn hens. Briefly, two hens from different flocks were caught, weighed, state of molt was noted, position in the social order in the home flock was recorded, and standard comb measurements (length plus height) were taken. The birds were then placed simultaneously in a strange pen purposely reduced to half size to insure closer association. The time of the latent period before contact and the length of the fight, if any, were recorded along

with notes on general behavior of birds toward each other. Controlled factors included sex, territorial familiarity, and social facilitation.

Collias found that comb size and the degree of molt were factors of major importance. Social rank in the home flock had much less influence, and weight was of only little importance.

The multiple correlation coefficient of success with the four factors analyzed was 0.75. Forty-four percent of all factors were unknown or not measured in this analysis.

Collias (1944) describes aggressiveness in vertebrate societies and populations as follows: "It is possible aggressiveness in a more subtle form may be expressed simply by independence of action, and its opposite, submissive behavior, merely by avoidance of another animal."

It has long been known that the castrate loses most of his aggressiveness. Males of several species may become vicious and unmanageable concomitantly with the attainment of reproductive maturity (Mumford, 1917). Although this alteration in behavior is probably not due exclusively to a change in gonadal secretions, these factors undoubtedly are involved.

A number of birds and males of other species of animals with a restricted breeding period are known to display marked aggressiveness only when in breeding condition. For example, Rowan (1931) has pointed out that in the spring the male bobolink is highly combative toward other males, although with the waning of the breeding season all males live peacefully together

in sex-segregated flocks. Boss (1943) states that the male herring gull fights frequently during breeding season.

Similar to the variations in aggressiveness which parallel different stages in the sex cycle are the waves of pugnacity in many species, comprising a normal accompaniment of preparation for the care of the young. Female fish, birds, and mammals often display aggressive behavior during the period that the young are receiving maternal care; this change in behavior is undoubtedly in part a reflection of altered hormonal balance. Whitman (1899) described the heightened aggression shown by pigeons from the time the nest site was selected until the young became independent. A relation between aggressiveness and the physiology of reproduction was suggested.

Allee, Collias, and Lutherman (1939) injected testosterone propionate into individual hens of organized flocks and observed the effect on their social positions. The dramatic feature of the experiment was the gradual advancing of the bottom bird to the top of the peck-order, where she dominated all except one individual which had also received substantial injections of the male hormone. Domm and Davis (1941) found that when poulards, which are normally neutral in behavior, were treated with androgen, they viciously attacked normal females or a dummy hen. Breneman (1939) injected newly hatched male chicks with male sex substances. Aggressiveness and cock-like behavior appeared in ten-day old chicks so treated.

Allee and Collias (1940) have discovered that administration

of estrogen has a slight tendency to lower aggressiveness and social status in hens. Davis and Domm (1943) found that capons given estrogen tended to retreat and avoided conflict with normal males.

Although the males usually dominate all the females, there are usually two peck-orders in a heterosexual flock, one among the cocks and the other among the hens. Aggressiveness in the fowl is not mediated entirely by sex hormones. Capons which lacked testicular tissue, in small flocks containing mature pullets of the same age, showed signs of aggressiveness and maintained social positions at various levels in the heterosexual peck-order (Guhl, 1949).

There are relatively few studies dealing with the possible effects of nongonadal hormones upon dominance and social status. According to Allee and Collias (1938) injection of adrenalin has no effect upon the establishment or maintenance of social orders among hens. Allee, Collias, and Beeman (1940) found that administration of thyroxin was without effect upon the social order in birds unless a severe molt was induced. (It is known that the process of molting temporarily effects social status).

Psychological factors and their association with aggressiveness need much more attention. However, Guhl, Collias, and Allee (1945) observed that dominant cocks would attack the inferior males when they courted or trod the hens in relatively small pens. In a rather short time the inferior cocks learned to ignore the hens and to remain at a distance from the dominant

cock; and the hens learned to avoid these beaten roosters. Under these conditions most of the matings were made by the top ranking cocks and in extreme cases the inferiors were "psychologically castrated". There is some evidence which indicates that experience in winning or losing may also be of some importance in deciding the outcome of paired initial encounters between domestic hens (Collias, 1944). Other factors which seem to be of importance are territorial defense, seniority, and training.

Heritable differences in aggressiveness have been demonstrated by Scott (1942) and Ginsburg and Allee (1942). They found differences in aggressiveness of three different laboratory strains of mice. By selective breeding (for another goal) it was found possible to separate from the original common stock two different strains of mice, in one of which the individuals were very aggressive in encounters with other mice while in the other strain the reverse held true. Among rats, individual differences in aggressiveness appeared to be fairly stable and consistent (Hall and Klein, 1942).

Potter (1947) compared the relative aggressiveness of six breeds of chickens including White Leghorn, Brown Leghorn, White Wyandotte, Rhode Island Red, Light Brahma, and game chickens (Brigham Red X Yankee Clipper). The White Leghorns ranked at the top, the Light Brahmas were at the bottom of the social order, and the game birds ranked fourth.

Light Brahmas were least successful in paired contacts and won the fewest fights of any breeds. Game birds participated

in and initiated more battles than hens of any other breed. They won fewer initiated fights than Leghorns and Rhode Island Reds, but they won more fights than any of the remaining breeds. Game birds were the best fighters and their technique differed from that of the other breeds.

Potter concluded that the breed was more important in effecting the outcome of paired-contacts than were other known factors.

Fennell (1945) stated that observations made on game chickens on walks with an area of one or more acres suggested that dominance-subordination relationships and social organizations are determined by factors which on final analysis are closely related to the hereditary background of the individual. He also states that courage, aggressiveness and shiftiness, all of which are important in such organizations, are hereditary since these characteristics are exhibited to a greater degree in game birds than in domestic fowl.

In recent years a few commercial poultry plants have been inbreeding poultry on a large scale. One of these plants noted the development of relatively aggressive and nonaggressive strains of poultry (personal communication). However, these birds were selected for egg production and changes in aggressiveness were incidental. Their plan of breeding was to make brother-sister matings for many generations. Aggressive strains were developed that required isolation from other stock because they were too combative. When large numbers of chickens are available inbreeding is possible to this extent without a complete

loss of strains.

The foregoing experimental data give many indications that aggressiveness could depend on hereditary factors. Due to the small numbers involved and the limited amount of direct evidence available the results are far from conclusive. However, there is very close agreement among authors with regard to methods, materials, and results in studies of aggressiveness. The present experiment was based primarily on the information available and was designed to obtain additional information. The purposes of the experiment were to select an aggressive and an unaggressive strain of chickens from a common parental stock.

METHODS AND MATERIALS

The chickens used as foundation stock for this experiment were hatched and reared at the Kansas State College Experimental Poultry Farm under standard conditions. Forty-two Single Comb White Leghorns were selected at random from a large population of pullets consisting of four different strains. These pullets were isolated for a period of two weeks before the initial placement in the observation pen. (Isolation for this period of time usually causes the individuals to forget their former pen mates, according to Schjelderup-Ebbe 1922, 1935). Following the period of isolation, the birds were placed in a pen where all were strangers. As expected some fighting occurred until the birds had established a definite peck-order. The

birds were marked with colored dyes according to a prearranged scheme which made it possible for the observer to recognize the identity of each bird.

Management of Stock

After the desired birds were selected as breeders they were mated by artificial insemination. Each of two males was used for a period of two weeks, and then replaced by a second pair of cockerels. This served to minimize inbreeding in future generations because of the small population. Eggs were obtained by trapnesting and marked as to the hen's identification. The method of filing, incubating, and hatching of eggs followed the usual procedure for all hatches.

All the chicks from the parental stock were raised under similar conditions. Weights were taken at four-week intervals up to 12 weeks of age, at which time the birds were separated according to age and sex. This division placed chicks into two groups of males and two groups of females; (because of the age difference they were not combined at this time). Pecks were observed on birds in these groups designated, as groups 1, 2, 3, and 4. When a peck-order was completely established on a group they were returned to the range in preparation for another test. All birds were thus isolated for a period of at least two weeks before being placed in observation pens. By the time the peck-orders were established in each group, the birds had reach-

ed maturity. The males were then combined (groups 1 and 3) and the females (groups 2 and 4). Peck-orders were established on these combined groups for a final measurement.

The offspring from the first year of selection were raised under similar conditions. Weights were taken at six and 12 weeks of age at which time the birds were separated according to sex and placed on their respective ranges.

At the time each group was housed, comb measurements (length and height) and body weights were recorded. The birds were housed in a regular 50-bird laying house unit. The parental stock and their offspring were measured for aggressiveness by flock observations, while the offspring of the birds of the first year of selection were confined to individual compartments for initial encounters. Comb measurements and body weights were again recorded when the first complete peck-order or initial encounter cycle was obtained. Any changes or deviations from the first ratings were recorded.

Methods of Measuring Aggressiveness

Flock Observation. The recording of the pecks was started five days after the birds were placed into the pen as strangers. This lapse of time was to permit the birds to establish a social organization. All flock observed pecks were recorded at the time of observation. The individual that administered the peck was recorded first, and the individual which avoided followed.

Pecks were transferred from the observation book to the peck chart where final ratings were determined. The birds were then ranked according to the number of individuals each pecked and a complete peck-order was established.

A peck-order was obtained on the original 42 females which was based on approximately 11,000 pecks. The first 14 birds were designated as the top one-third and the last 14 birds, or birds ranking 29 to 42, as the bottom one-third of the social order. Using similar methods 25 cockerels were selected from a large population, and a peck-order based on 4,000 pecks was determined for the 25 males.

The offspring of the parental matings was measured for aggressiveness during growth and at maturity. As previously mentioned (under management of stock) two separate peck-orders were established on each of groups 1, 2, 3, and 4. At maturity male groups 1 and 3 were combined and female groups 2 and 4 for the third and final measurement. A total of approximately 34,000 pecks was recorded as a basis of measurement for aggressiveness in those groups.

Initial Encounters. The author was under the impression that a more accurate measurement of aggressiveness could be obtained by keeping birds in individual batteries and fighting them in paired-contacts rather than by observing their reactions in a flock. This method, it was believed, would remove some of the variation in the peck-order due to chance encounters in the initial flock fighting. For example, a very aggressive bird

might win four or five hard fights in succession. It might then encounter a less aggressive individual which had not had a fight. The less aggressive bird could win easily because of the fatigued condition of the more aggressive individual. The aggressive individual would then avoid that particular bird in future meetings. Therefore, paired-encounters were used in the second generation as a measurement of aggressiveness.

Under this plan it was necessary to keep the birds in individual compartments, and due to the limited space available individual pens could not be arranged on the floor. Therefore, it was necessary to use battery compartments. The batteries used were in three sections consisting of three decks to each section, with six birds in each deck. A total of 54 birds were caged in these batteries at one time. Batteries were the regulation size individual hen laying units. Legbands were used for individual identification corresponding to the battery number. The entire population was under uniform environmental conditions in regard to feeding, watering, lighting, and temperature control.

All the initial encounters reported in this study were conducted in neutral pens. These pens were exhibition cages (46" x 42" in size). These cages were set on a concrete floor covered with about one inch of sand. Three separate pens were arranged so that three paired-encounters could be observed at one time. A set schedule was arranged so that birds were limited to a definite number of encounters per day. If a bird made

three encounters in one day (which was the maximum number), the time interval between the first and the second encounter was at least one hour. A lapse of more than four hours was given between the second and the third encounter. Most birds were limited to two encounters per day.

The birds were scored according to the degree of aggressiveness exhibited in each meeting. The winner and loser of each encounter were recorded according to the legband numbers of the birds involved. These birds were returned to their respective batteries after each encounter. The same system for measuring aggressiveness was used for both males and females. The final rank was determined by the number of encounters won and lost.

Scoring

As the number of individuals in each flock varied it seems desirable to establish a standard for showing an individual's aggressive rank within the flocks or groups compared. From the methods used it appears that a percentage rank would be most desirable. A percentage rank or score immediately reveals the aggressive rank of the individual as compared with the entire number of birds rated. The lowest ranking individual in the peck-order was given a score of 100 divided by the number of individuals ranked. The individual ranking highest in the peck-order was given a score of 100. All other birds were given scores ranging between those limits, according to the individual

rank of each. On this basis the most aggressive birds are indicated by the highest scores. Therefore, the relative position of an individual can be determined immediately by the score. An individual ranking in the top one-third of the aggressive rank would have a score of 66 or more, while a bird of the lower one-third rank would have a score of 33 or less.

Breeding Program

The aim of selection was to make the representative in the following generations as good as, or better than, those of the previous generations for the desired characteristics. Selection was based upon characteristics of the individuals, ancestors, sibs, progeny, or various combinations of the four. By this selection it was planned to establish a high and a low aggressive strain.

The breeders chosen, from the parental stock, for the high strain were females that ranked in the top one-third of the peck-order. The two highest ranking males of the male social order were chosen as sires. The female breeders selected for the low strain were from the bottom one-third of the peck-order. The males selected for the low strain were the bottom two birds of the male social order.

The offspring from the above matings were measured for aggressiveness by flock observation. These data were then summarized and birds for breeding stock were selected according

to their aggressive relationship between parent and offspring. Fifty-six females were available and 57 males for the first year breeding stock. Of these the high 16 females of the top strain and the low 16 females of the bottom strain were used as actual dams for the second generation. Sire selection consisted of the two highest males from the top strain with the highest dam average and the two lowest males from the bottom strain with the lowest dam average. The offspring from these matings were measured for aggressiveness by initial paired-contacts.

RESULTS

Relation of Aggressiveness to Some Physical Characteristics

Body Weight and Rank Obtained by Initial Encounters. The weights were recorded for both sexes at the time they were placed in the batteries, just before the initial encounters, and again at the completion of the cycle of encounters. Body weights as shown in Fig. 1 for both sexes are the weights recorded at the end of one complete round or cycle. Only one complete round was made on the pullets and part of a second round on the males. A coefficient of correlation between rank and body weight gives the following r-values:

Sex	r	Degrees of Freedom	Significance
♀	-0.258	45	.05
♂	-0.0296	46	non

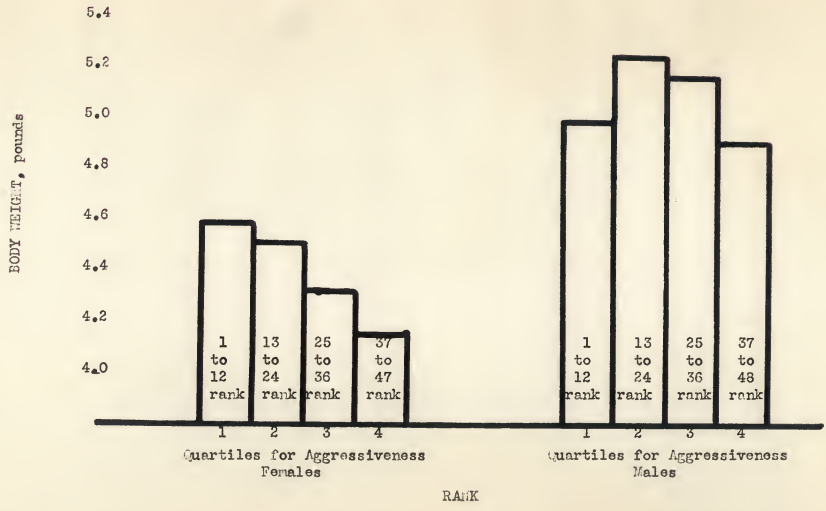

Figure 1. Relationship Between Body Weight and Rank. Rank is Shown by Quartile Groups.

The results reveal that body weight has little, if any, effect upon the outcome of an encounter. However, extremely light or extremely heavy birds seem to be at a slight disadvantage. The least variation, however, occurred in the top quartiles.

Comb Size and Rank Obtained by Initial Encounters. Measurements of the combs were made in millimeters and the relative size was determined by adding length and height together. Comb measurements and body weights were recorded at the same time. The measurements used in Fig. 2 are those comb sizes recorded at the close of a complete round of encounters. A coefficient of correlation between rank and comb size gives the following r-values:

Sex	r	Degrees of Freedom	Significance
♀	-0.2850	45	.05
♂	-0.3817	46	.01**

The r-values indicate that comb size in females and males appears to have some relation to rank in relative aggressiveness. These results gave evidence that in the males there appeared to be less variation in comb size among those in the top quartile, while in the females the least variation appeared to be in the third quartile. By dividing the social rank into quartile groups, it is possible to show the degree of variation between quartiles.

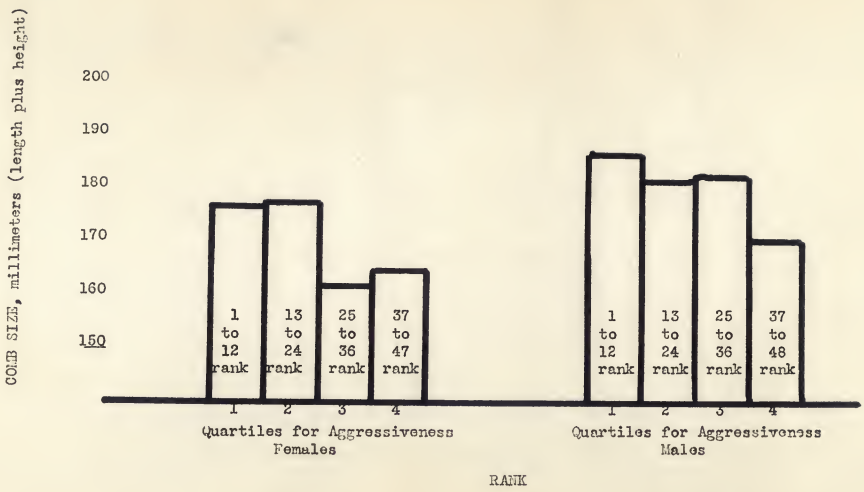

Figure 2. Relationship Between Comb Size and Rank. Rank is Shown by Quartile Groups.

Results of Selection for Aggressiveness

The parental generation (mated in 1946) produced offspring that gave the following results when ranked for aggressiveness by flock observation. The top ranking strain consisted of mating the most aggressive male (score, 100) with females of the average score of 84. The offspring from this mating averaged 46. Male 2 in rank (score, 96) mated to the same hens produced offspring with a score of 62. The combined offspring of the two males in the strain selected for aggressiveness had an average score of 53.

The results of measurement of aggressiveness in progeny of the two strains in relation to that of the parents are summarized in Table 1 (page 23). Also shown in this table are the relative scores for aggressiveness of individuals and families used as breeders.

Male 3, or the male ranking next to the bottom, was mated with the bottom one-third females or 16 birds that averaged 17. The offspring from this mating averaged 39. Male 4, the bottom ranking male, was mated to the above hens that averaged 17. The offspring from this mating scored an average of 54. The combined total rank of the low strain was 48.

The above results show a slight difference in favor of the top group as might be expected. However, this difference is not a significant difference from a statistical standpoint. As previously mentioned, three separate peck-orders were made on

Table 1. Summary of the results of breeding for aggressive and unaggressive strains.

Year	Strain	Sire			Average score			Progeny		
		Individual aggressiveness			Aggressiveness of progeny		Aggressiveness of mates		Average score for aggressiveness	Strain average
		No.	Rank	Score	Sire	Dam		No.		
1946 (Parental stock)	high	1	1	100	-	-	83.5	29	45.5	
	high	2	2	96	-	-	83.5	27	61.0	
										53.0
	low	3	24	8	-	-	16.5	23	38.9	
	low	4	25	4	-	-	16.5	41	54.4	
										46.0
1947 (First year of family selection.)										
	high	5	9	88	45.5	73.8	77.0	15	43.7	
	high	6	12	83	61.0	61.0	77.0	24	44.0	
										44.0
	low	7	52	22	54.0	19.0	35.0	16	40.0	
	low	8	8	89	54.0	49.0	35.0	39	62.0	
										56.0

the offspring in order to establish a reliable measure of aggressiveness.

The breeders selected for the first year matings (1947) produced offspring that gave the following results when ranked for aggressiveness by the initial paired-contact method: Male 5 individually ranked ninth out of 57 males rated. The average score for his sire's progeny was 45, while his dam's family average was 74. This individual male, when mated to females of an average rank of 77 had 15 offspring which averaged 44. Male 6 ranked 12 individually. The average score for his sire's progeny was 61, and his dam's family average was also 61. This male was mated to the same hens as was male 1; those hens averaged a score of 77. The resulting 24 offspring had an average score rank of only 44. The combined total rank of 40 individuals of the top strain was 44.

Male 7 ranked 52 individually out of 57 males. The average score for this sire's progeny was 54, and his dam's family average was 19. This male when mated with 14 hens whose average rank was 35 gave 16 offspring which averaged 40. The second male used in the unaggressive line ranked 54 individually. His sire's score for progeny was 38 and his dam's family average was 22. This male, when mated proved to be infertile and sired no chicks. He was replaced immediately by the only available male from the bottom strain. The new male, number 8, ranked 8 individually and his sire's average was 54, while his dam's family average was 49. When mated with females whose

average rank was 35, he sired 39 offspring with an average of 62. The combined total rank of the 55 individuals of the bottom strain was 56.

The above results show the highest rank score for the low strain, the reverse was true in the first year of selection. The above individuals were measured for aggressiveness by paired-contacts. Only one round of encounters was made for each sex; however, spot checks were made in random fashion as a check on previous encounters. A total of 474 spot checks were made and 82 percent agreed with the previous scoring record. At least a month lapsed between the first encounter and the time when spot checks were made. There were 2,867 individual encounters made for the measures of aggressiveness in the second year (1948).

A Whitney-Mann test was made between males in the high strain and also between males in the low strain. The offspring of these males were compared as to distribution of social rank as measured by the number of encounters won. Males 5 and 6 of the high strain were from different sires and different dams, but mated to the same females.

The offspring of male 5 and 6 were grouped together and tested for randomness of distribution of the offspring in the array. The statistical probability was .78 for males and .35 for the females. Both probabilities were insignificant.

Males 7 and 8 were also compared by the same test. These males were half brothers, each having the same sire but different dams, and were mated to the same individual hens. There were

only 6 male offspring of male 7 to compare with 26 from male 8. The probability was .50, which is insignificant. However, when the females were compared (13 from male 8 and 10 from male 7) the probability was .01. A statistical analysis on these females gave results that would occur by chance only one time in a hundred.

Although the method of isolation followed by initial encounters is a more critical means of measuring relative aggressiveness than the flock observation or peck-order method, there is some evidence that full control of the factors involved was not obtained. There were some indications that conditioning may have occurred in some encounters. Some birds which won a series of fights would lose several in a row subsequent to the loss in an encounter. Others that lost a series of contests appeared to win several after one successful outcome. Although these observations were not accepted as proof of conditioning to win or lose, they do raise a question as to the extent to which it is possible to obtain a highly accurate measure of relative aggressiveness. There was some control over physical conditions as the pen was heated and was lighted artificially with lamps operated by a time clock. None of the birds showed any noticeable molt during the round of initial encounters.

DISCUSSION

Physical Factors

As determined by Schjelderup-Ebbe (1935) and Allee, Collias and Lutherman (1939), there are a number of factors which determine the rank a given bird may attain in a peck-order. It is apparent therefore, that a measure of aggressiveness based on social ranking may not be sufficiently critical for selection in a breeding experiment such as the one reported here. An attempt at refinement of technique was made by methods somewhat similar to those developed by Collias (1943) with initial encounters. The factors of body weight and comb size considered by Collias were also used in the last selection as a means of establishing correlations. In general the results were somewhat similar to those obtained by Collias; i.e., body weight had little influence, at least within a certain range, and comb size tended to show some relation to rank, with high ranking individuals having the larger combs.

Breeding

The breeding results from the first year of selection do not show a decisive aggressive advantage in favor of the top strain. However, it would appear that there would be a wider or larger deviation in the average score after two years of

selection. The results of the second year of selection reveal that the lower strain was more aggressive and their average score was higher than the top strain in the first year of selection. This difference in aggressiveness could be accounted for by the fact that male 8 of the 1947 matings was an outstanding individual and also his parents were slightly above average in score. However, if male 8 and his offspring were discarded from the experiment because of the circumstances under which he was chosen, the results would still not be conclusive. If male 5 were compared with male 7 as to average aggressive score of offspring sired, the difference would only be a matter of a few percentage points in favor of male 5. Likewise if male 5 and 6 were compared with male 7, there would only be a few points difference in favor of the high strain. When comparing strain differences there was no statistically significant difference in lines after two years of selection. These results do not agree with the results obtained by Ginsburg and Allee (1942) in mice. By selective breeding, they found they were able to select aggressive and unaggressive strains from a common stock. The results with chickens give only a suggestion that aggressiveness may be inherited and certainly give no indication that aggressiveness is not inherited.

Individual differences in aggressiveness in mice appeared to be fairly stable and consistant, Hall and Klein (1942). In the second year of our selection 2,967 individual encounters were made, of which 474 were checks on the first paired-contact outcomes; 82 percent of these checks agreed with results of the

first paired-contacts. Therefore, it appears that individual differences in aggressiveness in chickens seem to be fairly stable and consistant.

The results the Whitney-Mann test revealed no significant difference between males of the high strain. However, when comparing the offspring of male 7 and 8 of the low strain as to their distribution of rank in accord with the number of encounters won, there appears to be a significant difference in the distribution of female offspring. This probability is less than .01 which reveals that this distribution would probably occur less than one time in a hundred due to random ranking of individuals. Since male 7 and male 8 had the same sire but different dams and were mated to the same females, the only difference would be that of inheritance from the dam. Therefore, one would conclude that this difference in aggressiveness might be hereditary in nature.

The system of breeding in this experiment followed the present methods used by poultry breeders on the basis of individual, progeny and family selection. Therefore, it appears that the variability in results probably was due to the methods of measuring aggressiveness. It seems possible that a better method of measuring aggressiveness could be obtained. A desired system should be faster, less time consuming and more convenient than the present method of measurement. If a more accurate method of measuring aggressiveness could be obtained the number of individuals used in this experiment would probably be of

sufficient size to establish more definite results. If a method could be established which would require less time, a larger number of individuals could be ranked. Therefore, larger families and more progeny could be tested.

The results from this experiment do agree in part with previous experiments of this nature. However, after two years of selection for an aggressive and unaggressive strain no definite results were obtained. Since these results were not conclusive a continuation of an experiment of this nature would be desirable.

SUMMARY

1. Body weight seemed to have little or no effect upon the outcome of initial encounters. However, extremely light or extremely heavy birds were at a slight disadvantage.

2. The number of encounters won appeared to be associated to some extent with comb size (length plus height). This relationship indicated the larger the comb size, the higher the aggressive rank.

3. Strain differences were not conclusive after two years of selection for aggressive and unaggressive lines.

4. There were indications of an association between inheritance and aggressiveness. However, this experiment failed to measure the degree of such an association.

5. The results were not as conclusive as they might have

been if a larger number of individuals could have been measured. However, a large amount of data was compiled on each individual used in this experiment.

6. The technique of paired initial encounters appeared to be a more reliable measurement of aggressiveness than the flock observation method, but even with the encounter method all the variables were not eliminated.

ACKNOWLEDGMENT

The author wishes to express his sincere appreciation to Dr. A. M. Guhl and Dr. C. D. Mueller for their guidance and cooperation throughout this study and to Professor L. F. Payne and the Poultry Department for making available equipment and facilities for these studies. Credit also is due Dr. H. C. Pryor for his assistance with statistical data.

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