VISUAL PATTERNS IN THE RECOGNITION OF INDIVIDUALS AMONG CHICKENS

by

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INTRODUCTION

Many of the vertebrates exhibit social organization. This is evidenced by the dominance-subordination relationships of animals. Schjelderup-Ebbe (1935), a pioneer in the scientific work on social behavior, described the social hierarchy in domestic chickens. This takes the form of a peck-order, which is based on the peck-rights of the individual. Allee, Collias, and Lutherman (1939) define the peck-right as the right to peck without being pecked in return.

The peck-order consists of an order of dominance. In a straight-line hierarchy the bird highest in the peck-order, or the alpha bird, pecks all the others and is pecked by none; the second bird pecks all the others, except the first bird. The bird at the bottom of the hierarchy, or the omega bird, is pecked by all the birds and pecks none in return. Hence, "a" pecks "b", "b" pecks "c", etc. An irregularity of this may occur when a bird of medium or low position may have the peck-right over a bird of a higher social rank. This may occur in triangular relationships, in which "a" pecks "b", "b" pecks "c", and "c" pecks "a" (Schjelderup-Ebbe, 1935; Allee, 1942, 1943; Collias, 1944).

The first meeting, or first few series of meetings, of two birds decides which is the dominant and which is the subordinate. On this occasion one of three things may happen: (1) both birds fight and the loser becomes subordinate; (2) one bird becomes frightened and becomes the subordinate; or (3) both birds become frightened and the first bird to conquer its "fear" becomes

dominant (Schjelderup-Ebbe, 1935). Schjelderup-Ebbe (1922) found that in initial encounters the "home" bird initiated more attacks and won more encounters than the strange bird. The familiar surroundings seemed to facilitate winning of encounters. Indications are that the birds in the presence of powerful familiar despots (social facilitation) had better chances to win (Collias, 1943).

In a typical initial encounter between females the birds first become oriented in position to each other. After examining each other, the hackle feathers are raised, the tail becomes erect, and the wings droop. After some hesitation the birds leap up and at each other with particular attempts made to peck each other's head, especially the comb. This may last only a few seconds after which the loser retreats and seeks to escape. The winner attains her dominant position. If one fight does not settle the dominance-subordination relationship, more similar fights will ensue until the relationship is settled. Dominance relationships may also be decided by passive submission rather than active battle (Collias, 1943).

Strangers have a difficult time entering the organized flock of chickens (Douglas, 1948). Schjelderup-Ebbe (1935) states that the resident birds regard strangers with "suspicious" eyes. Usually the resident birds become despots and constantly harass the newcomers. During the first few days the newcomers are chased around energetically by the flock members, and they usually rank low in the peck-order.

The social hierarchy leads to differential behavior. Each bird behaves in a specific manner to each of the other birds. It

avoids some birds and pecks or dominates others. In a peck-order one individual invariably has precedence over certain others. Both the dominant bird and the submissive bird display characteristic reactions (Schjelderup-Ebbe, 1935).

Whitman (1919) in his monograph on the behavior of pigeons, states that ring doves do not know the difference between the sexes until they meet and exchange salutations. Their differential behavior is the only means of selecting a mate of the opposite sex. Bennet (1939) found indications that each individual ring dove had its distinctive behavior.

Noble (1936) discovered that the response of a male flicker to a female bearing an artificial "mustache" was much more rigorous than that to a mounted male. The mustache in mature flickers was a badge of maleness. This he explained was due to the greater stimulation of a moving object. A quiescent female form did not produce the stimulation that a female with a cry or distinctive behavior did.

The peck-order of a flock of chickens is obviously based upon individual recognition. Recognition is shown by the regularity and specificity of pecking and avoidance reactions. The identity of each individual is well known to the members of the flock, because each bird has a particular place in the peck-order (Schjelderup-Ebbe, 1935). Bennet (1939) states that to continue a hierarchy there must be recognition and memory.

Observations on recognition, especially sex-recognition, have been made by Schjelderup-Ebbe (1935), Allen (1934), Chapman (1935), Noble and Vogt (1935), Noble (1936), and Tinbergen (1935). The

experiments of Noble and Vogt (1935) involved the alteration of the plumage of the females in dimorphic species. They found that modifications of plumage were important in sex recognition.

Bennet (1939) attempted to determine what importance the visual clues of color and contour of the plumage had on individual recognition in ring doves. Dyes were used to modify color. Contour was altered by plucking feathers in different areas of the body and by adding feathers to other areas of the ring doves. The modified bird was then introduced into her flock for observation of the effect it had upon recognition. Guhl (unpublished) found that removing the comb from a hen resulted in her being attacked by her inferiors and superiors upon returning to her flock, indicating a loss of recognition by her flockmates. But a gradual change of comb size by adding testosterone by unction did not result in a loss of recognition.

A method of approach similar to that of Bennet's (1939) was used to determine some means of individual recognition among chickens of the same sex. An attempt was made to discern the importance of structural characteristics, reactions or behavior of introduced birds as stimuli to evoke aggressive action of flock members, and the psychological importance of the comb.

Small flocks of pullets and hens were chosen because, after the social hierarchy has been established, the social order remains stable and reversals are few. Revolts rarely occur among hens and successful revolts that result in a change of social status are still more rare (Allee, Collias, and Lutherman, 1939).

MATERIALS AND METHODS

Four organized flocks of White Leghorn pullets were used. Three flocks obtained as chicks from a commercial hatchery, were placed in separate pens in room 9 in the basement of Fairchild Hall. Pen I, 6 feet square, contained eight pullets. Pens II and III were both 6½ feet by 7½ feet. Pen II had 10 pullets and pen III, 12 pullets. The fourth flock of 30 hens was located in room 1 of the Adams building at the College Poultry Farm. The size of the room was 20 feet square. This was a Kansas State College strain.

The birds in the basement of Fairchild Hall were five months old when the experimentation on each flock began. The experiments on flock I lasted for four and one-half months, and the work on flocks II and III was carried on for six months. The hens in the Adams building were about 15 months old at the beginning of those experiments which lasted about three weeks.

Feed and water were made available to the birds at all times. The feed consisted of mash and scratch grain for the flocks of Fairchild Hall. Mash and corn were provided for the Adams flock. Roosts were present for all the flocks. Artificial light was furnished for each pen in Fairchild Hall by 50-watt lamps, which were switched on and off by a clock. The lights were on from 7 a.m. to 7 p.m. The flock in the Adams building had natural lighting. The temperature of the pens of Fairchild Hall remained quite uniform at about 85° F. The work in the Adams house was done during July when the weather was hot and oppressive.

The individuals of all the flocks were in good plumage and good physical condition at the beginning of the experiments. However, there was one death in pen III and two deaths in pen II from undetermined causes. In the later tests some of the birds of flocks II and III developed pronounced lameness. Two other birds of flock II were removed and killed because of their inability to walk. Other birds were otherwise healthy which was indicated by their large red combs and continued laying of eggs. Two birds were removed and killed in flock I. One was removed because of the incessant chasing and harassing of it by flock members due to an alteration. The other became lame and was continuously pecked by her penmates.

The individual birds were marked with numbered wing bands for permanent identification. To identify the individual within the flock during observations each bird was dyed in a small area with colored dyes. The birds were dyed in three general areas - the neck, wings, or tail. Thus a bird dyed red on the neck was referred to as 1R, if dyed on the wings - 2R, or if dyed on the tail - 3R. To distinguish the birds of the same color in different pens the number of the pen was added. Thus the bird dyed red on the neck in pen II was designated as 1R-II. The birds of the Adams building were referred to as flock IV.

The birds of flock II were isolated for some time for an experiment not recorded here. Flock III was isolated for the tests on the psychological importance of the comb. When the birds of the two flocks were permitted to form a peck-order again it was referred to as the re-established peck-order. The re-established

peck-order of flock II was referred to as flock IIa and that of flock III as flock IIIa.

The peck-order of the flock was first ascertained. It was important that the relation of each bird to all the others was known. The test-bird: i.e., the bird to be altered, was taken from the middle or near the middle of the peck-order. The bird was chosen from this position so that the reactions of both the superior and inferior birds could be observed for indications of loss of recognition.

The alterations consisted of changing contour, color, or both. These were made with dyes, by adding and denuding the feathers, or by adding a dummy comb of larger size.

Color changes were made by brushing the alcohol soluble dyes or black stovepolish on the feathers, and in some tests on the comb and beak of the birds. The dyes were methyl green, gentian violet, picric acid, mercurochrome, and black stovepolish. White enamel paint was also used to alter the color of the comb or wattles.

Changes in contour only were made by either adding white feathers to the bird or by denuding it. Feathers were taken from a given body area of another bird (of an entirely different flock) and added to the same area of the test-bird. Airplane glue was applied to the rachis of the added feather which was then fastened to the vane of one or more feathers. To give a fluffy appearance the added feathers were turned outward. A smooth effect was obtained by laying the feathers flat against the bird's own feathers.

The former gives a greater effect on contour. The tail and wing feathers were extended by inserting the tip of the bird's feather into the rachis of the added feather. Glue held it in place. Denuding was accomplished by cutting the rachis with a pair of scissors.

Combinations of both color and contour changes were made several ways, by the addition of red feathers with the ruffled effect to the general body areas, neck, and head, and by red wing and tail extensions. Another method was by denuding the bird so that the color of the skin could be seen.

The color of the comb was altered by the application of dyes and paint. The appearance of the comb was enlarged by glueing it to either red innertube patching or red flannel (or felt) cloth shaped to resemble a comb. Contour was also altered by shifting the loppy comb from one side to the other, and by making it in the shape of a ring or cone. This was accomplished with the use of scotch tape. The appearance of the wattles was enlarged also by sewing red felt cloth shaped to resemble wattles.

The test-bird was removed from the flock and the alteration was made with as much comfort to the bird as possible. The bird was then placed in a separate holding pen to allow the glue or dye to dry. This also gave the bird time to become adjusted to its alteration, so that its reaction to the alteration would be minimized when it returned to the flock.

Before the test-bird was returned to its original flock, the flock was fed scratch grain or moist mash to lessen the distraction caused by the entering bird. The test-bird was made as

content as possible and was gently set down in its home pen. Observations of the behavior of the flock toward the individual were recorded for indications of loss of recognition.

Loss of recognition was most decisive when the position of the test-bird in the hierarchy changed. This was preceded either by vigorous fights with inferiors in which the test-bird lost, or by the test-bird's superiors avoiding it till the test-bird pecked them. In some tests loss of recognition was determined only by fights with inferiors, or by superiors avoiding the test-bird without a change of position in the peck-order. It was natural to assume that the test-bird would fight with great intensity to defeat its former inferiors, and also that while the superiors of the test-bird avoided it the test-bird would also avoid them because she knew them only as superiors. So a change in the peck-order was not necessary to indicate a loss of recognition. Some cases gave no definite results. Whether recognition was lost was not definitely established. The birds may have been reacting to the alteration only and not to the bird as a stranger.

It was frequently felt that recognition or the lack of it of the test-bird was affected by the way in which it reacted to the flock upon its return. Would it make a difference whether the test-bird was submissive or aggressive when it returned to the pen? An attempt was made to study the effect of the initial reaction of the test-bird and possibly the flock upon recognition. A strange bird was placed in the home flock. Reactions of both the introduced bird and the flock were observed. In this situation the test-bird was a stranger to all the birds in the pen.

Another test was set up in which the test-bird was a stranger to the flock and not to the environment or pen. This was accomplished by placing the home flock in a strange pen in which the strange test-bird introduced was at home. Observations were made for indications of what behavior or reactions of the test-bird may be important in provoking an attack.

A further test on behavior was tried. The flock members were transferred to a strange pen. A bird was removed (before the transferal) and an alteration was made on her. The modified bird was then placed in the strange pen with the home flock. What effect would the modified bird, plus its altered behavior, have upon the flock members attacking her? The introduced bird would be reacting to the strange pen, but not to a strange flock.

Allee, Collias, and Lutherman (1939) have pointed out that in initial pair-encounters the bird with the larger comb usually won the encounter. They have shown that the larger comb is related to aggressiveness. Testosterone was responsible for the aggressiveness of the bird and also for the comb size. These statements led to another phase of experiments, testing whether an enlarged comb independent of additional testosterone would be detected by the birds or whether it would be influential in the winning of encounters.

The individual birds of flock III were isolated for a period of two weeks. They were placed in a laying battery where they were in open cages next to each other. They could hear and see each other, but the physical contact was reduced to a minimum. After a period of two weeks recognition of former penmates was lost

(Schjelderup-Ebbe, 1935). Then they were placed in a small pen two at a time to determine their dominance-subordinate relationships. Three series of these initial pair-encounters were run as a control.

The birds which lost most consistently in the three series of initial encounters and which had the smallest combs were used in tests involving comb size. An imitation comb, consisting of two pieces of red felt sewed together, was fitted over the bird's comb and sewed on at three places. It was approximately the size of the largest found on any pullets of the flock. Standard procedures were employed in measuring the combs; i.e., height plus length expressed in centimeters.

Then another round of initial pair-encounters was run. Observations were made to detect any reversals from the four previous sets of data or indications of different reactions of the birds to the altered birds. To check the results another series was run with the dummy comb removed. The purpose of the last series was to find if the results in the experimental series were due to probable physiological changes in the birds.

RESULTS

The peck-order of each of the three flocks in Fairchild Hall is shown in Fig. 1. This gives the dominance relationships between all the birds in each flock before the experiments were begun. The bird on top of each list is the dominant bird, or the alpha bird, in the flock; the bird next in line is dominant to all the other

birds except the alpha bird. In flock III, IIIa, and IV there are arrows pointing from one bird to another above it. These indicate the triangular relationships in the flock. Except for these variations each bird pecked those listed beneath it in the list. Subsequent changes in position of the test-bird resulting from the alterations are given in the tables.

Alterations in Specific Areas of the Body

Table 1 shows the alterations made on certain areas of the body. All these tests were made on flock I. These changes were made by adding white feathers, red feathers, and by denuding. A ruffled appearance was given to the areas of the saddle, back, breast, and legs. The main tail feathers and the primary feathers of the wings were altered by adding feathers to lengthen or extend them.

The test-bird reaction to the alteration was some preening. The extended tail and wings were especially noticed due to their added weight. The time spent in the holding pen before the test-bird was returned to the flock gave it time to become adjusted to the alteration.

The extended red tail on 2R-I caused all birds to appear frightened. They scattered and flew away from the test-bird. When 2R-I turned her head to preen, she would appear startled and run. The flock was upset for several days, after which the extended tail was gradually accepted. During this disturbance the peck-order remained constant, and there were no threats or fights to indicate a loss of recognition.

Several weeks later the red tail feathers were removed from 2R-I and placed on 2RG-I. The pullets did not appear to notice the alteration on 2RG-I. This indicated that birds recognized the alteration apart from the bird. The flock members were frightened by the alteration of 2R-I, but when they became used to it, the same alteration was made on another bird (2RG-I) without disturbing the flock.

There was not one instance (Table 1) of a loss of recognition when these given areas were altered. In a few tests the flock reacted to the alteration on the test-bird. This was evidenced by the birds picking curiously at the alterations of the test-birds, such as the red feathers on 2VV's saddle, the red extensions of 1V's wings, or the red feathers on 1V's breast. Most of the picking occurred when colored feathers were added. Denuded areas were noticed less often by the penmates than were the additional feathers.

Alterations on the Body Proper

Alterations on the entire body, exclusive of the head and neck, are shown on Table 2. White feathers were added to 2VV-I to give a ruffled or enlarged body without changing color. There was some picking at the added feathers, but the test-bird's position in the peck-order was not contested by inferiors, nor did superiors avoid it. The addition of red feathers to 1V-I resulted in more picking at the alteration. Because of the indefinite results with 1V-I, this test was repeated with 1V-IIa (of the re-established peck-order, Fig. 1c). Again, a loss of recognition was not definitely ascertained; it appeared to be a border line case. The addition

of black feathers to 2VV-IIIa (of the re-established peck-order of flock III, Fig. 1e) resulted in a loss of recognition. 1G successfully attacked 2VV; 1V threatened 2VV, which 2VV suppressed, and 3G definitely avoided 2VV upon her entry.

Dyeing 2G-II red did not affect recognition of this test-bird. Birds dyed violet (2VV-I) and yellow (2Y-I) did not cause a loss of recognition. However, dyeing 1V-I and 1G-I green caused recognition to be lost (When 1G-I was dyed green, she no longer was the omega bird, but due to previous tests on the neck (Table 3) she became dominant over 2VV and 1V, and possibly through the turmoil she also became dominant over 2GR.). 1V-I's alteration resulted in two fights with inferiors (1G & 2GR), one (2GR) of which she lost, and the alteration of 1G-I resulted in losing position to one inferior (2GR-I). Birds dyed black were not recognized by their flock members. When 2R-I was dyed black, she went to the bottom of the peck-order from her fourth position. 2RV-I lost position to an inferior (2Y-I) after a fight. There was no loss of recognition when 2V-I was denuded.

Color changes of the whole body resulted in the loss of recognition more often than did changes in contour only. The addition of feathers and denuding resulted in definite changes of contour, but did not affect recognition. Green and black dyes produced a loss of recognition. But why violet and yellow did not has not been determined. There is a possibility that green and black showed more color contrast than did yellow and violet, or it may be due to the intensity of the color.

Alterations on the Neck

Tests consisting of changes in color and contour of the neck are shown on Table 3. Adding white hackle feathers to 1G-II did not affect recognition. Removing the hackle feathers from 2VR-I's neck, but leaving a white fuzz, did not impair recognition.

Denuding the necks of 1V-I and 2VV-I to permit the skin to show through, caused recognition of both individuals to be lost. This was evidenced by two inferiors (1G and 2GR) attacking 1V-I, which caused 1V-I to lose position to one bird (1G), and 2VV-I had a fight with 1G, to which it lost position.

Dyeing the hackle feathers of 2G-II reddish-black caused a fight with 2VV and a reversal with 1Y. Several dominant birds chased 2G-I. After the flock members accepted their new (altered) members, white feathers were added to cover the dye of the hackle feathers. This changed the color back to white. Upon return to the flock 2G-II fought twice, with 2VV, and won. There was again some chasing of the test-bird.

To the neck of 2YG-III were added red hackle feathers to give a ruffled appearance. 2YG-III became the dominant bird, rising from her former fifth position in the flock, because all the rest of the birds avoided her. After her dominance was established the added feathers were removed. Seven fights resulted. Before the removal of the added red hackle, she was the alpha bird; she now ranked fifth in the flock. (2YG now dominated only seven birds: 2Y, 2B, 2V, 3V, 2GG, 1G, and 1V.)

Alterations in contour consisting of the addition of white feathers to the neck or of partial removal of all the hackle

feathers did not affect recognition. But changing only contour apparently had no effect upon recognition. This illustrates again that changes in color were more effective than changes in contour in the loss of recognition.

Alterations on the Head

To perform the tests on the head of the birds, the head was taken as a complete unit, and also divided into areas (Table 4). The face was considered as the area from the beak upward to the eye. The crest was the area above the eye, to the sides and back of the comb. The beak, comb and wattles were also tested for their importance in recognition.

Removing all the feathers from the head of 2Y-I had no effect upon recognition. But dyeing the head of 2VV-II green caused the test-bird to be treated as a stranger. (2VV-II had become dominant over 2Y, 2G, and 2VR due to previous experiments on recognition.) Three inferiors, 2VR, 2Y, and 1V, unsuccessfully attacked 2VV-II. The dominant birds also chased her which also indicated a loss of recognition.

Painting the wattles of 2YG-IIIa caused no disturbance. Changing the contour of the wattles by sewing on the large dummy red felt wattles did cause some birds to pick at them which indicated that they were detected, but there were no indications of a loss of recognition (2G-IIIa).

The addition of red feathers to give an enlarged effect to the face of 2B-III and 1Y-II did not produce definite results. However, dyeing this area green (1Y-II) caused three fights with

her inferiors (2G, 1G, and 2Y), all of which 1Y-II won. (1Y became dominant over 2Y, 2G, 2VR, after the original peck-order was formed.) The dominant birds were hesitant to approach 1Y-II. There was a pause of three weeks before the second test with green dye was performed on 1Y-II.

1Y-III apparently was immature when the peck-order was established. When the following experiment was performed on 1Y-III, she had become dominant over six birds. They were 2YG, 2Y, 2GG, 2B, 1G, and 2VV.

Adding white feathers (ruffled) to the crest of 1Y-III did not make the test-bird a stranger to the flock. Placing reddish-black feathers on the same bird caused recognition of the test-bird by the flock members to be lost. Two fights with inferiors (2Y and 2GG) ensued. 3V threatened 1Y-III. Dyeing the crest of 2YG-III green had the same effect as the addition of colored feathers did. Three inferiors (1V, 2Y, 1G) unsuccessfully attacked 2YG, and she was chased by her superiors.

The beaks of 2VV-II and 3V-III were dyed with a dark color consisting of a mixture of violet, green, and black. In both instances there was much picking at the beak. This picking could be explained by the fact that the dark color resembled food on the beak and the birds were merely picking at the dark object. These were not dominance pecks. These "curious" pecks did not indicate a loss of recognition. However, because 3V-III was threatened by an inferior (2B) gives reason to believe there may have been a partial loss of recognition. But, as 2VV-II was engaged in a fight with 2R in defense of its position seemed to indicate

rather strongly that recognition was lost.

Tests on the comb involving changes of contour were accomplished by changing the actual shape of the comb, and by the addition of a large dummy comb. Color changes of the comb were done by applying dye to the surface of the comb (Table 5).

In pen I the comb of 2RV was shaped like a cone, 2Y's comb like a crown, and the side to which 2V's comb lopped was changed. In none of these three tests was recognition of the bird lost.

The same tests were performed on birds of pen II with a definite loss of recognition occurring in each test. Shaping the combs of 1R and 1V to resemble a cone caused fights with and threats by inferiors. 1R had two fights with inferiors (2R and 2G), and 2Y chased it. 1V fought 2G thrice, was threatened by 1R, and driven by 2Y. Shaping 2Y's comb to resemble a crown caused a loss of recognition, as also did reversing the side on which the comb lopped. Both tests resulted in inferiors contesting 2Y's position.

The difference between the reactions of the two flocks to the same alterations of the comb may be tentatively explained by the stability of the flock and the behavior of the altered bird. Flock I was less active; i.e., less pecking occurred, than in flock II, which was very active. The greater activity of flock II was probably an indication of less stability in the flock than in flock I.

Five tests were performed by placing dummy combs on birds to enlarge the appearance of the comb. A rubber innertube patch, cut to resemble a comb, was glued to 2GG-III. One fight with 1Y

ensued after which 2GG was driven about. Similar results occurred when dummy combs of red flannel cloth were sewed on the birds 2Y-II, 1V-II, 1R-II and 2R-II.

Dyeing the combs had an effect upon recognition. Painting 1Y-II's comb white resulted in one fight (2R) and the dominant birds avoided it for a while. 2G-III's comb, dyed green, caused three fights (two with 2V, and one with 2G), and two threats (by 2YG, and 1G), all of which 2G-III won.

From the results of the alterations on the head several facts were noted. Changing color of feathers had an effect upon the loss of recognition, whereas change of contour alone did not. The addition of white feathers and denuding the head did not cause a loss of recognition, whereas dyeing these areas did. Changes on the wattles, face, and beak were not as important in recognition as were those of the crest. The comb was the most important in recognition as either a color or contour change produced a loss of recognition. The results indicated that the most critical region in recognition was the crest and the comb. The wattles, face, and beak were less important.

Alterations in a Large Flock of Hens

A comparatively large flock of 30 hens was made available at the poultry farm for a limited period of time. The results of these tests are recorded on Table 6 (refer to Fig. 2f for the peck-order). The purpose of these tests was to find out if the tests used in a small flock could be used in a large flock.

Dyeing the entire body, exclusive of neck and head, of 2GV

green produced no reactions. Some dubious results were effected by 2YB's black dye. Some dominant birds chased it and others avoided it. There were, however, no fights or threats by inferiors.

The addition of black feathers (ruffled) to 2YV produced no reactions. But when the neck of 2G was completely denuded, 3RR unsuccessfully challenged 2G's position and both inferiors (2RR and 2GG) appeared "suspicious". Deleting had a greater effect upon recognition than adding hackle feathers.

All tests involving changes on the head were ineffective in their results. Addition of red feathers to the face of 2RR, white and red feathers to the crest of 2BB and 3YV, respectively, did not cause a loss of recognition. Dyeing the crest of 3RY green caused some superiors to peck at the dye, but these results did not suggest a loss of recognition.

The comb, of all the features tested, seemed the most important in recognition. Dyeing 3YR's comb black was merely noticed. Painting 1BG's and 2YG's combs white caused the position of these two birds to be contested in several instances. 1BG was contested unsuccessfully by an inferior, 2RR. Both 2VG and 1BG threatened 2YG.

The test resulting in the most definite loss of recognition occurred when 1BG's head, neck, and comb were dyed black. Twice 2G unsuccessfully fought with 1BG, thrice 2RR fought 1BG, in which 1BG lost. In the fight between 1BG and 1BV, 1BV was unsuccessful. A few dominant birds chased 1BG.

These results indicated that a loss of recognition could al be determined in a large flock of birds. Again color was more

important than contour. With the limited time in which the flock could be used there were insufficient tests to determine the extent, if any, of flock size on the ability to recognize individual penmates.

Behavior as a Stimulus to Aggressive Actions

While observing the effects on recognition of structural changes on the test-birds, the question arose as to the importance of the behavior of the bird in recognition. Did the way in which the bird entered the pen, or later reacted to the penmates, affect recognition? Were there some behavior patterns that instigated aggression from the flock members?

An attempt was made to separate the visual clues; i.e., structural and behavior clues for recognition. Birds foreign to the flock were introduced, and their behavior was closely watched for any evidences of any behavior of the bird that might cause the flock members to attack or avoid the stranger.

Five known strangers (from pen III) were introduced singly to flock II. The birds were 3G, 2VV, 1V, 1G, and 3V. In each instance the introduced birds assumed the submissive role upon entering the pen. This was believed due to the strangeness of the pen and birds. It is possible that penmates with modifications that caused them to be regarded as strangers were not immediately treated as strangers because their behavior was inconspicuous to the flock members.

The initial reaction of the flock members was to view the newcomers with caution. Then the newcomer was immediately

attacked by an aggressive member of the flock, not necessarily a high ranking bird. When attacked the newcomer never retaliated, but avoided the attackers. The newcomer either ran from the site or "bowed" its head. The exaggerated submissive behavior stimulated all the other birds to attack it. Subsequently the newcomer was driven until removed from the pen.

Further tests on the importance of behavior were conducted. In the following tests flock II was transferred to pen III for short periods of time for these tests. Known strangers from flock III (which were at home in the pen) were introduced singly into flock II. The four birds used were 2GG, 2YG, 2VV, and 2G.

In each of the four separate tests the strange birds instigated the initial fights and most of the succeeding ones. The strange birds might have ranked high in the peck-order had they been permitted to remain. 2GG-III walked around in the pen with the tail erect, and wings drooping. 2YG-III ran among the birds, acting "uninhibited". 2VV-III was aggressive, holding the tail erect, raising the hackle feathers and attacking the flock members. 2G-III walked around the pen, and started the initial fights which it won.

While the home flock was in a strange pen, a modified penmate was introduced (1R-II with a dummy red flannel comb). Thus, 1R-II was in a strange pen, but at home with the birds. 1R-II was hesitant as she entered and remained near the entrance. Immediately 1V-II attacked 1R-II and 1V won. 2G-II followed with an attack and won. Following these two attacks the birds began chasing 1R. 1R suffered loss of position to two birds. There was an indication

that the modification of the comb plus the hesitant behavior due to the strange environment stimulated the birds to immediate aggression.

Flock III was placed in a strange pen (pen II) with a modified penmate (2GG-III, with added black feathers to the crest). 2GG-III entered with ease and did not avoid the penmates. For a while it was not noticed, apparently because flock III was busy exploring the new and strange pen. After a time 2YG-III unsuccessfully attacked 2GG-III, and later 2B-III threatened her. Despite this 2GG-III never was hesitant and it seemed that the flock members with the exception of the two abovementioned attempts did not take particular notice of her.

Other tests involving flock III were performed in an improvised pen, which had no bedding, water, or food. The flock during these experiments remained huddled together on one side of the pen and their activity was reduced to a minimum. The introduction of 2YG-III (with red feathers on the crest) did not cause any disturbance. 2YG-III remained inactive as did the flock members and there was no action.

The same test was repeated in the improvised pen the following day. 2VV-III (black feathers on the crest) was introduced. The flock members and the test-bird were more free and active in the pen during this test. 2GG-III threatened 2VV, but 2VV pecked 2GG. Other birds threatened 2GG. The flock members were slightly more active in this test as opposed to the previous one, which may indicate that the activity of the flock is also important in the detection of a loss of recognition by the observer.

Flock III's reaction to a strange bird was tested while the flock members were in the improvised strange pen (pen was strange to both the flock and the introduced bird). In the first test (this test followed the introduction of 2YG-III) 2R-II was introduced. She reacted to the pen the same as did flock III. There were a few cases of threats (1V, and 3G), but even though she was pecked by 2GG and avoided in a corner the flock members did not harass her.

Again a complete stranger, 2Y-II (following the introduction of modified 2VV-III), was introduced to flock III while in the strange pen. Upon 2Y-II's arrival in the pen she was threatened by 2B-III, and 2VV-III. 2G-III and 2Y-III attacked her and she was chased more than 2R-II in the previously mentioned test.

The tests on the behavior of the birds as affecting recognition seemed to indicate that "cautious" or submissive behavior of a stranger is a stimulus for aggression. When the test-bird reacted normally to the flock; i.e., walked in and out of the flock without apparent fear, the bird was less likely to be noticed by the flock members. The activity of the flock was also a possible factor. When the activity of the flock was restricted there was a lesser tendency for aggressive action.

Psychological Aspects of a Large Comb in Initial Encounters

Collias (1943) found that female chickens with the largest combs won the most contests. The large comb is due to testosterone which also increases the aggressiveness of the bird. Now the

question arises, does the bird win more contests only because it is more aggressive or does the large comb cause the other birds to submit more readily? Does the large comb have a psychological value?

The eleven birds of pen III were isolated for two weeks in a laying battery so that individual recognition of flock members was lost. The birds were then fought by pairs in small pens. Three rounds of these initial pair-encounters were fought with about a week intervening between each series. Fig. 2 shows the degree of consistency of dominance relations won in the three series of initial pair-encounters. The correlation coefficient between the first and second initial pair-encounters was found to be 0.72, between the second and third it was 0.80, and between the first and third it was 0.84. These results are all statistically significant between the five and one per cent levels.

The comb of each bird was measured. The height (of the point above the eye) was added to the length (beak to end of blade) to obtain a measure of the size of the combs. The comb size was expressed in centimeters. Fig. 2 shows the comb sizes of all the birds of flock III, the number of contests each bird won in each series, and the total number of contests won. The correlation coefficient between the comb size and the first initial encounter was 0.85, second encounter, 0.70, and the third encounter, 0.71. The correlation coefficient between the total number of fights won and the comb size was 0.79. These results were all statistically significant (P-values range from less than 5 per cent to one per cent).

Three birds, 1G, 2GG, 1V, having the smallest combs and losing the greatest number of fights in the three rounds, were selected as the experimental birds. The comb sizes of these three birds were: 1G - 11.9 centimeters; 1V - 11.9; 2GG - 10.6. 1V lost all initial pair-encounters, 1G won 7 out of the 30 contests, and 2GG won 10 out of 30 contests. To each of these three birds was added a red felt dummy comb. These dummy combs were approximately the size and shape of 2G-III's comb. 2G-III's comb was the largest comb in flock III and measured 19.9 centimeters.

The three birds with the dummy combs were fought individually with the other eight birds (Fig. 3). In these 24 initial pair-encounters with the "low" experimental birds, there were five changes from the previous three series of pair-encounters which served as a control. 2G lost by default to two test-birds, 1V and 1G, and a brief fight ensued with 2GG to which 2G gave in readily. 1G won two other contests by default or avoidance of 3V and 2Y. Both 3V and 2Y defeated 2GG in three series of control pair-encounters.

In the experimental encounters, with the exception of one test in which 2G attacked 1G with great rapidity and no hesitation, the test-bird was first avoided, or the attack on the test-bird was made hesitantly. Only in three initial encounters was the attack initiated by the test-bird. These were all instigated by 2GG which evolved into three fights, with 2VV, 2G, and 2B, the last two of which 2GG won. In all the other tests the birds avoided or hesitated to attack the birds with the large dummy combs. Even after a peck was delivered on the test-bird, the birds that attacked

remained hesitant or cautious.

The three experimental birds were low-ranking in the previous initial pair-encounters. This is a possible indication of the reason that not more contests were won by them when they had the modified combs. Their reactions were submissive due, possibly, to their former conditioning occurring during the experiences when in the peck-order, and during the control initial pair-encounters, and to the lack of aggressiveness. Even though the other birds avoided them at first, they overcame their "fear" sooner than the test-birds and, therefore, won the contest. Those birds that did not overcome their "fear" of the altered birds gave way to the test-bird by default.

In the experimental pair-encounters, both 1G and 2G had three reversals from the preceding three series of initial pair-encounters. To find out whether these changes in relation to the control series were due to some physiological changes in the two birds or whether it was due to the dummy comb, the dummy combs of the three test-birds were removed and they were fought singly again with the other eight birds. The results of these initial pair-encounters were the same as those in the three series of controls. This indicated that the reversals and avoidances were due to the enlarged dummy comb.

The indications are that the bird with a large comb has a psychological advantage over the bird with a smaller comb. The extent to which the comb must be larger to give the bird a psychological advantage over another was not worked out. Other factors, such as color and texture, may also have entered in.

DISCUSSION

The dominant-subordination relationships, which form an aspect of social organization observed in many vertebrate animals, take the form of a peck-order in flocks of domestic chickens. The peck-order is the basis of the assumption that recognition between individuals of the flock does occur.

In these experiments some visual means of recognition of individuals were investigated. Hens have an absolute peck-right; i.e., the right of one chicken to peck another without being pecked in return (Allee, Collias, and Lutherman, 1939). Therefore, changes in the social hierarchy or reverse pecks would be much more significant than they would be in a dominant-subordination relationship in the form of a peck-dominance as described by Bennet (1939) for doves.

After the peck-order of a flock had been determined a bird from the middle or near the middle of the hierarchy was removed. The test-bird was modified and returned to the flock. Threats by or fights with inferiors, avoidances by superiors, and reverses in the position of the altered bird were evidences of loss of recognition.

Alterations of the birds consisted of changing color and/or contour of the plumage, facial skin, beak, wattles, and comb. The modification of specific body areas, as the tail, wings, saddle, back, and breast did not cause a loss of recognition. Colored feathers were picked at more frequently than the white feathers. Even the change of contour of the entire body, exclusive of the

neck and head, did not cause a loss of recognition. Yellow, red, and violet did not affect recognition. Green, and black, however, did cause a loss in recognition.

Changing only contour of the neck did not affect recognition. But again, color changes (reddish-black) or color and contour (denuding to permit the skin color to show through and by the addition of colored feathers) did cause a loss of recognition.

Modifications were made on the various areas of the head to test for recognition. Contour changes on the wattles, face, and crest did not affect recognition, whereas the contour changes of the comb did affect recognition. Altering the color of the wattles did not affect recognition, and color changes on the beak produced dubious results. Altering both color and contour of the face by the addition of red feathers did not cause a loss of recognition but merely dyeing the face green did. Altering either color, with dyes, or contour of the comb by changing the shape or by adding an enlarged dummy comb, caused a loss of recognition. It is apparent that as the areas were tested from the wattles up to the comb they became increasingly more critical in recognition.

Tests on the modification of structure were employed with a comparatively large flock of 30 hens at the poultry farm. Results obtained with the large flock were comparable to those obtained from the small flocks. Losses of recognition were also obtained in the larger flock. Color and anterior regions again were more important in recognition than posterior areas and contour. More experimentation is needed to determine whether the size of the flock affects the ability to recognize individuals.

The tests on the structural clues in vision also indicated that the behavior of the bird may have been important in recognition. The manner in which the test-bird entered the flock seemed to be either a stimulus for aggression or not. If the bird acted "at home" in the flock, and walked about as usual it apparently was not attacked. If the test-bird was submissive, hesitant, aggressive action was usually stimulated. It was also found that the tension of the flock was a factor in whether the test-bird or stranger was attacked or not. A constantly disturbed flock was more apt to attack a stranger than was a flock which was well integrated.

Modification of various areas and structures of the birds indicated that the comb was the most critical relative to recognition. Recognition implies memory and the question was raised concerning the extent memory of former conditioning played in the winning of fights by the birds with larger combs. The large dummy combs were sewed on birds ranking low in the three series of control initial-encounters and having the smallest combs. The series of pair-encounters with the dummy combs showed that in five instances the test-birds won where they did not in the control series. In all but one pair-contact the birds hesitated to attack the test-bird, and even after the first peck was delivered the birds still remained hesitant to attack the modified bird.

Collias (1943) states that as a rule birds with a larger comb win the greatest number of fights. Male sex hormone increases the size of the combs in birds, and also the aggressiveness of the individuals. Allee, Collias, and Lutherman (1939) have shown that

the injection of testosterone has caused low-ranking birds to become alpha birds. The results of the experimental pair-encounters indicated that the birds retained in their memory the association of a large comb and a loss of an encounter to the bird possessing the large comb. The birds apparently recognized a large comb and associated it with a superior. The birds may have been conditioned to avoid or "fear" birds with large combs. More tests would have to be performed to verify the psychological importance of the comb.

Most of the previous work in recognition with birds has been carried on in sex recognition. The pattern followed by the workers was to alter either contour, color, or both of a bird and observe the particular reactions of the other birds toward the modified bird. Noble (1936) in his work with sex recognition of mature flickers found that attaching a mustache (characteristic of male flickers) to the female flicker caused the female to be regarded as a male by the other flickers.

In her work with individual recognition of ring doves, Bennet (1939) found that alterations of color and contour caused disturbances in the flock. She found less disturbances occurring with contour changes than with color changes. Similar changes of structure on chickens caused a loss of recognition. The results given here also indicated that color was more important than contour in individual recognition.

Noble (1936) felt that the mustache on a live female was a greater stimulation to the males to attack her as a male than was the mustache on a stuffed female. Bennet (1939) came to similar

conclusions, namely that there were "some more subtle factor or factors than gross color or contour peculiarities" in recognition of individuals. She found evidence that the behavior of the bird may also be used as an explanation of recognition. Indications that behavior may be a factor in recognition were also found in chickens. The behavior of the test-bird upon entry and the tension of the flock may have had some effect upon recognition though the results obtained were not as pronounced as those of the ring doves.

In all four flocks comparatively large anterior areas of the body proper had to be altered before recognition of the individual by its penmates was lost. The entire body, exclusive of the head and neck, had to be altered to cause a loss of recognition. Modifying the neck caused a loss of recognition. Relative to the head significant changes had to be made on such areas as the face, crest, and the entire comb, to cause the test-bird to be regarded as a stranger. The fact that drastic changes in the structure of the birds must be made before recognition was lost agrees with the concept that the social organization of hens is stable (Allee, Collias, and Lutherman, 1939; Douglas, 1948).

The fact that comparatively large and anterior areas must be altered before recognition is lost is rather significant to poultrymen. Loss of recognition generally causes a disturbance in the flock. The disturbance in the flock organization results in lowered egg production and a reduction in weight gain (Guhl and Allee, 1944).

There are a few instances in nature which would change

structure of the bird causing a loss of recognition. A complete and sudden moult, especially in the anterior region of the bird (neck) would be such an example. Severely frozen comb tips would be another example of a condition in nature causing a loss of recognition.

Some practices of the poultrymen with respect to the flock may have a bearing upon recognition. Frequently flock members are dyed (as they were in this experiment) to facilitate the observer to recognize the individual flock members. The results indicated that one should refrain from dyeing the head, should make the marks small if dyeing the neck, and that dyeing with small markings on the general body area would be the preferred procedure.

Occasionally the birds are debeaked by poultrymen. The results indicated that this would not be detrimental upon recognition of the individual. If the comb is dubbed, that is, the major portion of the comb is removed, this should be done before the social hierarchy of the chickens has become established, because the comb is rather critical in recognition of individuals. Miller's (1951) results indicated that the peck-order was formed at approximately the eighth week of age. Hence, if dubbing is done it should be done before the chickens are eight weeks old.

SUMMARY

1. The definite social hierarchy in chickens presupposes that the birds recognize specific individuals.

2. Relatively large areas of the body had to be altered and pronounced changes had to be made before recognition was lost.

3. The anterior areas of the bird were more important in recognition than the posterior areas.

4. The dorsal side of the head was more critical in recognition than the ventral side, and the comb was the most important in recognition.

5. Color changes of the birds had a greater effect on the loss of recognition than did contour changes.

6. Losses of recognition were also produced in a comparatively large flock of hens. Results were similar to those obtained using small flocks.

7. The behavior of the bird may be a factor in recognition.

8. Attacks on test-birds or strangers were more likely to occur if the social relations in the flock were under tension than when there existed in the flock a marked state of tolerance.

9. Birds with larger combs, the results indicated, have a psychological advantage in initial pair-encounters over those with small combs.

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APPENDIX

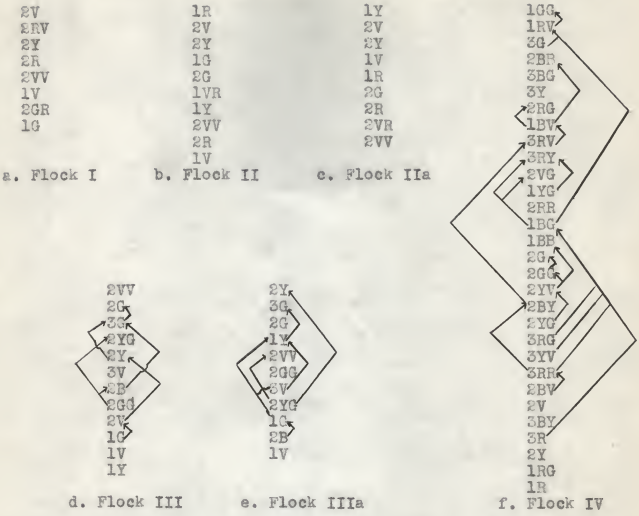

Fig. 1. Peck-orders of all the flocks. The bird heading the list is the dominant bird. The next bird is dominant of all birds except the one above it. The arrows indicate triangular relationships.

Flock IIa is the re-established peck-order of flock II. It is the peck-order of flock II following a period of isolation for another experiment.

Flock IIIa is the re-established peck-order of flock III. It is the peck-order of flock III following the period of isolation for the experiments on the psychological value of the comb.

	2VV	2YG	2G	3V	2B	3G	2Y	1V	1G	2GG	1Y	No. of contests won	Comb size
2VV		* # o	* # o	* # o	* # o		# o	* # o	* # o	* # o		24	14.3
2YG				* # o	* # o		* # o	* # o	*	*	#	15	13.5
2G		* # o		* # o	* # o	* # o	* # o	* # o	* # o	* # o	* # o	27	19.9
3V					#		* #	* # o	* # o	*	* # o	13	13.0
2B				* o		#		* # o	* # o	*		10	14.5
3G	* # o	* # o		* # o	* o			* # o	* # o	* # o	o	21	15.4
2Y	*			o	* # o	* # o		* # o	* # o	* # o		17	17.2
1V												0	11.9
1G		# o						* # o		* #		7	11.9
2GG		# o		# o	# o			* # o	o			10	10.6
1Y	* # o	* o			* # o	* #	* # o	* # o	* # o	* # o		22	18.5

Fig. 2. Showing the consistency of the initial pair-encounters. "*" are the fights which the birds to the left won in the first series of encounters. "#" are the encounters won in the second series, and "o" are the encounters won in the third series. The comb size is here expressed in centimeters.

	2VV	2YG	2G	3V	2B	3G	2Y	1Y
1V	0	0	0 *	0	0	0	0	0
2GG	0	3 x	0 *	2 x	3 x	0	0	1
1G	0	2 x	0 *	0 *	0	0	0 *	1

Fig. 3. The first row shows the number of contests the three birds with the modified comb had won in the first three series of initial pair-encounters. The second row with the "*" show reversals from the three control encounters. The last row shows the results from the final pair-encounters which was conducted after the dummy combs were removed. The "x" indicates the fight which the test-birds won.

Table 1. Summary of reactions by penmates to alterations in color and contour of the plumage made in various areas of the body. All these tests were made on birds of flock I.

Area altered	Type of alteration	Birds altered	Results
Tail	Extended the main tail feathers (white)	2VV	No challenge*
Tail	Extended the main tail feathers (red)	2R	"Feared" the alteration. No challenge
Tail	Extended the main tail feathers (red)	2RG	No challenge
Tail	Denuded	2VR	No challenge
Wings	Extended with white primaries	2R	No challenge
Wings	Extended with red primaries	1V	No challenge
Wings	Denuded	2Y	No challenge
Saddle	White feathers added	2VV	No challenge
Saddle	Red feathers added	2VV	No challenge
Back	White feathers added	2R	No challenge
Back	Red feathers added	2Y	No challenge
Legs	White feathers added	2Y	No challenge
Legs	Red feathers added	2R	No challenge
Breast	White feathers added	1V	No challenge
Breast	Red feathers added	1V	No challenge
Breast	Denuded	2GR	No challenge
Tail and wings	Denuded	1V	No challenge
Body, except tail and wings	Denuded	2V	No challenge

* "No challenge" means that the results indicated no loss of recognition.

Table 2. Summary of reactions by penmates to alterations of the whole body area except the head and neck.

Type of alteration on the body	Birds tested and flock	Results
White feathers added	2VV-I	Some picking at the feathers. No loss of recognition.
Red feathers added	1V-I	More picking at the feathers. No loss of recognition.
Red feathers added	1V-IIa	No challenge
Black feathers added	2VV-IIIa	2VV & 1G fought - G won. 3G avoided, 1V threatened 2VV, but 2VV - 1V.
Dyed red	2G-II	No challenge
Dyed violet	2VV-I	No challenge
Dyed yellow	2Y-I	No challenge
Dyed green	1V-I	1V & 1G fought- 1V won. 1V & 2GR, 1V lost to 2GR.
Dyed green	1G-I*	1G & 2GR reverse. 1G & 2VV fought, 1G won.
Dyed black	2RV-I	2RV & 2Y fought, 2RV lost.
Dyed black	2R-I	2R went to bottom of peck-order.
Denuded	2V-I	No challenge

* It should be noted that when this test was made on 1G-I, she no longer was the omega bird but had become dominant over 2VV and 1V due to previous experiments on the neck (Table 3). During this time it may also have been the turmoil which caused 2GR to submit to 1G.

Table 3. Summary of the reactions by the penmates to the alterations made on the neck only.

Type of alteration on the neck	Birds tested and flock	Results
Denuded partially	2VR-I	No challenge
Denuded completely	2VV-I	1G & 2VV fought, 1G won.
Denuded completely	1V-I	1G & 1V fought, 1V lost. 2GR & 1V fought, 1V won.
Added white hackle (ruffled)	1G-II	No challenge
Dyed hackle reddish-black	2G-II	2G & 2VV fought 2G & 1Y reversed; 2Y & 1G chased 2G.
Covered the dyed hackle with white hackles (smooth)	2G-II	2G & 2VV fought twice, 2G won. Some chasing of 2G.
Red-colored hackle added (ruffled)	2YG-III	All birds avoided 2YG. 2YG moved to top of peck-order.
Removal of the added hackles	2YG-III	2YG was the alpha bird, now only of seven birds; 2Y, 2B, 2V, 3V, 2GG, 1G, & 1V.
A line of red feathers across the neck	2Y-II	No challenge

Table 4. Summary of reactions by the penmates to alterations in the plumage of the head and color alterations of the beak, wattles, and facial skin.

Area of the head altered	Type of alteration	Birds altered and flock	Results
Entire head	Partially denuded	2Y-I	No challenge
Entire head	Dyed green	2VV-II*	2X(2VV & 2VR) (2VV & 2Y) (2VV & 1V) 2VV won all Top birds chase 2VV
Wattles	Sewed on a pair of dummy red felt wattles	2GG-IIIa	No challenge (some picking at dummy wattles)
Wattles	Painted white	2YG-IIIa	No challenge
Face	Added red feathers	2B-III	No challenge
Face	Added red feathers	1Y-II**	No challenge
Face	Dyed green	1Y-II**	2G & 1Y; 1G & 1Y; & 1Y & 2Y fought. 1Y won all.
Crest	Added white feathers (ruffled)	1Y-III#	No challenge
Crest	Added reddish-black feathers (ruffled)	1Y-III#	2X(1Y & 2Y) (1Y & 2GG), 1Y won.
Crest	Dyed green	2YG-III##	2YG & 1V; 2YG & 2Y; & 3X(2YG & 1G)-2YG won all. 2YG was chased.
Beak	Dyed dark color	2VV-II	2VV & 2R fought - 2VV won. Many birds picked the beak.
Beak	Dyed dark color	3V-III	2B raised hackle.

* 2VV-II had become dominant over 2YG, 2VR, and 2Y through previous experiments.

** 1Y-II had become dominant over 2G, 1G, and 2Y, after the original peck-order was formed.

1Y-III, apparently immature when the peck-order was formed, became dominant over 2Y, 2B, 2YG, 2VV, 2GG, and 1G.

2YG-III became dominant over 1G (refer to Table 3).

Table 5. Summary of reactions by penmates to alterations in color and contour on the comb.

Type of alteration	Birds altered and flock	Results
Cone-shaped	2RV-I	No challenge
Cone-shaped	1R-IIa	2R & 1R fought (2Y chased 1R). 2G & 1R fought, 1R won both.
Cone-shaped	1V-IIa	2X(1V & 2G fought, 1V won.) 2Y chased 1V; 1R threatened 1V.
Crown-shaped	2Y-I	No challenge
Crown-shaped	2Y-IIa	2Y & 2G fought, 2Y won. 2Y & 1R fought, 2Y won. 2RV & 2VV threatened 2Y; 2Y - 2RV & 2VV
Changed sides	2V-I	No challenge
Changed sides	2Y-IIa	3X(1V pecked 2Y) but 2Y - 1V. 2G looked at 2Y; 2V avoided 2Y.
Painted white	1Y-II	1Y & 2R fought slightly. Top birds avoided her for awhile.
Dyed green	2G-III	2X(2G & 2V) fought, 2G won. 2G & 3V fought, 2G won 2G & 2YG fought, 2G won 1G picked at 2G's comb, & 2G - 1G.
Rubber dummy (glued on)	2GG-III	2GG & 1Y fought, 2GG won. 2GG was driven about.
Red flannel dummy (glued on)	2Y-II	2Y & 1G; 2Y & 2VV; 2Y lost to both 2G & 2Y.
Red flannel dummy (sewed on)	1V-II	Some avoidance - it was noticed.
Red flannel dummy (sewed on)	2R-II	2R was low in peck-order; dominant birds chased it.
Red flannel dummy (sewed on)	1R-II	Some avoidance.

Table 6. Summary of reactions by penmates to various alterations made on a comparatively large flock.

Area altered	Type of alteration	Birds altered	Results
Saddle	Denuded	1YG	No challenge
Entire body	Dyed green	2GV	No challenge
Entire body	Dyed black	2YB	Some top birds chased it, others avoided it.
Neck	Added black feathers (ruffled)	2YV	No challenge
Neck	Denuded	2G	2G & 3RR fought, 2GG appeared suspicious.
Head (face)	Added red feathers	2RR	No challenge
Head (crest)	Added white feathers	2BB	No challenge
Head (crest)	Added red feathers	2YV	No challenge
Head (crest)	Dyed green	3RY	Some superiors pecked and looked at head.
Comb	Painted white	1BG	1BG & 2RR fought, 1BG won.
Comb	Painted white	2YG	2VG threatened 2YG; 1BG raised hackle at 2YG.
Comb	Dyed black	3YR	Probably was not noticed.
Head, neck, and comb	Dyed black	1BG	2X (1BG & 2G) fought - 1BG won. 3X (1BG & 2RR) fought- 1BG lost. (1BG & 1BV) fought- 1BG won. 1BG was chased by some birds.

VISUAL PATTERNS IN THE RECOGNITION OF INDIVIDUALS AMONG CHICKENS

by

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The dominant-subordination relationships, which form an aspect of social organization observed in many vertebrates, takes the form of a peck-order in flocks of domestic chickens. The peck-order is the basis of the assumption that recognition between individuals of the flock does occur.

In these experiments some visual means of recognition of individuals were investigated. A method of approach similar to that of Bennet's (1938) with doves was used to discern the importance of structural clues in recognition. An attempt was also made to discern the importance of reactions or behavior of introduced birds as stimuli to evoke aggressive action of flock members and of what psychological importance the comb is to the bird.

Three small flocks of White Leghorn pullets (flocks of 8, 10, and 12 birds each, located in room 3 of Fairchild Hall) were used. A comparatively large flock of 30 hens at the poultry farm was also used for tests on structural clues in vision. Pullets and hens were chosen because, after the social hierarchy has been established, the social order remains stable and reversals are few. Hens have an absolute peck-right, i.e., the right of one chicken to peck another without being pecked in return. Therefore changes in the social hierarchy or reverse pecks would be much more significant than they would be in a dominance-subordination relationship in the form of a peck-dominance as described by Bennet (1938) for doves.

Strangers have a difficult time entering the organized flock of chickens. The strangers are first regarded with "suspicious" eyes and then attacked by the flock members. The fight which

ensues is generally won by the "home" bird (Schjelderup-Ebbe, 1935).

The peck-order was first determined of each flock after which a bird was removed from the middle or near the middle of the hierarchy. The bird was modified and returned to her flock. Threats by or fights with inferiors, avoidances by superiors, and reverses in the position of the altered bird were evidences of a loss of recognition.

Alterations consisted of changing color, contour, or both of the plumage, facial skin, beak, wattles, and comb. Color was changed by dyeing the various areas of the bird with gentian violet, methyl green, picric acid, mercurochrome, black stovepolish, and white enamel paint. Contour changes were effected by adding an enlarged dummy felt comb or wattles, denuding or adding white feathers. Both contour and color were changed by denuding so the skin color could be seen by the addition of colored feathers.

Modifying specific areas of the body proper, such as the wings, tail, saddle, back, breast, and legs did not affect recognition. As the alterations were made more anterior, on the neck and head recognition was lost. Modification with color of the entire body proper, exclusive of the head and neck, caused a loss in recognition, but only contour did not. Only contour changes on the neck or head did not cause a loss of recognition, whereas only color change did. The dorsal side of the head was more important in recognition and the comb was the most important of all. Color changes were more important in causing a loss of recognition than were contour changes.

The tests on the structural clues in vision also indicated that behavior of the bird may be important in recognition. To find indications if the manner in which the bird entered the flock evoked aggression from the flock members three series of experiments were devised. In the first series the bird entered a flock and pen which were strange. In the next series the flock was transferred to a strange pen and a bird at home in the pen was introduced. The last series on behavior the flock was again in a strange pen, and a modified bird from the flock was introduced. The first series created a situation in which the bird was a stranger to the birds and pen, the second series the bird was a stranger only to the flock and in the last it was a stranger to the pen only. The last two series, it must be remembered, the flocks were in strange pens and their reactions may have been inhibited.

The results on the test of the effect of behavior indicated that if a bird is submissive upon entry of the pen, it is more likely to be attacked. If, however, the bird acts "at home" and is uninhibited, the stimulus for attack apparently is not there. The test-bird is also more likely to be attacked when the flock is in a state of tension than if in a state of tolerance.

The modifications of the various areas and structures of the birds indicated that the comb was most critical relative to recognition. Collias (1943) states that birds with larger combs as a rule win the largest number of fights. Male sex hormone increases the size of the comb of the bird and also the aggressiveness of the individuals. Do the birds with the large combs win

more fights because of their increased aggressiveness or is it partially due to the psychological value of the comb?

A flock was isolated for a period of two weeks, to cause the birds to forget their relationships (loss of recognition) (Schjelderup-Ebbe, 1935). The birds were fought in three series of initial pair-encounters with approximately a week lapsing between each one. A large dummy comb (the size of the largest comb in the flock) was sewed on each of the three birds which had the smallest comb and ranked the lowest in the three series of control pair-encounters. The series of pair-encounters with the dummy combs showed that in five series, in all but one pair-contact the birds hesitated to attack the test-bird, and even after the first peck was delivered the birds still remained hesitant to attack the modified bird. The results of the experimental pair-encounters indicated that the birds retained in their memory the association of a large comb and a loss of an encounter to the bird winning and possessing it. The birds may be conditioned to avoid or "fear" birds with large combs.

The results obtained from making structural changes on the body indicated that color was more important than contour in recognition and that anterior portions are more important than those made posteriorly. It was found that behavior clues (the way the test-bird entered the pen) and the tension of the flock may enter into the recognition of the individual. Because the anterior part of the bird was more critical in recognition than the posterior part and the comb was the most important, the psychological value of the comb was tested. The indications were that the bird with

a large comb besides having a high level of androgen which promotes aggressiveness, also has a psychological advantage over the bird with a smaller comb, as inferiors apparently associate large combs with their superiors. The fact that major changes in structure must be made before recognition is lost accounts in part for the stability of the peck-order of hens.