COLOUR PATTERN IN AUTO-SEXING REDBAR CHICKS

by

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ABSTRACT OF THESIS


A study of the colour pattern of Redbar chicks was undertaken to ascertain if the male and female chicks could be distinguished and if so, to devise a system of auto-sexing them. During the 1946 season, 1080 chicks from 36 female and 4 male parents were handled. Seventeen characteristics were described on each parental bird and forty-one on each chick. Down colour differences were found and the auto-sexing accuracy was improved from 62.1% to 94.0% with 80.0% for the whole season.

During the 1947 season, 542 chicks from 38 female and 6 male parents and 345 non-pedigreed pure Redbar chicks were handled. Twenty-two characteristics were described on each parental bird and eleven on each chick. Auto-sexing accuracy varied from 91.4% to 98.5% with 93.6% for the whole season. Characteristics of the heads and bodies of the chicks used to obtain these accuracies were as follows:

Females  - uniform brown colour, brown head stripes, brown back stripes.

Males  - mottled heads and backs, white head spots, very light heads and backs, short T or I shaped brown head stripe, two whitish back stripes.
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# Illustrations

Kodachrome illustrations of the key for the auto-sexing of female Redbar chicks -- facing p. 40

Kodachrome illustrations of the key for the auto-sexing of male Redbar chicks -- facing p. 41
Introduction

The origin and development of the Redbar breed has been described by Munro and Hagedoorn (1946). In the fall of 1945 the author began a study of the down colours of Redbar chicks. On this work a preliminary paper by Lloyd and Hill, was presented by the senior author at the 35th Annual Meeting of the Poultry Science Association, St. Louis, Missouri, July 22-23rd, 1946.

In this study the first step was to become familiar with the various down colours. The next step was to determine whether or not there were consistent differences between the male and female chicks. Afterwards when it became evident that these differences did exist an attempt was made to devise a key for the sexing of Redbars which would be easy to understand and to operate. Though the breed is not of commercial importance as yet, the data have been compiled and are presented in the belief that they may come to have practical value either in this breed or in other breeds of light down colour.

It will be observed upon examination of the work done for this thesis over the past two breeding seasons that numerous observations have been made on the chicks that have since proved valueless. Many were made in the belief that
they would prove to be of assistance in sexing the birds whilst others, for example, rate of feathering, were made in order to assist in the development of a breeding program. The latter has resulted in an improvement in the breed. Furthermore, it was considered that similar results might be obtained to those of Jaap who in experiments conducted at the Oklahoma Agricultural Experiment Station demonstrated that it was possible to greatly improve the accuracy of sexing by proper selection of chicks for the breeding flock.

**Review of Literature**

Comparatively little has been published on the sexing of Redbars. However, considerable data that are useful in working with this breed have been published by various authorities about Rhode Island Reds, Brown Leghorns, Cambars, Legbars, Ancobars and the Barred Plymouth Rocks.

Munro (1939) commenting on work done at the Agricultural Research center at Beltsville on the auto-sexing of Rhode Island Reds, stated that the female chicks generally have one or more spots or stripes of black on the head or back while the males generally possess no black down. On this basis an accuracy of 80-88% was obtained.

Hagedoorn (1946) observed that in his auto-sexing
Rhode Island Reds the cockerels were born white and the pullets buff. In the adult birds the males were red and white barred while the females were very little different from ordinary Rhode Island Reds.

Hays (1940) noted that both male and female Rhode Island Reds had brown and black pigment areas but after examining eight thousand seven hundred and thirteen chicks, stated that colour markings had no commercial value as an indication of sex in the strain he studied.

Hays and Klein (1943) reported on an improved method for sex identification of Rhode Island Red chicks as developed by Homer Rowell of Massachusetts. They laid stress upon the uniformity of the colour of the females as opposed to the more varied degrees of redness over the various parts of the down of the males.

Jaap (1946) elaborated a system whereby on three hundred and fifteen Rhode Island Red chicks an accuracy of 94.9% was obtained. This authority used the white wing web spot to identify the males but stressed that, for breeding purposes, only those of both sexes which had a uniform colour tone over the whole surface and the male chicks that had a relatively large white spot in the web margin of the dorsal wing surface should be kept.

Byerley and Quinn (1936) reported that 47.5% of the baby chicks in their strain of Rhode Island Reds showed a
small black spot or dark coloured stripes on the head or dorsal surface. Approximately 85% of birds having these spots of intensified melanic pigment were females.

Quinn and Knox (1939) in their work with sex identification in hybrid chicks for Barred Plymouth Rock males crossed with Rhode Island Red females presumed that the chicks with silvery back down and yellowish shanks would probably be males, and chicks with intense black down and black shanks would be females, as was found in the standard bred Barred Plymouth Rock chicks. Shank pigment was found to be of no help.

MacArthur and MacIlraith (1946) reported that in colour sexing Brown Leghorns, there were marked sexual differences in the characteristic wild type down pattern of the stripe on the crown, neck, back, face and also upon the down colour along the edge and below the wing front. These differences were more clearly defined in pullets than in cockerels. Furthermore, they stated that these sex contrasts were fully as marked on a silver down as on a gold ground colour.

Punnett (1940) found in Legbars that the males had a blurring of the light rump stripes besides a light head patch which aided in distinguishing them from the females. He also found that in the shank colour there was an inhibiting factor tied in with the barring one, with the result that
no differences appeared between the males and females.

Punnett and Pease (1930) working with Cambars found that the male chicks were a pale blotchy colour, whereas the females were darker, showing the typical Campine down colour. They pointed out that the Cambar had both the barring of the Barred Plymouth Rock and of the Campine, the one being sex-linked and dominant to self colour and the second being autosomal and recessive to self colour.

Lamoreux (1941) in auto-sexing his Ancobars used the presence and absence of black head spots and the density of the pigment on the backs of his chicks to distinguish the sex of the birds.

Finally, in the "Autosexlinkage in the Barred Plymouth Rocks", Jerome (1939) described the white head spots characteristic of the males and females. Again it was significant to note that the emphasis was upon the head markings.

Material (1946)

There were forty-six female and fourteen male Redbars available for breeding material. The majority were approximately nine months old though a few were two and three years of age. Records of their breeding were not available.
In setting about this project it was immediately evident that the parental stock were far from uniformly coloured as described later under the selection of the breeding stock. Hence it was anticipated that their offspring would be similarly variable in down colours.

Since initially it was not known whether the chicks could be auto-sexed or not, the policy of producing as wide a range of colour-downed chicks as possible was followed. Furthermore if the chicks were to become "auto-sexable" it would be done on colour differences. Thus a breeding program was set up to provide material to study the inheritance of the colour differences and their possible application in sexing the chicks. The parental stock, both male and female, were divided into three groups, and the pullets were trapnested in small breeding houses containing single males.

A. Objects of the breeding plan:

1. To produce a wide range of colour intensities and colour markings in the chicks.

2. Assuming that sex differences would appear, to select several characteristics which could be used to distinguish the males and the females. Sex differences might apply to all chicks but at the same time it was appreciated that this might not prove to be the case.
3. To keep records of the parents and offspring so that those parents giving the most easily "auto-sexable" chicks could be bred from in the future.

4. To keep records of the economic characteristics of the parents and their offspring, e.g. meat qualities, egg production, egg size, fertility and hatchability, so that birds with the desirable characteristics could be produced in future generations, in conjunction with the sexable colour characteristics.

5. Having drawn some conclusions as a result of killing the chicks in the first two hatches, to obtain more chicks from those parents that have given easily sexable chicks. At the same time chicks within a narrower colour range could be selected.

6. To save representative chicks from the initial crosses to see the relationship between chick and adult colours. Among other things this will help when it is necessary to introduce desirable coloured birds of new blood from the Redbar males crossed with Rhode Island Red females.

7. To change the males from one pen of pullets to another so that the transmission of certain outstanding characteristics such as smokiness or mousiness in the undercover, could be studied.

8. To cross pure Redbar males with Record of Performance, Rhode Island Red females to permit the introduction of new blood into the strain of Redbars and thereby
concentrate the economic characteristics of the breed.

B. Selection of breeding stock:

1. Females.

By January 4th all the Redbar birds on the Poultry Farm had been handled. Among other things notes were taken on the colour of their plumage. From these results it was evident that the birds could be divided into three colour groups as follows:

a. Lightish red birds with white barring. Smokiness was noted in three of the birds. Though not considered typical of the group two of these were used in the breeding pens.

b. Medium red birds with white barring. Again smokiness was avoided though black ticking on the hackle was permitted.

c. Medium to dark birds. Those with the smokiness of the undercover fell into this group.

Even with the birds being divided into the above three groups, considerable variations could be seen in birds of the same group, the differences in clarity of barring being the most obvious.

Using the above method of classification it was found that 18, 15 and 13 birds fell into the light, medium and medium to dark groups, respectively. Provided that the health, vigour, weight and meat qualities were satisfactory, four birds from each
group were put together in each of three pens. From the remainder, four birds were selected to make up the fourth pen. To secure further data for a breeding plan in the future, notes on egg weight, texture of shell and number of eggs laid during the next four months were taken.

2. Males.

The fourteen males were divided up into the three groups in a similar manner to the females. Clarity of colour markings and meat qualities were weighed equally in selecting the best bird from each of the three groups. A fourth male was selected from the medium colour group to put with the fourth pen of pullets. The best four of the remaining males were selected to be put with the Rhode Island Red pullets in the Record of Performance pen.

It will be noted that the medium to dark male was an old bird. There was a chance of inbreeding but the greater longevity thereby obtained weighed in his favour. Particularly was this worth while because of the fact that any other male used might easily have been a brother to some of the pullets, since in the mass matings of the previous years, the records did not show pedigrees.

The medium coloured male outwardly had clear white barring but at the time he was put into the breeding pen it was noted that he had some smokiness
in the undercover. This smokiness was about two-thirds of the way up the feathers and did not show on the surface of the plumage of the bird nor did it extend below half way down the feathers.

C. Movement of the birds during the breeding season:

The pullets were left in the same pens for the whole season. On the other hand, the males, first of all the three and later the four, were rotated using the following system: the initial collection of hatching eggs was started after the males had been in their respective pens for two weeks. After twelve days collecting, the first hatch was set and similarly at the end of the twenty-fourth day a second hatch was put in the incubators.

In the meantime on the nineteenth day all males were removed from their pens. On the morning of the twenty-fifth day they were rotated and put back with the pullets; then on the thirty-second day hatching eggs for the third hatch were collected. Similarly on the fifty-first day the males were once again removed, egg collecting being continued until the fifty-sixth day, at which time the males were once again rotated and returned to the breeding pens. Eggs for the fifth and sixth hatches including eggs from the fourth pen of odd birds, were then collected from the sixty-fourth day until the eighty-eighth day.

On the eighty-third day the males were removed from all four pens being rotated and returned to their new
pens on the eighty-ninth day. Egg collection for the non-pedigreed seventh hatch was started on the eighty-ninth day and for the pedigreed eighth hatch on the hundredth day. On the hundred and twelfth day hatching eggs ceased to be saved.

D. Estimated number of chicks that this system should produce:

On the basis of four chicks from each female parent, thirty-six pullets might be expected to give one hundred and forty-four chicks per hatch or a total of eight hundred and sixty-four chicks from the first six hatches. Birds from these hatches were considered early enough to be worth saving.

From the seventh and eighth hatches two hundred and eighty-eight chicks plus an additional sixty-four from the four hatches from the fourth pen were expected. Since most of these would be late, they were produced with the intention of testing the accuracy of any autosexing key that might be developed earlier in the season and were killed immediately afterward. In all, preparation was made to handle approximately twelve hundred chicks.

E. Significance of the three colour groups of pullets in each breeding pen:

To elaborate, where \( L \) = light, \( M \) = medium and \( M-D \) = medium to dark colour types, the nine crosses were:

Pen 1. \( L \) male \( X (1) L \) females, \( (2) M \) females, \( (3) M-D \) females.


By this means the results of the nine crosses were obtained at the time the first hatch came off, rather than having to wait until the fifth one was hatched which would have been the case if the three colour groups of pullets had been put in three separate pens. Furthermore, there was a possibility that when the nine groups of chicks were set out side by side in boxes, characteristic differences between males and females common to all or at least several groups might become evident. If all the light, medium, and medium to dark pullets had been put in separate pens then only three groups would have hatched each time and it would have been much harder to make the same observations by examination of the notes at the end of the season.

F. Other breeding plans:

So that some new blood could be brought into the strain of Redbars, four Redbar males were put with a pen of Rhode Island Red pullets that were qualifying for Record of Performance. No individual pedigreeling was carried out and few notes were taken on the chicks obtained from this cross. These birds were mated up before the regular Record of Performance breeding work for the year was started on the farm.
G. Data collected:

The details regarding the parental stock were recorded with a series of notations on each of the birds. Additional remarks on such characteristics as fertility, hatchability and egg laying were added as the breeding season advanced. Though this method of note-taking made the analysis of the data difficult, the numbers were so small that the development of a new system did not appear to be warranted.

This same procedure was followed in describing the first hatch of chicks. The data proved so hard to interpret however, that a new method whereby one characteristic was recorded in each column was devised. As further hatches were handled, certain characteristics proved valueless while others that had not previously been described were discovered and included. All characteristics used one time or another were included in the table below.

a. On parental stock.

1. Identification number or numbers.
2. Date hatched when known.
3. Sex.
4. Weight at maturity.
5. Meat grade.
6. Colour group of bird—light, medium or medium to dark.
7. Clarity of barring over hackle, back, and wings.
8. Presence of smokiness in the hackle and on the back.
10. Colour of primaries, secondaries and coverts.
11. Suitability for breeding stock—vigour and health.
12. Fertility results.
13. Hatchability results.
14. Laying results.
15. Size of egg.
17. Egg colour.
18. Shape of egg.
20. Livability of chicks hatched.

b. On chicks hatched.
1. Chick leg and wing band numbers and parents' numbers where known.
2. General colour grouping of the entire down of the chick from the dorsal view—light, medium, or dark.
3. Beak colour—flesh, brown or light.
4. Colour of beak tip—yellow, white or brown.
5. Notching of the beak present or not.
6. General colour of head—light, medium or dark.
7. White head spot present or not.
8. Small spots present or not. If so colour and number—refers to black and brown spots.
9. Large spots and stripes present or not. If so colour, number and whether carried down the neck or not—refers to black and brown spots and stripes.
10. Collar present or not. If present colour.
11. Presence or absence of head mottling—absent, trace, little or clear.
12. Incidental remarks on head—clarity of marking.
13. General body colour—light, medium or dark.
15. Colour down center of back—#Ridgeway's colour chart.
17. Colour between central stripe and two hip stripes—#Ridgeway's colour chart.
18. Colour outside two hip stripes—#Ridgeway's colour chart.
19. Smokiness present or not. If present where?
20. Colour of down on underside—white, tinted or yellow.
21. Colour of margins of the scales of the feet—yellow or white.
22. General colour of feet—flesh or yellow cast.
23. Black pigment on feet present or not.
24. Colour of toes—faint yellow, yellow or flesh.
25. Colour under feet—flesh or light yellow.
26. Colour of primaries—white, mauve, brown or black.
27. Colour of secondaries—as above.
28. Colour of coverts—as above.
29. Rate of feathering—slow, medium and fast.
30. Colour of wings—#Ridgeway's colour chart.
31. Light wing web present or not.
32. Colour of ventral surface of the wing—white, tint, or light yellow.
33. Size of shank in m.m.—side view and at the narrowest point.
34. Weight of chick in grams.
35. Presence or absence of black spots behind the eyes.
36. Miscellaneous remarks—clarity of marking and description of some odd coloured chicks not adequately covered by this table.
37. Suggested sex of the chick when in a group with its brothers and sisters.
38. Suggested sex of the chick when mixed in with all the other chicks in the hatch.
39. Actual sex—as determined upon death or when the bird was mature.
40. Category—refers to the grouping of the chick in the sexing key that was being developed.
4. Disposal of the chick.

With the first hatch of chicks, the colours were described without the use of a tabular chart. The latter system was decided upon when it was found to be difficult to analyse the results.

For ease in analysis at the end of the year the notes on the chicks from each hen were put on separate pages.

For both the parental stock and their progeny, a day by day account was kept of the health, mortality, movement of the birds, lost and changed bands, significant irregularities in the brooding or management in general and any other factors that might be considered affecting the pedigree or general well-being of the birds.

H. Significance of the two methods of auto-sexing the chicks:

It will be noted that an attempt was made to sex the chicks, first, when they were in groups from individual hens, and second, when they were all mixed in with the rest of the chicks in the hatch. In the first year the primary aim was to discover if there were auto-sexing differences between the chicks, and if so, a method to describe them. The auto-sexing was performed in family groups in order to limit some of the conflicting types and thereby simplify distinction. The auto-sexing differences, if they were to appear, would be far more evident in the small, more uniform family groups than
where the chicks were all mixed up and of widely diversified colours. Since the ultimate aim was to auto-sex all of the chicks in the breed, the chicks after first being described and auto-sexed in families, were mixed up and again auto-sexed. In this way an indication of progress was obtained.

I. Objectives in taking colour pictures of the Redbars:

1. To demonstrate and record the appearance of the down and plumage on a bird at a day old and at maturity, respectively. When this work was complete it helped in the selection of chicks that grew into desirably marked birds.

2. To show the colour of the parental stock and their offspring. By this means the parental stock could be selected that gave easily auto-sexable chicks, and chicks that themselves grew into desirably coloured birds.

3. To record the various characteristics that helped in the auto-sexing of the chicks.

4. To illustrate the very diversified down colours to be found on the chicks in a hatch.

5. To show the more uniformly coloured chicks to be found in the family groups.

6. To have a lasting record of the auto-sexing key, if and when finally established.
Results and Discussion (1946)

First hatch:

Upon analysis of the data taken on this hatch of forty-three chicks which were killed, it was evident that there were colour differences on some of the male and female chicks. These included:

a. Many female chicks had brown head and body stripes.

b. Still other female chicks were medium to dark in colour.

c. A few female chicks had grayish brown backs.

d. A good percentage of the males had light heads or bodies and sometimes both.

White spots seemed to be indicative of males but two exceptions were in evidence. Thus, at this time, this marking could not be included as characteristic of males. Later evidence has proved that chicks with white head spots are invariably males. That the two white spotted chicks were sexed as females can be explained on the basis that when the chicks from the first hatch were killed, considerable difficulty was experienced in distinguishing the gonads of a few of the birds.

In the past a white or lightish coloured collar over the back of the neck has been considered indicative of a male. However the evidence drawn from the four chicks from hen 70(L) would seem to refute this. Her two female chicks had the
collar while the two males did not.

In seeking for an explanation of the high percentage of striped birds, it was found upon examination of the pedigree of these chicks, that they were very largely from parents that had smokiness in the undercover on their backs and hackles.

Second hatch:

Using the observations made upon the first hatch, as shown in Table I, an auto-sexing accuracy of only 62.1% was reached when the chicks were all mixed. Twenty-seven percent of the chicks had brown head and body stripes, 7% were medium to dark brown in colour, 15% had greyish brown backs and 51% had lightish heads or bodies or both.

Thirteen of the nineteen greyish brown chicks were found to be males. These birds were of such an undesirable colour that they were culled from the flock and no particular attempt was made to improve on the technique in auto-sexing them. Later evidence showed that the errors had been made because the significance of the white stripes on their backs had not been appreciated. However, most of the errors were made with the light down coloured chicks, twenty-four of the fifty-one being females.

Third hatch:

In an attempt to find out where the mistakes were being made with these light coloured birds, they were divided up into the following groups:

a. Those with white head spots.
b. Those with very light bodies and heads.
c. Those with light heads and medium coloured bodies.
d. Those with light bodies and medium coloured heads.
e. Those of uniform light brown colour.

The greyish brown chicks were classified as males.

With a somewhat improved auto-sexing accuracy of 68.8%, as shown in Table I, 30% of the chicks had head and body striping, 6% were medium to dark brown in colour, 10% had greyish brown heads, 10% had white head spots, 19% had very light heads and bodies, 17% had lightish coloured heads and medium bodies, none had medium coloured heads and light bodies and 8% were a light brown colour.

The greatest percentage of errors occurred with the medium or dark brown striped chicks and those with the light heads and medium coloured bodies.

An explanation of the fact that some of the birds with head and body stripes were males was not immediately forthcoming, so before the next hatch came off, a key with the striped birds subdivided, was devised. At the same time there was no apparent reason why some of the chicks with light heads and medium brown bodies were males and others were females. The idea of the lighter collar on the back of the neck was again considered but it offered no solution. On the other hand, all of the lighter chicks with two white stripes seemed to have been males. Thus in the next hatch special note was made of birds that had this characteristic. These stripes occurred immediately next to and just inside of
where the brown or black hip stripes are to be found if present. Unless the colour is specified, back striping refers to these two brown or black hip stripes together with a similar coloured central back stripe.

Fourth hatch:

Using these additional modifications in dividing the chicks into groups, the sexing accuracy as shown in Table I, was further improved to 76.3%. These groups, including the sex and percentage of birds falling into them, were:

1. One or two head spots with clear back striping-- (females) -11%.
2. One or two head spots without clear body striping-- (males) -9%.
3. No spots with clear back striping-- (females) -1%.
4. Medium to dark brown coloured down-- (females) -3%.
5. Greyish brown coloured down-- (males) -0.
6. White head spots-- (males) -17%.
7. Light coloured head and back-- (males) -18%.
8. Light head and medium coloured back-- (females) -10%.
9. Light coloured head and body with two white back stripes-- (males) -7%.
10. Light brown down colour-- (females) -15%.
11. Light head with some yellowness included with medium coloured body-- (females) -9%.

In this hatch no chicks were put in the greyish group. The two reasons were, firstly, that with the male parents rotated into new pens there were not so many of this type
hatched and secondly, an attempt was made to put all those that were found into one of the other existing groups.

The most numerous errors occurred in groups 2, 7, 10, and 11. In the case of those chicks where the brown or black striping was not distinct, the use of the presence or absence of the two white stripes just inside the above hip stripes showed promise of helping to distinguish the males from the females.

In the three other groups, eight females were found in twenty-six of the light down coloured chicks, five males in the twenty-two light browns, and six of the thirteen chicks with light faintly yellowish heads with medium coloured backs, were males. Common to all three of these light groups where the errors were found, the females were comparatively uniform while many of the males were mottled. The significance of this point became more apparent as further hatches were handled and an additional group for the mottled males was added.

Fifth hatch:

With an overall auto-sexing accuracy of 82.2%, as shown in Table I, the same groupings were again used. As mentioned above more emphasis was placed on the uniformity of the females as contrasted with mottling and the white back stripes of the males. Some notice was also taken of the length of the brown head stripe on some of the brown chicks. The sex and percentage of chicks falling into each group was as follows:
1. One or two head spots with clear back striping—(females) -16%.
2. One or two head spots without clear body striping—(males) -8%.
3. No spots with clear back striping—(females) -0.
4. Medium to dark brown coloured down—(females) -9%.
5. Greyish brown coloured down—(males) -0.
6. White head spots—(males) -9%.
7. Light coloured head and back—(males)-14%.
8. Light head and medium coloured back—(females) -12%.
9. Light coloured head and body with two white back stripes—(males) -20%.
10. Light brown down colour—(females) -3%.
11. Light head with some yellowness included with medium coloured body—(females) -9%.

Again most of the errors occurred in groups 2, 10 and 11 with 8 being substituted for 7. In group 2 only five of the twelve chicks were males, in 8 only thirteen of the nineteen were females, in 10 there were two of each sex and in 11 only eleven of the fourteen were females.

In both groups 7 and 8 there was some difficulty in auto-sexing the lighter chicks though the presence of mottling helps the identification of many of the males in group 7. Again from observations made on this hatch it was noted that many of the female medium and light brown chicks in groups 8, 10 and 11 had a "T" or an "I" shaped head stripe. This characteristic was added to the grouping system for the
next hatch, being substituted for groups 8 and 11, and minor modifications were made on the others.

Sixth hatch:

The auto-sexing accuracy for this hatch was 80.4%, as shown in Table I. Details of the grouping with the sex and percentage of chicks falling into each group were as follows:

1. One or two head spots with clear back striping-- (females)-8%.
2. One or two head spots with a medium brown back-- (females)-6%.
3. No spots with clear back striping-- (females)-4%.
4. Medium to dark brown coloured down-- (females)-8%.
5. Greyish brown coloured down-- (males)-0.
6. White head spots-- (males)-12%.
7. Light coloured head and back; often mottled-- (males)-31%.
8. T- or I-shaped head stripe with a medium coloured back-- (females)-7%.
9. Light coloured head and back with two white back stripes-- (males)-8%.
10. Uniform medium or light brown down colour-- (females)-16%.

The greatest number of errors occurred in groups 2, 7 and 10, though most of them were still among the medium and light brown chicks. No new observations were made upon this hatch which would result in the improvement in the auto-sexing qualities of the breed, though the twelve chicks with the
T- and I-shaped head stripes were all females.

Up to and including the fifth hatch it was the practice to put the chicks that were similar into groups and then to attach a sex to the group. This system proved satisfactory where the emphasis was upon the discovery of the major auto-sexing differences. To discover the finer distinguishing features, the chicks in this sixth and following hatches were first of all sexed into males and females and were then divided into the groups which were in turn modified when necessary. By this means the auto-sexing key was developed.

Seventh hatch:

With a greatly improved auto-sexing accuracy of 89.2%, as shown in Table I, the following data on the grouping system were obtained:

1. One or two head spots with clear back striping--
   (females)-20%.
2. One or two head spots with a medium brown back--
   (females)-3%.
3. No spots with clear back striping--(females)-0.
4. Medium to dark brown coloured down--(females)-4%.
5. Greyish brown coloured down--(males)-1%.
6. White head spots--(males)-8%.
7. Light coloured head and back, often mottled--
   (males)-37%.
8. T- or I-shaped head stripe with a medium coloured
   back--(females)-22%.
9. Light coloured head and body with two white back
stripes—(males)—5%.

10. Uniform medium or light brown down colour—(females)—0.

The three chicks classified in group 2 were all males and six of the forty-nine put in group 6 were females, thus accounting for nine of the twelve errors.

From this case of the three males with two black head spots with indistinct medium brown back striping, a significant point was illustrated. In addition to the indistinct brown stripes there were also two white stripes just inside the latter. Thus when both the indistinct medium brown and white striping occurred together the chick involved was a male.

In the case of the six female chicks incorrectly identified, they had uniform backs. Two had faintly mottled heads while the other four had very faint brown head stripes.

It was also worthy of note that in this hatch no chicks were put into group 10. It seemed that as more was learned about the T and I head stripe on the female chicks, fewer chicks had to be put into this group.

Eighth hatch:

This final hatch for the year was auto-sexed with the accuracy of 94.0% as shown in Table I. Details on the grouping were as follows:

1. One or two head spots with clear back striping—(females)—13%.
2. One or two head spots with a medium brown back—(females)—0.
3. No spots with clear back striping—(females)-7%.
4. Medium to dark brown coloured down—(females)-4%.
5. Greyish brown coloured down—(males)-0.
6. White head spots—(males)-18%.
7. Light coloured head and back, often mottled—(males)-14%.
8. T- or I-shaped head stripe with a medium coloured back—(females)-27%.
9. Light coloured head and body with two back white stripes—(males)-17%.
10. Uniform medium or light brown down colour—(females)-0.

Three of the six males incorrectly sexed had definite head stripes which were somewhat shorter than similar female stripes. The errors made on the remaining three males and six females could be understood, and were not confined to any particular group.

All hatches in 1946:

For the whole year the auto-sexing accuracy was 78.9% as shown in Table I. In estimating the percentage of chicks falling into each group only the last three hatches were considered, since just prior to the sixth hatch, several modifications were made in the system. The final grouping with sex and percentages falling into each one were as follows:

1. One or two head spots with clear back striping—
2. One or two head spots with a medium brown back--
   (females)-3%.
3. No spots with clear back striping--(females)-5%.
4. Medium to dark brown coloured down--(females)-5%.
5. Greyish brown coloured down--(males)-0.
6. White head spots--(males)-14%.
7. Light coloured head and back, often mottled--
   (males)-25%.
8. T- or I-shaped head stripe with a medium coloured
   back--(females)-18%.
9. Light coloured head and body with two white back
   stripes--(males)-11%.
10. Uniform medium or light brown down colour--
    (females)-6%.

The auto-sexing accuracy was noticeably increased as the
number of chicks in groups 2, 10 and to a less extent 7, were
reduced and those in the more easily "auto-sexable" groups 3,
6, 8, and 9 were increased. This regrouping was not due to
any significant change in the breeding program but rather
the changes seemed to be made as the author became more
familiar with the colour patterns.

The three tables for the 1946 breeding season, to be
found in the appendix, are primarily used to show the
development of the technique used in auto-sexing the chicks.

Though on the chicks from the various parental males
there were some differences in the auto-sexing accuracy, these
cannot be regarded as significant since not all the males had chicks hatched from them all through the season when the accuracy was being improved. On the other hand it was noteworthy that the auto-sexing accuracy from the medium and medium to dark females which had chicks all through the year was practically the same. Thus despite the impression given at the beginning of the year that those chicks with head and back brown or black stripes were easier to sex than the brown chicks, the figures in Table III "By colour group of female parent", do not bear this out. The percentage of accuracy with the chicks from the light females was lower but this was likely due to the rather late discovery of the significance of the female brown head stripe for separating the light brown chicks.

No particular significance could be attached to the fact that there was some difference in the auto-sexing accuracies between the pens except pen 17 where the fifth hatch was the first one handled.

Material (1947)

In January 1947 among the hundred and five pullets, there were eighty-eight birds of known parents, four whose dams were known and thirteen of unknown ancestry from pure Redbar males crossed with Record of Performance, Rhode Island Red females. Twelve hens with the best breeding and laying records from the
previous year were kept over and included in the breeding stock.

Out of thirty-six cockerels kept until eight months of age, ten were selected for breeding. No males from the '46 season were kept.

Procedure (1947)

In the second year of the study (1947), the task was to improve upon the technique of distinction between the colour pattern of the sexes in order to develop a more accurate key if possible. The medium and light brown chicks for example were sometimes among those that were difficult to sex. Furthermore, it was not known just what constituted a female head stripe and when it was short enough to distinguish the chick as a male.

At the same time that these problems were being attacked, a program for the improvement of the breed was carried on. Since this year the birds were entered under the Record of Performance policy, this plan conformed with the Dominion Government regulations. Besides a pen of the twelve best birds from last year, three more pens of pullets were selected and mated to individual males. Further specific details on the procedure are given below.

A. Objects of the breeding plan:

1. To concentrate upon the use of parental stock which
produce desirably coloured, and easily auto-sexed chicks. Thus the three colour groupings, light, medium and medium to dark were dropped.

2. To obtain a sufficient number of chicks from at least four males for further multiplication within the flock, without breeding too closely.

3. To concentrate upon the study of the inheritance of the characteristics which in the first year's work had been shown to be important in sexing the chicks.

4. To again rotate the males so that the poor male and female breeders might be eliminated. This has the advantage that at the end of the year, offspring from all of the best breeders will be available for next year. Furthermore, the transmission of such individual characters as smokiness and livability can be studied. A reduction in the number of pedigree chicks is involved but the advantages outweigh the disadvantages.

5. To try to increase the size of the families over the first year by collecting eggs for three hatches rather than only two, before moving the males.

6. To use a vigorous, fast feathering, well barred, Grade A blocky male Redbar free from smokiness, on a pen of proven Record of Performance, Rhode Island Red hens. The offspring would be individually pedigreed and then should the Redbars prove to be deficient in certain characteristics that this new blood could
improve, this material can be introduced in the 1948 breeding program.

7. To eliminate the use of Ridgeway's Colour Standard now that the shape of the spots and stripes have proved to be more important than the colour in sexing the chicks.

B. Selection of the breeding stock:

1. Females.

In selecting the best twelve birds for pen 9 from last year's breeding pullets, the more important factors utilized were last year's hatchability and characteristics of the progeny with regard to early feathering and auto-sexing. Furthermore, the birds had to be Grade A meat type and free of smokiness though black ticking on the hackle was permitted. Also preference was given to good layers of large tinted eggs.

In the three pullet pens the objective was to obtain the best representatives from as many of last year's families as possible. Since those that were not selected would be kept under Record of Performance they would not be lost and if their sister or sisters proved to have exceptional breeding qualities, they could be used the following year.

Owing to the fact that the egg records of the hundred and five pullets were very meagre, the selection had to be made upon the basis of the morphological characteristics of the pullets themselves and where
possible upon the records of their parents.

Where applicable the morphological characteristics were the same as those used in the selection of the hens in pen 9, though where possible more stress was laid on the clarity of the barring. The one exception was that of smokiness which was allowed on those birds in pen 20.

Again the ancestral characteristics of both the males and the females were similar to those used in the selection of the hens for pen 9. Where particularly poor auto-sexing qualities, or small numbers of mature birds per family were in evidence, their offspring were avoided. In this connection since fifty of the ninety-two pedigreed pullets came from the male L.B. 798, his progeny was very largely used, despite the fact that he was transmitting some smokiness.

After thus placing thirteen, twelve and twelve birds respectively in pens 20, 22 and 25, the remaining sixty-eight pullets were left in pen 27. They were trapped for egg production but no attempt was made to individually pedigree their progeny.

2. Males.

On December 13th, 1946 when the birds were seven to nine months old, all of the cockerels on the farm were handled. On the basis of good weight, vigour, body conformation and colouring, the best twenty-one from the sixty birds were taken.

After examination of the records of the parents and
using the same technique as for the pullets, these were again reduced by selection to nine. To avoid further unnecessary inbreeding, the males to be put into pens 9, 20, 22 and 25, were not selected until all the pullets had been assigned to their particular breeding pens. By January 30th the four males were in their respective pens and the remaining five to be used as spairs were in pen 27.

It is important to note that at this point in the development of the Redbars, only a limited emphasis can justifiably be put on the colour markings of the male and female breeding stock. Otherwise, other qualities such as egg laying and hatchability are liable to deteriorate to the extent that the birds are not worth keeping.

C. Movement of the birds during the breeding season:

A similar practice to last year was followed, subject to modifications resulting from the birds being entered under the Record of Performance policy. Since two hatches from each mating had not given large enough families last year, the males were not moved until eggs had been collected for three fourteen-day periods this season. Also the collection of individually pedigreed eggs was stopped for fourteen days after the males were moved around. Nevertheless for additional data in auto-sexing the chicks, these eggs were hatched.

Thus for forty-two days, starting from February 10th,
pedigreed eggs were collected. At this time the males L.B. 82285 and L.B. 82410 were moved around, while L.B. 82267 because of infertility and L.B. 82527 because of the transmission of considerable slow feathering, were returned to pen 27. L.B. 82286 and L.B. 82534 were substituted. On the fifty-sixth day the eggs were again pedigreed. This season due to the greater interval between the movement of the males, a second movement of the males was not possible.

D. Estimated number of chicks that this system should produce:

Again on the basis of four chicks per hatch from each female, forty-nine birds should produce one hundred and ninety-six chicks per hatch. Thus from the five pedigreed hatches, nine hundred and eighty chicks might be expected.

Since this year incubator space was at a premium non-pedigreed Redbar eggs could only be hatched when space was available. Hence an estimate of the number of chicks from these eggs was impossible. As it was, poor weather in January led to an over-estimate of the number of pedigree chicks that would be hatched.

E. Other breeding plans:

This year in contrast to the season just past, in order to introduce some new blood, it seemed advisable to mate a good Redbar male, with Rhode Island Red hens that had qualified as Record of Performance birds. By this means the egg laying qualities of the Redbars might be improved without losing the barring of the female offspring.
Unfortunately the movement of the breeding houses and inclement weather in January made the breeding season so late that this plan could not be carried out at the end of the season.

F. Data collected:

On account of the larger number of good birds available in 1947, from the start, the notes on both the cockerels and pullets had to be laid out systematically. Since there was also a considerable reduction, with a few modifications, in the descriptions of the parental stock, the notes taken are again listed below.

In describing the chicks, with the exception of the first hatch, there were many fewer details noted. Since the previous year's work had shown that there were differences between male and female chicks, it was not considered necessary to continue auto-sexing on a family basis. Accordingly the sexing was conducted with the chicks all mixed up. Those used for the second and ensuing hatches were given:

a. On parental stock.

1. Identification number or numbers.
2. Date hatched.
3. Male and female parents where known.
4. Sex.
5. Weight at maturity.
7. General shade of colouring.
8. Clarity of barring.
9. Presence of smokiness in the hackle and on the back.
11. Rate of feathering from the growing period.
12. Suitability for breeding stock—vigour and health.
13. Fertility results.
15. Laying results.
16. Size of egg.
17. Strength of shell.
18. Egg colour.
19. Shape of egg.

b. On chicks hatched.
   1. Chick wing band number.
   2. Male and female parents, where known.
   3. Date hatched.
   4. Category—refers to the group the chick falls into in the sexing key.
   5. Presence or absence of smokiness in the hackle and back.
   6. Rate of feathering.
   7. Presence or absence of a light wing web.
8. Suggested sex of chick when mixed in with the rest of the chicks in the hatch.
9. Actual sex as determined upon death or when mature.
10. Disposal of the chick.
11. Miscellaneous remarks for any unusual markings on the particular chick.

Again for ease in analysis, the data were taken down in separate columns. However, instead of keeping the records of the chicks from each female parent on separate pages, all notes were made in sequence so that a hatch was covered in four to six pages, each chick being assigned to a line.

In 1946 the chicks were both leg and wing-banded with numbers respectively, in different series. To simplify the system of identification in 1947 a series of a thousand wing bands was obtained in duplicate thus avoiding the use of the round type of leg bands that had to be transferred into the wings of the birds as they grew.

Results and discussion (1947)

On all hatches.

On the basis of the analysis of the data obtained in 1946, the auto-sexing key was again modified at the beginning of the 1947 breeding season. No further changes were found to be necessary except after the fifth hatch, at
which time two of the groups were found to be superfluous since the chicks in these groups could be classified equally as well in those of "la" and "3a" respectively. The down colours of the groups in this final key, with the sex, the percentage of chicks classified in each group and the number of errors in brackets after each one, were as follows:

Females.

1. Head with uniform and unbroken light, medium or medium to dark brown colour with one of the following:
   a. Back of a uniform light, medium or medium to dark brown colour--7%, (11).
   b. Back with a broad, central medium to dark brown back stripe with or without two narrower parallel hip stripes. All three stripes may have margins that are black--.2%, (0).

2. Head with a faint to distinct light, medium or dark brown stripe passing over the crown of the chick with one of the following:
   a. Back of a uniform light, medium or medium to dark brown colour--26%, (10).
   b. Back with a broad, medium to dark brown central back stripe with or without two narrower parallel hip stripes, with or without black margins--16%, (4).

Males.

3. Generally lighter head and back down colour, the darkest showing light to medium brown with one or
many of the following characteristics:

a. White spot on the head—12%, (6).
b. Mottled head—4%, (4).
c. Mottled back—6%, (5).
d. Two whitish back stripes that are lighter than the ground colour over the hips, to be found just inside the position of the hip stripes seen on females—16%, (8).

4. Faint to distinct, diffuse and light to medium brown head stripe, (viz—linear T- or I-shaped) broken off on the crown of the head of the chick and often in the form of a horseshoe at this point. The rest of the head with a comparatively uniform light or light to medium ground colour or mottled. The down colours on the backs include one or more of the following:

a. Mottled down—3%, (4).
b. Two whitish back stripes that are lighter than the ground colour over the hips, to be found just inside the position of the hip stripes seen on females—2%, (0).
c. Comparatively uniform light or light to medium brown down colour—2%, (4).

5. Very light coloured chick with no clear markings—6%, (1).

Note:

1. No notice was taken of one or two black head spots on a chick since other characteristics about it
determined its sex.

2. A female head stripe took precedence over a whitish head spot forward of this stripe, a mottled head, or a back with two whitish stripes.

3. A back with a broad, central, medium to dark brown back stripe with or without two narrower parallel hip stripes, took precedence over two whitish back stripes.

In the case of group 3, 4% of the chicks had white head spots and mottled backs, 10% had white head spots and two whitish head stripes, 2% had mottled heads and mottled backs and 2% had mottled heads and two whitish head stripes. To include these in the above table the percentages were halved and were credited to the percentages of the two sub groups concerned. Thus in the case of the 10% with white head spots and two whitish back stripes, 5% was added to the total of the males with the white head spots and 5% was added to those with the two whitish back stripes.

Using this key, the auto-sexing accuracy for the second, third, fourth, fifth and sixth hatches, as shown in table IV in the appendix were 91.4%, 98.5%, 94.4%, 91.5%, and 93.7% respectively. In the first hatch 92.2% of the chicks were correctly identified for an accuracy of 93.6% for the eight hundred and eighty-seven chicks of known sexes. All hatches were similarly handled except for those of three and five. In the case of the third hatch another person was being shown how to use the key in auto-sexing the chicks. Thus it
was quite probable that the greater attention thereby paid to each individual chick, resulted in the greater auto-sexing accuracy.

On the other hand, hatch five was the only one handled out in the brooder house, the remainder having been auto-sexed in the incubator room under artificial light. It was noticed afterward that the individual who was taking the notes for the author, had inadvertently been blocking off the sunlight. This had the tendency of making the mottled male chicks harder to pick out. Five of the nine errors made in this hatch have since been attributed to this cause.

The figures given in brackets after each group in the key described above, illustrated that the number of errors were not confined to one group and occurred approximately in proportion to the percentage of the birds classified in the particular group. Thus these figures would seem to indicate that no specific characteristic used to auto-sex the chick was responsible for the errors.

This year particular attention was given to the wings of the Redbar chicks. Dr. R. George Jaap had reported that, depending on the strain of Rhode Island Red chicks, they could be colour sexed with an accuracy of 90 to 95% by his wing-spot method. This identification mark consisted of a white or yellowish white spot on top of the wing in the margin of the wing web in the baby cockerels. Among the nine hundred and sixty-nine Redbar chicks handled this year twenty-seven male and two female chicks had this white wing-spot.
Also the wing webs on seventy-seven males and sixty-five females were too light to distinguish the white wing-spot if it were present in the wing web. Thus it was concluded that unless the wing web-spot was clearly present that this characteristic was of no help in auto-sexing the Redbar chicks.

As shown in table V in the appendix, there was little difference between the males in regard to the auto-sexing qualities of their chicks. L.B. 82286 and L.B. 82534 represented the two extremes and with the small numbers of thirty-six and forty-two chicks respectively, there was only 7.5% accuracy difference between them.

This year one of the objectives was to obtain further data on the difference between the female and male brown head stripe. While the author is still not convinced that all has been learned about their differences, reference to the colour prints to be found in these results, illustrate some of them. For example the third chick from the left in "2a" showed a typical female brown head stripe while the second chick in "4c" showed a typical male head stripe. Whereas the female brown head stripe was narrow, long, T-shaped and usually reasonably clearly defined, the male brown head stripe had a tendency to be fainter, broader, more diffuse, shorter and tended to end in the form of a horseshoe.

With the exception of the two whitish back stripes, the remainder of the characteristics show quite clearly in the colour prints. The two whitish back stripes are best seen on
the back of the second male in "3c".

Conclusions.

1. At the beginning of the 1946 breeding season it was discovered that there were differences in the down colour of Redbar chicks.

2. By the end of the 1946 breeding season, the females were found to have one or more of the following characteristics: uniformity of colour, brown head stripe and a back stripe or stripes. The males on the other hand had one or more of the following: a very light down colour, a white head spot, a mottled head, two whitish back stripes, a mottled back and a shortened form of the female head stripe.

3. At the beginning of the 1946 breeding season the auto-sexing accuracy was only 62.1%. With the second, third and succeeding hatches the improvements were 68.8%, 76.3%, 82.2%, 80.4% and finally on the basis of the characteristics given in '2' above, the last hatch for the 1946 season was auto-sexed with an accuracy of 94.0%.

4. The auto-sexing accuracy for the whole of the 1946 season on the basis of the one thousand and twenty-nine chicks handled was 80.0%.

5. Chicks from the parents with smokiness in the undercover of their feathers were not easier to auto-sex than those
from the parents without the smokiness.

6. During the 1947 breeding season the key used to auto-sex the chicks contained the same characteristics as those in '2' above with a modification to the male brown head stripe. Typically the latter appeared to be rather indistinct, broad, diffuse, short and to end in the form of a horseshoe. This point emphasized the fact that the shape of a stripe was as important as or often more important than the colour.

7. Using the key containing the above characteristics, during the 1947 breeding season on the eight hundred and eighty-seven chicks with completed results, the auto-sexing accuracy was 93.6%.

8. The fifty-seven errors which were made during the 1947 season in auto-sexing the chicks occurred approximately in proportion to the percentage of the birds classified in the particular group.

9. Good lighting was shown to be essential for the accurate auto-sexing of the chicks.

10. Except where clearly present, the white wing-spot found on some of the males, was of no help in the auto-sexing of the Redbar chicks.

Summary

The study on the colour pattern of the Redbar chicks was
started in the fall of 1945. The objects were primarily to ascertain if the male and female chicks could be distinguished and if so, to devise a system to auto-sex them. At the same time a breeding program was undertaken with individual pedigreeing to improve the economic qualities of the breed as well as to try and discover the inheritance of any of the characteristics that might help in the auto-sexing of the chicks.

During the 1946 breeding season, one thousand and eighty chicks from thirty-six female and four male parents in four pens were handled. The parents were sub-divided equally into light, medium and medium to dark brown groups depending on the density of the brown colour and the presence or absence of smokiness in the undercolour. Seventeen characteristics were described on each parental bird and forty-one on each individual chick. It was found that there were differences between the down colour of the males and females and the auto-sexing accuracy was improved from the initial 62.1% for the first hatch to 94.0% for the last hatch with an accuracy of 80.0% for the whole season. Certain families were auto-sexed with greater accuracy than others while the chicks from those parents with smokiness in the undercolour were found to be no easier to auto-sex than the chicks from the parents of lighter undercolour. The shape of the male and female head stripes were shown to be more important than the colour.

During the 1947 breeding season the objectives were to
carry on the breeding work of the previous season and to attempt to improve the auto-sexing accuracy by studying the more complicated characteristics such as the shortened head stripe of the male. Records were completed on five hundred and forty-two pedigreed chicks from thirty-eight female and six male parents in four pens and on three hundred and forty-five non-pedigreed chicks from pure Redbars in a fifth pen. The parents were not sub-divided this year. Twenty-two characteristics were described on each parental bird while the number on the chicks was reduced to eleven. Using the key given below, the auto-sexing accuracy varied from 91.4% to 98.5% with 93.6% accuracy for the whole season. The fifty-seven errors made on the total of eight hundred and eighty-seven chicks were evenly distributed and indicated that no particular sub-group in the key was at fault. Good lighting was shown to be particularly important in picking out the mottled males as opposed to the light uniformly coloured brown females. Only twenty-seven males of the eight hundred and eighty-seven chicks had a definite white wing-spot so it was concluded that this characteristic unless clearly defined was of little help in auto-sexing the chicks. The male brown head stripe was shown to be faint, broad, diffuse and short and tended to end in the form of a horseshoe.

In the future it may be possible to improve the accuracy of the key by further study and testing of the birds. Further experimentation will be necessary to show
whether the auto-sexing accuracy can be improved or not by breeding from selected families.

The key for auto-sexing the Redbar chicks finally decided upon was as follows:

Females.
1. Head with uniform and unbroken light, medium or medium to dark brown colour with one of the following:
   a. Back of a uniform light, medium or medium to dark brown colour.
   b. Back with a broad, central medium to dark brown back stripe with or without two narrower parallel hip stripes. All three stripes may have margins that are black.
2. Head with a faint to distinct, light, medium or dark brown stripe passing over the crown of the chick with one of the following:
   a. Back of a uniform light, medium or medium to dark brown colour.
   b. Back with a broad, medium to dark brown, central back stripe with or without two narrower parallel hip stripes, with or without black margins.

Males.
3. Generally lighter head and back down colour, the darkest showing light to medium brown with one or many of the following characteristics:
   a. White spot on the head.
b. Mottled head.
c. Mottled back.
d. Two whitish back stripes that are lighter than the ground colour over the hips, to be found just inside the position of the hip stripes seen on females.

4. Faint to distinct, diffuse and light to medium brown head stripe, (viz—linear T- or I-shaped) broken off on the crown of the head of the chick and often in the form of a horseshoe at this point. The rest of the head with a comparatively uniform light or light to medium ground colour or mottled. The down colours on the backs include one or more of the following:
   a. Mottled down.
   b. Two whitish back stripes that are lighter than the ground colour over the hips, to be found just inside the position of the hip stripes seen on females.
   c. Comparatively uniform light or light to medium brown down colour.

5. Very light coloured chick with no clear markings.

Note:

1. No notice was taken of one or two black head spots on a chick since other characteristics about it determined its sex.

2. A female head stripe took precedence over a whitish head spot forward of this stripe, a mottled head or
a back with two whitish stripes.

3. A back with a broad central medium to dark brown back stripe with or without two narrower parallel hip stripes took precedence over two whitish back stripes.
References


Acknowledgements

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He also wishes to express his appreciation to Mr. N. Barton whose co-operation in taking both black and white as well as coloured pictures of the chicks and the mature birds, when they were wanted, has greatly helped in the preparation of this thesis.
Appendix
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**Note:** Table I provides the seeded numbers for each hatch across different batches, with a focus on the accuracy percentage. The data includes the total seeds seeded in each group and the percentage of accuracy based on the seeded hatch counts.
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### TABLE III

#### SEXING ACCURACY FOR HENRIGS (1946)

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#### Totals and Percentage Accuracies

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#### SCDING ACCURACY FOR REDRUMS [1947]

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**Per cent acc.:**

- 100.0

**Note:** Includes the totals from the non-sighted first batch.
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TABLE V

SEXING ACCURACY FOR NEBRASKA (1947)

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Totals: 150 160 170 180 190 200 210

Percentage Accuracy: 99.2 99.3 99.6 99.6 100.0 99.5 94.1
COLOURS USED IN DESCRIBING THE CHICKS
FROM RIDGEWAY'S COLOUR STANDARD

1. Deep Chrome
2. Amber Yellow
3. Orange Rufus
4. Ochraceous Orange
5. Light Cadmium
6. Ferruginous Maroon
7. Mars Yellow
8. Mahogany Brown
9. Bay
10. Orange Rufus
11. English Red
12. Kaiser Brown
13. Hazel Brown
14. Dragon's Blood Red
15. Hessian Brown
16. Hazel
17. Zinc Orange
18. Russet
19. Vinaceous Tawny
20. Chocolate
21. Terra Cotta
22. Light Quaker Drab
23. Deep Mouse Gray
24. Dark Quaker Drab
25. Black