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DISTINGUISHING SEX OF CHICKS AT HATCHING

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DISTINGUISHING SEX OF CHICK AT HATCHING[1]

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NEED FOR METHODS

The need for a method of identifying the sexes of poultry at hatching has long been felt. In most other animals there are external characteristics that make the sexes readily distinguishable. However, in the chicken there are no easily recognized marks for sex until it is at least a few weeks old. With the development of the hatchery industry, this need has been emphasized. Due to the specialization in the industry, there is a demand for chicks of one sex. If the poultryman who buys chicks primarily for replenishing his supply of layers can be guaranteed 100 percent females, his facilities for brooding may be reduced by half. In certain regions during the late season the males are reared at a loss, so that it would be more profitable to kill them at hatching. The broiler industry is becoming an important phase of poultry husbandry, and since it is known that males grow more rapidly than females they are quite acceptable to this branch of the industry. Capon producers are also glad to be able to purchase male chicks exclusively.

The first method of sex identification in day-old chicks to be used commercially was that utilizing sex-linkage in crossbreds. Punnett (1919) listed crosses in which the sex in the offspring could be recognized by down color. Some years later the so-called Japanese or vent method of sex identification came into use.

VIGOR OF CROSSBREDS[2]

The exceptional sturdiness of first generation crossbred animals has long been recognized by breeders of livestock, and the practice of keeping such crossbreds is common. In the past decade there has been an increased utilization of crossbred poultry. In general it can be said that any stimulation derived from the crossing of breeds and varieties of poultry is confined to the first generation. The use of crossbreds themselves as breeders is not to be encouraged. Most of the methods of identification of sex at hatching have involved crossing of breeds and varieties of chickens.

Considerable data have been accumulated in the past few years for the comparison of the vigor of crossbred and purebred poultry. Data obtained at the Kansas Agricultural Experiment Station are presented in Table 1. This table carries data obtained in five different years and four different crosses. For each year results were available from reciprocal crosses between the two breeds involved. Data are given on chick and adult mor-

[1]Contribution No. 145, Department of Poultry Husbandry.

[2]More detailed data on the vigor and popularity of poultry crossbreds are found in Technical Bulletin 52 entitled "The Crossbreeding of Poultry" and published by the Kansas Agricultural Experiment Station.

tality; chick growth; age at sexual maturity; egg and adult weight; and egg production. Different strains of the same breeds are seen to vary greatly in the characteristics used as a measure of vigor.

As a whole, the data in Table 1 support the view that crossbreeding stimulates the vigor of the resulting offspring. In many instances the stimulation is not great but the cumulative gains from consideration of all characteristics are of economic significance. There is considerable variability in the results of crossbreeding but in many instances there is a tendency to combine in crossbreds the more desirable characteristics of the two breeds utilized. The reciprocal matings show wide differences with respect to some characteristics. Comparing roughly the data for reciprocal matings and considering the results as a whole it will be seen that in a large majority of the comparisons the crossbreds were equal to or better than the superior of the two parent stocks.

TABLE 1. COMPARISON OF RECIPROCAL CROSSES BETWEEN VARIOUS PURE BREEDS TO THE PUREBREDS THEMSELVES.

	Per-cent chick mor-tality	Mean 8-week weight*	Mean age at ma-turity	Mean egg weight	Mean egg pro-duction	Mean adult weight	Per-cent adult mor-tality
1928							
White Leghorn (Strain A)	6.0	547	170	51.5	212	1763	31.5
Rhode Island Red (Strain F)	7.0	627	242	54.4	172	2602	25.5
White Leghorn male by Rhode Island Red female	3.1	647	175	54.6	214	2160	42.9
Rhode Island Red male by White Leghorn female	0.1	611	206	54.5	201	2065	18.3
1936							
White Leghorn (Strain B)	2.9	488	202	55.4	200	1831	73.6
Rhode Island Red (Strain G)	14.7	509	230	56.4	210	2594	71.2
White Leghorn male by Rhode Island Red female	2.9	493	215	55.8	230	2291	43.1
Rhode Island Red male by White Leghorn female	3.1	525	217	58.2	202	2215	48.8
1934							
White Leghorn (Strain C)	4.9	474	180	53.4	194	1763	53.8
Australorp	26.9	558	260	56.6	152	2525	66.7
White Leghorn male by Australorp female	2.9	457	197	53.9	232	1942	57.6
Australorp male by White Leghorn female	4.8	613	188	57.7	187	2195	44.1
1937							
White Leghorn	10.1	491	205	54.6	170	1642	73.6
New Hampshire	10.7	701	264	60.6	124	2471	38.2
White Leghorn male by New Hampshire female	4.3	596	208	58.0	173	2054	50.0
New Hampshire male by White Leghorn female	5.8	633	221	59.3	168	2098	36.4
1939							
Barred Plymouth Rock	5.8	532	232	55.6	154	2513	66.7
Rhode Island Red (Strain G)	8.7	553	218	54.1	177	2545	52.3
Barred Plymouth Rock male by Rhode Island Red female	5.9	569	216	53.9	188	2586	50.0
Rhode Island Red male by Barred Plymouth Rock female	2.0	621	208	57.9	199	2881	33.8

*All weights are in grams.

It is seen that not all crossbreds are superior to purebreds but in general their sturdiness ranks them above the purebreds used in the study. It is evident that there is a reflection in their offspring of the qualities of the purebreds used in the production of the crossbreds. Crossbreds appeal most to those poultrymen who have no breeding program of their own but depend upon the hatcheryman for the replenishment of their stock. Crossbreds are extensively used by broiler producers who find the high viability and uniform growth a valuable asset. So in addition to the advantage of being able to identify sex at hatching in some crossbreds, their vigor is also a recommendation for them.

POPULARITY OF CROSSBREDS

The writer contacted through a questionnaire 52 hatcherymen who were selling crossbred chicks, to learn the crosses which were proving most popular. About half the replies came from Kansas hatcherymen and the rest from other states. Each hatcheryman was asked to name his three most popular crosses in order of their popularity and to list all the crosses he was making. In each rating the commonly called Austra-Whites, resulting from the mating of the Australorp male with the White Leghorn female, out-ranked all others. Thirty-five of the reporting hatcherymen listed this cross and 31 ranked it as their most popular crossbred. Other popular crosses were reciprocal matings between Barred Plymouth Rocks and Rhode Island Reds and between White Plymouth Rocks and White Leghorns. The Black Minorca male mated to White Leghorn females was also a popular cross. In many of the more popular crosses including that producing the Austra-Whites sex cannot be identified at hatching except by the Japanese method.

SEX IDENTIFICATION IN PUREBREDS

BARRED PLYMOUTH ROCKS

It had long been recognized that the size of the light head spots in Barred Plymouth Rocks varied in the two sexes. The males tend to have larger headspots and the females to have darker colored legs. However, this method has not been sufficiently accurate to be of much commercial value.

Quinn and Knox (1939) attempted to separate the sexes of Barred Plymouth Rocks by means of the intensity of the black pigment in the down and legs. In different lots of chicks they report 83.5, 86.1 and 91.8 percent accuracy.

Jerome (1939) describes a method of sex identification in Barred Plymouth Rocks based upon the regularity of the outline of the head spot rather than the size of the spot. Those chicks having headspots irregular in outline and scattered in appearance are males while the females tend to have headspots with

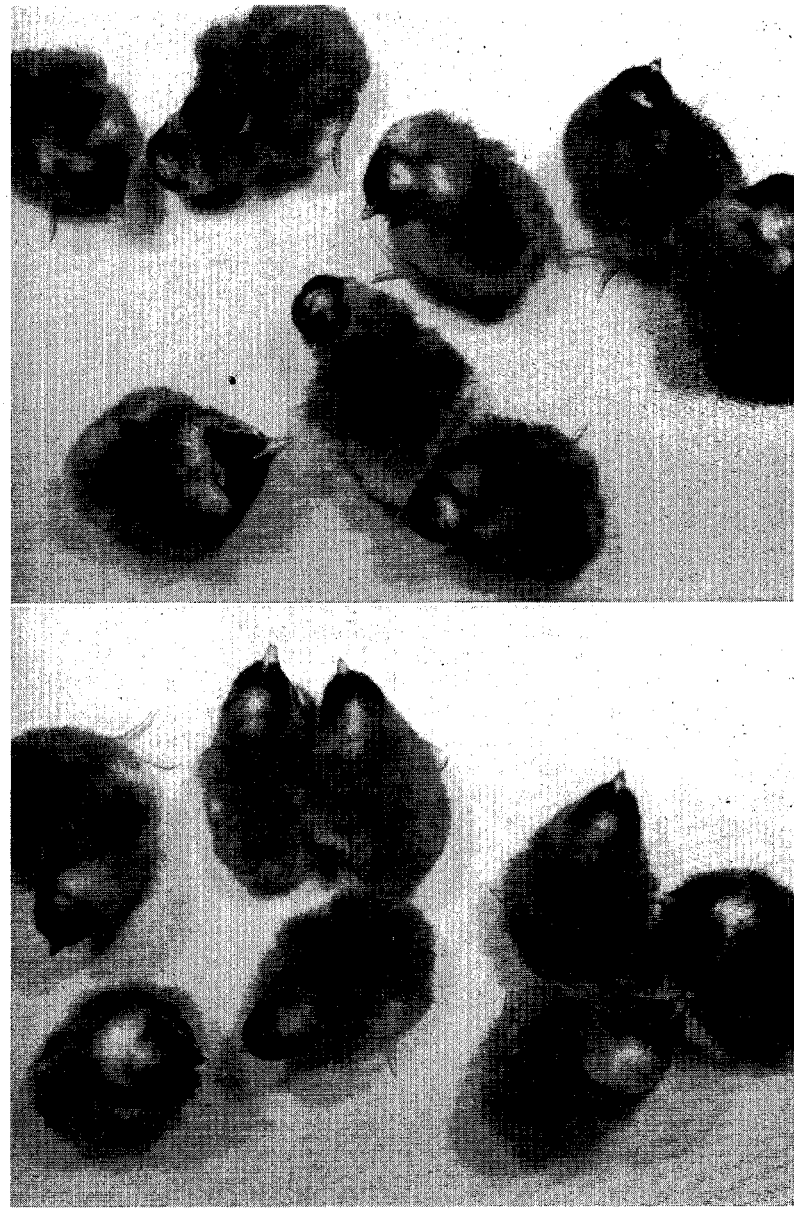

Fig. 1.—Groups of male (top) and female (lower) Barred Plymouth Rock chicks. There is considerable variation in the shape of the head spot in both sexes but the spot in females is much more regular in outline and compact than in the males. Note that the male head spots are more dispersed and tend to form an indistinct circle extending down on the neck. (Photos reproduced through the courtesy of the Department of Agriculture of the Dominion of Canada.)

more regular outlines. The author claimed an accuracy of 90 percent or better when considering only the headspot and 95 percent if the color of the legs was included in the consideration. The Canadian Department of Agriculture (Anonymous 1941) issues an excellently illustrated bulletin describing the method. It is stated in the bulletin that the method "is widely practiced in Barred Rock chicks by commercial chick sexers." Sex identification is based upon outline of head spot, color of legs and shade of down color. There are several types of male and female head spots some of which are shown in Figure 1.

RHODE ISLAND REDS

Byerly and Quinn (1936) report that there is some sex difference in the down of Rhode Island Red chicks. The females tend to show spots or stripes of darker color in the down on the head and back. By separating the chicks into groups with and without spots or stripes sex was identified with 82 percent accuracy.

AUTOSEXING BREEDS

Punnett and Pease (1930) were the first to produce a breed in which sex could be recognized with accuracy at hatching. This breed, Cambar, was the result of crossing Barred Plymouth Rocks and the Campine. The males have much lighter colored heads than do the females. It is now known that this condition can be brought about when bringing the barring factor into any variety with brown striped down. Legbars are the result of bringing the barring factor into Brown Leghorns.

Considerable interest is now expressed in these so-called autosexing breeds and it is probable that various types will be available in the next few years. The chief advantage of this method of sex identification is that it requires no special crosses when once the breed is established. When autosexing breeds with economic characteristics equal to those of the well established breeds, are available, they will probably be accepted by poultrymen. As yet, such autosexing breeds are not available.

FEATHERING STRAINS

The possibility of the use of rate of feathering as a basis of sex identification was first called to attention by the writer (1930). The method was first used for sex identification in day-old crossbred chicks and is more fully discussed under that heading later in this publication. However, in more recent years the wing feathering method is being used extensively for sexing day-old purebred chicks. The method is especially popular in Canada at present. It requires the development of early and late feathering strains of the breed being sexed. This may be done either by selection or crossbreeding.

Most of the larger breeds (other than Mediterraneans) are of the sex-linked late feathering type. However, some early feathering chicks appear in these breeds and proper selection of them makes possible the establishment of early feathering strains of the larger breeds. In the case of most Mediterranean breeds such as the White Leghorn it has been necessary to crossbreed to bring late feathering into these breeds. Following this, careful selection and back crossing are practiced to reestablish the other characteristics of the Leghorn breed. When both early and late feathering strains are available in any breed, sexing is possible by mating males from the early feathering strain to females of the late feathering. From such a mating the males will be late feathering and the females early feathering. Methods of identification of early and late feathering in day-old chicks are described later in this bulletin.

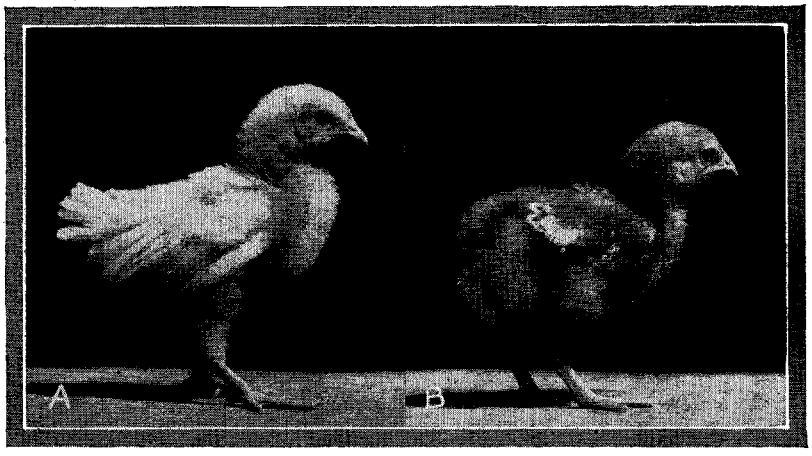

Fig. 2.—Showing difference between sex-linked early and late feathering at the 8- to 14-day age. Note absence of tail in late feathering chick. Late feathering chick has wings one-half to three-fourths the length of the body while the early feathering chick has wing length equal to or greater than body length. (A) Early feathering White Leghorn. (B) Late feathering Rhode Island Red.

Aside from their use in sexing there is considerable interest in developing early feathering strains of the larger breeds in order to avoid the problem of obtaining satisfactory feathering in broilers and fryers. The "barebacks" occurring in males of the larger breeds frequently are sources of considerable loss when they are marketed. In many of the larger breeds early feathering strains are being developed for the purpose of overcoming the broiler feathering problem. It is now known that early feathering can be introduced into a breed without affecting any of its other economic characteristics.

The procedure to be followed in developing early feathering strains of the larger breeds is first to examine chicks of the strain when they are from 9 to 12 days old and mark those which have well developed tails, and wings approximately equal to the length of the body. This will be the feathering typical of most White Leghorns. Some strains of the large breeds will have no early feathering chicks. If the early feathering chicks are scarce in a strain, those marked are likely to be females. If both male and female early feathering chicks are found and later mated, their offspring will be pure for early feathering and the strain will breed true for the characteristic thereafter.

If only early feathering female chicks are found they may be mated to a male of their variety in order to obtain early feathering males. Their sons will be late feathering but if these sons are mated to any early feathering females they will produce some males and females which are early feathering.

Poultrymen interested in the production of early feathering strains frequently do not recognize the necessity of examination of the chicks at 9 to 12 days of age. They have too often relied upon one examination made at the broiler stage. Birds showing good feathering at the broiler stage will not necessarily breed true for good feathering. However, if only birds are mated which have well developed tails at the 9- to 12-day age and good feathering at the broiler age, the "bareback" problem will be overcome. After one mating of this type only limited further selection need be made unless new blood is introduced. If new blood is to be brought in it should be done through females and only their female offspring saved. Such female offspring will be pure for early feathering provided their tails are well developed at ten days.

JAPENESE OR VENT METHOD

This method, probably first used by the Chinese was introduced into this country by the Japanese and thus gets its name. It requires the examination of the vent or cloaca of the day-old chick, in which slight anatomical differences are present in the sexes. Due to the smallness of the vent at this age, the differences are detectable only by careful examination by an experienced operator. The skill in the technique is in knowing how to make the proper application of pressure on the abdomen of the chick for exposing the anatomical differences. Accuracy of sex-identification and speed of operation come only after considerable practice. Accuracy is above 95 percent in skilled sexers and this method is the one most widely used in the United States.

SEX IDENTIFICATION IN CROSSBREDS (SEX-LINKED METHOD)

The possibility of the utilization of sex-linked characteristics in chickens for the identification of sex in day-old cross-

breds was first called attention to by Punnett (1919) of England. He recommended the utilization of down color and the writer later suggested the use of rate of feathering characteristics for the same purpose.

The four longer known characteristics of poultry which exhibit the sex-linked type of inheritance are gold and silver color, barring and non-barring, slaty and non-slaty shank color, and early and late chick feathering. Shank color is not sufficiently well developed at hatching to be of value in sex identification. The use of the other three characteristics for sex identification in day-old crossbreds has become widespread in this country and in Europe.

In the early development of crossbred poultry, the possibility of sex identification was a factor in stimulating its use. With the introduction of the Japanese method it might have been expected that their popularity would decline but this does not appear to be true. The use of sex-linked characters for sex identification places certain limitations as to breeds which may be used and the manner in which they are crossed. Some hatcherymen are overcoming the limitation by using the Japanese method for sex identification in crossbreds. However, where sex-linked characters can be used for identification of sex in chicks, the method requires less expert knowledge than does the Japanese method.

To give an example of sex-linked inheritance, if a Rhode Island Red male is mated with a Light Brahma female, the female chicks will show various shades of buff- or red-colored down and the male chicks will be white or smoky white, being very similar to the chicks of standard-bred Light Brahmas. This is a case of crisscross inheritance where the daughters show the down color of the father and the sons that of the mother. As adults the females are buff or red in color and the males will be much like pure Light Brahmas. If the cross is made in the opposite direction, using the Light Brahma male, the chicks will all resemble pure Light Brahmas and the sexes cannot be identified at hatching.

GOLD-SILVER CROSS

Among the common breeds and varieties that carry the gold factor and may be used as the sire in a cross are all buff varieties, partridge pattern, gold laced, Brown Leghorn, and Rhode Island Red. The breeds and varieties from which the females for a cross may be chosen include all silvers, all Columbian varieties, Light Brahmas, and White Wyandottes. Any cross of a male from the gold group by a female from the silver group produces offspring that show a different color pattern in the two sexes. (Fig. 3) The gold females can be much more easily distinguished from the silver males if the Columbian pattern is involved. (Fig. 4) The breeds and varieties carrying this pattern

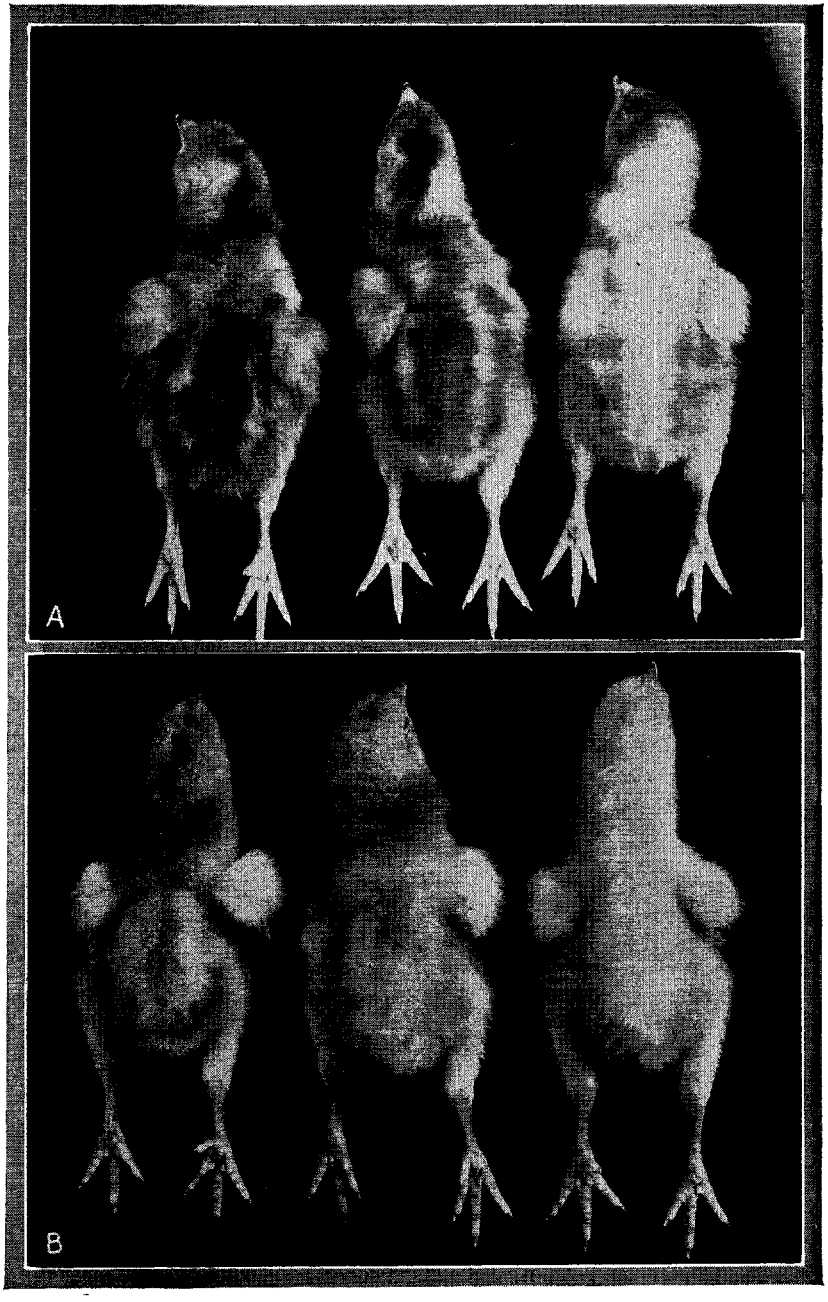

Fig. 3.—Chicks from cross of Rhode Island Red male by White Wyandotte female, showing gold-silver method of sex identification. (A) Female chicks ranging in color from definitely brown striped to light buff. (B) Male chicks with white, yellowish, or smoky down but never red or buff.

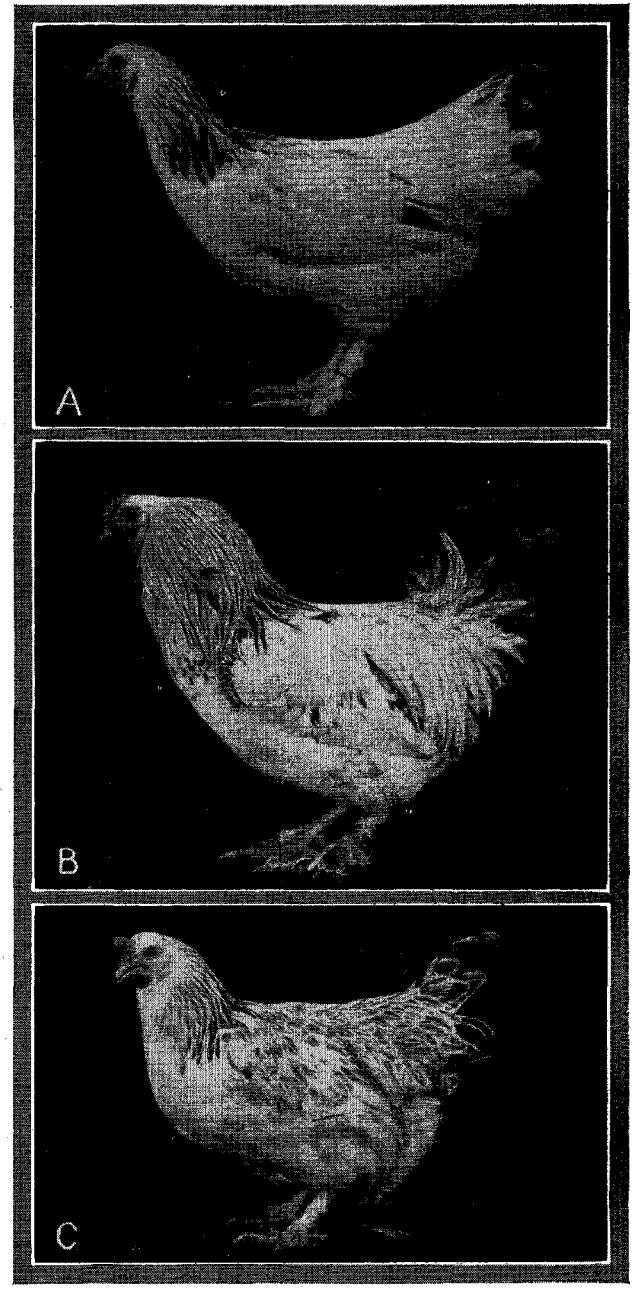

Fig. 4.—Color patterns similar to the above are obtained from mating the Light Brahma or Columbian pattern males with females of most particolor patterns. (A) Light Brahma male by Silver Laced Wyandotte female. (B) Brown Leghorn male by Light Brahma female. (C) Light Brahma male by Brown Leghorn female.

are all buffs, Rhode Island Reds, Columbians, and Light Brahmas. It does not matter from which side this pattern enters the cross, but since it is a dominant character, most of the offspring will show its pattern. Chicks from such a cross have very little pattern in the down and allow the difference between the gold and silver to exhibit itself. As adults the males will show the Columbian pattern and the females will be buffs or reds. Where the Brown Leghorn male is crossed with laced or penciled varieties, the broad brown down stripe covers so much of the crossbred chick's back that the golds and silvers are not so easily distinguished.

The most serious handicap to the use of the gold-silver cross is that there are relatively few production-bred silver varieties in America and the silver varieties are not especially popular. On the male side one has the Rhode Island Red, the Brown Leghorn, and all buff varieties, which supply an abundance of well-bred birds of the one sex. The White Wyandotte, although in the white group, is a recessive white and has usually been found to carry silver. Difficulty arises, however, from the fact that the white plumage makes it impossible to detect the individuals that do not carry silver. Some White Wyandottes also carry black and will throw many black chicks the sex of which cannot be determined. Although these difficulties may be encountered in using the White Wyandotte breed as a silver, it is here listed because of its availability and production qualities. Many strains of this breed when crossed to gold males will give good crisscross inheritance, and when satisfactory strains can be found the White Wyandotte probably will produce better crossbreds than most other silver breeds in America. Because of the lack of satisfactory breeds, the gold-silver method has not been widely used.

BARRED-NONBARRED CROSS

The cross which has been used more extensively than any other in this country is the one in which the presence or absence of the factor for barring has been the distinguishing feature. If Barred Plymouth Rock females or the females of any breed showing the Dominique pattern are mated to blacks or any breed showing other patterns, the female chicks are uniformly black or brownish black above and the males are black with a prominent light spot on top of the head. (Fig. 5) This head spot makes it possible to separate the sexes. As adults the males will be barred and the females predominantly black. (Fig. 6) Neither the White Leghorn nor the White Plymouth Rock male may be used, since the former will give all whites and the latter may yield only barred offspring. If black males are used, the female offspring will be uniformly black, but where the sire comes from breeds showing other patterns the daughters may show some silver or gold, usually on the breast.

TABLE 2. A LIST OF SOME OF THE MORE COMMON BREEDS AND VARIETIES THAT MAY BE USED IN THE VARIOUS CROSSES FOR DISTINGUISHING SEX AT HATCHING.

(Only the more easily distinguished crosses are given.)

Cross		Type of chick	Type of adult
Male	Female		
		Gold-Silver Cross	
1. Rhode Island Red	White Wyandotte Silver Penciled Rock Silver Penciled Wyandotte Silver Laced Wyandotte Columbian Rock Columbian Wyandotte Dark Brahma Light Brahma	Females buff or red color. Males cream or white; may show smokiness in down. Both sexes may show narrow striping.	Females buff to red; may show some stippling or striping. Males Columbian pattern.
2. Brown Leghorn Partridge Rock Partridge Wyandotte Golden Laced Wyandotte	Columbian Rock Columbian Wyandotte Light Brahma	Same as No. 1	Same as No. 1
		Barred-Nonbarred Cross	
3. Blacks	Barred Plymouth Rock	Females all black above. Male black above except white spot on head.	Females black. Males barred.
4. All other color varieties except White. White Wyandotte may be used.	Barred Plymouth Rock	Same as No. 3	Same as No. 3 except females may show some gold stippling or striping on breast.
		Rate-of-Feathering Cross	
5. White Leghorn or most Mediterranean breeds.	All American, Asiatic, and Orpington breeds	Females have well developed wing feathers at hatching. Males show none or very short feathers.	Difference in feathering not shown in adult.

Note.—Certain European breeds could have been included, but due to their restricted availability, were omitted. Males of the Buff varieties may be substituted for the Rhode Island Red male but the resulting light gold color makes sex identification difficult at times.

Barred Plymouth Rocks, White Plymouth Rocks, Blacks, and White Leghorns cannot be used in this cross because of the masking effects of the patterns carried by these breeds upon the gold and silver colors.

The Rhode Island Red male by Barred Plymouth Rock female is the cross most frequently used in this country, since it utilizes two of the most widely distributed production-bred dual-purpose

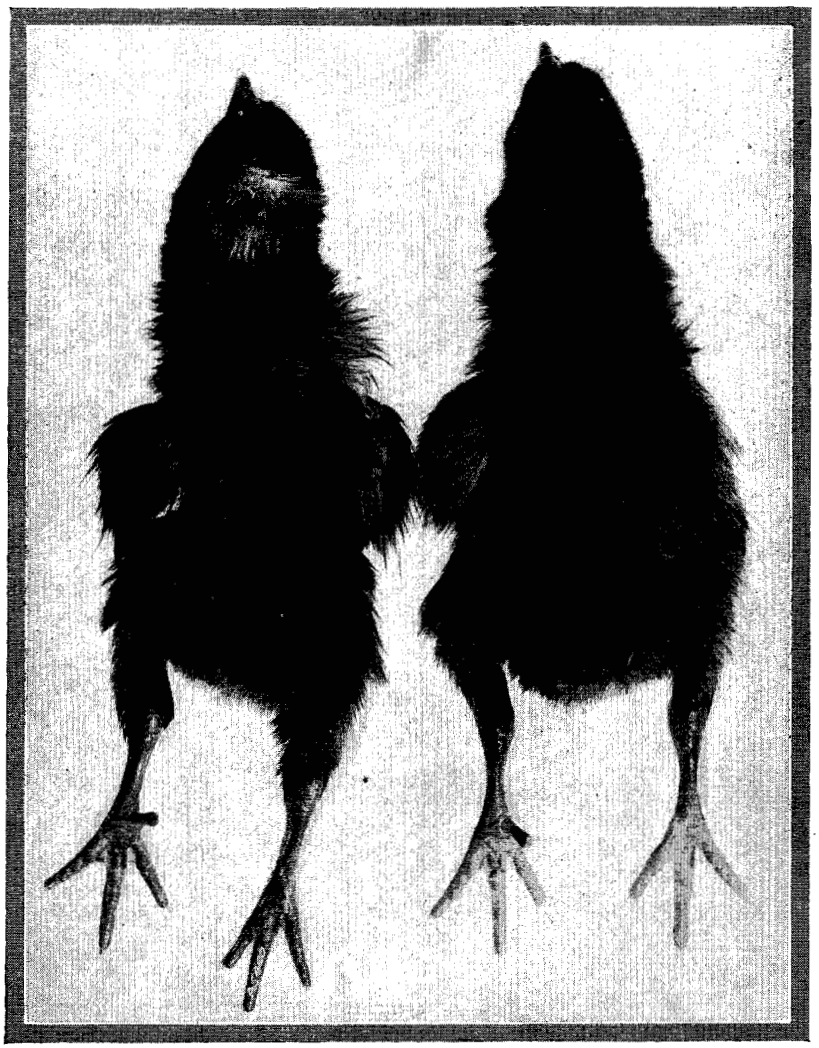

Fig. 5.—Barred-non barred method of sex identification in cross of Rhode Island Red male by Barred Plymouth Rock female. Left, male chick showing light head spot. Right, female chick which is entirely black on head and back.

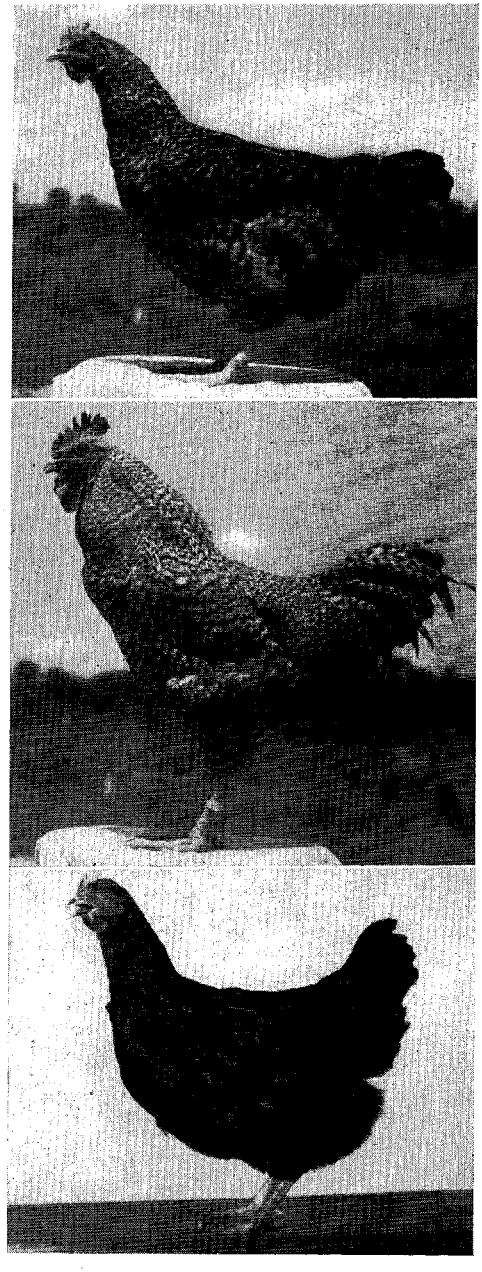

Fig. 6.—Rhode Island Red-Barred Plymouth Rock crossbreds. A barred female (top) is obtained when the mating is made using the Barred Plymouth Rock male and a black female (lower) when the Rhode Island Red male is used. A barred male (center) is obtained regardless of the direction of the cross. A popular cross for broiler production.

breeds. There are, however, other breeds which might be used with as good success. Both the Black Minorca and Ancona should produce crossbreds the sexes of which could be identified. The Australorp is another high-producing breed from which the male could be obtained for crossing on the Barred Plymouth Rock female. The last three mentioned will give more uniform-colored crossbreds than the cross utilizing the Rhode Island Red.

FEATHER GROWTH CROSSES

The more common breeds and varieties fall into two groups, the early- and the late-feathering. The terms early and late refer to the age at which the adult type of plumage begins to replace the chick down. The primary and secondary wing feathers are the first to develop, being visible in some breeds at hatching. In studies of rate of feathering the age at which tail feathers appear has been found to be the most definite basis of classification. In early-feathering breeds the tail feathers appear at from six to eight days of age, and in late-feathering ones these feathers do not appear before the twentieth day. The term late-feathering is not here used to apply to the extremely late-feathering characteristic of Barred Plymouth Rocks but only as contrasted with the very early feathering of the Mediterranean breeds. This extremely late-feathering is due to other genetic or physiological factors. Observations have shown that the early-feathering is largely confined to the Mediterranean class of fowls. Late-feathering has been found in most other breeds. It is true, however, that some breeds of the American class throw varying percentages of early-feathering chicks.

It has been shown that differences in rate of feathering belong to the sex-linked group and show the crisscross inheritance. If an early-feathering male is mated to a late-feathering female, the daughters are early-feathering and the sons are late-feathering. (Fig. 7) If the cross is made using the male of the late-feathering breed, all chicks are late-feathering. A study of newly hatched chicks in crosses involving rate of feathering has shown that the sexes may be distinguished with a high degree of accuracy. Identification is made by means of the growth of the primary and secondary wing feathers. For most accurate separation the examination should be made as soon as most of the chicks are fluffed out. If the inspection is delayed there may be some difficulty in separating the earliest hatched males from the latest hatched females. The comparison of male and female wing feathering shown in Figure 8 is for chicks taken from the incubator when the hatch was just completed. The wings shown are from crossbred chicks in the mating of the White Leghorn male on Rhode Island Red females. The right-hand row of wings shown in Figure 8 is from females and the other row from males. The female wing feathers are much longer than those

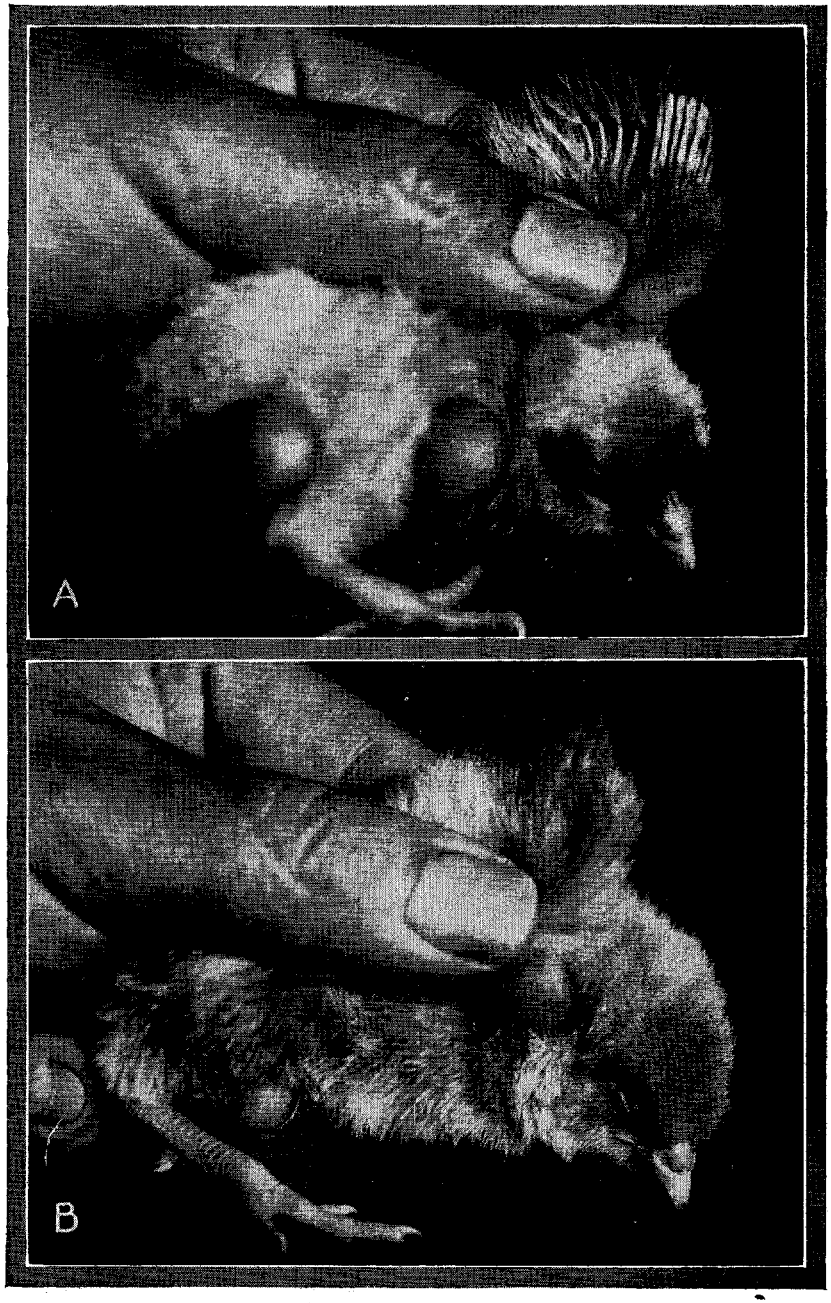

Fig. 7.—Female (A) and male (B) chicks showing wing feathering method of sex identification at the day-old age. Note conspicuous wing feathers in female.

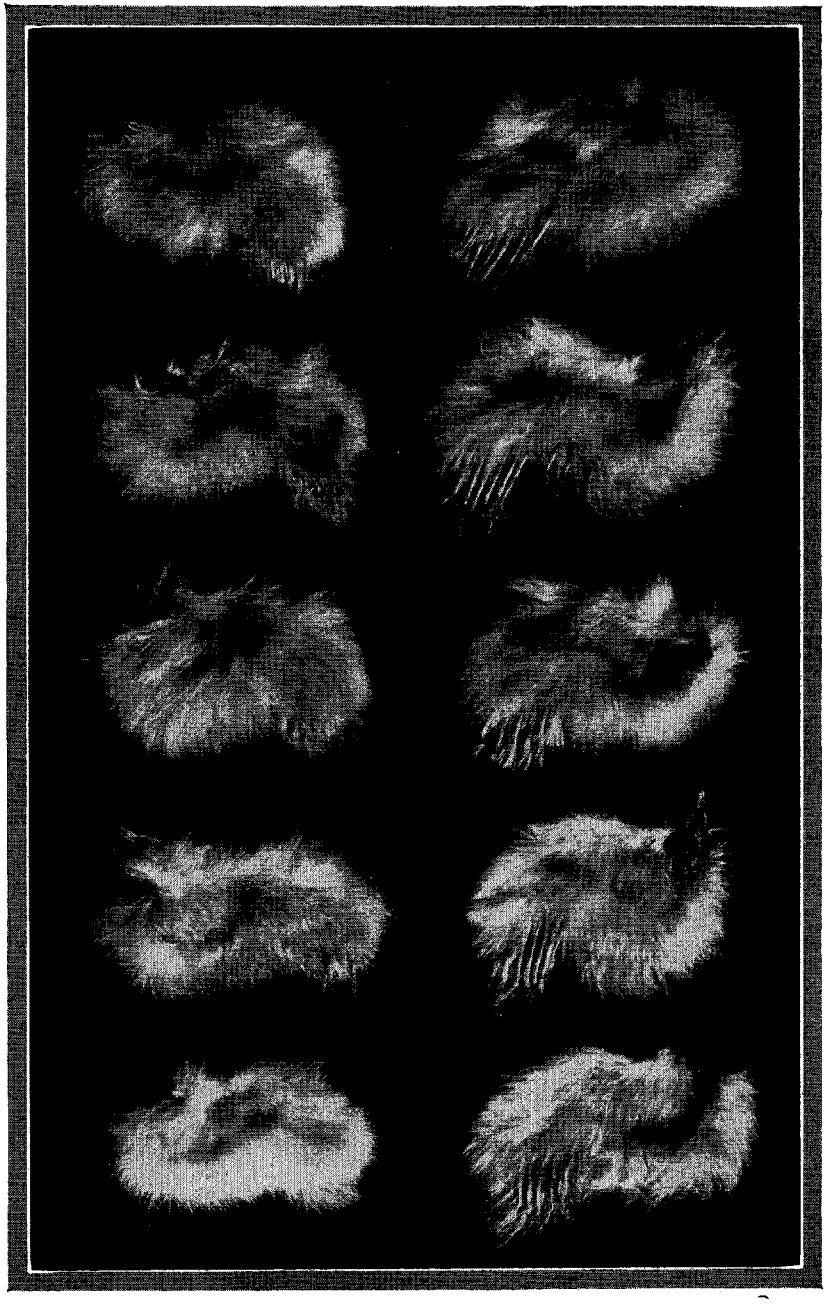

Fig. 8.—A series of wings showing range of flight feather development in day-old chicks from cross of White Leghorn male by Rhode Island Red female. Males are at left and females at right. Similarity of bottom female and top male wings is partially due to the fact that this male hatched several hours earlier than the female. Aids in distinguishing sex in such instances are discussed.

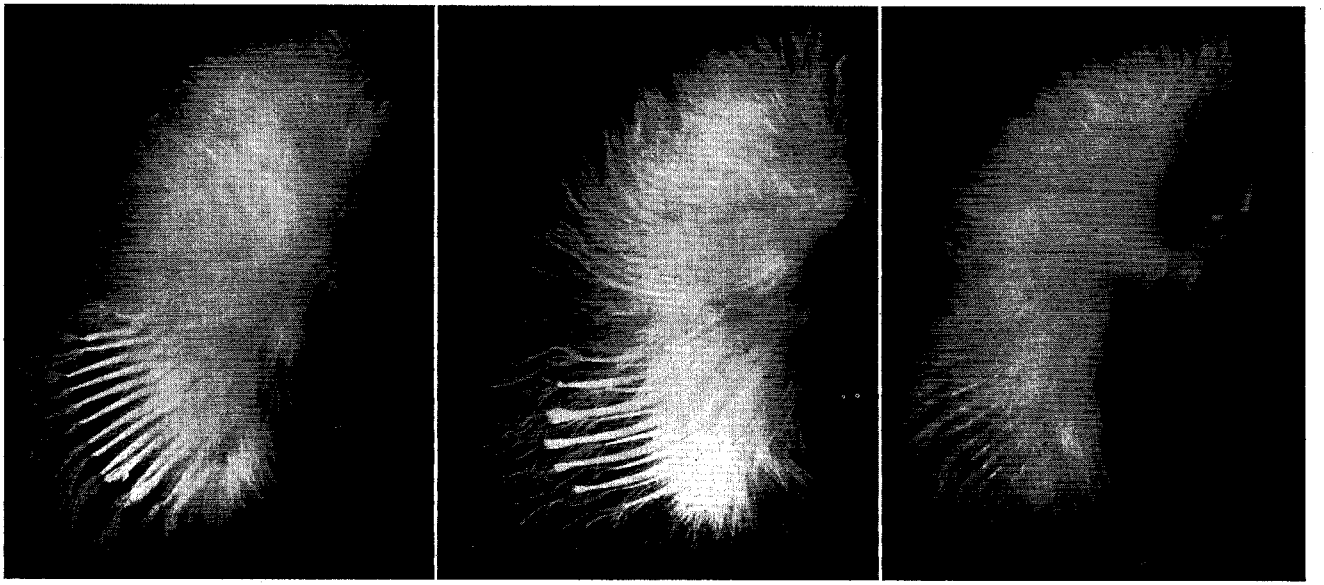

Fig. 9.—Wings of day-old chicks showing development of the primary flight feathers. A typical late feathering chick wing is shown (right) and a typical early feathering wing (center). Note difference in length of the sheathed feathers. A chick (left) hatched several hours ahead of the other two is sometimes confusing due to the length of the flight feathers. It may be distinguished from an early feathering chick by possessing paired flight feathers of equal length and smaller diameter. The center chick has five well developed primary feathers each paired with a much smaller covert feather. The type shown at the left is sufficiently extreme to be seldom found.

of the males. The ends of the rows of wings show the most extreme conditions for each sex. It is seen that in the example of the most advanced development in the male, the flight feathers are scarcely visible beyond the down, while the female having the least development shows them very conspicuously. The photograph in Figure 8 was taken from the under side of the wing, from which view the development of the flight feathers may be best seen. If there is a delay in making the examination, consideration should be taken of the fact, and in this case the most advanced males will have wing feathers similar to the least advanced females while most of the females will have distinctly longer wing feathers.

In the instances of chicks which cannot readily be distinguished as to sex because of differences in period since hatching, an examination of the small covert feathers will help. Close examination will show that with each primary wing feather there is a closely associated covert feather. Both it and the primary feather are enclosed in sheathes at this stage and the covert feather is of smaller diameter. In the early feathering chick the covert is from two-thirds to three-fourths the length of the primary wing feather. In the late feathering chick the covert is of length similar to that of the primary. Noting the relative length of the primary and covert feathers will help to classify the sex in doubtful cases. So even though the flight feathers may be relatively long because of age, if the covert feathers are of similar length the chick is classed as a late feathering male. (See Figure 9.) In the late feathering chick the primaries are of small diameter like the coverts while in an early feathering one the primaries have a much larger diameter than the coverts.

If there is a question about one's judgment in separating the sexes, a few autopsies may be made in questionable cases to check upon accuracy. The testes and ovaries are plainly visible in a newly hatched chick. Figure 10B shows the incision to be made for examining the sex organs of a newly hatched chick. The cut is most easily made with a small pair of scissors. The incision is made through the ends of the ribs on one side, across the back and through the ribs on the opposite side. The section of the back included in the cut may then be lifted, exposing the internal organs.

When making the incision the point of the under blade should be kept in contact with the wall of the abdominal cavity so as to avoid rupturing the yolk sac which has not yet been absorbed. If ruptured, the yolk will be freed in the cavity and obscure the organs. If the yolk sac and digestive organs are pushed aside, the sex organs may be seen on the wall of the back just above the gizzard.

As is shown in Figure 10A, the male sex glands are paired, elongated, ovoid organs, usually creamy white in color. At this stage the ovary (Fig. 10C) may be seen on the left side only.

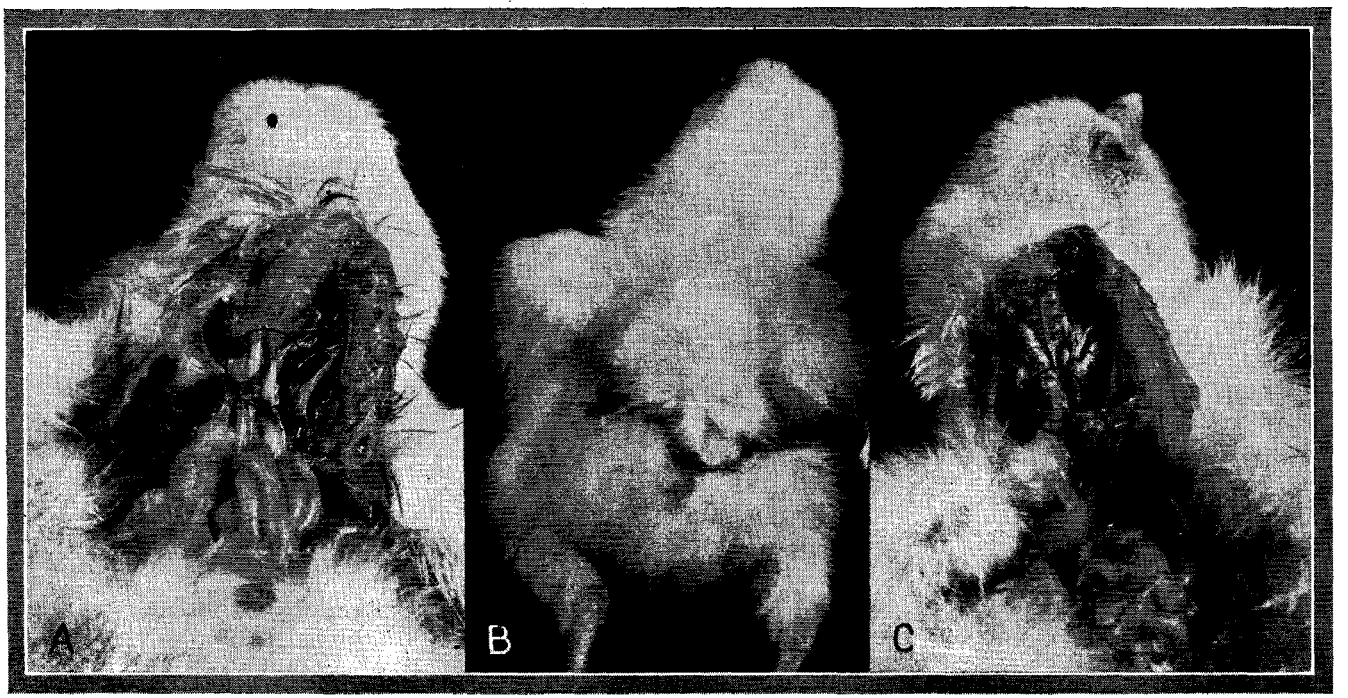

Fig. 10.—The sex glands of day-old chicks. An incision was made across the back and through the ribs on each side as shown in (B). The portion of the back included in the cut has been lifted to show the sex organs (A and C) attached to this region. (A) A male. The paired testes have been encircled in black. (C) A female, with a single sex organ, the ovary, on the left side, also encircled. The ovary is more flattened and differs in shape from the testes.

Sometimes there may be a trace of a right ovary, but the female organ is differentiated from the testis by its more flattened leaf shape. If the incision is made immediately after killing, the vision may be obscured by hemorrhages, but this may be avoided by waiting a few minutes for the blood to clot.

In using the wing-feathering method of sex identification, males of the early feathering (mostly Mediterranean) breeds are mated to the late-feathering, larger breeds. It should be emphasized that here as in other matings for sex identification the cross can be made in one direction only. The most commonly used crosses are the White Leghorn male by females of the more popular American breeds. From such crosses the pullet chicks will be early feathering and the cockerel chicks late feathering.

This method of sex identification is being used commercially with a high degree of accuracy. It requires a little more care than does the barred down color crosses and accuracy is probably slightly less.

One of the greatest sources of error will be through the use of flocks of females that are not pure for late feathering. It is seen that any females which were as chicks early-feathering will make it impossible to classify correctly their male offspring, since the sons will be early-feathering (have long flight feathers at hatching) instead of late. Fortunately it is a relatively simple matter to eliminate this source of error. If the flock from which the females for mating to the White Leghorn are to be obtained is examined when it is between 10 and 20 days of age, the early-feathering chicks may be detected. Any chick which at this time shows tail feathers should be removed from the flock or marked so that it will not be used as a breeder. The late-feathering chicks do not show tail feathers before three weeks of age. (Fig. 2.) By this procedure the female flock may be made pure for late feathering and much of the error in classification thus eliminated. The more recent practice of breeding for early feathering in the heavier breeds will somewhat complicate the technique of sex identification by means of wing feather growth.

OTHER METHODS

Crosses of black males by White Leghorn females produce predominantly white chicks which may have black spots or flecks in the down (See Fig. 11). It is known that in such crossbreds the female chicks are usually more flecked than the males. Some hatcherymen have attempted to sex crossbreds from the above mentioned mating on the basis of the presence or absence of black spots in the down. The writer attempted to use this method of sexing but found it not sufficiently accurate to be of practical value.

Other hatcherymen believe that they can sex chicks from

matings of black males by White Leghorn females on the basis of black in the upper and lower eyelids or so-called eye ring. The females show black in the eyelids. The writer has not used this method but has statements from reliable hatcherymen indicating that the method checked closely with the Japanese method.

Fig. 11.—Chicks from the mating of Australorp male with White Leghorn female, known as Austra-Whites. Chicks with these markings are obtained from the mating of any black male with the White Leghorn female.

CHOICE OF CROSSES FOR SEX IDENTIFICATION

The choice of crosses for sex identification in day-old chicks will depend somewhat upon the purpose for which the stock is being produced. If the crossbreds are to be used in broiler production it will probably be more satisfactory to use two of the larger breeds. The growth data show the Leghorn-heavy breed crossbreds to grow somewhat slower after eight weeks than do those from two heavy breeds. The Leghorn-heavy breed crossbreds also tend to resemble the Leghorn in comb size and earlobe color thus encountering discriminations in some markets. (See Figures 12 and 13.) Further considerations are market preferences regarding plumage color. Whites receive a premium in some markets while the barred pattern is preferred at other points. When birds are reared exclusively as broilers sex identification is of no great importance, since there is no need for segregation of the sexes.

The mating of the Barred Plymouth Rock females to most

colored heavy breed males produces barred males and predominantly black females which may be identified at hatching. The reciprocal cross produces barring in both sexes. The Rhode

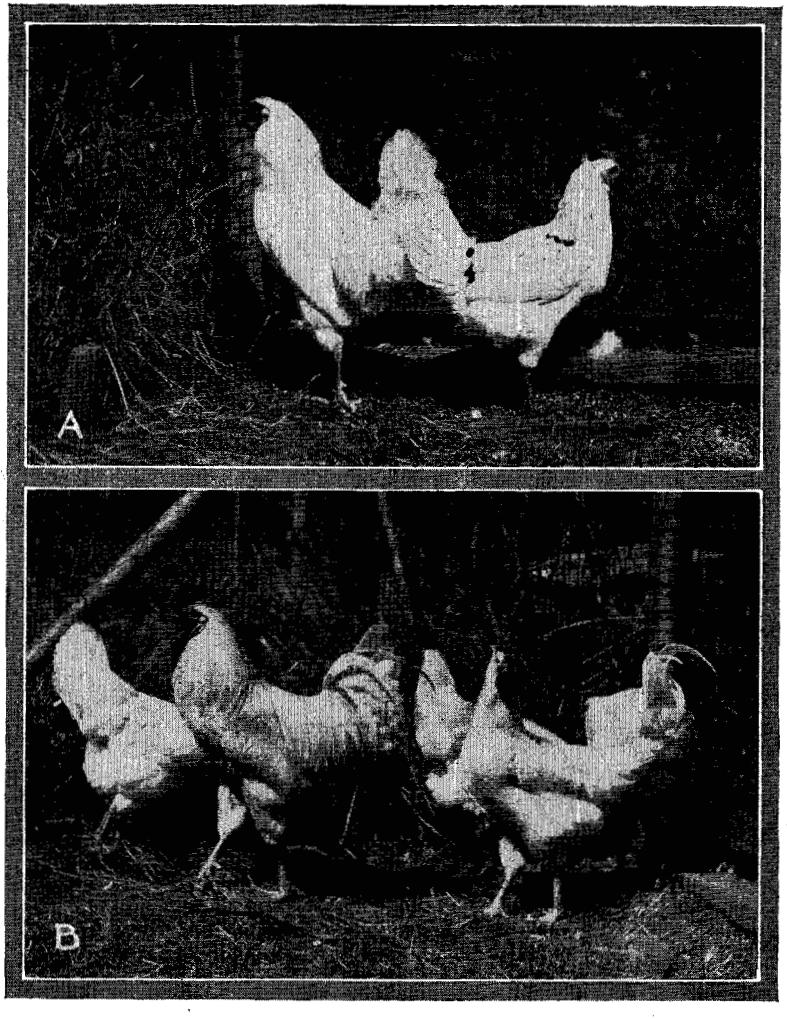

Fig. 12.—Crossbreds from a mating of the White Leghorn and Jersey Black Giant; (A) using Jersey Black Giant male and (B) using White Leghorn male.

Island Red or New Hampshire males mated to White Wyandotte or Columbian variety females produces Columbian pattern males and red plumage females which may be distinguished at hatching. If the cross is made in the opposite direction the offspring will be of the Columbian pattern in both sexes.

Where sex separation at hatching is desired primarily for the purpose of obtaining females for egg production the White Leghorn male-heavy breed female cross seems most promising. The data by the writer (1942) show such crosses to give highest egg production. In the Leghorn male-heavy breed female cross sex is identified by wing feather growth. The most serious objection to this cross is the production of cream colored eggs which do not grade well as either whites or browns. The Black

Fig. 13.—First generation crossbreds from the mating of White Leghorn male with Rhode Island Red female. These birds are predominantly white frequently showing black flecks and some buff or red on the surface plumage.

Minorca male mated with the White Leghorn female produces crossbreds which lay large white eggs well received on a quality egg market but sex identification through sex-linkage is not possible at hatching in such crossbreds.

An important factor in sex identification by sex-linked crosses is the availability of suitable stock. This frequently becomes a serious problem to the hatcheryman needing large numbers of flocks on the female side of the cross. In the barred-non barred method of sex identification he is limited entirely to Barred Plymouth Rocks on the female side. The gold-silver method also presents a problem because of the scarcity of silver variety flocks to be used on the female side. The most readily available breed to be used in the latter cross is the White Wyandotte. The wing feathering method has the advantage of having a considerable number of breeds available on the female side. Most heavy breed flocks will be satisfactory as female flocks if they have not been bred for early feathering.

LITERATURE CITED

Anonymous.

1941. Sight sexing Barred Rock baby chicks. Canadian Department of Agriculture Farmers' Bul. 102:1-18.

Byerly, T. C., and Quinn, J. P.

1936. Sexual dimorphism in Single Comb Rhode Island Red down color. Jour. Hered. 27:319-322.

Jerome, Fred J.

1939. Auto-sex linkage in Barred Plymouth Rocks. Poultry Sci. 18:437-440.

Punnett, R. C.

1919. The early elimination of surplus cockerels. Jour. (Gt. Brit.) Bd. of Agr. 25:1319-1323.

Punnett, R. C., and Pease, M. A.

1930. Genetic studies of poultry. VIII. On a case of sex-linkage within a breed. Jour. Genet. 22:395-397.

Quinn, Joseph P., and Knox, C. W.

1939. Sex identification of Barred Plymouth Rock baby chicks by down, shank and beak characteristics. Poultry Sci. 18:259-264.

Warren, D. C.

1930. Crossbred poultry. Kan. Agr. Expt. Sta. Bul. 252:1-54.

Warren, D. C.

1942. The crossbreeding of poultry. Kan. Agr. Expt. Sta. Tech. Bul. 52.