THE BREEDING OF TURKEYS

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The chief problems of the turkey industry in its rapid development in the past have centered around feeding, management, and disease control. While advances have been made in these fields there is much yet to be learned, for new problems continue to arise. Breeding problems have received less study up to the present, partly because they have been crowded out by these other considerations, and partly because the turkey stocks of the United States have in a great measure fulfilled their purpose, which was to produce a superior meat product.

PRESENT NEEDS IN TURKEY BREEDING

But this situation will not necessarily hold forever and today both breeders and scientists are beginning to think about turkey-breeding problems. From the standpoint of the geneticist and the practical breeder, the desirable breeding objectives today might be summed up as follows:

1. The production of smaller size strains of turkeys to meet the growing demand for a family-size bird.
2. The improvement of body type to provide a higher proportion of edible meat, especially on legs and breast.
3. Early maturity in reaching market condition.
4. Higher egg production.
5. Higher fertility and hatchability.
6. Greater viability—that is, a lower mortality rate from various causes, including disease.

Constructive breeding methods can and should play an important part in reducing costs by considering these six objectives.

The breeding achievements of the past have consisted mainly of the production of color variations, a substantial increase in body weight and egg production, and a reduction in the length of legs and neck.

At present, for reasons that will be discussed later, there is a definite trend toward breeding a smaller, more efficient, more rapidly growing turkey. The main objective is a live bird weighing approximately 7½ to 10 pounds as a young hen or 11 to 15 pounds as a young tom, to meet the increasing popular demand for a well-matured small turkey. It might be thought that this demand could be supplied by selling turkeys at an early age when they average 8 to 15 pounds in weight. However, turkeys at this weight are continuing their rapid growth and they have too much "framework" and too little flesh. The real
object in breeding is to develop a small turkey that will be as plump and well grown as present-day turkeys are at Thanksgiving or Christmas time. A young tom of the small type is shown in figure 1.

The mortality of growing turkeys is a pressing problem and it is one that the breeder can materially assist in solving. Turkey breeders, especially those that trap-nest their stock, can decrease these losses to a considerable extent by breeding from large families and from families whose progeny have had comparatively little mortality.

Egg production is an important factor in determining profit or loss in turkey-breeding work. Turkey eggs are sold for hatching purposes by the producer for 10 to 50 cents each, depending on locality and breeding. Hence any increase in egg production will help profits considerably because it results in lowering the overhead and feed costs of producing hatching eggs. In addition, turkeys are seasonal producers of eggs. They lay at a fair rate in the Northern and Central States from about the latter part of March to

NOTABLE progress, based on scientific research, has been made in controlling that major menace to turkey growing, the blackhead disease. Less attention has been paid to breeding problems. Today the turkey industry would gain by a breeding program based on production records, pedigrees, and progeny testing, like that which has meant so much to progressive breeders of chickens. There is a great need for turkey breeders willing to initiate trap-nesting and pedigreing, and possessed of the knowledge necessary to isolate superior families and breed from them. State and Federal stations might well lead the way by developing strains notable for certain characteristics of major importance.
about the first of July. The use of electric lights has helped in getting birds to start laying in January, so that the laying season is extended to approximately 6 months. However, egg production in commercial quantities is still confined to about 6 months of the year, and this means that fresh-killed roasting turkeys must also be a seasonal product unless turkeys can be bred to lay throughout the year. This situation is partially remedied by cold storage, which makes a limited supply of frozen turkeys available at times when there is no fresh stock and

permits a large turkey crop to be marketed in the fall in an orderly manner without a serious price depression.

The greatest drawback to breeding for high egg production and the other desirable characteristics is the lack of a program based on production records, pedigrees, and progeny testing. Such a program has meant much to progressive breeders of chickens. Here the State and Federal experiment stations can lead the way by developing strains of high-producing turkeys with good viability, quick maturity, and good market quality. The greatest need of the industry today is for a number of breeders who are informed concerning the practices involved in selection and breeding and who are willing to initiate trap-nesting and pedigreeing and, on the basis of the information so obtained, to isolate superior families and breed from them. This is an essential step in the production of a superior strain. Two of the steps involved in the pedigree breeding of turkeys are shown in figures 2 and 3.
THE STATUS OF TURKEY GROWING
AS AN INDUSTRY

Turkey raising has been increasing since about 1920 in the United States and now ranks as a 50,000,000-dollar industry. The interest in turkey raising has increased rapidly since that time. It was stimulated by a better knowledge of feeding and more effective control of the disease known as blackhead. The annual loss due to blackhead still amounts to approximately $5,000,000 a year, or 10 percent of the total gross income. In the past, often entire flocks of young turkeys were lost from this disease.

On January 1, 1920, the census showed 3,627,028 turkeys on 670,834 farms held as breeders after the marketing season. On January 1, 1935, the number had increased to 5,381,912 on 676,114 farms, which is 9.9 percent of all the farms in the United States. The leading States according to the number of turkeys kept were Texas, California, Minnesota, North Dakota, and Oklahoma.

The 1930 census was the first to record the number of turkeys raised rather than the number on farms on January 1. According to this census, there were 16,794,485 turkeys raised in the United States, most of them as a sideline to other farm enterprises. The distribution and number of turkeys raised on farms in 1929 is indicated in figure 4. The number of turkeys raised in 1936 has been estimated by the Bureau of Agricultural Economics to exceed 20,000,000—an increase of at least 20 percent over the 1930 figures. There was little increase, however, in the number of farms keeping turkeys. In some localities, turkey raising has reached such proportions as to be a major full-time enterprise, and a great many commercial flocks are large enough to demand the time of one or more persons throughout the year. The largest turkey farm was reported to have produced approximately 50,000 turkeys in 1 year.

NEW OPPORTUNITIES THROUGH THE CONTROL OF BLACKHEAD

From a production standpoint, the opportunities in commercial turkey raising are more promising now than formerly, largely because of improved methods of management that aid in the control of blackhead and other filth-borne diseases.
Beginning late in the nineteenth century, blackhead invaded one district after another, traveling from east to west with the extension of the turkey industry, until nearly all of the turkey-growing areas became infested with it. It was this disease that ruined turkey growing in the East and Midwest and by 1920 threatened to ruin it everywhere. In the early eighties production per year amounted to one bird for the average American family of about 5 persons, but by 1920 this had been reduced to approximately one bird for 15 persons. Since that time more adequate methods of controlling blackhead have been largely responsible for the increase to approximately one turkey for 6.5 persons. The new knowledge of sanitation and management as it affects the control of blackhead has meant a gradual return of turkey production to the East and Midwest and its firm establishment on a more profitable basis in all sections of the country except the Southeastern States.

MODERN TURKEYS AND THEIR WILD ANCESTORS

Turkeys are now classified by zoologists as a separate family, Meleagrididae, of the order Galliformes, or fowl-like birds. In this family there are two genera now living—Agriocharis, the ocellated turkey of Yucatan (fig. 5), and Meleagris, the North American or common turkey. These genera contain only one species each.

The ocellated or Yucatan turkey (Agriocharis ocellata) is confined to the Yucatan Peninsula of Mexico and the adjoining territory, where it dwells in the tropical forests. Its flesh is considered a delicacy. It is smaller than the common turkey, lacks the breast tuft, is brighter colored, has two fleshy appendages on the head instead of one, and has eyed or ocellated tail feathers, from which it takes its name. So far as
is known, it has never been domesticated although natural crossing with the common turkey has been reported. In striking beauty the plumage of the ocellated turkey rivals that of the peacock. The plumage pattern is similar to that of the Bronze turkey although the colors are different. The general effect is green and black with a coppery red iridescence. The large wing feathers of the male are distinctly barred, almost exactly as in the Bronze, while those of the female are indistinctly barred. The head and neck of the ocellated turkey are described as blue, studded with orange warts. The eggs are brown and spotted like those of *Meleagris* but smaller.

**Five subspecies** (races or varieties) of North American wild turkeys have been described. They interbreed freely with each other and with domesticated turkeys. Table 1 contains a brief description of these subspecies.

![ocellated turkey](image)

**Figure 5.**—The ocellated turkey (*Agriocharis ocellata*) (male).

<table>
<thead>
<tr>
<th>Subspecies</th>
<th>Original range</th>
<th>Color description</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Meleagris gallopavo gallopavo</em> Linnaeus, the Mexican turkey.</td>
<td>Central Mexico</td>
<td>Similar to the Bronze variety but lacks the distinct tail penciling and the heavy-copper-colored bronzing. The terminal edgings are almost white.</td>
</tr>
<tr>
<td><em>M. gallopavo silvestris</em> Vieillot, the eastern turkey.</td>
<td>Eastern United States, excepting southern Florida, to the western and northern limits of the species as described above.</td>
<td>Similar to the Bronze but lacks the heavy copper-colored bronzing and the pure white terminal edgings. The latter are dark chestnut or iodine color in <em>silvestris</em>.</td>
</tr>
<tr>
<td><em>M. gallopavo osceola</em> Scott, the Florida turkey.</td>
<td>Florida, at least as far north as Gainesville.</td>
<td>Closely resembles <em>silvestris</em> but is distinguishable from it by the white bars of the large wing feathers, which, in <em>osceola</em>, are much narrower than the black bars and do not cross the shaft of the feather. In all other wild varieties and in the Bronze and Narragansett, the white bars are as wide as or wider than the black ones and extend completely across the feathers.</td>
</tr>
<tr>
<td><em>M. gallopavo intermedia</em> Sennett, the Rio Grande turkey.</td>
<td>Middle-north Texas to north-eastern Coahuila, Nueva Leon, and Tamaulipas.</td>
<td>Resembles <em>silvestris</em>, but its terminal edgings are light chestnut or cinnamon and its back feathers present a decidedly blackish appearance.</td>
</tr>
<tr>
<td><em>M. gallopavo merriami</em> Nelson, Merriam's turkey.</td>
<td>The mountains of southern Colorado, Arizona, New Mexico, western Texas, northern Sonora, and Chihuahua.</td>
<td>Resembles <em>silvestris</em> but the terminal edgings are creamy to buffy white.</td>
</tr>
</tbody>
</table>
The North American wild turkey (*Meleagris gallopavo*, fig. 6) formerly ranged over all of Mexico except the extreme southern and western parts; over southern Ontario, Canada; and over the United States south and east of a line extending from south to north through western Arizona, northeast diagonally across Colorado and Nebraska to include a small portion of southeastern South Dakota, east across northern Iowa, southern Wisconsin, southern Michigan, northern New York, northern Vermont, northern New Hampshire, and southern Maine.

Wild turkeys, principally the eastern turkey, are now bred to some extent on game farms, both public and private.

**Varieties of Domesticated American Turkeys**

The turkey, the Muscovy duck, and the Canada (gray) goose constitute the contribution of the Western Hemisphere to the list of species of poultry. At the time North America was discovered, the wild turkey was found in large numbers and, in some instances, had been domesticated by the natives. From the meager historical data available it appears that turkeys were first taken to Spain in 1498. The sources of these and later importations to Europe were turkeys domesticated by the natives of Mexico and Central America. All these turkeys apparently belonged to the Mexican subspecies of the North American turkey. From Spain turkeys were taken to other European countries, being introduced into England between 1524 and 1541. Several European varieties were developed, notably the Cambridgeshire Bronze and the Norfolk Black. From Europe and North America, turkeys were exported to all parts of the civilized
TURKEYS

After the United States was settled, it appears that the first domesticated turkeys to be raised came not from the native wild stock, but from the domesticated turkeys of Europe. These birds were probably all of the Bronze color pattern, although some Blacks may have been included. For a considerable time no serious attempts were made to domesticate the native wild turkeys, but finally early in the nineteenth century turkey breeders began to cross the domesticated stock with the wild.

About 1830-40, in the Narragansett Bay district of Rhode Island there was developed a local variety which was the forerunner of the modern Narragansett (fig. 7) and Bronze (fig. 8) varieties. About 1860 the first superior strain of Bronze turkeys came into prominence and this variety was described in the first (1871) American Standard of Perfection.

The development of the Narragansett and White Holland varieties appears to have paralleled approximately that of the Bronze. A color standard for the Narragansett was published in 1874, along with standard descriptions for the Slate, Black, and Buff varieties. The last-named variety never became popular and was dropped from the standard in 1915.

The White Holland was admitted to the standard in 1878 and the Bourbon Red about 1909. Authentic information concerning the origin of the Slate and Buff varieties appears to be lacking. The White Holland variety originated as far as is known in North America, not in the Netherlands, and was developed from white mutations appearing in Bronze flocks. The Black turkey is an old variety that appears to have been developed in Europe, although some strains may have been developed independently in North America. The Bourbon Red had its origin in Bourbon County, Ky., and is the newest of the standard varieties.

According to the American Standard of Perfection all standard-bred turkeys are now classified as one breed, which is subdivided into varieties. The standard varieties all have the same shape and, except for the Bronze, which is a little heavier than the others, they are all
the same size. They are differentiated only by plumage color, and one variety is as good as another for commercial turkey production. However, there is considerable variation within each variety, so that the selection of a good strain is more important, from the standpoint of economical production, than the selection of a variety. Six stand-

**Figure 8.**—A farm breeding unit of Bronze turkeys.

ard varieties of domesticated turkeys are now bred in the United States. The data in tables 2 and 3 show some of the characteristics of these varieties.

| TABLE 2.—Standard weights of the six standard varieties of American turkeys

<table>
<thead>
<tr>
<th>Variety</th>
<th>Adult tom</th>
<th>Yearling tom</th>
<th>Young tom</th>
<th>Yearling and adult hen</th>
<th>Young hen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bronze</td>
<td>Pounds</td>
<td>Pounds</td>
<td>Pounds</td>
<td>Pounds</td>
<td>Pounds</td>
</tr>
<tr>
<td>White Holland, Narragansett, Bourbon Red, Black, and Slate</td>
<td>36</td>
<td>33</td>
<td>25</td>
<td>20</td>
<td>16</td>
</tr>
</tbody>
</table>

1 The weights shown are for young turkeys 8 to 12 months of age, for yearlings 12 to 24 months of age, and for adults 24 months of age or older. Actually, very few flocks of turkeys attain standard weights.

| TABLE 3.—Color of the six standard varieties of American turkeys

<table>
<thead>
<tr>
<th>Variety</th>
<th>Plumage color</th>
<th>Shank color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bronze</td>
<td>Ground color is dull black but the exposed surfaces of the feathers are glossed with rich iridescent red green on the fore part of the body and with a brilliant copper-colored bronzing edged with black on the rear half. On the tail, tail coverts, and sides there is, in addition, a terminal edging of white, which also appears on the breast feathers of the female. Main tail feathers and tail coverts are distinctly penciled, light brown and black.</td>
<td>Blackish in young birds, pinkish in adults.</td>
</tr>
<tr>
<td>Narragansett</td>
<td>The plumage pattern resembles that of the Bronze, but there is no red-green sheen and no bronzing. The Narragansett colors are metallic black with light steel-gray edging bordered in certain sections by a narrow black band on the ends of the feathers; main tail feathers and tail coverts distinctly penciled, light brown and black.</td>
<td>Blackish salmon in young birds; deep salmon in adults.</td>
</tr>
<tr>
<td>White Holland</td>
<td>White in all sections.</td>
<td>Pinkish white.</td>
</tr>
<tr>
<td>Bourbon Red</td>
<td>Dark brownish red with white wings. The breast feathers have narrow black tips which in the females, are bordered with white. The tail is white with an indistinct reddish bar near the end.</td>
<td>Reddish brown in young birds; reddish pink in adults.</td>
</tr>
<tr>
<td>Black</td>
<td>Black in all sections.</td>
<td>Slate black in young birds; pinkish in adults.</td>
</tr>
<tr>
<td>Slate</td>
<td>Slate color in all sections.</td>
<td>Pink.</td>
</tr>
</tbody>
</table>
**TURKEYS**

**PAST WORK IN BREEDING**

Even when raised in captivity and given every opportunity to make maximum growth, wild turkeys are smaller than their domesticated relatives. According to reliable observations, young North American wild turkey toms, when in good condition, in December and January average approximately 12 pounds in live weight and the young hens about 8 pounds. The adult wild males usually weigh from 19 to 22 pounds and in rare instances attain a weight of 33 pounds when fat. When grown in captivity under favorable conditions, the live weights of wild turkeys are somewhat greater than those mentioned. However, there is a decided contrast between the weights commonly attained by strains of Bronze turkeys and the much smaller weights attained by wild turkeys even when they are raised under similar conditions. Egg production in the better strains of modern turkeys has been increased substantially over that of the wild turkey. Progress in breeding for plumage color is evident by the variety of colors and patterns in the domestic birds. Some improvement in type has also been effected. The wild turkey has a rather shallow body, a long neck, a slender head, and long legs. The breeders of domesticated turkeys have developed a larger bird with a deeper body, shorter legs and neck, and heavier fleshing except over the breast, where the wild turkey is probably the equal of the domesticated bird.

Improvements made have been few and slow and thus the good qualities of the original stock have not been sacrificed. For example, the eggs laid by domesticated turkeys are as fertile and hatch fully as well as those laid by wild turkeys, and modern strains of turkeys are as resistant to disease as the wild type. Rate of maturity to market condition has been little influenced by domestication.

Comparatively little inbreeding or cross-breeding has been practiced in turkey breeding, except by a very few breeders who have developed distinctive strains or new varieties.

Private breeders have been responsible for the development of the modern turkey in all its beauty and usefulness. However, there is no accurate, detailed history of breed development and there has never been a pedigree-recording system for turkeys similar to the herdbook used with other animals. Such evidence as there is has been summed up in the preceding paragraphs.

Today the Bronze variety predominates to an overwhelming extent. Narragansetts, White Hollands, and Bourbon Reds are fairly common and appear to be gaining in popularity. The Black variety is less common although it too is probably gaining in favor. The Slate turkey may be classified as rare and the wild turkey as rare except on game farms.

**MARKET TRENDS AND THEIR RELATION TO BREEDING**

So far turkeys have been produced almost exclusively for roasting purposes and marketed between 6 and 8 months of age. Turkey broilers or fryers have not been produced in significant numbers and there is little reason to believe that they will ever be a factor in the turkey industry since smaller types of poultry fulfill this need. Turkey capons have been successfully produced but have not met with
special favor on the markets. Until they do, the extra cost of production will not be justified. Turkey eggs, although palatable and suitable for cooking, do not possess the delicacy of flavor and fineness of texture characteristic of chicken eggs. The profitable production

Figure 9.—Illustrating body type in dressed turkeys. A, Two young Black toms. No. 2798, on the left, when killed at the age of 32 weeks, weighed 22.6 pounds (dressed), had a narrow poorly meated breast, a keel measuring 8.2 inches long and a shank 8.1 inches long and produced 3.9 pounds of breast meat. No. 2793, on its right weighed 22.3 pounds, had a broad well-meated breast, a keel bone measuring 7.5 inches in length, and a shank 8.3 inches long, and produced 4.1 pounds of breast meat. It is desirable to have a broad well-fleshed breast. The keel should be as long as the shank or longer. (Length of shank is distance between rear of hock joint and the ball of the foot.) B, Side view, no. 2798 on left, no. 2793 on right.

of market eggs from turkeys seems highly improbable even as a sideline enterprise for the turkey grower.

According to various observers, most but not all larger eating establishments and individuals buying for large dinner groups prefer turkeys weighing more than 15 pounds (dressed) while most of the smaller places and American housewives in general prefer dressed birds weighing less than 15 pounds. This preference for small turkeys by what is now the majority of consumers has increased the demand for hens and small toms.

Accurate estimates of the average weights at which turkeys are marketed throughout the country are not available, but the average
for young hens probably ranges, in different producing areas, between 9 to 12½ pounds live weight and 8 to 11½ pounds dressed weight (blood and feathers removed). The average for young toms probably ranges between 15 to 21½ pounds live weight and 13½ to 19½ pounds dressed weight. In some producing areas where large stock and good feeding methods are used, the average body weight will be larger than in other sections. A few years ago the average body weight of turkeys was smaller than at the present time, but the advent of commercial turkey raising with better feeding methods and stock bred for large size has increased the average weights. Standardbred young Bronze tom turkeys raised on full feed will average 18 to 19½ pounds dressed, and young hens 10½ to 11½ pounds, when marketed at the age of 26 to 28 weeks. Birds from strains of extra large turkeys may exceed these weights by 25 percent or more. Figure 9 A and B illustrates body types in dressed turkeys.

The present demand for smaller turkeys appears to be based on sound economics—the fitting of the dressed turkey unit to the needs of two great groups of consumers, the small-scale vendor of cooked turkey meat and the average family. For large family groups and for hotels and restaurants, the large turkey is in demand, as large toms dress out better than small toms and are fully as palatable. At the present time, the market receipts of large turkeys are slightly in excess of the demand, resulting in a price differential of ½ to 4 cents per pound in favor of hen turkeys and small toms. Unless the demand changes, which appears unlikely, future breeding operations in turkey production should be in the direction of smaller turkeys.

RESEARCH IN TURKEY BREEDING

There has been little breeding research with turkeys. One drawback has been the lack of sufficient funds for this purpose; a lack of adequately trained personnel with the proper interest in this aspect of poultry production; and third, the susceptibility of turkeys to blackhead—but this last drawback is being rapidly overcome. A brief description of the results of scientific investigations to date follows and a list of references is included at the end of this article.

WORK OF STATE EXPERIMENT STATIONS

Except for matings to replenish flocks, turkey-breeding work has not been carried on extensively by the State experiment stations, though a few have initiated projects in the past or have some work under way at the present time.

Studies on the inheritance of plumage color have been limited and only a few individuals were used in the experiments from which conclusions were drawn. Some of the more important findings may be summed up as follows: (1) Black plumage color is imperfectly dominant to the bronze plumage pattern and imperfectly epistatic to the Narragansett plumage patterns and red plumage color. (2) Red plumage color and Narragansett plumage pattern are epistatic to the bronze plumage pattern. (3) The factor for slate plumage color is a dominant dilution factor affecting the bronze and black

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1 Characterized by the dominant action of a gene over another gene situated on a different chromosome or at a different place on the same chromosome.
plumage patterns to produce slate-colored turkeys, or red plumage to produce slate-red turkeys. (4) The factor providing for the presence of plumage color is dominant to the absence of pigmentation of plumage. When allowed to express itself, the recessive factor produces a white bird that has brown eyes because this particular factor affects plumage color only and does not affect eye color. All white birds, therefore, carry the plumage pattern or color for bronze, Narragansett, black, or red but do not show any of these patterns or colors unless they are crossed with colored turkeys. However, when mated together, these white turkeys always produce white offspring. (5) Buff-colored turkeys may be produced by first crossing black turkeys with red ones. The resulting rusty black offspring are then crossed back to the red turkeys, which results in progeny having four types of plumage color—rusty black, Bourbon Red, bronze red, and buff. (6) The factor for Narragansett plumage color pattern is recessive and sex-linked. Males showing the Narragansett plumage pattern are produced only from matings of Narragansetts, but females showing Narragansett color and males showing bronze color may be produced from a mating of Narragansett males and bronze females. The reciprocal of the mating produces all bronze-colored progeny.

**Work of the Federal Government**

In the field of plant and animal genetics, there has been a good deal of experimental work in making wide crosses such as crosses between species. Certain of these results have been worth while. This is more true of plants than of animals, although the mule is an outstanding example of a useful wide cross in the animal kingdom. In most cases, however, the hybrid proves to be without economic value, although this means of obtaining a cross of unusual value cannot be overlooked.

An attempt was made by Quinn, Burrows, and Byerly at the National Agricultural Research Center, Beltsville, Md., to effect an intergeneric cross between the turkey and the chicken by the use of an artificial insemination technique developed at the center. Semen of turkey males was used to fertilize Rhode Island Red females and semen from purebred and cross-bred chicken males was used to fertilize turkey females. About 20 percent of the eggs laid by the turkey females were fertile, but all except one died in the early stages of embryonic development. In the reciprocal cross only a few of the eggs were fertile and all of these died within a 3-day period of incubation.

Although 25 percent of the fertile eggs died as embryos during the first day of incubation, one hybrid embryo, from the chicken male × turkey female cross, lived until it was fully developed and apparently ready to hatch. This hybrid embryo was found dead in the shell on the twenty-eighth day of incubation, death having occurred some time between the twenty-third and twenty-eighth days. No daily observations were made after the twenty-third day, so that the exact time of death, and the age of the embryo when death occurred, were unknown. The hybrid was obtained from an egg laid by a Bronze turkey hen on July 3, 20 days after the last fertile turkey egg had been obtained and 66 days after the removal of the turkey male.
The turkey-chicken hybrid was intermediate in conformation between the chicken and the turkey. The hybrid was also lighter in down color than the turkey, having a reddish cast in both head and body. It had yellow shanks whereas the shanks of the turkey parent were quite dusky. The hybrid had a distinct comb and no evidence of the characteristic fleshy protuberance of the turkey. It also showed a polydactylism in which the fourth toe of the left foot was triplicated, a malformation sometimes found in wide crosses. In various external characteristics such as head type and shape, down color and shank color, the turkey-chicken hybrid may be said to have shown the characteristics of the chicken rather than the turkey.

The latest development in poultry breeding for the creation of superior strains is the building up of inbred strains in order to produce successful hybrids by subsequent crossing. It is much more difficult to build up inbred lines of chickens or turkeys than of many plants, since fewer individuals can be used and self-fertilization cannot be practiced.

Although he cannot catalog the characteristics of the turkey, and their mode of inheritance, the scientific breeder might accumulate and purify certain good characteristics by the process of inbreeding, which fixes various good and bad traits of the parents in the different lines of inbred progeny. Sires that show an accumulation of bad traits might be discarded. A line that showed an accumulation of good traits might be crossed with another good line, with the object of producing superior hybrid individuals.

Because inbreeding might play an important role in the improvement of turkeys in some such way as this, an experimental turkey-breeding project was begun in 1931 by the Bureau of Animal Industry at its range livestock experiment station, Miles City, Mont. This project was terminated in 1935 and the results of approximately 5 years' work were summarized. One purpose of the project was to measure the effect of inbreeding on the fertility and hatchability of eggs, the egg weight, and the egg production of Bronze turkeys. In order to make an adequate comparison of the effects of inbreeding, a series of outbred matings were maintained. These outbred matings were made between unrelated or distantly related individuals, and each year the progeny was systematically outbred with the idea of maintaining a line indefinitely without resorting to close inbreeding or the introduction of new stock. This plan of outbreeding included seven matings and constituted a separate experiment that will be discussed later.

Table 4.—Summary of the egg fertility and hatchability and of egg production and egg weight for 773 inbred and outbred Bronze turkeys

<table>
<thead>
<tr>
<th>Degree of inbreeding</th>
<th>Coefficient of inbreeding</th>
<th>Fertility</th>
<th>Hatchability</th>
<th>Production of eggs to June 1</th>
<th>Average egg weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outbred</td>
<td>0.000-0.063</td>
<td>87.8</td>
<td>67.6</td>
<td>47.7</td>
<td>83.6</td>
</tr>
<tr>
<td>Mild</td>
<td>0.125-0.218</td>
<td>86.4</td>
<td>66.1</td>
<td>45.2</td>
<td>82.7</td>
</tr>
<tr>
<td>Close</td>
<td>0.250-0.411</td>
<td>82.8</td>
<td>62.8</td>
<td>39.0</td>
<td>82.1</td>
</tr>
<tr>
<td>Intensive</td>
<td>0.500-0.672</td>
<td>69.3</td>
<td>34.9</td>
<td>41.4</td>
<td>81.5</td>
</tr>
</tbody>
</table>
The data in Table 4 show the results obtained from unrelated turkey matings and from matings of different degrees of relationship on fertility, hatchability of eggs, egg weight, and egg production.

Some general conclusions from this work are as follows:

1. Mild and close inbreeding had little effect on fertility, egg production, and egg weight when compared to outbreeding.

2. Mild and close inbreeding had an adverse effect on the hatchability of turkey eggs. The inbred lines averaged approximately 52 percent hatchability whereas the outbred lines averaged 67.6 percent.

3. Intensive inbreeding adversely affected fertility and hatchability of eggs but had slight effect on production and average egg weight.

These conclusions are taken from the final averages. However, there was considerable variation in the results obtained from various matings within each of the four groups. For instance, some of the mild and close inbred turkeys gave better results in regard to the four factors considered than the outbred turkeys that were used as controls. In other words, it appears that it might be possible with careful selection and mating to obtain lines of inbred turkeys that would be as good as the outbred turkeys in these respects.

Matings were made between unrelated or distantly related individuals each year and systematically outbred with the idea of establishing a line of outbred turkeys without resorting to close inbreeding or introduction of new stock. The method used was briefly as follows:

The start was made with stock purchased from seven different breeders. Seven breeding pens were mated in such a way that the males and females in no two pens were from the same source. The progeny were individually wing-banded, which made it possible to identify the progeny of each mating at any time. The best young hens and the best young tom turkeys were selected in each generation in each pen. The selected young hens from each pen remained together as a breeding unit each year and were placed in the pen previously occupied by their parents, but the selected young tom was placed in the next pen. For example, the selected young hens from the mating in pen 1 were placed in pen 1 the next year. The best young tom available from this mating, however, was placed in pen 2. The young tom turkey from pen 2 was placed in pen 3, and so on, the young tom from pen 6 being placed in pen 7, and that from pen 7 being placed in pen 1. This revolving process was followed each year.

The plan proved to be satisfactory, simple, easily workable, and effective in maintaining the average egg weight and improving the fertility and hatchability of eggs and egg production. The data in Table 5 show the results obtained in the operation of this plan for 5 years. It is regrettable that it was necessary to sell the progeny of the 1935 matings before records of egg production and egg weight could be obtained.

Practical breeding operations are well served by basic research, especially in a field so new as turkey breeding. The mode of inheritance of characters, the physiology of reproduction, and the study of mating systems all have a direct application to practical problems. Through these findings, unwise practices may be brought to light and discarded and more efficient methods developed.
Table 5.—Summary of the egg fertility and hatchability and of egg production and egg weight for 390 systematically outbred turkeys

<table>
<thead>
<tr>
<th>Year</th>
<th>Coefficient of in-breeding</th>
<th>Fertility</th>
<th>Hatchability</th>
<th>Production of eggs to June 1</th>
<th>Average egg weight</th>
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<tbody>
<tr>
<td>1931</td>
<td>.000</td>
<td>72.7</td>
<td>59.2</td>
<td>44.6</td>
<td>84.7</td>
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<tr>
<td>1932</td>
<td>.000</td>
<td>85.0</td>
<td>56.6</td>
<td>47.4</td>
<td>83.0</td>
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<tr>
<td>1933</td>
<td>.031</td>
<td>92.9</td>
<td>71.4</td>
<td>49.6</td>
<td>79.6</td>
</tr>
<tr>
<td>1934</td>
<td>.050</td>
<td>85.3</td>
<td>68.7</td>
<td>48.6</td>
<td>84.0</td>
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<tr>
<td>1935</td>
<td>.053</td>
<td>92.6</td>
<td>74.9</td>
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<tr>
<th>State</th>
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<td>L. W. Taylor, V. S. Asmundson</td>
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<td>Indiana</td>
<td>C. W. Carrick, E. E. Schnetzler</td>
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<td>Iowa</td>
<td>H. L. Wileke</td>
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<td>W. R. B. Robertson</td>
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<td>L. F. Payne, H. M. Scott, D. C.</td>
<td>Manhattan</td>
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<td>Berley Winton, S. J. Marsden</td>
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<td>Bureau of Animal Industry</td>
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1 Head of department or section.