

BIRD-BANDING

A JOURNAL OF ORNITHOLOGICAL INVESTIGATION

VOL. V.

JULY, 1934

No. 3

INDIVIDUAL AND SEXUAL VARIATIONS IN THE EUROPEAN STARLING

By LAWRENCE E. HICKS

THE first record of the European Starling (*Sturnus vulgaris vulgaris*) from Ohio was in January, 1916. The bird was recorded every year thereafter, being known as a breeding species from 1920 on. All parts of the State had been invaded by 1923, and the species was everywhere abundant by 1928. The Starling is now the most numerous winter resident and one of the five most numerous breeding birds of the State.¹

Because of its numbers, aggressiveness, motility, omnivorous food habits, and promise as a research subject, the Starling was thought deserving of a detailed study. Much has been learned of the species through the cooperative bandings in the Columbus region conducted by various members of the Wheaton Club. During the last seven winters 29,884 were banded, the summer captures bringing the total to 30,151. About 38,000 birds have been handled, some attention usually being given to individual differences. Mr. Edward S. Thomas compiled the recovery and return data of the early banding work of 1927-1930.

TABLE NO. 1. STARLINGS BANDED IN CENTRAL OHIO, 1927-1934

Winter	Number of Bandings	Dec.	Jan.	Feb.	Mar.	Total
1926-27	7	0	0	269	587	856
1927-28	6	208	333	263	724	1528
1928-29	9	0	960	1689	2164	4813
1929-30	4	0	275	173	1	449
1931-32	4	0	0	0	1474	1474
1932-33	23	1584	702	1895	2034	6215
1933-34	32	1266	3144	3098	7041	14547
Totals	85	3058	5414	7387	14025	29882

¹ Hicks, Lawrence E., *The Auk*, 50:317-322, 1933.

From March, 1932, to March, 1934, inclusive, the writer, with the help of one or two student assistants, banded 16,696 birds² while handling more than 25,000 individuals. A study made of the individual and sexual variations of many of these living birds and of 3284 kept as specimens is the basis for the present paper. At all times specimens were taken in sufficient quantity and in such a way as to be actually representative of the total flock as determined by experiment. The great majority of the specimens were taken from a large roost of one thousand to eight thousand birds found in ten towers at the Ohio State Hospital, Columbus, Ohio. Many others came from eighteen roosts in towers, steeples, ventilators, and warehouses of the downtown district of Columbus. Collections were also made from twenty-two roosts elsewhere in Franklin County and from nineteen roosts located from fifteen to sixty miles from Columbus. In addition, 284 birds were shot from forty-seven feeding flocks in the field in sixteen central Ohio counties.

I. SEX RATIOS

During the study 3161 Starlings were sexed by internal examination. The sexual organs are sufficiently large throughout the winter to make determination easy.

Of 171 examined in March, 1932, 121, or 70.8 per cent, were males. Of 468 examined during the winter of 1932-33, 313, or 66.9 per cent were males. Of 2522 examined during the winter of 1933-34, 1714, or 67.9 per cent, were males. The percentages of males by months for 1933-34 were: December, 70.1 per cent of 147 birds; January, 64.3 per cent of 252; February, 63.1 per cent of 431; March, 69.7 per cent of 1691 birds. Smaller samples taken during other months of the year were inconclusive as to the actual sex ratio. It seems almost impossible to obtain during the nesting season an adequate sample which will be truly representative of the whole population from the standpoint of sex ratio. However, extensive field observations during the breeding season seem to indicate that the males are somewhat in the majority, though probably not to the extent found in winter.

This unbalanced sex ratio, if actual for the whole American Starling population, is of great biological interest—and perhaps of significance from the standpoint of behavior and reproduction of the species. A preponderance of males has been

² Hicks, Lawrence E.: *Bird-Banding*, 4:112, 1933; *Bird-Banding*, 5:42-43, 1934; *Bird-Banding*, 5:93-94, 1934.

reported for many other species, including most of the ducks of the eastern United States (Lincoln, McIlhenny, and others), but seldom has it been suspected that the males of a species outnumbered the females as much as 3 to 2, 2 to 1, or even 3 to 1.

In Europe several writers have surmised that male Starlings probably somewhat outnumbered the other sex. One bit of evidence given is that during the breeding season apparently unmated males sometimes build dummy nests or females may consort with more than one male.

If this observed unbalanced sex ratio for Central Ohio in winter does not apply to the total Starling population of the United States, we then have problems to solve as to where the "missing" females winter, and why the sex ratios of widely separated localities differ either temporarily or permanently. It would be of great value if some observers in each section of the eastern United States, would sex an adequate sample of Starling specimens taken from several roosts at all seasons obtainable.

During the present study several ornithologists have looked over one or more specimen lots and by suggestions helped to formulate the following statements which limit the possible explanations of the lop-sided sex ratios found in Central Ohio Starlings in winter:

1. Differences in the habits and the behavior of the two sexes could not account for the preponderance of males at the large roosts, as their roosting habits are essentially the same and the females have been found to be no less gregarious than the males at this season.

2. The size and location of the roosts from which the specimens came cannot be used as an explanation, as collections from roosts in rural districts, from numerous small roosts of 2 to 25 birds each and from birds shot in the field, give the same general sex ratios.

3. Collections from widely separated Ohio localities give nearly the same sex ratios; hence male Starlings must actually far outnumber the females in Ohio, at least from December 1st to April 1st.

4. A greater percentage of the females may winter southwest of Ohio than of the males, accounting for their being in the minority. Examples of this type have been reported in several species, including the Mississippi Song Sparrow (Nice). Collectors also usually find that winter-collected individuals of most semi-hardy passerine species include a very high percentage of males. If, however, the great bulk of the Starling

females wintered south of Ohio, their numbers should be proportionately increased during the spring migration. This is not true. Instead, the males are even better represented during the spring migration period than during the winter months. Hence, we can hardly believe that the unaccounted-for females winter south of Ohio.

5. The "missing" females may winter to the north of Ohio; *i.e.* the center of winter distribution for the female Starling population may be north of that of the males. If this is the correct explanation, it could be easily verified by other observers in the Northern States and southern Canada. This alternative seems unlikely, however, as there is no known parallel among other species.

6. A last and more likely suggestion is that the females are actually, decidedly outnumbered in the total Starling population of the country, though owing to migration influences or differences in the behavior and habits of the two sexes, the difference may not be as great as data now available would seem to indicate.

In Table No. 2, the number and percentage of males and females found in collections taken during the winter of 1933-34 are shown. Numerous small collections from scattered localities are omitted for the sake of brevity and because lots of less than about 35 birds have been found to be inadequate samples and may not actually be representative of the whole flock.

TABLE NO. 2. SEX RATIOS OF STARLINGS—WINTER OF 1933-34

Date	Number of Specimens	Number of Males	Number of Females	Per cent of Males	Per cent of Females	Where Collected
Dec. 6	33	22	11	66.6	33.4	State Hospital, Columbus
Dec. 16	50	38	12	76.0	24.0	State Hospital, Columbus
Jan. 6	34	22	12	64.7	35.3	State Hospital, Columbus
Jan. 20	52	30	22	57.9	42.1	State Hospital, Columbus
Jan. 25	24	16	8	66.6	33.4	Columbus Mattress Co.
Jan. 27	39	24	15	61.6	38.4	Canal Winchester
Feb. 1	112	67	45	59.8	40.2	Linworth
Feb. 5	85	54	31	63.5	36.5	State Hospital, Columbus
Feb. 6	108	66	42	61.1	38.9	J. P. Gordon Co., Columbus
March 6	141	84	57	59.7	40.3	State Hospital, Columbus
March 16	218	154	64	70.6	29.4	State Hospital, Columbus
March 17	336	238	98	70.8	29.2	State Hospital, Columbus
March 21	173	132	41	73.9	26.1	Mt. Vernon
March 23	322	234	88	72.7	27.3	State Hospital, Columbus
March 24	254	173	81	68.1	31.9	State Hospital, Columbus
March 31	192	123	69	64.1	35.9	State Hospital, Columbus
Totals	2173	1487	696	Av. 68.3	Av. 31.7	

The data when evaluated make possible the following generalizations:

1. The percentage of males in Central Ohio in December is usually high—nearly 70 per cent—although considerable difference is found in the sex-ratios of different roosts at that time. Both facts are believed to be due to a partial separation of the sexes or a shuffling of mixed populations during migration. (Returns from banded birds indicate that considerable migration and shifting of the population takes place in the fall in most years until late in December.)

2. The percentage of males in January and early February ranges from about 60 per cent to 64 per cent (relatively low). During this period the percentage of males varies only slightly with different roosts, and the percentage of males at any one roost is nearly constant unless an early migratory movement takes place.

3. During late February and March (the big migration month) the roosts usually double or triple in size owing to the influx of birds from the southwest—and to the attraction of birds from the smaller rural roosts as the expression of the gregarious instinct becomes increasingly pronounced. During this period the percentage of males gradually mounts to a high of 70 per cent to 74 per cent, and then gradually decreases to about 63 per cent as the last flocks break up or leave for the northeast. Note that the percentage of males never drops below 58 per cent to 60 per cent.

4. The rise and then the fall of the percentage of males during migration are believed to be due to the bulk of the males performing the spring migration to the northeast to the breeding grounds slightly in advance of the bulk of the females. Similar cases have been detected in the Eastern Red-wing and the Eastern Cowbird, where the earlier advance of the males is readily observable by our being able to distinguish the sexes by plumage or song characters in the field.

5. During March at the Ohio State Hospital, towers observed to be attractive to the more wary migrants, contained 70 per cent to 76 per cent males. (The few bands on these birds also indicated that they were chiefly migrants.) Two towers with very small hidden openings, and hence not likely to be entered by migrants, had a lower percentage of males—64 per cent to 68 per cent. (The many bands on these birds indicated that they were largely winter residents—not migrants.)

6. As one would expect from the above, roosts receiving few migrants had a somewhat lower percentage of males. Also, adjacent roosts tended to have nearly the same percentage of males. (Examples—the several towers at the Ohio State

Hospital roost, the several roosts in the downtown district of Columbus, or roosts in barn cupolas of the same township). The larger roosts and the city roosts averaged a slightly larger percentage of males.

II. WEIGHTS OF STARLINGS

During the study the weights of more than two thousand male Starlings collected were compared with the weights of about half as many females. Several hundred birds shot in the field were also compared with the specimens taken at roosts at night. The data summarized in table No. 3 are of birds taken from various roosts in central Ohio, mostly during the winter of 1933-1934. The lots are nearly comparable, for all were collected at approximately four hours after sunset, or about five hours after the last possible feeding. At this time the stomachs are nearly empty of food; so the weight listed is very near to the true body weight.

During the winter period (December to March), 1942 males averaged 84.67 grams, and 915 females 79.89 grams. Thus the average male Starling in central Ohio in winter outweighs the average female by 4.78 grams. In December the males average 81.46 grams, and the females 77.15 grams. This relatively low weight during the early winter is believed mostly due to the immature portion of the population not having reached full development. (Banded returns, at least one and one-half years old, average 4-8 grams heavier). Undersized birds collected in December usually prove to be immature. If decidedly undersized they are almost invariably immature females. Perhaps these small birds are from late broods. The relatively low December weight may also be partly due to activities of the late fall migration and adjustment to the wintering locality.

By January these small immatures have nearly reached their complete development; so the total male population averages 84.65 grams and the females 80.73 grams. Both sexes reach their maximum weight in early February, the males in this month averaging 87.42 grams and the females 82.24 grams. In March both sexes decrease slightly in weight (males 85.15 grams, and females 79.46 grams), probably owing to the spring migration and the greatly increased activity with more hours of daylight. Also it should be noted that many of the December birds and most of the March birds captured are not winter residents in central Ohio.

Females average 4.31 grams lighter than the males in December. As the small females mature in another month, this sex averages only 3.92 grams less than the males in

January. In February and March the males exceed the females by 5.18 grams and 5.69 grams. This relative increase in weight of the males over the females is difficult to explain but is believed to be linked with their earlier increase in glandular (and sexual?) activity, as evidenced by their behavior and the development of secondary sexual characters, such as bill color.

Unusually large or small specimens of both sexes were weighed separately. Ranges established for the males were 73 to 96 grams and for the females 69 to 93 grams, although rare dwarf, giant, or diseased individuals somewhat exceeded these weight limits. Ninety per cent of the population, however, usually fell within relatively narrow limits.

No correlation could be noted between body weight and the feeding territory of the birds. Starlings known to feed entirely in rural sections averaged nearly the same as others known to feed mostly within the city limits of Columbus. However, weather conditions were found to have sufficient influence on body weight to sometimes obscure seasonal weight trends. Weight fluctuations of individual birds were found to be due mostly to the gain or loss of a fatty layer which is very conspicuous after incision of the body. A thick fatty layer may develop within one to two weeks or may be lost under adverse conditions in four or five days.

TABLE NO. 3. SEXUAL DIFFERENCES IN THE WEIGHTS OF STARLINGS

Date	Number of Males	Average Weight of Males	Number of Females	Average Weight of Females	Where Collected
Dec. 6, 1933	112	80.12	55	76.81	State Hospital, Columbus
Dec. 16, 1933	226	81.34	117	77.12	State Hospital, Columbus
Dec. 22, 1933	23	82.91	13	77.51	Fredericktown
Jan. 6, 1934	22	87.65	12	84.65	State Hospital, Columbus
Jan. 20, 1934	30	86.46	22	81.19	State Hospital, Columbus
Jan. 25, 1934	32	84.20	16	78.64	Columbus Mattress Co.
Jan. 27, 1934	24	80.29	15	78.43	Canal Winchester
Feb. 1, 1934	67	87.63	45	82.52	Linworth
Feb. 2, 1934	42	87.06	20	83.15	Columbus Merchandise Co.
Feb. 5, 1934	54	88.99	31	80.93	State Hospital, Columbus
Feb. 6, 1934	66	87.21	42	82.35	Gordon Co., Columbus
Mar. 6, 1934	84	82.21	57	77.08	State Hospital, Columbus
Mar. 16, 1934	154	87.14	64	81.50	State Hospital, Columbus
Mar. 17, 1934	238	85.75	98	80.71	State Hospital, Columbus
Mar. 21, 1934	132	85.90	41	78.53	Mt. Vernon
Mar. 23, 1934	234	87.71	88	81.02	State Hospital, Columbus
Mar. 24, 1934	173	85.64	81	80.71	State Hospital, Columbus
Mar. 31, 1934	192	85.27	69	80.11	State Hospital, Columbus
Mar. 28, 1932	37	81.02	29	76.22	State Hospital, Columbus
Totals	1942		915		

December—81.46	December—77.15 (4.31 g. less than males)
January — 84.65	January —80.73 (3.92 g. less than males)
February —87.42	February —82.24 (5.18 g. less than males)
March —85.15	March —79.46 (5.69 g. less than males)

Starlings commonly gain weight in cold weather if the ground is bare or the snowfall light. When heavy snows come, much of the food consumed is garbage from cities or grain put out for livestock. Starlings in central Ohio seldom "freeze" or starve, as the fatty layer usually suffices to carry the birds over until the end of the usually brief cold wave. As in most species, starvation takes place only after cumulative effects. Winters of New York and Ontario, with many long severe cold waves and deep snows, certainly result in the destruction of an appreciable portion of the Starling population, as many recoveries from those regions, during the unusually severe winter of 1933-1934, of birds banded at Columbus, had an added note "bird found dead (or dying) of cold at a weather temperature of 22 (to 49) degrees below zero."

Starlings at Columbus (winter of 1933-1934) did not lose weight during the near-zero weather of December 26th-29th and actually gained weight during the near-zero weather of January 28th-31st. However, the sub-zero weather of February 8th-10th, followed by the long near-zero cold wave and snows of February 20th-28th, resulted in an average loss of 9.1 grams weight per bird. Many are known to have perished from starvation. The February temperature average was 22 degrees F., 8.7 degrees below normal. Half of this lost weight was regained during the first week, and all of it during the first two weeks of relatively warm weather in March.

III. DEVELOPMENT OF BILL COLOR

During the breeding season all but 2 to 4 per cent (mostly non-breeding birds, diseased or immatures, usually females) of the total population have beautiful golden-yellow bills (usually appearing cream-colored in the field). By late fall or early winter only 5 to 10 per cent of the population have yellow bills, though 5 to 15 per cent more may show some trace of yellow. The remainder have bills of grayish-black. We are not yet able to explain why these few birds retain the yellow bills, except that the problem is a physiological one (nearly all such birds are large vigorous adult males). At all times of the year, a greater percentage of the males than of the females have yellow bills. At certain periods nearly all birds showing much yellow in the bill are males.

The change from black to yellow is a gradual one, the yellow first appearing near the base, and the last dark area to disappear being at or near the tip. During the winter of 1933-1934, 2705 Starling specimens were studied by sexes as to the bill color. Several hundred birds repeated during the winter from

one to eight times, and, where possible, the gradual development of bill color was noted.

A careful study of most of the banding data of 31,000 Starlings banded discloses that there is no good evidence that immature Starlings ever develop any yellow bill color before January first. In fact, it seems certain that the population groups develop colored bills in the following order: old males, old females, immature males, and immature females. A few of the latter may retain the dark bill during the first spring.

As a working basis, birds of each lot studied were divided arbitrarily into three groups: "yellows" (bills more than 85 per cent yellow), "partials" (bills 20 per cent to 85 per cent yellow) and "darks" (less than 20 per cent yellow). Usually few birds were border-line cases, so that a lot may be re-sorted several times with practically the same results in each case.

Bill color in the Starling is linked with the health and general physiological condition of the bird, the sex and the degree of sexual maturity and activity, and, to a certain extent, with age. Few of the five- and six-year-old birds taken have had yellow bills.

Hence, when different roosts on the same date are found to have different percentages of yellows, partials, and darks, the explanation is that the roosts have, (1) different sex ratios, (2) different percentages of immatures, or (3) different proportions of migrants. Birds arriving from new localities (1) may have been subjected to different environmental influences, and hence be in a different stage of sexual development, or (2) may represent the "cream," *i.e.* an isolation through migration of a group of the most sexually active birds.

As a relatively greater proportion of the yellow-billed birds are males, birds with colored bills will average heavier than the total population. Of 85 birds taken on February 5, 1934, the 33 yellows averaged 88.92 grams each, the 20 partials 84.34 grams, and the 29 blacks, 82.61 grams.

Table No. 4 gives the percentages of yellows, partials, and darks found in the total population on each date. Pronounced development of the bill color begins in January. First a decided increase in the percentage of partials is noted, then a rapid increase in the percentage of yellows. When the last flocks break up or leave for the northeast (usually about April 1), 85 per cent are yellow bills, another 12 per cent are partials, and only 3 per cent to 4 per cent blacks. The 180 birds taken at Mt. Vernon on March 21st gave an unusually high percentage of yellows (96.1 per cent). This flock probably

was composed entirely of migrants, as not a single bird from a previous banding at the same place was included.

TABLE NO. 4. DEVELOPMENT OF YELLOW BILL COLOR IN MALE AND FEMALE STARLINGS, 1933-1934

Date	Bill Color (Total Population)				Percentage of Each Sex Having Bills						Where Collected
	Number of Birds	Per cent Yellow	Per cent Partial	Per cent Dark	Yellow		Partial		Dark		
					♂	♀	♂	♀	♂	♀	
Dec. 16	343	8.4	11.3	80.3	10-2	14-4	76-96				State Hospital
Jan. 6	299	10.7	15.4	73.9	14-2	17-7	69-91				State Hospital
Jan. 20	52	15.4	48.1	36.5	13-18	67-23	20-59				State Hospital
Jan. 25	24	33.3	37.5	29.2	50-0	31-50	19-50				Mattress Co.
Jan. 27	39	46.2	25.6	28.2	62-20	21-33	17-47				Can. Winchester
Feb. 1	112	37.5	25.8	36.6	57-9	25-27	18-64				Linworth
Feb. 5	85	42.3	25.3	34.1	61-10	19-32	20-58				State Hospital
Feb. 6	108	25.0	40.7	34.3	40-2	44-36	16-62				Gordon Co.
Mar. 6	141	44.1	46.8	9.2	62-18	35-64	3-18				State Hospital
Mar. 16	218	74.3	18.8	6.9	86-47	13-43	1-20				State Hospital
Mar. 17	336	72.6	22.0	5.3	81-53	17-33	2-14				State Hospital
Mar. 21	180	96.1	3.5	.6	99-87	1-11	0-2				Mt. Vernon
Mar. 23	322	76.7	18.6	4.7	84-58	14-31	2-11				State Hospital
Mar. 24	254	70.5	23.6	5.9	79-52	19-35	2-13				State Hospital
Mar. 31	192	84.4	12.0	3.6	90-75	10-15	0-10				State Hospital

Table No. 4 also gives the percentage of the birds of each sex which were yellows, partials, or darks, in each collection. The data show that the majority of the males are either yellows or partials by January 10th and that after late January more than half of them are yellows. During the March migration three-fourths to four-fifths of the males have yellow bills and less than 3 per cent black bills. The percentage of females with colored bills also mounts, but at a later date and less rapidly, until nearly 75 per cent are yellows, 15 per cent partials, and little more than 10 per cent darks, with the disappearance of flocking birds about April 1st.

IV. SEX DETERMINATION BY EXTERNAL CHARACTERS

The writer has been questioned repeatedly by various ornithologists as to whether there are any external characters which can be used to differentiate the sexes in the Starling. Mr. Frederick C. Lincoln (letter of January 8, 1934) writes: "I do not know of any reliable external characters. Occasionally a coöperator will attempt to sex one of these birds that he has banded, but I have never been satisfied as to the reliability of this part of the record." Dr. H. C. Oberholser (letter of January 17, 1934) writes, "While there is no certain method of determining the sex of Starlings by external characteristics, it usually is the case that the female has less brilliant plumage, with more numerous light tips on the feathers."

Because of the great interest in this question, an attempt was

made to determine the value and extent of all external variations. During the study 3161 Starlings were judged as to sex on the basis of external differences. Later these judgments were tested by internal examination.

TABLE NO. 5. SEX DETERMINATION BY EXTERNAL EXAMINATION

<i>Month</i>	<i>Per cent of Males Correctly Sexed</i>	<i>Per cent of Females Correctly Sexed</i>	<i>Per cent of Total Population Correctly Sexed</i>
December	94.5	78.2	89
January (first half)	95.4	79.6	90
January (last half)	96.2	81.2	91
February (first half)	98.2	86.2	94
February (last half)	99.6	93.7	98
March (first half)	100.0	99.3	99.8
March (last half)	100.0	100.0	100.0

The work indicated that practically all of the adult males can be determined at any time during the winter, the few males misdetermined being immature birds. After the first of February practically no males are misdetermined, and after the first of March perfect results may be obtained. Most of the females misdetermined also are believed to be immature birds from general appearance, size, and the fact that none carry bands from the previous winter. After February 1st nearly perfect results can be obtained. During March, 1934, 968 males and 427 females were sexed without error except in the case of three females. These sexual differences remain obvious during the breeding season, but during the late summer, fall, and early winter determination becomes increasingly difficult. Considerable experience and practice are necessary to sex Starlings in the early winter, as a number of characters must be carefully evaluated, none of which are more than about 70 per cent to 90 per cent constant with sex. In January and February nearly all birds begin to show a secondary sexual character (color of the base of the lower mandible), which upon becoming discernible, makes 100 per cent determination possible.

The following sexual differences have been used as aids or important criteria in external sexual determination. The extent and the value of each are discussed.

1. *Color of Base of Lower Mandible*

The one infallible criterion for sexual determination, is the color of the basal half of the lower mandible.² As the breeding

² Another character which may prove to be of equal value in the living bird, eye color, will be reported upon later after more extensive studies.

season approaches, this area becomes conspicuously bluish white to bluish gray in the males and pinkish white to pinkish gray in the females. Unfortunately this character is a seasonal one. It is such a very obvious and definite character, however, that even bird-banders inexperienced with this species may safely sex birds caught during the months of March, April, May, and June. During the other months most of the adults show some color trace, though for a quarter of the year the black color of the bill may entirely obscure this character to even the most expert observers. This character usually becomes fairly obvious before the remainder of the bill begins to show much yellow. Like the yellow bill color, it shows with more faithfulness in the males, in adults, in sexually active and mature birds, and in birds in good health.

2. *Brilliancy of the Plumage*

In general the males average considerably more brilliant in plumage than the females, but this varies greatly with the season. The females commonly have more light tips on the feathers and these wear away less rapidly than on the males. Brilliancy of the head, neck, breast, and shoulders is of much less value than the brilliancy of the sides, belly, and back. If fifty specimens of each sex are arranged in one row in the order of the general brilliancy of the plumage, many females will be near the brilliant end of the series and some of the males near the dull-plumaged end of the series. Several of the largest and most brilliantly plumaged birds ever handled have been females. This character when used in connection with others, however, is often of considerable value.

3. *Bill Color*

In another part of this paper the change from dark to partial to yellow bill color in each sex is discussed. In December nearly all of the birds with yellow bills are males, and at all times of the year a greater percentage of the males than of the females have yellow bills. However, some females always have yellow bills and practically all have colored bills during the breeding season. This character is also of great value when used in connection with others.

4. *Measurements and Weights.*

As stated elsewhere in this paper, the males average larger than the females by 3.1 millimeters in total length, 2.5 millimeters in wing-length, 2.3 millimeters in tail-length, .7 millimeters in length of exposed culmen and 4.78 grams in weight.

These differences are slight, but of some value, as they are more constant than others more frequently used, such as the brilliancy of the plumage.

V. MEASUREMENTS

About 560 Starlings have been measured to determine the extreme and average size-variations between the sexes. All measurements were made according to the standard methods described by Baldwin, Oberholser, and Worley ("Measurements of Birds," 1931). Birds taken during the fall and early winter averaged somewhat smaller than the measurements given below, owing to the large portion of immatures in the population which have not reached full development at that time. Also measurements of the total length in the living bird as reported by Wetherbee³ are considerably less than those found for Ohio birds measured in a dead and relaxed condition. Stevenson,⁴ 1933, has reported sexual differences in the Starling in body-weight and length of the small intestine.

The males were found to have a somewhat greater range of size fluctuation than the females for all measurements. The average male measurements also exceeded those of the females for total length, 3.1 millimeters; wing-length, 2.5 millimeters; tail-length, 2.3 millimeters; and exposed culmen, .7 millimeter. These represent differences of 1½ per cent to nearly 4 per cent. Table No. 6 gives the maximum, minimum, and average measurements of 104 males and 72 females taken at the Ohio State Hospital, Columbus, Ohio, on March 6, 1934. On this date all immature birds have reached approximately full development. Also banding data indicated that the population at that time was almost entirely made up of winter residents.

TABLE NO. 6. MEASUREMENTS OF 104 MALE AND 72 FEMALE STARLINGS IN MILLIMETERS

	Males			Females		
	Maximum	Minimum	Average	Maximum	Minimum	Average
Total Length	231	206	218.2	224	203	215.1
Wing-Length	136	123	129.0	131	120	126.5
Tail-Length	68	59	63.4	66	58	61.1
Exposed Culmen	31.5	24.0	27.4	30.0	24.5	26.7

Of seven immatures collected on May 25, 1934 (one to three weeks out of the nest), the first five named were males. Measurements were: length, 221, 213, 208, 206, 201, 201, and

³Mrs. Kenneth B. Wetherbee. "Some Measurements and Weights of Live Birds." *Bird-Banding*, Vol. V, 1934, pp. 55-64.

⁴Stevenson, James. "Experiments in the Digestion of Food by Birds." *Wilson Bulletin*, 45:155-167, 1933.

184 millimeters; wing, 117, 116, 112, 108, 108, 105 and 106; tail, 61, 59, 60, 61, 56, 51 and 49; culmen, 20, 20.5, 21, 20.5, 21, 20 and 18. Weight in grams, 86, 80, 77, 76, 72, 69 and 64. Average of the five males, 78.2 grams.

VI. PHYSICAL DEFORMITIES

On account of the great amount of work involved in the banding of more than 30,000 Starlings and the handling of about 8,000 others, and the relatively poor illumination available for the night work, only a part of the birds captured could be examined for external visible physical deformities. Table No. 7 shows the frequency with which each malformation occurred in the 10,000 birds which were most carefully observed by the writer. Doubtless many abnormalities, especially the less conspicuous ones, were overlooked. The frequency of the occurrence of each type can readily be converted into percentage if desired by dividing by 100.

TABLE NO. 7. NUMBER OF PHYSICAL DEFORMITIES PER 10,000 STARLINGS

One Toenail Absent	314	Pigmy Size	6
Two Toenails Absent	210	Tail Missing	1
Three Toenails Absent	163	Swallow Tail	1
Four Toenails Absent	49	Giant Crossed Bill	14
Five Toenails Absent	12	Split Bill	5
Six Toenails Absent	8	Stub Bill	2
Seven Toenails Absent	3	Sparrow-Bill	2
Eight Toenails Absent	1	Grosbeak Bill	1
One Toe Absent	182	Hooked Bill	6
Two Toes Absent	104	Curled Bill	3
Three Toes Absent	68	Transparent Bill	3
Four Toes Absent	28	Chalk Bill	2
Five Toes Absent	3	One Eye Blinded	46
Six Toes Absent	1	Broken or Crooked Wing	6
One Foot Absent	21	One or More White Wing- Feathers	5
One Leg Absent	12	One or More White Tail- Feathers	2
Club Foot	18	Patch of White Body Feathers	4
One Broken or Crooked Leg	83	Total Birds with Abnormalities, 535 or 5.35 per cent of the 10,000	
Both Legs Crooked	6		
Red Legs	3		
Pink Legs	1		
Giant Size	7		

When duplications are eliminated, it is found that 535, or 5.35 per cent, of the 10,000 birds had some physical deformity. About 3.14 per cent lacked toenails, 1.82 per cent lacked toes, .21 per cent lacked feet or legs, .83 per cent had broken legs, .38 per cent had bill deformities, and .46 per cent were blind in one eye. A few of the leg injuries could be traced to the banding activities or the effects of poorly placed bands. A few were traced to disease, infections, or parasites. The remainder

were either inexplicable or presumed to be due to natural causes (injuries and physiological disturbances). Few were of a degree sufficient greatly to affect health or survival as most of the affected birds were not underweight.

Most of the minor leg injuries are believed to be due to the effects of cold and freezing. Birds collected in the field in winter sometimes have large frozen lumps of clay adhering to the toes or legs. Legs may be broken or severed when the birds, in quest of garbage, step into traps set for rodents. Birds with club feet usually have toes or toenails missing, the lower foot being swollen into a diseased lump one-half to three-fourths inch in diameter. Four birds examined seemed to have little or no pigment in the legs. The legs of these were of a red or pink color. In each case both legs were affected but the remainder of the bird was normal.

Seven "giant" birds, appearing normal otherwise, measured 241 to 249 millimeters in length, all being males. (Average length for adult males is 218.2 millimeters. Six "pigmy" birds (five females) measured 189 to 194 millimeters in length. (Average length for adult females is 215.1 millimeters.) Both the giant and pigmy specimens had other measurements and weight in proportion to their unusual lengths. Many birds, of course, were handled which lacked tail-feathers but which had regained them when repeating at a later date. One individual not only lacked any tail-feathers when handled in three different months, but appeared to have the posterior portion of the body shriveled and rounded, being entirely devoid of a tail. One bird had a "swallow tail," the two outer pairs of tail feathers being 19 millimeters longer than the others.

Three birds had bills without pigment and semitransparent. Two had powdery white bills of a chalky nature which could easily be pared away with the fingernail. Six had the upper mandible conspicuously hooked over the lower one. Three had the upper mandible curved upward and backward into a nearly complete loop. Five birds had the upper mandible split into distinct spreading forks, while two others had both mandibles flattened into a small stubby disk. One bill of less than half normal length was shaped and proportioned like the beak of an English Sparrow, while another was thickened and deepened, resembling that of a Cardinal.

Fourteen birds had very curious crossed bills of more than twice normal length. Some of these showed a definite tendency to spiral and most were somewhat split at the tip. All but one had the upper mandible crossing to the left. One bird (band

A-215952—winter 1932-33) was taken on December 3, December 26th, February 2nd, and February 21st, and when caged for several days, experienced no difficulty in partaking of all kinds of foods.

Ohio State University, Columbus, Ohio.

A STUDY OF STARLINGS BANDED AT COLUMBUS, OHIO

By EDWARD S. THOMAS

IN February, 1927, the writer and some companions conceived the idea of capturing and banding flocks of European Starlings (*Sturnus vulgaris vulgaris* Linnæus) at their roosts by means of flashlights. This appears to be the first recorded instance of capturing Starlings by this method in the United States. Over one thousand Starlings were thus banded in 1927 at their roosts in barns in central Ohio, and fifteen hundred were banded in 1928. In 1929, we discovered a large roost of the birds in the towers of the Columbus State Hospital and were successful in capturing over four thousand birds, including 840 repeats and 31 returns from previous years.

The main tower of the State Hospital building was remodeled in 1930, cutting off this fruitful source of supply, but 750 birds were banded in other places. No birds were banded in 1931, but in the last three years the work has been renewed under the direction of L. E. Hicks, until more than thirty thousand Starlings have been banded to date.

Almost the entire membership of the Wheaton Club of Columbus immediately joined in the Starling-banding activities. Although the bands are credited principally to George Wolfram, L. E. Hicks, R. W. Franks, and the writer, the work soon came to be considered a Wheaton Club project.

The present study is based upon a total of 7062 birds banded in 1927, 1928, and 1929 and the returns and recoveries from them up to April 4, 1932. The large amount of material accumulated since that date is being studied by Dr. Hicks with the view of publishing additional papers.¹

Our technique has not changed materially from that described by the writer in the *Wilson Bulletin* in 1927. Briefly,

¹See article in this issue of *Bird-Banding*.