VARIATION IN A FLOCK OF THE EUROPEAN STARLING

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THE European Starling (*Sturnus vulgaris*) has become so numerous in the region of Syracuse, New York, that there are several flocks, numbering into the thousands, roosting in or on various towers or buildings during the winter. One such flock roosted in a tower of one of the buildings at Syracuse University and was the source of the 455 specimens (240 males and 215 females) utilized in this study.

A study of the literature relative to weights, measurements, and variations in birds reveals the fact that many studies have been made on only a few specimens, and oftentimes these were collected at widely different places over a considerable length of time and frequently by different individuals. Each of these factors lessens the accuracy of the information collected.

In this study all of the specimens were collected at the same time, at the same place, and in the same manner and given the same treatment by the same person. All weights and measurements were taken in the same way by means of the same instruments. Therefore, the resulting figures are as nearly comparable as possible.

This study was conducted to determine the normal variation in a flock at one time, the sex ratio in a late winter flock, sexual differences in size and weight, and the variation in the weights of the internal organs.

The specimens were collected on March 28, at night after the flock had quieted down. The birds were caught by hand or in insect nets after screens had been placed over the exits from the tower in which they were roosting. As they were captured, they were placed in large burlap bags. The birds in the bags were then lowered into galvanized trash cans and chloroformed.

When the collecting was completed, the birds were spread in a cold room to remove the body heat. The following morning the birds were weighed in groups of 50 and then stored in a cold room (from 32° to 35° F.) for further study. As removed from the cold room, each group was again weighed to determine the percentage of weight lost through dehydration. This factor was then used in computing individual weights. The amount of weight lost in this way decreased daily, beginning with a high of four-tenths of one per cent during the first 24 hours.

Six external measurements were taken on each fresh specimen as follows:

Total length (tip of bill to tip of tail feathers) was measured after the bird had been relaxed by repeated flexing. The bird was then suspended against the measuring board so that the weight of the bird acted as a stretching force.

Tail length was measured by raising the tail to approximately a 90-degree angle with the back and measuring from that angle to the tip of the longest tail feather.

Wing length was measured from the distal joint of the wing (the wrist) to the tip of the longest primary. The measurement was taken while that part of the wing was pressed against the measuring board.

Head length was taken as the maximum length from tip of bill to back of skull.

Cranial width was measured as greatest width of the skull.

Bill length was taken by measuring from tip of bill to corner of mouth.

Total length, tail length, and wing length were measured on a board accurate to one millimeter. Head length, bill length, and cranial width were taken with calipers calibrated to one-tenth of a millimeter. Weights of the birds were taken on a scale calibrated to one-tenth of a gram, and the internal organs were weighed on a balance calibrated to one ten-thousandth of a gram.

As soon as the external measurements were taken, the body cavity of each bird was opened in order to examine the gonads. This served to determine the sex and to reveal the size of the gonads. The largest and smallest gonads were weighed while fresh, and all others were left in place for preservation. The birds were then stored in five per cent formaldehyde in preparation for further study.

After hardening in this preservative for several months, the internal organs were carefully removed and weighed. The weight in each case was therefore the preserved weight. This made for greater accuracy since the tissues were then hardened and there was no bleeding or loss of tissue fluids during the operation. Each part was rolled over blotting paper to remove excess moisture before being weighed.

Birds captured in winter present a minimum of variation. Young birds have attained adult size in most respects, and most adults do not yet show variations associated with the breeding season.

Table 1 gives the arithmetic mean, the standard deviation, and the standard error of the mean for these measurements. In a normal distribution, the standard deviation is greater than the mean deviation in the proportion of 1.0000 to 0.7979. It is used in this study because it gives greater emphasis to the extremes than does the mean deviation.

TABLE 1

SIZE VARIATION SHOWN BY 240 MALE AND 215 FEMALE STARLINGS
LENGTHS IN MILLIMETERS. WEIGHTS IN GRAMS

Item		*Maximum*	*Minimum*	*Mean ± Standard Error*	*Standard Deviation*	*Standard Dev. × 6*	*Range*
Total length	♂	238	215	228.6 ± 0.30	4.53	27	23
	♀	237	211	224.9 ± 0.31	4.41	26	26
Tail	♂	80	64	73.5 ± 0.53	8.13	49	16
	♀	78	64	72.1 ± 0.62	8.89	53	14
Wing	♂	137	122	129.2 ± 0.14	2.08	12	15
	♀	137	120	126.5 ± 0.18	2.62	16	17
Head	♂	61	53	56.5 ± 0.10	1.62	10	8
	♀	59.5	53	55.2 ± 0.09	1.32	8	6.5
Cranial width	♂	21.5	20	20.9 ± 0.03	0.41	2	1.5
	♀	21.0	19.5	20.2 ± 0.03	0.38	2	1.5
Bill	♂	40.0	31.5	35.7 ± 0.12	1.70	10	8.5
	♀	39.0	31.0	34.8 ± 0.10	1.52	9	8
Weight	♂	98.0	66.5	82.0 ± 0.36	5.22	31	32
	♀	89.5	60.0	76.2 ± 0.39	5.66	34	29.5
Brain	♂	2.20	1.65	1.897 ± 0.010	0.111	0.664	0.55
	♀	1.95	1.55	1.754 ± 0.011	0.121	0.728	0.40
Gizzard	♂	3.00	1.45	2.292 ± 0.012	0.134	0.803	1.55
	♀	3.05	1.55	2.264 ± 0.009	0.099	0.591	1.50
Heart	♂	1.90	1.10	1.494 ± 0.002	0.022	0.131	0.80
	♀	1.85	1.10	1.399 ± 0.003	0.028	0.168	0.75
Liver	♂	5.55	3.20	4.110 ± 0.044	0.498	2.985	2.35
	♀	5.00	2.95	3.823 ± 0.043	0.460	2.759	2.05
Lungs	♂	2.10	1.20	1.726 ± 0.016	0.183	1.096	0.90
	♀	1.95	1.10	1.585 ± 0.018	0.188	1.087	0.85
Gonads	♂	1.30	0.02	0.222 ± 0.007	0.076	0.453	1.28
	♀	0.14	0.002	0.048 ± 0.005	0.047	0.282	0.138

The mean plus or minus one standard deviation includes 68.28 per cent of the area under the distribution curve; two standard deviations on each side of the mean include 95.46 per cent; and three standard deviations on each side include 99.73 per cent of the area. For the number of observations made, the standard deviation is close to one sixth of the normally expected range. Standard deviation times 6 (S. D. × 6) and range are therefore included in the tables to show how the data in this study conform to the normal distribution.

Standard error of the mean is included to show whether or not the differences in measurements between the males and females are

statistically significant. The standard error is greater than the probable error in the proportion of 1.0000 to 0.6475. If the difference between two means is greater than three standard errors, the difference is highly significant.

External Measurements (table 1).—The average total length of the males was 3.7 mm. greater than that of the females; however, there was a 78 per cent overlap in this measurement. All birds less than 215 mm. in total length were females and all birds over 237 mm. were males. Such narrow limits are useless in determining sex from measurements of total length. The difference in the means for males and females (3.7 mm.), however, is over eight times the standard error for the difference, and therefore is significant and cannot be accounted for by chance.

The minimum tail length was the same in both sexes, but the maximum length for males was 2 mm. greater, and the mean, 1.4 mm. greater for the males. This difference, however, is less than twice the standard error of the difference and therefore not statistically significant. It is too small a difference to be helpful in distinguishing the sexes. The high standard deviation for these measurements probably does not reflect unusually great variation in tail length. Had the tails been measured in the usual way (cf. Ridgway, U. S. Natl. Mus. Bull. 50, pt. 1: xv, 1901), not only would greater precision have been obtained, but the standard deviation would have been less and a significant sexual difference in tail length might have been found.

The wings of the males average 2.7 mm. longer than those of the females, and since this difference is over 11 times the standard error of the difference, it is significant. The table shows that an occasional female may have as long a wing as the male and therefore sexes cannot be determined on this basis.

Head length is an actual skeletal measurement and not dependent upon feathers. The measurements were taken with the skin on.

Both males and females have a minimum head length of 53 mm. Only one male had this short a head, however, and it was evidently an immature specimen, judging from the small size of the gonads. Six females had heads of this length. All individuals with heads over 59.5 mm. long were males. There were 17 in this group. Head length in the male averaged 1.3 mm. larger than that of the female. This difference is about seven times the standard error of the difference and therefore is statistically significant.

Cranial width is also a skeletal measurement and, although small, bears out the larger size of the males. The difference between the

means for the two sexes is 0.7 mm., which is over 18 times the standard error of the difference for these measurements.

Bill length for the males averaged 35.7 ± 0.12 mm. and for the females 34.8 ± 0.10 mm. The difference of 0.9 mm. between these two is therefore over five times the standard error of the difference and is significant.

Weight is probably the most variable measurement taken since it varies with the physiological condition of the animal. Of course disease or injury might produce abnormal individuals, although none were noticeably affected in this study. February is a time when weight should be fairly constant since juveniles are well developed and the gonads, particularly of the females, are still small. (There were a few exceptions to this among the males.) It is known that the gonads of juveniles are usually somewhat smaller than those of adults at this time. They are also slower to enlarge in the spring. The average weight of the males was 82.0 grams, which is 5.8 grams more than the average for the females. This difference is over 10 times the standard error of the difference and therefore significant. During the breeding season when the gonads of both sexes are greatly enlarged, the average weight would be greater. Since the ovary is relatively huge while eggs are being matured, the females might average as heavy, or even heavier, than the males during that period.

Internal Measurements (table 1).—Brain weights were larger in the males—the average being 1.897 ± 0.010. The average for the females was 1.754 ± 0.011, thus the difference between the means is 0.143 gram, which is over nine times the standard error of the difference and therefore statistically significant.

The weight of the empty gizzard is more variable; the distribution curve would be more flat in both sexes than that of the brain, but the standard deviation is about the same. The average weight in the male is 2.292 ± 0.012 and in the female is 2.264 ± 0.009. Thus the difference between the means (0.028) is less than two standard errors of the difference and therefore not significant.

The standard deviation of the weight of the heart is 0.028 in the males and 0.028 in the females. The males have the larger hearts, the average weight being 1.494 ± 0.002 grams. This is 0.095 gram heavier than the average weight of 1.399 ± 0.003 grams for the females. This difference of 0.095 is over 28 times the standard error of the difference.

The liver, like the gizzard, shows a relatively flat distribution curve. The standard deviation is higher for this organ than for any other organ measured, being 0.498 for males and 0.460 for females. The

males have the heavier livers—their average being 4.110 ± 0.044 grams, which is 0.287 grams heavier than the average weight of 3.823 ± 0.043 grams in the females. This difference is over four times the standard error of the difference and therefore has statistical significance. The males have the heavier lungs—the average being 1.726 ± 0.016 grams. This is 0.141 gram heavier than the average of 1.585 ± 0.018 for the females. This difference is significant since it is nearly six times the standard error of the difference.

TABLE 2

THE WEIGHT IN GRAMS AND PER CENT OF BODY WEIGHT OF THE PRINCIPAL INTERNAL ORGANS

		Brain		*Gizzard*		*Heart*	
Sex	*Total Weight*	*Weight*	*Per Cent*	*Weight*	*Per Cent*	*Weight*	*Per Cent*
Males	82.0	1.90	2.31	2.29	2.79	1.49	1.82
Females	76.2	1.75	2.30	2.26	2.97	1.40	1.83

		Liver		*Lungs*		*Gonads*	
Sex	*Total Weight*	*Weight*	*Per Cent*	*Weight*	*Per Cent*	*Weight*	*Per Cent*
Males	82.0	4.11	5.01	1.73	2.10	0.22	0.27
Females	76.2	3.82	5.02	1.58	2.08	0.05	0.06

The gonads are subject to great seasonal variation, and since the sexes differ so greatly no direct comparison of size or weight between the sexes seems desirable. The distribution curve for the male is not a normal curve apparently because recrudescence had begun in the gonads of a few individuals. This is shown in table 1 by the fact that the range is 1.28 whereas the normal or expected range should be about six times the standard deviation or 0.453. However, after removing the 13 individuals (5.4 per cent) with the largest gonads, the remainder show fairly normal distribution. This is in agreement with the findings of Kessel (Bird Banding, 22: 16–23, 1951), and according to her study they probably represent adult males rather than first-year males. Miss Kessel's study was not published in time to make use of the age indicators in studying these specimens.

The average weight of gonads for all males was 0.222 ± 0.007 grams. The smallest weighed 0.02 gram and the largest, 1.30 grams.

The weight distribution curve for the ovary is much more normal as shown by the range. Three individuals, or 1.4 per cent, had ovaries that were considerably larger than those of the others and probably represent adult females (Kessel) in which recrudescence of

the gonads had begun. The average weight of the ovaries was 0.048 ± 0.005 gram.

The above statistical treatment of the data collected shows that male starlings are significantly larger than the females not only in external measurements, but also in the size of each of the principal internal organs with the exception of the gizzard. This means that the digestive system, at least the gizzard, may be relatively larger in female than in male starlings. Table 2 shows the relative size relations for each organ and for each sex.

The per cent of the total weight made up by each organ reveals that the following organs are alike for the two sexes to two one-hundredths of one per cent: brain, heart, lungs, and liver. This is too small a difference to have any significance. Aside from the gonads, the only organ which appears to be proportionately larger in one sex than the other is the gizzard, which is relatively larger in the female than in the male.

SUMMARY

The variation shown by 455 birds from a single flock of Starlings taken in March follows a normal curve very well and has a spread of approximately six standard deviations.

The sex ratio was 52.7 males to 47.3 females.

Males are significantly larger than females in all external measurements. The overlap, however, is 78 per cent, and therefore the difference can not be used to determine the sexes in the field.

Sexual variation in the size of internal organs compares very closely with that in the external measurements, the male being significantly larger. The per cent of the total weight made up by each organ is alike for the two sexes to one-hundredth of one per cent for the brain, heart, and liver, to two one-hundredths of one per cent for the lungs. The gizzard is eighteen one-hundredths of one per cent more of the weight of the female than of the male. Therefore, even in the organ (gizzard) showing greatest diversity, the per cent of total weight varies less than two-tenths of one per cent between the sexes.

The testes varied in weight from 0.02 gram to 1.30 grams. Thus, the largest was 65 times larger than the smallest.

The ovaries varied from 0.002 gram to 0.140 gram. Thus, the largest was 70 times as heavy as the smallest.

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