GENERAL NOTES

Statistical comparison of wing-lengths measured by four observers.—Wing-length is the most convenient measure of body-size in both live and dead birds and in study skins. It is being increasingly used by bird-banders to make statistical comparisons between populations, and to identify individual birds to age, sex, subspecies or even species. However, measurements of wing-length, like all measurements, are subject to error. Several recent papers and notes (Evans, *Bird Study*, **11**(1): 23-38, 1964; Johannesson, *Vår Fågelvärld*, **26**(3): 249-255, 1967) have commented on discrepancies in measurements on the same bird, measured by different observers or on different occasions. However, these notes have discussed small samples. This note compares measurements by four observers of a large sample of birds.

The sample consisted of 424 White-throated Sparrows (*Zonotrichia albicollis*) killed at the Prudential Center in Boston, Massachusetts, in the early and late morning of 4 May 1968. The birds were collected, those that had fallen into the moat surrounding the tower were allowed to dry, and the entire sample was placed in airtight plastic bags and frozen within 12 hours of collection. Over the next three months, Baird and Howard thawed the birds in small groups, and numbered, weighed, measured and sexed them. During the processing, the bent primaries of about a dozen birds were straightened by steaming. Baird measured the chord of the right wing and Howard (who is left-handed) measured the chord of the left wing. It was the uncertainty introduced by this measuring of different wings that led us to number the birds and seek another set of measurements. This was accomplished in one day, about three months later (30 July 1968), when the birds were thawed again and the chords of their right wings measured by Nisbet and Anderson. Since the birds had been carefully packaged there was very little weight loss (it averaged less than 0.1 g in a sample of 10 birds), and the wings were still very flexible. However, there were 23 birds with severely bent primaries that were rejected by one or both of the latter observers; the figures quoted below refer only to the 401 birds measured by all four observers.

All the observers were experienced bird-banders: Nisbet measures several hundred birds annually, Howard about a thousand, and Anderson and Baird several thousand. All measure the wing without flattening (chord) and in general their techniques are similar, largely due to the tutorial influence of Baird. However, no attempt was made to standardize techniques further during this study. Since the birds were individually numbered, each observer measured them independently, without knowledge of the others' measurements.

As measured by Baird, the mean wing-length of the series was 70.57 mm and the standard deviation 2.90 mm. Nisbet's mean was larger by 0.08 mm, Howard's by 0.20 mm, and Anderson's by 0.37 mm. Comparing measurements by different observers of the same individual birds, the standard deviations of the differences were between 0.78 and 1.03 mm (Table 1), so that the standard errors of the differences between observers' means were between 0.039 and 0.052 mm. Hence, most of the differences between observers' means were statistically significant, indicating slight differences in measuring technique. However, the differences were small and biologically insignificant.

Table 1 summarizes the variances of the differences between observers measuring the same birds. The standard deviations of the differences averaged 0.93 mm. Individual discrepancies were of course much larger than this: of 2,406

TABLE 1. VARIANCES OF DIFFERENCES BETWEEN OBSERVERS MEASURING THE SAME BIRDS (UNITS: MM²)

	Anderson	Nisbet	Baird	Mean
Howard	1.06	0.88	0.80	0.91
Anderson		0.61	0.98	0.88
Nisbet			0.85	0.78
Baird				0.88

pairs of measurements, five differed by as much as 3.5 mm, 10 by 3 mm, and 38 by 2.5 mm.

Discrepancies between the measurements by two observers of the same object may arise from three sources: errors by one observer, errors by the other, and variations in the object. If the contributions of the three sources are independent (i.e., uncorrelated with each other), statistical theory indicates that they should contribute additively to the variance of the difference.

In this study the only important variation in the object is likely to be the difference between right and left wings. Baird and Howard, who measured right and left wings respectively, double-checked measurements that differed by more than 1 mm, and found that in the original sample of 424 birds there were only 21 (5 percent) whose wings actually differed by more than 1 mm (9 by 1.5 mm, 11 by 2 mm, 1 by 3 mm). These differences would have made only a small contribution (less than 25 percent) to the variances involving Howard in Table 1. Otherwise these variances result from individual differences in measurement of the same wings.

Table 1 indicates no consistent differences between observers in their contributions to the variances, suggesting that each made errors of similar magnitude. However, the fact that the lowest and the two highest variances in Table 1 involve the same observer suggests that the assumption of independence is not correct: there may, for example, be consistent differences between the observers in the way they treat bent or frayed wing-tips.

We conclude:

(1) that different observers can measure mean wing-chords in a large sample within about 0.4 mm. (0.6 percent), without special care to standardize techniques (other than instruction to measure wing-chords without flattening);

(2) that errors by individual observers have a root mean square value of 0.6-0.7 mm, so that errors of 2.0 mm (3 percent) are not exceptional;

(3) that measurements of the same bird by different observers may differ by as much as 3.5 mm (5 percent). However, the variance introduced by individual observers is only a small fraction (about 5 percent) of the total variance of each sample. We recommend that wing-lengths which may be significant in identification should be measured twice (the same wing), preferably by different observers.

This study should be repeated on live birds under field conditions.—I. C. T. Nisbet, J. Baird and D. V. Howard, Massachusetts Audubon Society,* Lincoln, Massachusetts 01773; K. S. Anderson, Manomet Bird Observatory, Manomet, Massachusetts 02345. *Contribution No. 81 from the Hatheway School of Conservation Education.

Spotted Eggs in a Local Population of Starlings.—In June 1968, during the course of a study of nestling behavior in hole-nesting birds, I received a clutch of 4 eggs of the European Starling (*Sturnus vulgaris*) that had distinct but very fine reddish-brown spots on the normal light blue ground color. These eggs had been taken from a martin house on the east side of Lawrence, Douglas Co., Kansas. From the stage of embryonic development the eggs appeared to have been incubated 4-5 days. This clutch was not saved.

Subsequently, I examined the oological collections of several major museums and found no other spotted eggs of the European Starling.

On 26 June 1969, I removed a set of 3 spotted Starling eggs from a martin house on the west edge of Lawrence, approximately 3 miles from the location of the first nest. These eggs were fresh and have been preserved in the oological collection of the University of Kansas (# 1753). In 1968 and 1969 I examined 4 additional Starling clutches in Lawrence which were all normally colored.

During the spring and early summer of 1970 I examined 13 Starling clutches in Lawrence; 5 of these clutches were spotted. Only one of the spotted clutches was found in a nest box known to have previously contained spotted eggs. Two young known to have hatched from spotted eggs were banded (F. and W. S. # 602-92819 and # 602-92820).

It appears that this is a rather localized phenomenon that may be of relatively recent origin in the Lawrence population. Amadon (1943) indicates that spotted eggs are common in the family Sturnidae, though the genus *Sturnus* characteristically has unspotted eggs. To my knowledge there is no North American record