

## RELIABILITY OF EXTERNAL SEX CHARACTERISTICS OF THE STARLING IN CALIFORNIA

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Determining a bird's sex by means of external characteristics is a prerequisite to many avian investigations. There are at least two external sex-related characteristics which can be used to determine the sex of European starlings (*Sturnus vulgaris*). These are:

1. The presence of a yellow ring along the outer edge of the iris, usually conspicuous in females over 6 weeks of age but absent in males. The occurrence of the eye-ring is generally considered to be independent of the season.

2. Somewhat prior to and during the breeding season of the starling, a portion of the normally dark-colored bill becomes bright yellow in both sexes. At this time the color of the proximal portion of the rami of the lower mandible is generally pale pink in females and blue to blue-black in males. This seasonally reversible expression of bill pigmentation is associated with changes of hormonal levels during the breeding cycle (Witschi and Miller, 1938).

Kessel (1951), Davis (1959 and 1960), and Parks (1962) have reported that these two characteristics permit reliable sex determination in starlings in the eastern United States. However, it is known that measurable morphological variations often exist between populations in bird species with wide geographical distribution. In Britain, for example, resident starlings can be distinguished morphologically from migrants (Bullough, 1942) but this cannot be done in North America (Davis, 1960). The purpose of the present paper is to report the reliability of the two characteristics in determining sex of starlings in a relatively new and expanding population in western United States.

The European starling has, since its introduction on the eastern seaboard of North America in the early 1890's, extended its range toward the west. This westward movement has been documented by Forbush (1920), Cooke (1925 and 1928), Lewis (1927), Hoffman (1930), Kalmbach (1931), Dickerson (1938), Kessel (1953) and others. Starlings were first reported in California in 1942 by Jewett (1942) with documented nesting in 1958 (Ball and Koehler, 1959). Howard (1959) summarized the information on the early influx of starlings into California. His prediction that starlings would become abundant has since been verified, as the species is presently well established in suitable habitats throughout much of the state.

In addition to resident populations, large numbers of migrant starlings inhabit California during the winter months, especially

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TABLE 1. RELIABILITY OF EXTERNAL CHARACTERISTICS IN DETERMINING THE SEX OF STARLINGS FROM HETEROGENEOUS FLOCKS WINTERING IN CALIFORNIA

EXTERNAL SEX CHARACTERISTIC	RELIABILITY OF SEX CHARACTERISTIC					
	Males		Females		Both Sexes	
	No./Sample	Percent	No./Sample	Percent	No./Sample	Percent
<i>Eye-ring:</i>						
Correct indication of sex <sup>1</sup>	84/89	94.4	94/97	96.9	178/186	95.7
Characteristic indefinite	11/100	11.0	3/100	3.0	14./200	7.0
<i>Bill Coloration:</i>						
Correct indication of sex <sup>1</sup>	95/97	97.9	89/92	96.7	184/189	97.4
Characteristic indefinite	3/100	3.0	8/100	8.0	11/200	5.5
<i>Combination of Characteristics:</i>						
Correct indication of sex <sup>1</sup>	83/85	97.6	88/90	97.7	171/175	97.7
Correct indication of sex <sup>2</sup>	95/98	97.0	94/98	96.0	189/196	96.5
Both characteristics indefinite	0/100	0.0	2/100	2.0	2/200	1.0
Both characteristics erroneous	2/100	2.0	2/100	2.0	4/200	2.0
Eye correct—bill erroneous	0/100	0.0	0/100	0.0	0/200	0.0
Eye correct—bill indefinite	2/100	2.0	5/100	5.0	7/200	3.5
Bill correct—eye erroneous	2/100	2.0	0/100	0.0	2/200	1.0
Bill correct—eye indefinite	11/100	11.0	1/100	1.0	12/200	6.0

<sup>1</sup>Excluding those individuals with indefinite characteristics.

<sup>2</sup>Preliminary judgment of the sex of each individual excluding only those individuals with both characteristics indefinite or giving contrasting sex indications.

the San Joaquin and Sacramento Valleys. Band returns (Zajanc, unpublished data) indicate that these migrants originate in several western states, principally in the north and northeast, and also in portions of western Canada.

#### METHODS AND MATERIALS

All starlings used in this study were captured in live-traps placed in a cattle feed lot near Collinsville, Solano County, California, during late winter and early spring 1965. The thousands of starlings frequenting the feed lot were believed to be a segment of a population, estimated at several million birds, which congregated nightly at a winter roost on Sherman Island near the mouth of the Sacramento River, approximately two miles from the feed lot. This aggregation of male and female starlings presumably included both resident and migrant birds of varying ages.

At the time of capture, the bills of all birds were brightly pigmented, thereby facilitating the use of the mandibular characteristic for sex determination. Eye-ring and bill coloration methods were used independently to determine the sex of each individual in a large sample of starlings. The reliability of the two external characteristics was subsequently determined by comparing the first 100 individuals of each sex as proven by examination of the gonads with the external determinations.

The starlings for this study were provided by the California Department of Agriculture and the Bureau of Sport Fisheries and Wildlife, U.S.D.I. The assistance of Mr. Mark E. Campney, Laboratory Technician, was much appreciated.

#### RESULTS AND DISCUSSION

*Sex Determination by Means of Eye-ring and Bill Coloration:* This study indicates that the eye-ring characteristic is a more accurate criterion of the sex of females than of males. In this population, an accuracy of 96.9 percent for females and 94.4 percent for males was attained. These percentages are based on the number of correct determinations made per sample, exclusive of individuals with indefinite eye-ring characteristics. Because of obviously inconclusive eye-ring characteristics, no attempt was made to ascertain the sex of 7 percent of the population (11 of 100 males and 3 of 100 females). On a population basis, exclusive of birds with obviously atypical eye-ring characteristics, the sex determination was 95.7 percent accurate (Table 1). This approximates the expected accuracy, as Davis (1959) reports that about one percent of the females lack a bright-colored eye-ring and that this characteristic is present in about three percent of the males.

Bill coloration gave no obvious indication of the animal's sex in 3 of 100 males and 8 of 100 females. However, because of its relation to the breeding season, it is possible that this characteristic may have been better defined in these individuals if they had been examined at a slightly different date. Sex determination

based on bill coloration was 97.9 percent accurate for males and 96.7 percent accurate for females when those birds with obviously inconclusive bill colorations were omitted. Based on this sample, the sexes were identifiable with 97.4 percent accuracy, an increase of 1.7 percent over that attained by the eye-ring characteristic. This agrees with Kessel's (*op.cit.*) findings that bill coloration is slightly more accurate than the eye-ring as an indicator of sex in starlings in the eastern United States.

By employing both eye-ring and bill coloration, the sex was correctly determined in 95 percent of the total sample regardless of the definition of the characteristics. The accuracy of sex determination by external characteristics was increased to 97.7 percent by excluding the small number of birds with poorly defined or obviously atypical characteristics. The probability of both characteristics being simultaneously incorrect appears greater (2.0 compared to 0.5 percent of the 200-bird sample) than that of both characteristics being poorly defined or obviously atypical in an individual starling. Unfortunately this tends to reduce the accuracy of sex-determination by external characteristics as birds with both characteristics well-defined, but erroneous, give no indication that they are in fact atypical.

Parks (*op.cit.*) reports that of 500 starlings captured and banded in Connecticut, the external characteristics of only 10 individuals were inconclusive, conflicting, or too indefinite to justify a decision as to the sex of the bird. Although his study did not permit verification of the accuracy of the sexing methods by examination of the gonad, it appears that it would closely compare with the percentage of the California starling sample having inconclusive or atypical external sex-related characteristics.

#### SUMMARY

A sample of 100 male and 100 female starlings, collected from Solano County, California, was used to determine if the methods of sexing starlings by external characteristics used in eastern United States and in Europe were reliable in western starling populations. The sample presumably contained resident and migrant birds of varying ages. The sex of each bird was determined on the basis of two external characteristics, the eye-ring and bill coloration. The reliability of these characters as sex indicators was subsequently determined by the examination of reproductive organs.

In starlings with well-defined external sex characteristics, the bill coloration, although useful only during the breeding season, is somewhat more accurate than the eye-ring (97.4 percent compared to 95.7 percent). By using both characteristics and excluding individuals with poorly defined or atypical characteristics, sex determination was attained in this heterogeneous population with an accuracy of 97.7 percent. This compares favorably with the accuracy of these characteristics in determining the sex of starlings in the eastern United States.

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Received February, 1966.

GENERAL NOTES

**Nesting Behavior of a Crippled Chimney Swift.**—Over three seasons a crippled Chimney Swift (*Chaetura pelagica*) attempted to nest in a colony of swifts which has been under observation since 1944 on the campus of Kent State University at Kent, Ohio. Only once was it successful, and then as a replacement for a bird which disappeared after its nest with three eggs fell from the wall. With two other swifts over the years of 1963-65, it was apparently incompatible. It is not certain whether its failure to complete nesting in three instances was a result of its crippled condition or whether the birds were simply incompatible, a condition which is occasionally found among nesting swifts (Dexter, 1951b; 1961a). Also, nesting has been accomplished by swifts with a similar foot injury. However, its life history is of interest since the behavior pattern was unusual. Normal nesting behavior has been described earlier (Dexter, 1950; 1951a; 1961b). Chimney Swift No. 25-137573, which later proved to be a male, was captured in air shaft I3 on 24 May 1963. The right toes were missing, and it is possible this injury was the result of a previously attached band which had slipped over the toes resulting eventually in their amputation. Such has been known to occur on