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RICHARD F. HARLOW AND MICHAEL R. LENNARTZ, *USDA Forest Service, Southeastern Forest Experiment Station, Department of Forestry, Clemson University, Clemson, South Carolina 29631.* Accepted 6 Dec. 76. (This paper was subsidized by the United States Department of Agriculture Forest Service.)

Bilateral size dimorphism in House Sparrow gynandromorphs.—The occurrence of bilateral gynandrism among birds is rare; only 28 cases involving 12 species have been reported (Laybourne 1967 and references therein, Laskey 1969). In species whose plumage is genetically controlled, this condition results in one lateral half of the bird exhibiting male plumage, the other half female, with a sharp line of demarcation. Several specimens of sexual abnormalities are known for House Sparrows (*Passer domesticus*), but none of the 14 specimens reported or reviewed by Harrison (1961) showed a distinct bilateral dimorphism in plumage. Among the collections of the Museum of Natural History, University of Kansas, are 6 additional specimens of sexual abnormalities: 4 skins and 2 skeletons. Of the skins only one shows noticeable bilateral gynandrism in plumage. The skeletal specimens are of special interest in that their skeletal morphologies show bilateral size dimorphism that reflects the normal sexual size dimorphism shown in House Sparrows. These two specimens are considered true gynandromorphs rather than intersexes (see Strickberger 1968: 468).

One specimen (KU 68610) from a sample of 45 sparrows collected in Burlington, Iowa, during December 1973 and January 1974 exhibited a mixture of male and female plumage patterns. The crown showed gray coloration; throat feathers were black, with additional black feathers on the right side of the breast; and the rhamphotheca was black. The paler eyeline of females was evident. (The bird was photographed because of its unusual appearance, but only a skeleton was prepared and the skin was not saved. Dissection revealed an apparent ovary on the left side but no testislike structure.) The measurements of right and left limb components show that the left side elements are from 0.5 to 4.6% smaller than right side elements (averaging 2.3% smaller, Table 1). For these same variables I measured the right and left sides of five males and five females of the Burlington sample and found the average difference in measurements between sides to be 0.41%. For the Burlington sample, male mean values averaged 2.0% larger than female means for these six variables. This amount of sexual dimorphism is similar to that demonstrated in House Sparrow skeletal measurements by Johnston and Selander (1971).

I used a stepwise discriminant function analysis program (BMD07M, Dixon 1970) to separate males and

TABLE 1

MEANS FOR EACH SEX OF THE 14 VARIABLES MEASURED (IN mm) AND FOR EACH SIDE OF THE GYNANDROMORPH

	Burlington, Iowa sample (20♀♀, KU68610, 23♂♂)					Manhattan, Kansas sample (29♀♀, KU67925, 45♂♂)				
	♀	Gynandromorph			♂	♀	Gynandromorph			♂
Variable	Mean	left		right	Mean	Mean	left		right	Mean
1 Premaxilla	7.00		6.8		6.88	6.89		7.3		6.89
2 Skull width	15.13		15.4		15.41	15.11		15.5		15.26
3 Skull length	30.14		30.8		30.23	29.84		30.4		29.78
4 Dentary	6.23		6.3		6.28	6.17		6.0		6.16
5 Mandible	20.48		20.5		20.44	20.21	20.6		20.7	20.26
6 Coracoid[1]	17.70	17.8		18.2	18.24	17.67	18.1		18.4	17.89
7 Sternum length	22.40		23.4		23.37	22.67		24.5		22.96
8 Keel length	20.64		21.8		22.13	21.29		22.7		21.85
9 Sternum depth	9.92		10.0		10.39	9.85		10.6		9.96
10 Humerus[1]	18.38	18.4		18.3	18.70	18.21	18.4		18.8	18.56
11 Tibiotarsus[1]	27.76	28.6		28.9	28.01	27.61	28.0		28.2	27.76
12 Tarsometatarsus[1]	19.15	19.4		20.3	19.39	18.82	19.2		19.6	18.90
13 Ulna[1]	20.66	21.0		21.7	21.44	20.52	20.9		21.3	21.18
14 Femur[1]	17.38	17.7		18.1	17.65	17.51	17.3		17.5	17.66

[1] Variables of the 6-character subset.

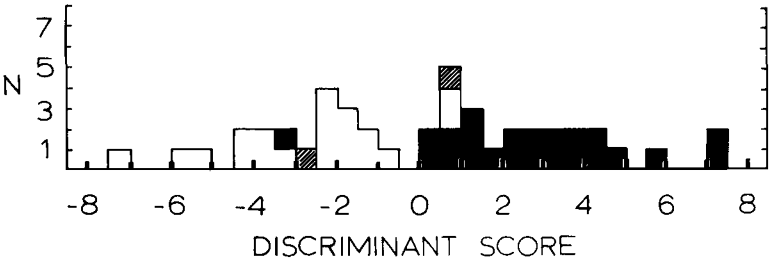

Fig. 1. Histogram showing the frequency distribution of discriminant scores of males (black), females (clear), and the gynandromorph (striped) of the Burlington sample. Birds with a negative discriminant score are classed as females, a positive score as males. The discriminant function is $f' = -2.587\ V_{11} - 1.810\ V_{12} + 8.386\ V_{13} - 69.532$.

females on the basis of skeletal morphology and then classified each side of the gynandromorph according to the resultant discriminant function. Analyses were made using a 14-character set (containing measurements of the skull and limb and pectoral girdle elements) and a subset of only the six limb measurements (i.e. those bones with both right and left elements). The use of all 14 characters resulted in only one misidentification of individual's sex for the 43 specimens, but the discriminant function, f, based on the first six characters selected for entry, gave only one misidentification. (An F to enter >1 was required here for inclusion into the discriminant function. Subscripts refer to variable numbers in Table 1.)

$$f = 3.383\ V_2 - 2.044\ V_3 - 2.273\ V_5 + 2.424\ V_8 - 3.160\ V_{11} + 6.173\ V_{13} - 37.121$$

The two sides of the gynandromorph were then classified using f. This bird is somewhat intermediate in size between male and female means, but the bilateral size dimorphism was sufficient to allow clear classification of the left side (with ovary) as a female and the right side of the bird as a male. The discriminant function generated from the limb measurements only, f', selected three variables to separate sexes and resulted in only three misidentifications (Fig. 1):

$$f' = -2.587\ V_{11} - 1.810\ V_{12} + 8.386\ V_{13} - 69.532$$

Each side of the gynandromorph was separated further by f' as is shown by Mahalanobis distances: $D^2 = 1.369$ in f, and $D^2 = 2.220$ in f'.

The Burlington bird most clearly demonstrates bilateral gynandrism in skeletal morphology. Each side of the bird is classifed as the appropriate sex. Skeletal measurements of another gynander (KU 67925) collected in Manhattan, Kansas, in November 1971 (with 29 adult females and 45 adult males), were also examined in the same manner, but similar results were not so easily obtained as this individual showed a smaller difference in size between the two sides (1.59%). This bird appeared to be a male by plumage and possessed a testis on the right and no apparent oviduct.

For the Manhattan sample the following discriminant function was obtained to separate sexes:

$$f = -4.676\ V_{10} - 1.572\ V_{11} - 2.988\ V_{12} + 10.344\ V_{13} - 29.828$$

As the four variables entered in f are all included in the 6-character set, f' is identical to f.

The discriminant scores of the Manhattan bird were within the female range of values, so that while the right side was closer to values for the males, it was still classified as a female by f.

When Manhattan and Burlington samples were combined, the resulting discriminant function classified the left sides of both gynandromorphs as females and the right sides as males (Fig. 2):

$$f' = 3.766\ V_{10} + 1.793\ V_{11} + 2.691\ V_{12} - 9.978\ V_{13} + 38.362$$

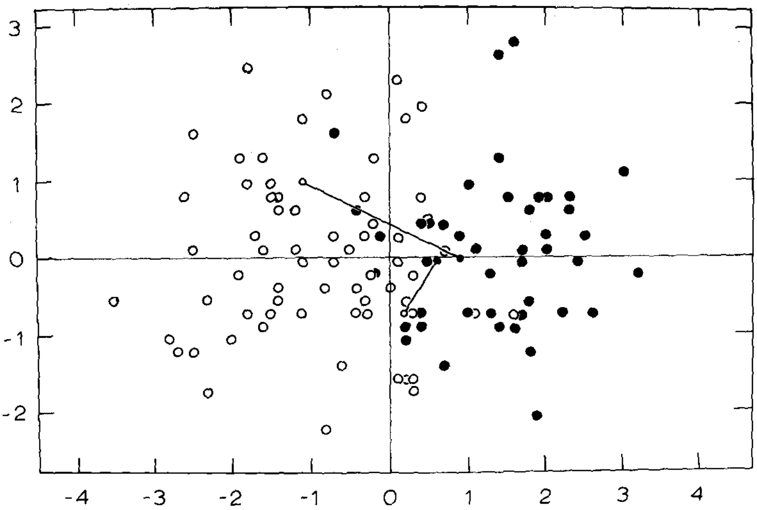

Fig. 2. Plot of Manhattan and Burlington samples on canonical axes I (abscissa) and II (ordinate). Position on canonical axis II is meaningless as there are only two groups. Males are shown by open circles, females by closed circles. The gynandromorphs are shown as bars joining the plotted values for each side. The Burlington bird is above; the Manhattan bird below.

This function incorrectly identifies the sex of 15 of the 117 individuals (13%). This greater percentage is expected because of the larger heterogeneity of the sample, which combines two localities. Both gynandromorphs are represented on the same canonical axes, which allows comparison of the relative degree of bilateral size dimorphism they show. For the Burlington bird, $D^2 = 3.834$, and for the Manhattan bird, $D^2 = 0.218$, as the distances separating each side. Distances are measured along the first axis only because position on canonical axis II is meaningless (only two groups were defined, which properly restricts analysis to a single canonical axis).

For these two specimens, the precise nature of the abnormality is not known. As House Sparrow plumage coloration is genetically controlled (only male bill color is under hormonal control, Keck 1934), it is assumed that one side is genetically male and the other female in bilateral gynandromorphs. Witschi (1961, citing Riley 1938) illustrates the large chromosomes of *P. domesticus*, showing the ZZ configuration of males and ZO of females, and he feels that gynandrism is a result of the loss of a Z chromosome during an early cleavage. This process does not seem complex, although the result may usually be detrimental, and the different degrees of bilateral differentiation, as shown in the two sparrow skeletons, may well be related to the developmental stage during which the Z chromosome is lost. If the Z chromosome is lost at the first cleavage of the zygote, a bilateral gynandromorph is expected; if the loss occurs later, the resulting gynandromorph may show less distinct bilateral dimorphism. Also if the left side (which normally has the functional ovary) becomes female while the right side remains male, differentiation between sides may be more evident than if the other possibility occurred.

The effects of gynandrism are thus more extensive than just the appearance of aberrant plumage. As shown here, skeletal morphology demonstrates dimorphism consistent with normal sexual size dimorphism. Such dimorphism suggests genetic control of skeletal morphology, with little hormonal influence on its development.

I thank the following individuals who offered advice and criticism of this paper: R. F. Johnston, N. A. Slade, J. E. Bucher, C. L. Cink, K. S. Harris, J. W. Koeppl, and E. C. Murphy. Computer time was provided by the Computation Center, University of Kansas. My work was partially supported by NSF grant BMS72-02374 to Johnston.

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PETER E. LOWTHER, *Museum of Natural History and Department of Systematics and Ecology, The University of Kansas, Lawrence, Kansas 66045*. Accepted 29 Dec. 75.

The effect of time of day on avian census results.—The ornithological literature often comments on variation in census results during the day (e.g. Berger 1961: 100, Pettingill 1970: 405). Robbins and Van Velzen (1970) found that during the breeding season, the maximum number of avian contacts occurred about 30 minutes after sunrise. Fewer than 80% of this number were recorded in the same area 2 h later. Robbins (1972) also found a variation in winter census results that correlated with time of day. Though my primary interest was to examine the effect of a treatment on population numbers (Shields ms.), I report here the effect of time of day on my census and a technique for counteracting this effect.

I performed field studies in the Watchung Reservation, Union County, New Jersey. Shields and Grubb (1974) describe the study site's vegetation and topography. I performed censuses from the second week of December through the third week of January in 1973 and 1974 and from 28 May through 6 July in 1973. During the winter I used three 1.6 km trails, maintained on the south slope as transects. Each transect was censused once on each of 10 days in 1973 and 11 in 1974. Starting times (0800, 0900, and 1000 E.S.T.)were rotated between transects so that each was begun at every starting time seven times. Local sunrise during the study varied from 0705 to 0717. I measured air temperature at the start and allowed 20–30 min. for the completion of each transect. Using Emlen's (1971) method, I determined coefficients of detectability (CD_{412}). Only the eight most abundant species were included in this analysis. During the breeding season I censused two 0.8 km transects on 24 days. Starting times (0600 and 0730) were rotated daily. Local sunrise varied between 0528 and 0535 E.D.T. during the study. Air temperature was measured at the start and 30–40 min. were allowed for the completion of each transect. Only those species sighted on a total of 3 days on both transects were included in this analysis. The width of the transects was 125 m for both seasons making the areas sampled 10 ha in summer and 20 ha in winter for each transect.

TABLE 1

NUMBER OF CONTACTS PER 1.6 KM OF TRANSECT IN WINTER

Species	0800	0900	1000
Hairy Woodpecker	0.4 (8)[1]	0.6 (12)	0.7 (14)
Downy Woodpecker	0.8 (16)	1.2 (24)	1.3 (25)
Blue Jay	1.8 (36)	1.7 (33)	2.0 (40)
Common Crow	1.0 (20)	1.3 (26)	1.2 (24)
Black-capped Chickadee	2.4 (48)	3.2 (64)	5.5 (110)[2]
Tufted Titmouse	0.6 (12)	1.4 (28)	2.1 (41)[3]
White-breasted Nuthatch	0.9 (19)	1.1 (22)	1.2 (24)
Cardinal	0.7 (14)	0.9 (19)	1.6 (33)[3]

[1] $\bar{x}$ (N)

[2] $P < 0.01$

[3] $P < 0.05$