Notes on the Standard Body Measurements of Two Populations of Herring Gulls (*Larus argentatus*)

WILLIAM THRELFALL AND DAVID D. JEWER
Department of Biology, Memorial University of Newfoundland, St. John's, Newfoundland, Canada A1B 3X9

During the past 20 yr many papers concerned with the circumpolar distribution and systematics of the Herring Gull (*Larus argentatus*) have been published (e.g. Vouss 1959), with particular reference being paid to northwestern European populations by Barth, who summarized his work in 1975. While large numbers of specimens from Europe have been examined the number from North America has tended to be small. During the course of broadly-based parasitological studies in Great Britain and Newfoundland, Canada, large numbers of Herring Gulls were examined (Threlfall 1967, 1968), and measurements of wing length, culmen length and depth, tarsus length, and tail length were taken of each bird, as outlined in Witherby et al. (1965). The birds were also weighed. During 1962–1964, 206 adult (98 male, 108 female) Herring Gulls were taken in Anglesey, Wales, mainly in the Newborough Warren National Nature Reserve (53°09′N, 4°23′W) and near Bryn-Siencyn (53°12′N, 4°16′W). The majority of the birds (>90%) were obtained from late March to early October. A further 258 birds (180 male, 78 female) were obtained in the Witless Bay Sea Bird Sanctuary, Newfoundland, Canada (47°15′N, 52°46′W) during the summers of 1966–1968.

Basic statistical values, (sample mean, range, standard deviation, and 95% confidence limits) were computed (Table 1), and it was determined whether any differences noted between males and females and between colonies were statistically significant. Analyses were performed using an IBM 370/158 computer. The major statistical tests used were a two-way analysis of variance fixed effect model with unequal observations in each cell (ANOV252, University of Alberta, Division of Educational Res. Ser.

TABLE 1. Morphological statistics for Herring Gulls from Great Britain and Newfoundland, Canada

Variable	Group[a]	Mean ± 95% confidence limits	Range	Standard deviation
Wing length (mm)	BM	414.54 ± 24.79	365–440	12.65
	BF	396.06 ± 20.19	372–423	10.30
	NM	440.37 ± 22.40	412–470	11.43
	NF	416.58 ± 26.01	388–445	13.27
Weight (g)	BM	966.39 ± 168.44	725–1,150	85.94
	BF	795.47 ± 154.66	600–975	78.91
	NM	1,231.76 ± 208.90	1,014–1,618	106.58
	NF	998.62 ± 175.87	832–1,274	89.73
Tarsus length (mm)	BM	58.88 ± 4.86	52–64	2.48
	BF	54.69 ± 4.96	49–61	2.52
	NM	69.92 ± 7.02	59–80	3.58
	NF	63.61 ± 6.97	56–71	3.54
Culmen depth (C.D.) (mm)	BM	20.02 ± 1.69	18–21.5	0.86
	BF	18.19 ± 1.85	16–21	0.94
	NM	21.33 ± 2.38	19–25	1.21
	NF	19.46 ± 2.19	16–23	1.11
Culmen length (C.L.) (mm)	BM	54.46 ± 4.43	49–61	2.25
	BF	50.56 ± 5.06	40–57	2.57
	NM	60.83 ± 5.44	53–69	2.76
	NF	55.04 ± 4.93	48–63	2.50
Tail length (mm)	BM	170.45 ± 11.92	151–184	6.05
	BF	162.95 ± 11.35	149–176	5.76
	NM	177.52 ± 14.79	158–196	7.51
	NF	168.08 ± 16.73	150–190	8.49
C.D. × C.L. (mm × mm)	BM	1,090.42 ± 139.93	900–1,268	71.03
	BF	920.68 ± 159.92	660–1,176	78.64
	NM	1,298.41 ± 212.27	1,080–1,675	107.75
	NF	1,071.44 ± 169.93	833–1,357	86.26

[a] BM, British male (98); BF, British female (108); NM, Newfoundland male (180); NF, Newfoundland female (78)

TABLE 2. Results of the analysis of variance for morphological differences between sexes and localities

Variable	Source	Degrees of freedom	F. ratio	Probability[a]
Wing length	Sex	1	342.51	**
	Locality	1	411.40	**
	Interaction	1	5.10	*
	Error	460		
Weight	Sex	1	491.93	**
	Locality	1	661.41	**
	Interaction	1	11.62	**
	Error	460		**
Tarsus	Sex	1	295.75	**
	Locality	1	1,007.62	**
	Interaction	1	11.86	**
	Error	460		
Culmen depth	Sex	1	317.43	**
	Locality	1	154.08	**
	Interaction	1	0.0	NS
	Error	460		
Culmen length	Sex	1	376.24	**
	Locality	1	471.81	**
	Interaction	1	13.78	**
	Error	460		
Tail	Sex	1	153.29	**
	Locality	1	79.39	**
	Interaction	1	1.96	NS
	Error	460		

[a] * = significant at the .05 level, ** = significant at the .01 level, NS = not significant

Computer Program Documentation, December 1968, revised July 1969) and a multivariate analysis by stepwise discriminate analysis (BMDO7M, Dixon 1970).

The analysis of variance revealed that for each of the six variables tested there is a significant difference between sexes regardless of locality and that there is a difference between localities regardless of sex (Table 2). Further, the degree of sexual dimorphism in British birds is significantly different from that of Newfoundland birds in all cases except culmen depth and tail length.

Discriminant function analysis revealed that the best single feature for distinguishing between colonies

TABLE 3. Results of discriminant analysis of two populations of gulls, regardless of locality, utilizing seven variables. The three most important variables, plus F values are listed

Variable(s) considered	Group	Number of cases (%) of the total material classified into group			
		British male	British female	Newfoundland male	Newfoundland female
Tarsus length	British male	65 (67)	16 (16)	0 (0)	17 (17)
	British female	29 (27)	79 (73)	0 (0)	0 (0)
	Newfoundland male	3 (2)	0 (0)	153 (85)	24 (13)
	Newfoundland female	18 (23)	3 (4)	17 (22)	40 (51)
Tarsus length & C.L. × C.D.	British male	71 (73)	10 (10)	0 (0)	17 (17)
	British female	14 (13)	94 (87)	0 (0)	0 (0)
	Newfoundland male	5 (3)	0 (0)	164 (91)	11 (6)
	Newfoundland female	14 (18)	3 (4)	3 (4)	58 (74)
Tarsus length & C.L. × C.D. & weight	British male	77 (79)	7 (7)	0 (0)	14 (14)
	British female	11 (10)	97 (90)	0 (0)	0 (0)
	Newfoundland male	2 (1)	0 (0)	170 (94)	8 (5)
	Newfoundland female	15 (19)	2 (3)	2 (3)	59 (75)

F values: wing length 337.09; weight 521.59; tarsus length 600.92; culmen depth 203.29; culmen length 388.86; tail length 103.35; C.D. × C.L. 413.65

TABLE 4. Results of discriminant analysis of measurements (seven variables) of a population of Herring Gulls from Great Britain. The three most important variables, and F values are listed

Variable(s) considered	Group	Number of cases (%) classified into group	
		Males	Females
C.D. × C.L.	Male	88 (90)	10 (10)
	Female	13 (12)	95 (88)
C.D. × C.L. & weight	Male	91 (93)	7 (7)
	Female	12 (11)	96 (89)
C.D. × C.L. & weight & wing length	Male	91 (93)	7 (7)
	Female	12 (11)	96 (89)

F values: wing length 133.33; weight 221.43; tarsus length 144.82; culmen depth 209.16; culmen length 133.92; tail length 82.92; C.D. × C.L. 262.35

and sexes was the tarsus length, with accuracy improving as each additional feature was added (Table 3). It is of interest to note that the best sex-discriminating feature for British birds is the product of the culmen length and depth (Table 4) whereas in Newfoundland birds the best feature is the weight (Table 5). In all cases the accuracy of the analyses improves as extra features are included (the three most significant are given in each case). On the basis of all seven variables the computer examined each bird and gave it a probability of being male or female. In the case of the British birds the results were as follows: known males, 89(91%) classified as males, 9(9%) as females; known females, 99(92%) as females, 9(8%) as males. The results for Newfoundland were as follows: known males, 176(98%) as males, 4(2%) as females; known females, 76(97%) as females, 2(3%) as males.

Table 6 shows the results obtained when all birds from both localities are considered. The separation of British females and Newfoundland males is quite distinct, but some confusion exists between British males and Newfoundland females.

Barth utilizes the coefficient of difference (Co.D.) in many of his papers (e.g. 1975) as an indicator of differences between populations and sexes. In the present study the coefficient of difference was calculated for various variables within both populations and between sexes (Table 7). Using a Co.D. value of 1.28 as the conventional 90% significance level (Mayr 1969), significant differences are evident between the populations and sexes. No differences were found in the size of Newfoundland and Norwegian birds (latter figures from Barth 1975; compare males: Co.D. for wing length 0.54, culmen length 0.57; tarsus length 0.18; females: Co.D. wing length 0.51, culmen length 0.52, tarsus length 0.02). Significant differences were noted between the means of measurements of British and Norwegian birds (latter figures from Barth 1975; compare males: Co.D. for wing length 1.61, culmen length 0.76, tarsus length 2.04; females: wing length 1.53, culmen length 0.47, tarsus length 1.96).

A further indicator of subspecific identity is the mantle color. Utilizing the Munsell Neutral Value Scale a mean figure of 6.55 (SD = 0.17) was obtained for 14 Newfoundland birds, which differs significantly from that noted by Barth (1975) for Scandinavian *L. a. argentatus* and British *L. a. argenteus* (5.40 and 5.96, respectively). The coefficient of difference was 3.11 for the former and 1.90 for the latter.

TABLE 5. Results of discriminant analysis of measurements (seven variables) of a population of Herring Gulls from Newfoundland, Canada. The three most important variables, and F values are listed

Variable(s) considered	Group	Number of cases (%) classified into group	
		Males	Females
Weight	Male	159 (88)	21 (12)
	Female	8 (10)	70 (90)
Weight & C.L.	Male	170 (94)	10 (6)
	Female	3 (4)	75 (96)
Weight & C.L. & wing	Male	173 (96)	7 (4)
	Female	3 (4)	75 (96)

F values: wing length 213.47; weight 285.38; tarsus length 170.15; culmen depth 137.13; culmen length 253.54; tail length 79.35; C.D. × C.L. 270.72

TABLE 6. Results of discriminant analysis when both sexes and localities are considered, utilizing seven variables

Group	Number (%) of cases classified into group			
	British male	British female	Newfoundland male	Newfoundland female
British male	81 (83)	4 (4)	0 (0)	13 (13)
British female	13 (12)	94 (87)	0 (0)	1 (1)
Newfoundland male	1 (1)	0 (0)	173 (96)	6 (3)
Newfoundland female	17 (22)	1 (1)	2 (3)	58 (74)

An examination of the foregoing data shows that significant differences exist between the size of British (*L. a. argenteus*) and Norwegian Herring Gulls (*L. a. argentatus*) and between British and Newfoundland birds (*L. a. smithsonianus*). It would appear that *L. a. argenteus* is smaller than either of the other two subspecies and is indeed a valid taxon, as suggested by Barth (1968).

With regard to *L. a. argentatus* and *L. a. smithsonianus*, the size of members of these two subspecies are almost identical, indicating that the latter lies close to the nominate race and is not a valid taxon. However, if mantle color is considered a highly significant difference is seen, with *L. a. smithsonianus* having a much lighter mantle than *L. a. argentatus*. This suggests that, until further skins are examined, *L. a. smithsonianus* should remain a valid subspecies.

Barth (1968) examined 24 birds from Maine to New York and found mantle color ranging from 5.3 to 6.0 (mean 5.61), which is much darker than found in this study. Vouss (1959) noted a similar coloration when he examined 10 skins. It may well be that a cline exists, with lighter-mantled birds being found in the northern parts of the range and darker ones in the south, this being the reverse of the situation obtaining in the Fennoscandian area. Further studies should be conducted in this area, particularly when one considers the fact that the birds breeding in Newfoundland winter in the Maine to New York area where Barth obtained his birds.

With regard to utilizing measurements of birds as an indicator of sex, the foregoing shows that where a bird species is widely distributed and subspeciation has occurred, different variables may be of use in different subspecies and that generalizations should not be made. The best discriminant for sexing British

TABLE 7. Coefficients of differences (Co.D.) for significance of differences between means of six variables of two populations and male and female Herring Gulls

Comparison	Variable	Co.D.	Joint nonoverlap (%)	Level of significance[a]
British male versus Newfoundland male	Weight	1.37	91	***
	Wing	1.07	86	***
	Tarsus	1.82	97	***
	Culmen depth	0.63	—	—
	Culmen length	1.27	90	***
	Tail	0.62	—	***
British female versus Newfoundland female	Weight	1.20	89	***
	Wing	0.87	81	***
	Tarsus	1.47	93	***
	Culmen depth	0.62	—	—
	Culmen length	0.88	81	***
	Tail	0.36	—	***
British male versus British female	Weight	1.04	85	***
	Wing	0.81	79	***
	Tarsus	0.84	80	***
	Culmen depth	1.48	93	**
	Culmen length	1.12	87	***
	Tail	0.64	—	***
Newfoundland male versus Newfoundland female	Weight	1.18	88	***
	Wing	0.96	83	***
	Tarsus	0.89	81	***
	Culmen depth	1.18	88	—
	Culmen length	0.92	82	***
	Tail	0.59	—	***

[a] *t*-Level of significance: ** = 5%, *** = 0.1%

birds is apparently the product of the culmen depth and length, as noted by Harris and Jones (1969), whereas in Newfoundland birds it is weight. Should measurements be used to discriminate between populations (subspecies) yet another variable may be important; i.e. the tarsus is the best measurement to use in separating British and Newfoundland birds.

We express our thanks to Dr. Jake Rice for his help with the statistics and for critical comments during the writing of the manuscript. We also thank the former Department of Scientific and Industrial Research of Great Britain and the National Research Council of Canada for the grants to WT that made this work possible.

Literature Cited

Barth, E. K. 1968. The circumpolar systematics of *Larus argentatus* and *Larus fuscus* with special reference to the Norwegian populations. Nytt Mag. Zool. 15, suppl. 1, 1–50.

———. 1975. Taxonomy of *Larus argentatus* and *Larus fuscus* in north-western Europe. Ornis Scand. 6: 49–63.

Dixon, W. J. (Ed.) 1970. BMD: Biomedical Computer Programs (2nd Ed.) Univ. of Calif. Publications in Automatic Computation, No. 2, Berkeley, Univ. Calif. Press.

Harris, M. P., & P. H. Jones. 1969. Sexual differences in measurements of Herring and Lesser Black-backed Gulls. Brit. Birds 62: 129–133.

Mayr, E. 1969. Principles of Systematic Zoology. New York, McGraw-Hill.

Threlfall, W. 1967. Studies on the helminth parasites of the herring gull, *Larus argentatus* Pontopp., in Northern Caernarvonshire and Anglesey. Parasitology 57: 431–453.

———. 1968. Studies on the helminth parasites of the American Herring Gull (*Larus argentatus* Pont.) in Newfoundland. Can. J. Zool. 46: 1119–1126.

Vouss, K. H. 1959. Geographical variation of the Herring-Gull, *Larus argentatus*, in Europe and North America. Ardea 47: 176–187.

Witherby, H. F., F. C. R. Jourdain, N. F. Ticehurst, & B. W. Tucker. 1965. The Handbook of British Birds, vol. 5. London, H. F. and G. Witherby Ltd.

Received 28 February 1977, accepted 5 April 1978.

Individual Differences in the Head and Neck Plumage of Ruddy Turnstones (*Arenaria interpres*) During the Breeding Season

Peter N. Ferns
Department of Zoology, University College, Cathays Park, Cardiff, Wales

Sexual dimorphism in the breeding plumage of Ruddy Turnstones (*Arenaria interpres*) has been described by Witherby et al. (1940) and Nettleship (1967). During the course of a survey in 1974 of the breeding populations of wading birds in Ørsted Dal, northeast Greenland (Ferns and Mudge 1976) it was observed that, in addition to sexual variation, individual Ruddy Turnstones possessed distinctly different patterns of black and white markings on the head and neck. The object of this note is to describe these individual differences and to discuss their possible significance.

Eight adults were captured either at the nest or while attending young in Ørsted Dal and several color transparencies were taken of each of these, as well as of another four adults captured on Traill Ø about 85 km farther north. Drawings were subsequently prepared from these transparencies by R. M. Bishop (Fig. 1). These birds were sexed on the basis of their plumage. Only one breeding pair is actually illustrated (band numbers 7046185 and 7046186). In the remaining cases, only one member of each pair was caught though both were observed in the field.

Distinct individual differences are evident in Fig. 1. For example, the black band that runs across the forehead between the eyes is wide in 7046185, narrow in 8160019, and incomplete in 7046186. The white bib in the region of the chin is large in 7046167, small in 7046164, and absent in 8160379. The black band across the upper mantle is wide in 8160339, broken in 7046186, and absent in 8160348. The neck has an almost complete white collar in 7046167, a partial one in 8160379, and none at all in 7046163.

These differences enabled a degree of discrimination to be made in the field when birds were seen from the back or the front, as well as from the side. Abrasion, fading, and the early onset of prebasic molt