Acknowledgements

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Measurements of White-fronted Geese wintering at Slimbridge

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Summary

BETWEEN 1959 and 1963 181 White-fronted Geese caught alive or handled after death at Slimbridge in the months January to March were weighed and measured. As in other geese, males were found to be bigger than females. First-winter geese weighed less and had shorter wings than older geese, but were indistinguishable by length of bill, head or tarsus. In early March, 1959 the geese weighed were heavier than at any other time. Males and females were identified by examination of the gonads of dead birds and the cloaca of live ones: attempts to classify males and females on the basis of measurements alone did not give sufficiently reliable results. Weights and lengths are highly correlated. An investigation of the possibility of developing an index of "condition" utilising these correlations showed that for statistical reasons such an index would be too unreliable to be of much value.

Introduction

257 White-fronted Geese *Anser albifrons* caught for ringing at Slimbridge, Gloucestershire between February, 1958 and March, 1962 were weighed and many of them had several linear measurements made. These data from live birds have been supplemented by those from 55 geese shot in the vicinity and from 12 others picked up dead or dying. This investigation had four objects. First, to provide for *A. a. albifrons* morphometric data comparable with those available for Pink-footed Geese *A. brachyrhynchus* and Greylag Geese *A. anser* (Elder, 1955, Beer and Boyd, 1962). Second, to seek a reliable method of determining the sex of a White-fronted Goose from its external characteristics. Third, to investigate the relationships between body-weight and other measures of size, in order to establish criteria for the "condition" of an individual for use in pathological studies. Fourth, to look for differences in weight in the course of the winter and between one year and another.

The geese handled alive, after capture in rocket-propelled nets, were weighed and measured in the field. For weighing, each goose was wrapped in a sack and laid on a dial spring balance calibrated in 20 gm. intervals, periodically standardised against brass weights. The sack was check weighed at frequent intervals. The weight of the goose was determined by subtraction of the sack weight from the indicated weight, and recorded to the nearest 0.01 kg. Wing lengths were measured, to the nearest mm., on a metal scale with a stop at the zero end. Other linear measurements were made with a vernier caliper reading to 0.1 mm. The sex of live geese was determined by eversion of the cloaca to detect the presence or absence of a copulatory organ. Geese in their

first winter were identified by the presence of notched juvenile tail-feathers and of dark-shafted contour feathers on the breast and by the absence of heavy spotting on the breast.

Dead geese were examined, with less haste, in the laboratory. Measurements were made with the same equipment as in the field, though it was of course unnecessary to wrap the geese for weighing. The sex of dead birds was determined by examination of the gonads. Because of damage, it was often not possible to obtain the complete range of measurements from dead birds.

All linear measurements were made by the procedures described by Baldwin, Oberholser and Worley (1931): 'wing' being the chord of the closed wing, without flattening of the primaries; 'bill' being the length of the exposed culmen; 'head' being the length of a straight line from the extreme base of the culmen to the hindmost point of the head, on the occiput; 'tarsus' the distance from the mid-point of the joint beween the tibia and metatarsus behind to the middle of the articulation of the matatarsus with the base of the middle toe in front. 'Tarsus thickness', not defined by Baldwin *et al,* was determined by measuring the lateral width of the tarsus at its narrowest point; since this was intended to be an index of bone size, the calipers were applied firmly: both tarsi were measured and the mean value used.

Linear measurements

The results recorded in Table I show that in these Whitefronts, as in other geese, males tended to be larger than females in all the measured characteristics, though with extensive overlapping.

Table I. Measurements of White-fronted Geese handled at Slimbridge 1958-62. N = sample size; s.e. = standard error of mean; range = observed range; V = coefficient of variation = $\frac{100\sigma}{m}$. Measurements in mm.

	males					females				
	N	mean	s.e.	range	V	N	mean	s.e.	range	V
ADULTS										
wing	73	423.4	1.66	377 - 464	3.35	60	399.7	1.79	379 - 438	3.46
bill	74	47.1	0.32	42.8-53.2	5.90	64	44.9	0.33	40.0-50.5	5.79
head	50	57.4	0.30	53.3-62.6	3.65	33	54.1	0.40	49.9-58.9	4.23
tarsus	49	72.8	0.41	67.8-79.6	3.98	34	69.3	0.47	63.5-76.4	3.97
tarsus thickness .	47	6.8	0.05	6.1- 7.7	4.56	33	6.7	0.52	6.0- 7.1	4.50
1st WINTER										
wing	15	398.8	3.98	375 - 419	3.86	18	388.1	4.23	359 - 410	4.63
bill	15	47.1	0.71	40.2-52.1	6.30	18	44.4	0.73	40.2-49.5	6.98
head	7	57.7	0.68	54.9-59.5	3.12	9	55.1	0.70	52.5-59.7	3.80
tarsus	7	72.3	0.94	67.0-74.9	3.44	10	69.4	0.76	66.5-74.2	3.50
tarsus thickness .	7	6.9	0.07	6.6- 7.3	2.69	10	6.5	0.06	6.2- 6.8	2.75

There were no differences in size of bill, head and tarsus between first-winter and older birds of the same sex. This suggests that the growth of the skeletal elements involved must be virtually complete by the age of six months.

The wings of first-winter geese tended to be a little shorter than those of older birds: the averages for young males and females being about 6% and 3% less than the corresponding averages for older birds.

There were no clear differences in the dimensions of geese handled in different winters or at different times in the same winter: nor was this to be expected since, from recoveries of ringed birds, it is known that the geese visiting Slimbridge are drawn from a small breeding area and that a very high proportion of them return regularly to Slimbridge.

The relatively large standard errors associated with the means for first-winter birds seem to be simply a consequence of small sample size: the coefficients of variation for adults and first-winter birds are remarkably similar. It appears that the length of the bill is inherently more variable than the other measures taken, a fact of some taxonomic consequence.

Weights

Table II summarises the information on weights obtained in the years 1958-62. The coefficients of variations are higher than those of the linear measurements. The weights of adults seem to be more variable than those of geese in their first winter.

Table II. Weights (in kg.) of White-fronted Geese at Slimbridge, 1958-62

	number	mean	s.e. of mean	observed range	V
all years combined					
adult males	87	2.45	0.029	1.79-3.34	11.07
adult females	92	2.18	0.027	1.72-3.12	11.91
first-winter males ..	63	2.15	0.023	1.67-2.49	8.40
first-winter females ..	67	1.99	0.023	1.49-2.40	9.32

Most comparisons between sub-samples grouped according to date of weighing show no clear differences, often perhaps because the groups are small. The most marked divergence, other than the low weights of January, 1963 considered separately later, is that the average weights of adult males and females on 9th March, 1959 were 325 gm. (13.6%) and 280 gm. (13.2%) above the corresponding averages based on all other birds handled. Only three first-winter males and two females were taken at that time; these were also heavier than usual. It seems likely that this difference was due to unusually favourable feeding conditions in February and March that year, after a mild and wet winter.

Determination of sex from measurements

It is clear from Tables I and II that the overlap in size between males and females is so great that few birds could be sexed correctly using as a criterion any one of the measurements recorded. In such a situation an obvious remedy is to make use of multiple regression to obtain a "discriminant function" (Fisher, 1938, Mather, 1943), but calculation of a number of such functions, coupling together the values of the six available measurements in pairs or in threes, has failed to provide one of useful precision. In all the cases tried it seemed that at least 10% of the geese handled would have been classified incorrectly by means of the calculated functions.

An experienced observer can achieve better results than this by looking at the shape of the head and bill together: males seem to have larger and

deeper heads than females. The most promising approach in future work on this problem thus seems likely to be by concentration on measurements of the head, though it is not easy to find measurements that can be adequately standardised.

Weight and size

If a single linear measure of body-size has to be chosen, wing-length seems to be the most suitable: it and the length of the bill are those most widely used in taxonomy and the wing is evidently less intrinsically variable than the bill. Estimation of the relationships between weight and wing-length leads to the results shown in Table III. There is strong positive correlation between weight and wing-length in all four age and sex classes. The regression coefficient for adult females is significantly less than that for adult males. The first-winter samples do not show a parallel difference.

Table III. Statistics for correlation and regression of weight on wing-length for different age- and sex-classes of White-fronted Geese

	adult males	adult females	1st winter males	1st winter females
sample size, N	73	62	15	18
correlation coefficient, r ..	+0.57	+0.73	+0.68	+0.83
z	+0.65	+0.93	+0.83	+1.19
σ_z	0.120	0.130	0.289	0.258
regression coefficient, b ..	+1.21	+0.57	+0.99	+1.30
$s_{y.x}$	25.88	28.26	16.92	15.01
s_b	0.219	0.068	0.298	0.211
t ($= b/s_b$)	5.50	8.36	3.31	6.16

These relationships were studied in order to provide a basis for classifying the condition of individual geese. As Snedecor (1946) has emphasised, predicting the performance of individuals from a regression equation is a hazardous venture unless the standard deviation from regression ($S_{y.x}$) is unusually small, which is not so here. The scatter of the points for males and females was compared with the straight lines of the corresponding regression equations and with limits calculated from the standard deviation from regression for individuals. The latter are not straight lines, for the standard deviation is least at the mean value of the wing-length and weight and increases on either side of the mean. The theoretical limits ($\pm$ 1 standard deviation), within which about two-thirds of the population values should lie, are very wide. The scatter of the values actually obtained is relatively small. It seems to follow that an index of condition derived from the regression of weight on wing-length (or on any other of the lengths measured) will be too unreliable to be of much practical value except in extreme circumstances, such as those of the cold weather in January, 1963, when an index is scarcely necessary. It may be more helpful to measure condition more directly, for example by assessing the amount of subcutaneous fat and the thickness of the pectoral muscles, though standardised techniques for doing so have not yet been developed.

Comparisons with other material

No morphometric studies of large samples of *A. a. albifrons* have yet been made. Most text-books give only the ranges of measurements—usually from

samples of unspecified size. For comparative purposes these are almost valueless. The best available data seem to be those of Schiøler (1925) relating to Danish birds and of E. S. Ptushenko (in Dementiev and Gladkov, 1952) on Russian material. These are summarised in Table IV.

Table IV. Measurements of *Anser a. albifrons* in Denmark and the U.S.S.R. published by Schiøler (1925) and Ptushenko (in Dementiev and Gladkov, 1952)

	Denmark			U.S.S.R.		
wing (mm.)	number	mean	range	number	mean	range
males (ad.) ..	11	414.9	395 - 431			
(1st w.) ..	5	406	395 - 410			
males				31	421.4	385 - 455
females (ad.) ..	14	408.2	387 - 420			
(1st w.) .	4	382	369 - 401			
females ..				27	405.7	380 - 420
bill (mm.)						
males	16	46.3	43.0-50.5	36	48.2	39.8-56.5
females	18	44.9	39.0-51.0	30	48.8	39.8-51.5
tarsus (mm.)						
males	16	73.6	70 - 78	—		
females	18	70.7	65 - 76	—		
weight (kg.)						
males	—			15	2.67	2.40-3.20
females	—			10	2.43	2.00-3.00

Schiøler's samples agree with those of this study in showing the wings of geese in their first winter to be shorter than those of older birds. The limits of adult wing-lengths in the Danish material are less extreme than in the British sample, as would be expected from such a small number of birds. For the same reason, the fact that the difference between the mean wing-lengths of males and females is only 6.7 mm. in the Danish and 15.7 mm. in the Russian, against 23.7 mm. in the British geese is not likely to be important.

There are no valid differences between the measurements of the bill in the three groups. Salomonsen (1948) indicated a range of 43-50 mm. for Danish-taken birds, compared with 48-55 mm. for English, but without giving any reason for supposing that a significant difference exists between the groups.

Alpheraky (1905) and Ivanov (1951) give the range of tarsus length, of both sexes together, as 51-81 mm. and 50-81 mm., including specimens far shorter, and others rather longer, than any encountered in the fully-detailed Danish and English studies. Neither author indicates where the short-legged geese were found but both were chiefly concerned with Russian birds: perhaps there is a stock breeding in central Siberia and wintering in south-east Europe or in Asia which tends to be short-legged.

Schiøler only mentions the weights of three birds. The weights of *albifrons* in Russia given by Ptushenko tend to be rather higher than those of the birds caught at Slimbridge, though the largest weights he quotes are less than those of the largest geese found here. Witherby *et al* (1939) cite records by H. L. Popham of 21 British Whitefronts, not sexed and taken before 1903, with an average weight of 5 lb. 3 oz. (2.35 kg.) and a range of 4-6 lb. (1.81-2.70 kg.) and Fisher (1951) gives ranges of 4½-7½ lb. (2.04-3.40 kg.) for males and 4-6½ lb. (1.81-2.95 kg.) for females, presumably in Britain. The impression given by these figures is consistent with the views that geese handled in January-March are likely to weigh less than at other times of year and that the differences between Russian and British weights do not indicate any fundamental distinction between stocks.

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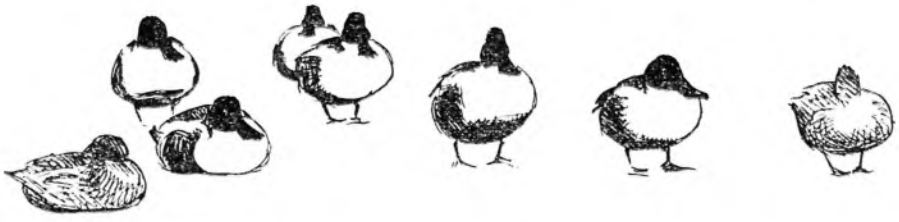

CORRECTIONS TO THE TEXT OF THE THIRTEENTH ANNUAL REPORT, FOR 1960-61

Page 44. Wildfowl Research and Conservation in Portugal. *Geoffrey M. Tait.* The inclusion of the Teal as a common breeding duck is an error. *Anas crecca* is not known to breed regularly in Portugal.

Page 94. Brent Goose population studies, 1960-61—*P. J. K. Burton.* The last line of p. 94 should be omitted, so that the sentence reads " Observations in Strangford Lough, near Dublin, in Wexford Harbour and at Dungarvan showed 435 young in 1087 geese (40%) with no significant variations from place to place."

Page 174. The pre-nuptial display of the Shoveler — *John Hori.* The quotation from Lorenz in paragraph three should read " a distinct turning of the back of the head to the female " instead of " . . . back of the head of the female."