

A MORPHOMETRICAL STUDY OF THE CANADA GOOSE,  
*BRANTA CANADENSIS INTERIOR* TODD

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THE classification of Canada Geese of the genus *Branta* continues in a state of flux. Responsible in large measure for the lack of agreement among systematists is the dearth of an adequate series of specimens, both adults and downy young, from the breeding grounds. The need for adult specimens from the breeding range is, however, appreciably lessened when sufficient banding is done to show the breeding range of the various wintering populations from which collections are more easily obtained. This is particularly true in eastern North America where the breeding grounds of the various flyway populations are now fairly well understood. It is not true for the populations that migrate across the plains states. Because there has been insufficient banding to show the breeding grounds of these latter populations, a study based on wintering specimens from this area might be misleading. For example, any attempt to unravel the relationship of the various races by the use of specimens from the Gulf Coast would be especially deceiving, for individuals in flocks in that area range in size from that of *Branta canadensis hutchinsii* to *Branta c. interior* or *B. c. moffitti* (Arthur S. Hawkins, personal communication, 1945).

In this study of variation in *Branta c. interior*, the usual handicap of lack of knowledge concerning the origins of the population examined is minimized since the breeding grounds are known with considerable exactness. Findings presented are based on data from a total of 414 geese trapped for banding purposes at Horseshoe Lake, Alexander County, Illinois, in the autumn of 1943. Sex and age of each bird were determined by criteria discussed by Elder (1946) and Hanson (1949a). The segment of the trapped population studied is believed to be, within each sex and age class, a random sample of the Horseshoe Lake flock, which in recent years has comprised about 50 per cent of the Mississippi flyway population. The breeding grounds of the Mississippi flyway population, which are discussed in detail by Hanson and Smith (1950), lie in the muskeg country of northern Ontario, inland from the west coast of James Bay and the south coast of Hudson Bay, between the Albany and Severn rivers.

Geese termed "juveniles" in this report are birds from five to eight months of age; "adults" include all birds 17 or more months of age at time of study. As geese in their second year of life frequently ranked

among the largest in size, it was concluded that a significant difference between the size of yearling adults and older adults probably did not exist.

The writer appreciates the advice on statistical matters received from Mr. H. W. Bean of the College of Agriculture, University of Illinois.

#### LENGTH OF WING (FLATTENED)

The distribution of wing lengths is given in Table 1. In Figure 1 the observed and calculated ranges ( $\pm 3$  standard deviations) and the average of wing lengths for each sex and age class are presented. The difference in wing length between the sexes within each age class proved to be statistically significant, but the difference in wing length between juvenile males and adult females was not statistically significant.

TABLE 1  
DISTRIBUTION OF WING LENGTH IN *Branta canadensis interior* TODD,  
TRAPPED AT HORSESHOE LAKE, ALEXANDER COUNTY, ILLINOIS

Length of wing (mm.)	JUVENILES				ADULTS			
	Males		Females		Males		Females	
	Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent
410-419			1	1.02				
420-429			1	1.02				
430-439	1	0.88	4	4.08				
440-449			15	15.31				
450-459	2	1.75	22	22.45			4	4.35
460-469	8	7.02	23	23.47	1	0.91	14	15.22
470-479	23	20.18	25	25.51	1	0.91	19	20.65
480-489	31	27.19	7	7.14	7	6.36	33	35.87
490-499	34	29.82			18	16.36	16	17.39
500-509	11	9.65			36	32.73	3	3.26
510-519	4	3.51			29	26.36	1	1.09
520-529					12	10.91	2	2.17
530-539					4	3.64		
540-549					2	1.82		
TOTALS	114	100.00	98	100.00	110	100.00	92	100.00

#### LENGTH OF TAIL

The distribution of tail lengths for each sex and age class is shown in Table 2. In Figure 2 the observed and calculated ranges ( $\pm 3$  standard deviations) and the mean of each class are compared. The difference in tail lengths between each class is statistically significant.

Measurement of tail length in the juvenile age class was complicated because many of the juveniles had moulted the central pair of rectrices, and in some cases the adjoining pair as well, and were in the process of

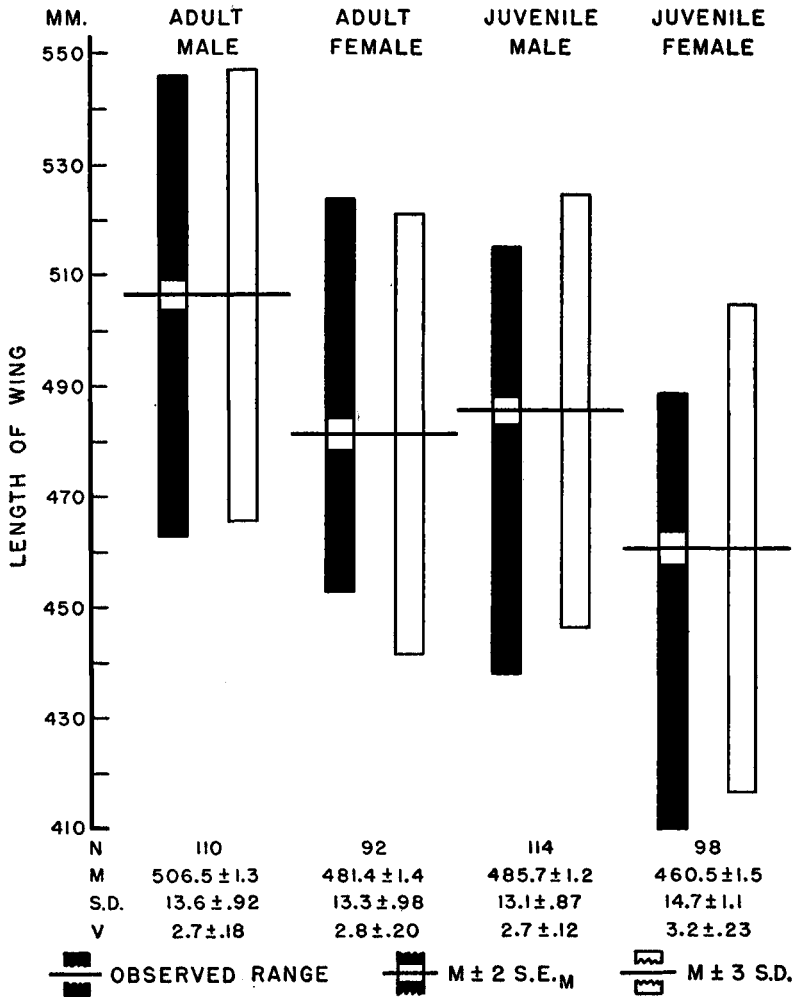


FIGURE 1.—Observed and calculated range and mean wing length of *Branta canadensis interior* by sex and age classes. (Adapted from Cazier and Bacon, 1949.)

replacing these lost feathers with broader and longer adult-type tail feathers. While individuals whose tail moult had proceeded beyond the central pair or the adjoining pair of rectrices were excluded from the sample, it was not practical to eliminate all birds whose tail moult involved only the two central pairs of rectrices. In the latter birds, a tail measurement was secured by bunching the rectrices so that their shafts were parallel and then obtaining the greatest projection of the next centermost pair as measured directly out from the tip of the

TABLE 2  
DISTRIBUTION OF TAIL LENGTH IN *Branta canadensis interior* TODD,  
TRAPPED AT HORSESHOE LAKE, ALEXANDER COUNTY, ILLINOIS

Length of tail (mm.)	JUVENILES				ADULTS			
	Males		Females		Males		Females	
	Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent
105-109			2	2.04				
110-114			10	10.20				
115-119	4	3.60	16	16.33				
120-124	21	18.92	26	26.53				
125-129	41	36.95	26	26.53				
130-134	28	25.23	11	11.23			2	2.20
135-139	10	9.00	7	7.14	1	0.92	19	20.88
140-144	5	4.50			12	11.01	28	30.77
145-149	2	1.80			35	32.11	25	27.47
150-154					26	23.85	10	10.99
155-159					24	22.02	6	6.59
160-164					9	8.26	1	1.10
165-169					2	1.83		
TOTALS	111	100.00	98	100.00	109	100.00	91	100.00

coccyx. While this procedure may at first seem questionable, measurement of a few specimens with entire tails by both methods, assuming in one instance that the central pair of rectrices has been moulted, will show that the difference between the two measurements is not important, approximately 2 to 3 per cent of the total tail length.

#### LENGTH OF EXPOSED CULMEN

The distribution of culmen lengths for each sex and age is shown in Table 3. The observed range, calculated range ( $\pm 3$  standard devia-

TABLE 3  
DISTRIBUTION OF LENGTH OF EXPOSED CULMEN IN *Branta canadensis interior* TODD,  
TRAPPED AT HORSESHOE LAKE, ALEXANDER COUNTY, ILLINOIS

Length of exposed cul- men (mm.)	JUVENILES				ADULTS			
	Males		Females		Males		Females	
	Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent
43-44			1	1.02			1	1.09
45-46			9	9.18	1	0.91	7	7.61
47-48	2	1.75	10	10.20	2	1.82	20	21.74
49-50	14	12.28	36	36.24	10	9.09	30	32.60
51-52	27	23.68	24	24.49	19	17.27	21	22.83
53-54	36	31.59	14	14.29	37	33.64	12	13.04
55-56	24	21.05	3	3.06	28	25.45	1	1.09
57-58	8	7.02	1	1.02	9	8.18		
59-60	2	1.75			2	1.82		
61-62	1	0.88			2	1.82		
63-64								
TOTALS	114	100.00	98	100.00	110	100.00	92	100.00

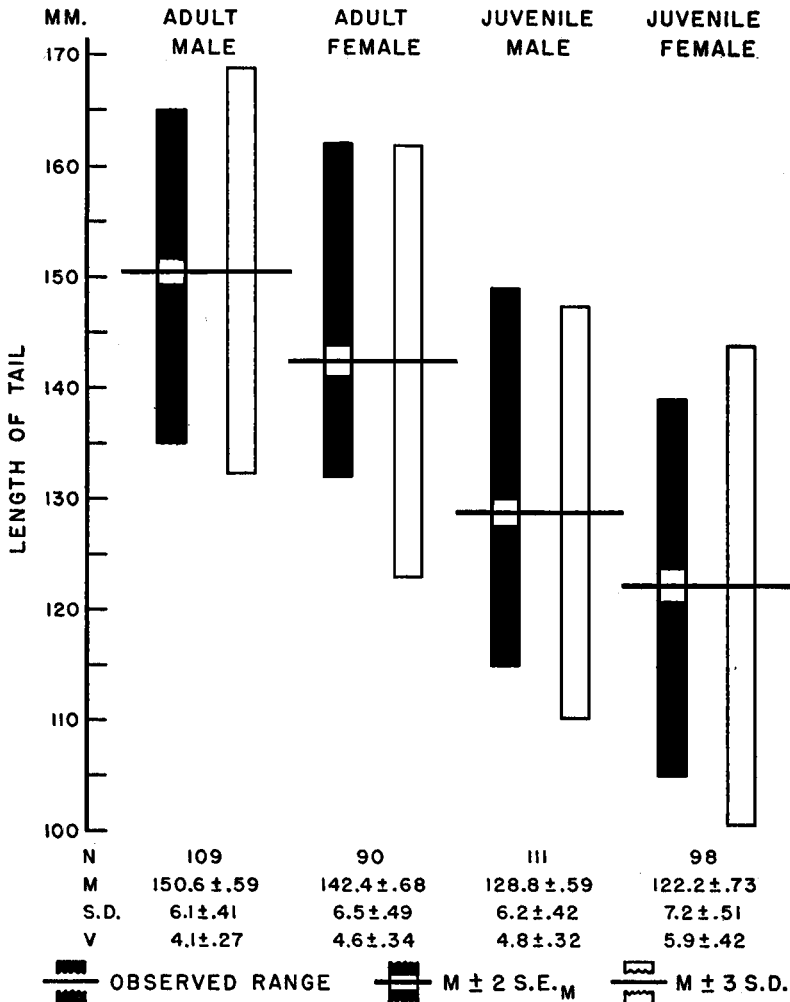


FIGURE 2.—Observed and calculated range and mean of tail length of *Branta canadensis interior* by sex and age classes. (Adapted from Cazier and Bacon, 1949.)

tions), and mean for each sex and age class are presented in Figure 3. The difference in culmen lengths between the two sexes was found to be statistically significant, while the difference between age classes within each sex was not statistically significant.

#### DIFFERENCES ASSOCIATED WITH SEX

Males were found to be significantly larger than females in respect to wing length, tail length, and length of exposed culmen, when the

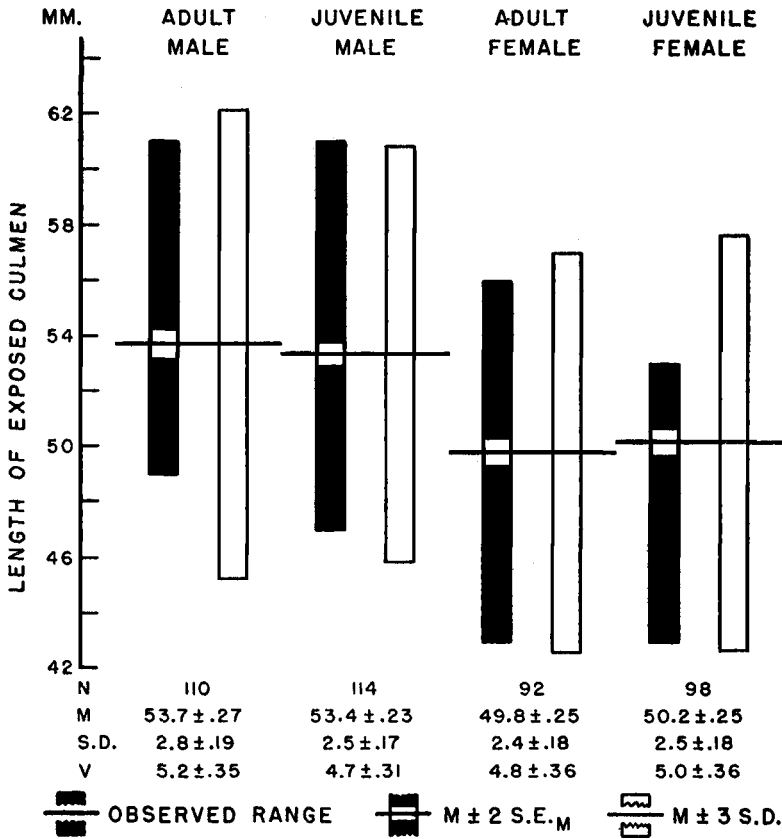


FIGURE 3.—Observed and calculated range and mean of length of exposed culmen of *Branta canadensis interior* by sex and age classes. (Adapted from Cazier and Bacon, 1949.)

comparison was confined to similar age classes. For wing, tail, and culmen length, respectively, adult males averaged 5.2, 5.8, and 7.8 per cent larger than the adult females; for the same measurements, juvenile males averaged 5.4, 5.4, and 6.3 per cent larger than juvenile females.

#### DIFFERENCES ASSOCIATED WITH AGE

The importance of determining the age of specimens in any taxonomic study of allied geese has been stressed by Brooks (1926) "Unless the separation of young from adults is adhered to, the table of measurements will show an amount of overlapping existing in no other groups of birds unless it be the Swans and Cranes, which have a similar longevity and variation in size with age."

Brooks' emphatic statement implying that unusually large differences in measurements exist between juvenile and adult geese, as compared with other families of birds, may be generally true insofar as wing and tail measurements are concerned; it does not hold true in regard to culmen measurements. While the wings of the adults averaged 4.3 and 4.5 per cent larger than those of the juveniles, and the tails of the adults exceeded the length in the juveniles by 16.9 and 16.5 per cent (males and females, respectively), there was no significant difference in culmen measurements between age classes. This latter finding seems to be at variance with Alpheraky (1905) who wrote: "In regard to the dimensions of the bills, it must first of all be remembered that geese, as we have already seen, are very long-lived, and at the same time it is absolutely incontestable that with age the bill tends to become continually longer and more massive, so that in very old and large specimens it will considerably exceed in size that of younger, although fully mature, birds of the same species . . . Moreover, for the most part, it is the more youthful and less shy rather than the very old, very wary, and experienced birds that fall into the hands of collectors, so that short-billed specimens are the most common."

#### MATURATION IN THE CANADA GOOSE

The time of attainment of full size of the culmen is probably representative of cessation of growth in other parts of the skeleton. Thus it appears that the Canada Goose attains full physical and sexual maturity in three successive steps: (1) completion of bone growth during the first six to eight months; (2) attainment of mature body weight by the end of the second autumn, and assumption of adult-type plumage with the renewal of flight feathers after the first eclipse period or when about 14 months of age; this step involves increased pigmentation in the tail feathers and certain other tracts, but paradoxically sometimes depigmentation of some tracts, such as the under wing-coverts (Elder, 1946; Hanson, 1949b); and (3) attainment of sexual maturity, just prior to beginning the third year of life, at least in some cases, and in practically all cases by the beginning of the fourth year of life. The hormonal processes bringing about sexual maturity in females is well under way during the third summer of life since almost all females when about two and one-half years of age have an open oviduct, that is, the occluding membrane over the opening of the oviduct at its juncture with the cloaca has disappeared (Hanson, 1949a).

#### VARIABILITY AND RELATION TO TAXONOMY

In a study of measurements of 20 families of birds treated in Ridgway's 'Birds of Middle and North America,' Bergtold (1925), after

recording the number of times individuals of a species varied from the average, plus or minus by more than ten per cent, concluded that for the purpose of comparing size between closely related subspecies or allied species, the "wing is nine and one half times more valuable than the tail, three and one half times more valuable than the tarsus and eleven and three-quarter times more valuable than the bill. . . ."

A better appraisal of the variability of body measurements and their relative value in taxonomic work is obtained in the use of the coefficient of variability (Figures 1, 2, and 3). These values indicate that the wing is about twice as valuable as the tail, while the tail and culmen appear to be of about equal value for comparing samples of one population of Canada Geese with another.

#### COMPARISONS WITH OTHER SAMPLES AND RACES

The difficulty of collecting and preparing large birds such as the Canada Goose, as well as the cost and problems of storage, as compared with smaller species, has necessarily resulted in limited skin collections of Canada Geese in museums. The question that arises is how well do these limited collections succeed in portraying the distribution of the populations represented. Although there are statistical techniques whereby small samples may be treated to secure an estimation of the actual range (Simpson and Roe, 1939), insofar as the mensural aspects are concerned, taxonomic revisions of Canada Geese have been based on the observed ranges and the means of the specimens at hand. In Table 4, measurements of adults at Horseshoe Lake are compared with measurements of other samples of the same subspecies, *interior*, and with samples of adjacent closely allied subspecies, *canadensis* and *moffitti*, as presented in the literature. Since some revisers of the genus *Branta* have measured the chord of the wing rather than the flattened wing, a correction factor based on the measurement of 25 adults has been applied to data for the Horseshoe Lake flock in Table 4. It is apparent from the data presented in Table 4 that many samples of *Branta canadensis* have been of inadequate size to approximate the range of the various races and, in some cases, to indicate the true means.

#### SUMMARY AND CONCLUSIONS

The deficiencies in our present understanding of the relationships of the various races of Canada Geese of the genus *Branta* stem in large measure from the lack of sufficient numbers of specimens from the breeding grounds. As the stepped-up tempo of banding operations of waterfowl hastens our knowledge concerning the breeding grounds



TABLE 4  
MEASUREMENTS OF ADULTS OF THE LARGER RACES OF THE CANADA GOOSE,  
*Branta canadensis*

<i>Subspecies</i>	<i>Number measured</i>	<i>Wing (chord)</i>	<i>Tail</i>	<i>Culmen</i>	<i>Authority</i>
MALES					
<i>B. c. interior</i>	9	456.8 (430-473)	143.9 (131-149)	50.7 (46-55.5)	Aldrich, 1946
<i>B. c. interior</i>	109-110	491.6 (448-531)	150.6 (135-165)	53.7 (46-61)	this report
<i>B. c. canadensis</i>	7	466.3 (444-485)	143.0 (131-149)	56.0 (53-58)	Aldrich, 1946
<i>B. c. moiffitti</i>	11	502.8 (480-522)	161.1 (144-177)	57.9 (52-68)	Aldrich, 1946
<i>B. c. moiffitti</i>	10	500.6 (418-527)	156.8 (134-174)	52.4 (47-55)	Swarth, 1913
FEMALES					
<i>B. c. interior</i>	10	445.5 (427-467)	145.4 (133-155)	49.7 (45-53)	Aldrich, 1946
<i>B. c. interior</i>	90-92	466.4 (438-509)	142.4 (132-162)	49.8 (43-56)	this report
<i>B. c. canadensis</i>	7	465.0 (435-488)	147.3 (134-158)	53.9 (51.5-56.5)	Aldrich, 1946
<i>B. c. moiffitti</i>	6	474.3 (435-503)	141.8 (121-166)	54.8 (50-61)	Aldrich, 1946

of the various populations of Canada Geese, the desirability of measuring large numbers of banded geese to gain a better understanding of the size relationships of these races is apparent. Museum collections are often too small to demonstrate adequately the size relationships of most of the races.

The wing, being less variable than either the tail or culmen, is the best criterion of size for comparing samples of the Canada Goose, *Branta canadensis*, of similar age and sex. The tail and the culmen are of about equal value for comparative purposes.

No statistically significant difference could be found, within each sex class, between the juveniles and the adults for mean length of culmen. It would, therefore, seem permissible to combine culmen data for both age classes by sex, when the samples of the adults alone are inadequate.

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