BIRD-BANDING

A JOURNAL OF ORNITHOLOGICAL INVESTIGATION

VOL. 40, NO. 2 APRIL 1969 PAGES 85-180

A MORPHOLOGICAL ANALYSIS OF A LARGE SAMPLE OF LESSER SCAUP AND RING-NECKED DUCKS

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INTRODUCTION

In December, 1963 about one million gallons of petroleum oil escaped from a broken pipeline into the bottomlands of the Minnesota River near Savage, Minnesota. During a period of severe cold a month later, three million gallons of soybean oil escaped when a storage tank burst at Mankato, Minnesota. A significant portion of this oil spilled onto the ice of the Blue Earth River near its confluence with the Minnesota River at Mankato.

By the time this oil reached the Mississippi River the waterfowl migration was in full swing. Migrating birds seeking food and a resting place settled on the oil slicks. An account of the ensuing death appeared in Audubon Magazine (Peller, 1963). A total of 3,333 birds affected by this pollution were picked up; Lesser Scaup (*Aythya affinis*) and Ring-necked Ducks (*Aythya collaris*) constituted 65 percent and 17 percent respectively of the affected birds which were picked up. A sample of this size offered an excellent opportunity to study the morphology of the age-sex classes of these two species.

METHODS

The bursa of Fabricius was used to distinguish birds in their first spring (hereafter referred to as yearlings from older birds. Validity of this technique has been discussed elsewhere. (Anderson, *et al.*, 1969).

Body, skeletal and gonadal measurements were taken in the following manner:

Total Length—with the bird placed on its back, from tip of the tail to the tip of the bill, to the nearest millimeter. We agree with Raveling (1965) that this measurement is most accurate when taken with the bird tautly stretched.

Extent or Wingspread—with the bird on its back, the wings stretched tautly, the distance from one wing tip to the other was measured to the nearest millimeter.

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TABLE 1. LENGTH OF VARIABLE IN MILLIMETERS

Summary of external morphological measurements of Lesser Scaup and Ringnecks with statistical comparisons of age classes.

LESSER SCAUP Character		*Females* Yearlings	*Females* Adults	*Males* Yearlings	*Males* Adults
Extent	N	57	86	50	146
	$\bar{X}$	718	731*	742	749*
	1SD	12.20	10.60	13.30	12.80
	1SE	1.62	1.14	1.88	1.06
	Range	690–749	710–769	710–769	710–779
Total length	N	63	101	67	163
	$\bar{X}$	414	418 **	430	431
	1SD	11.7	11.5	11.7	12.0
	1SE	1.31	1.15	1.43	.94
	Range	385–440	385–445	400–455	400–455
Wing	N	105	184	115	381
	$\bar{X}$	199	203 *	206	208
	1SD	3.90	2.60	3.96	4.24
	1SE	.38	.18	.37	.22
	Range	190–210	192–213	193–217	191–220
Tail	N	56	70	46	131
	$\bar{X}$	50.20	52.30*	51.18	52.32*
	1SD	3.66	2.66	3.03	3.03
	1SE	.49	.32	.45	.26
	Range	40.2–57.0	48.0–57.6	47.2–63.0	46.9–61.8
Culmen from the anterior edge of the nostril					
	N	99	179	105	373
	$\bar{X}$	26.52	26.68	27.68	27.78
	1SD	1.00	1.10	1.00	.95
	1SE	.10	.08	.10	.05
	Range	23.6–29.2	23.0–30.6	25.2–29.6	25.0–30.4
Culmen	N	92	140	94	290
	$\bar{X}$	40.60	40.35	41.50	41.37
	1SD	1.45	1.45	1.45	1.20
	1SE	.13	.12	.15	.07
	Range	38.0–44.4	36.2–43.6	37.6–44.4	38.2–45.2
Ulna	N	99	124	114	342
	$\bar{X}$	68.36	68.92*	69.62	69.94
	1SD	1.56	1.52	1.60	1.62
	1SE	.16	.14	.15	.09
	Range	63.8–71.7	62.8–72.3	63.7–73.5	63.8–73.9
Sternum	N	116	213	143	441
	$\bar{X}$	79.79	80.35**	83.00	83.41**
	1SD	2.12	2.32	2.15	2.16
	1SE	.20	.16	.18	.10
	Range	74.1–84.7	47.9–86.5	78.4–88.0	77.2–90.8
Tarsus	N	98	135	99	322
	$\bar{X}$	34.77	34.92	35.70	35.93**
	1SD	.80	.87	1.05	.93
	1SE	.09	.07	.11	.05
	Range	32.7–36.7	32.7–37.1	33.3–37.9	33.0–38.4

TABLE 1 — (Continued)
LENGTH OF VARIABLE IN MILLIMETERS

LESSER SCAUP Character		*Females* Yearlings	*Females* Adults	*Males* Yearlings	*Males* Adults
Toe	N	98	126	92	260
	$\bar{X}$	53.50	54.52*	55.21	55.96*
	1SD	1.84	1.68	2.03	1.22
	1SE	.19	.15	.21	.01
	Range	49.3–58.0	51.6–59.3	51.2–59.5	51.6–60.4
RING-NECKED DUCKS					
Extent	N	32	37	32	47
	$\bar{X}$	684	694 *	716	721
	1SD	13.50	13.60	14.80	12.20
	1SE	2.39	2.24	2.61	1.78
	Range	650–709	665–715	680–755	680–749
Total length	N	38	54	39	71
	$\bar{X}$	417	421	433	439 **
	1SD	11.30	9.68	10.60	11.30
	1SE	1.83	1.32	1.70	1.34
	Range	395–445	395–445	410–460	410–464
Wing	N	51	72	60	94
	$\bar{X}$	191	194 *	202	203
	1SD	3.69	3.57	4.26	4.08
	1SE	.52	.26	.55	.42
	Range	184–201	188–203	193–212	192–212
Tail	N	24	32	29	43
	$\bar{X}$	53.60	54.91	54.30	56.80**
	1SD	2.82	2.61	3.18	2.78
	1SE	.58	.44	.59	.44
	Range	46.9–58.9	51.4–60.8	49.9–59.9	51.0–64.5
Culmen from the anterior edge of the nostril					
	N	50	63	39	89
	$\bar{X}$	28.88	29.53*	30.54	30.70
	1SD	.94	.80	1.02	.99
	1SE	.13	.10	.13	.14
	Range	25.9–30.8	27.6–31.1	28.4–32.4	28.4–33.3
Culmen	N	48	53	53	78
	$\bar{X}$	45.18	45.68	47.19	47.51
	1SD	1.34	1.47	1.93	1.43
	1SE	.19	.20	.27	.16
	Range	42.0–48.2	42.2–49.0	44.4–50.5	43.6–50.5
Ulna	N	40	57	58	68
	$\bar{X}$	63.61	64.43*	65.22	66.48*
	1SD	1.30	1.49	1.48	1.59
	1SE	.21	.20	.19	.19
	Range	61.0–66.2	59.6–67.2	62.4–70.9	63.2–69.7
Sternum	N	51	65	67	98
	$\bar{X}$	80.86	81.95**	85.74*	86.16
	1SD	2.28	2.34	2.26	2.56
	1SE	.32	.29	.28	.26
	Range	76.6–87.8	75.8–86.5	78.3–91.4	81.0–92.5

TABLE 1 — (Continued)
LENGH OF VARIABLE IN MILLIMETERS

RING-NECKED DUCKS Character		*Females* Yearlings	Adults	*Males* Yearlings	Adults
Tarsus	N	42	55	48	77
	$\bar{X}$	33.41	33.66	34.61	34.94**
	1SD	1.37	.81	.86	.80
	1SE	.21	.11	.12	.09
	Range	31.6–35.2	31.6–35.2	33.0–36.7	32.9–36.9
Toe	N	46	46	44	72
	$\bar{X}$	51.84	52.65**	54.89	55.40
	1SD	1.76	1.76	1.69	1.32
	1SE	.25	.25	.25	.16
	Range	49.0–55.2	48.2–55.6	51.2–58.6	53.0–58.8

N = sample size, $\bar{X}$ = the sample mean, 1SD = one standard deviation, 1SE = one standard error of the mean.

* = The means of the yearlings are significantly smaller than the means of adults at the .001 level.

** = The means of yearlings are significantly smaller than the means of adults at the .05 level.

Wing—on a wing gauge, from the carpometacarpus to the end of the longest primary with the wing pressed flat and straight, to the nearest millimeter. (Again we agree with Raveling that the wing should be flat for greatest accuracy.)

Tarsus—with a dial caliper, from the joint between the tarsometatarsus and tibiotarsus to the joint at the base of the middle toe, to the nearest one-tenth millimeter.

Toe—with a dial caliper, from the joint at the base of the middle toe and the tibiotarsus to the junction between the toe and nail, to the nearest one-tenth millimeter.

Tail—with a dial caliper, from the point of insertion of the two central rectrices to the tip of the longest tail feather, to the nearest one-tenth millimeter.

Culmen— a) with a dial caliper, from the anterior edge of the nostril to the tip of the bill, to the nearest one-tenth millimeter, b) with a dial caliper, from the base of the bill to the tip, to the nearest one-tenth millimeter.

Ulna Length—with a dial caliper, after separating the ulna from the rest of the skeleton, to the nearest one-tenth millimeter.

Sternum Length—with a dial caliper, the length of the keel was measured to the nearest one-tenth millimeter.

Gonads—with a dial caliper the length and the width at the widest part was measured to the nearest five-tenths millimeter. These values were multiplied to obtain a relative figure of gonad size.

TABLE 2. STATISTICAL ANALYSIS OF THE RELATIVE OVARY SIZE OF LESSER SCAUP AND RING-NECKED DUCKS. (CONVENTIONS AS IN TABLE 1.)

		ADULTS	YEARLINGS
LESSER SCAUP	N	178	90
	$\bar{X}$	127.14	110.38
	1SD	26.20	27.60
	1SE	1.96	2.96
	Range	64–198	65–188
RING-NECKED DUCKS			
	N	60	40
	$\bar{X}$	134.16	108.75
	1SD	33.00	32.70
	1SE	4.13	5.17
	Range	69–201	53–201

RESULTS

A summary of measurements for each age-sex class of Lesser Scaup and Ring-necked Ducks is presented in Table 1. Yearling scaup in each sex class have smaller average measurements than the respective adults. The two culmen measurements and tarsus length were not significantly different between the female age classes and total length, ulna length and the two culmen measurements were not significantly different between the male age classes. The Ring-neck measurements reveal a similar situation; yearling females have a significantly smaller extent, wing, culmen from the anterior edge of the nostril, ulna, sternum and toe. Yearling males have a significantly smaller total length, tarsus, tail and ulna than adult males. Yearlings of both sexes and species average less than one percent smaller than adults.

TABLE 3. STATISTICAL ANALYSIS OF THE RELATIVE TESTIS SIZES OF LESSER SCAUP AND RING-NECKED DUCKS (CONVENTIONS AS IN TABLE 1.)

		ADULTS		YEARLINGS	
		Left Side	Right Side	Left Side	Right Side
LESSER SCAUP	N	353	134	118	60
	$\bar{X}$	35.65	31.30	28.65	25.83
	1SD	8.22	8.52	7.35	5.75
	1SE	.54	.71	.68	.74
	Range	19–76	23–74	20–61	26–54
RING-NECKED DUCKS					
	N	105	53	55	38
	$\bar{X}$	45.35	40.91	42.50	38.18
	1SD	13.60	11.40	13.50	13.80
	1SE	1.33	1.57	1.82	2.05
	Range	15–82	22–77	22–78	17–61

TABLE 4. MORPHOLOGICAL COMPARISONS OF MALE RING-NECKS AND MALE LESSER SCAUP AS PRESENTED IN SEVERAL STUDIES. THE RANGE OF EACH MEASUREMENT IS IN MILLIMETERS

Character	Coues (1872)	Ridgway (1896)	Forbush (1925)	Phillips (1925)	Chapman (1934)	Kortright (1943)	Delacour (1959)	Anderson** (1969)
Total Length								
Ring-necks	406–457	394–457	394–457		419*	417–462		410–464
Lesser Scaup	381–432	394–432	381–457		410	399–475		400–455
Extent								
Ring-necks	762+		665–762			668–749		680–749
Lesser Scaup	762−		762−			673–838		710–779
Wing								
Ring-necks	191–203		178–216	195–206	191		195–206	192–212
Lesser Scaup	191–203	191–210	191–210	185–198	203		190–201	191–220
Tarsus								
Ring-necks	31.75	33.02–36.83	31.75–36.83	46	31.75		45–47	32.9–36.9
Lesser Scaup	38.10		30.40–38.10	35	34.25		36–38	33.0–38.4
Culmen								
Ring-necks	44.45	44.45–50.80	44.45–50.80	45–49	45–72		45–50	43.6–50.5
Lesser Scaup	44.45	40.13–48.26	39.37–48.26	36–40	40–64		43–46	38.2–45.2

*Males and females combined.
**For a more complete statistical summary of measurements in this study see Table 1.

Excluding male Ring-necks, the gonads of yearlings are significantly smaller than those of adults (Tables 2 and 3). The data also show significant differences between the left and right testes of Lesser Scaup, the right testis being significantly smaller (at the .01 level) than the left. There is an average difference between the right and left testis of Ring-necks, the right again averaging smaller, the difference not being statistically significant at the .05 level.

Table 4 compares the findings of this study with measurements presented by other authors. Since nearly everyone takes measurements in a slightly different manner and, as a result, gets somewhat different average values, the purpose of the comparison is not to point out differences that exist between the average measurements they present and those presented in this report. However, since the same method of measuring is used by a single investigator for all the species in his study, one can get an idea of the relative size of one species compared to all of the other species in the study. Therefore the main point of Table 4 is to show the comparative size relationships found to exist between Lesser Scaup and Ring-necked Ducks in this and other studies. Some authors have lumped the sex classes and many have apparently lumped the age classes. This study differs from those in that all of the age-sex classes are kept separate. Measurements presented in inches by other authorities have been converted to millimeters to make comparison easier.

The studies listed in Table 4 are quite consistent, indicating that Ring-necks have a slightly longer total length. Mendall (1958) mentions a specimen of Ring-neck with a total length of 487 millimeters and believes some error was made in measuring the specimen. We concur with this conclusion. All of the studies giving data on extent, except Coues (1872), indicate that Lesser Scaup have a somewhat greater extent. The present study and Chapman (1934) are the only two references cited that indicate that Lesser Scaup have a longer average wing length than Ring-necks. The relationship of the wing of the two species as presented in this study is based on 384 adult male scaup and 94 adult male Ring-necks and we find no reason to suspect that this is inaccurate. Therefore the data of Coues (1872), Phillips (1925) and Delacour (1959) probably give an inaccurate impression of the comparative wing lengths of the males of the two species. Mendall (1958) believes the upper extreme wing measurement given by Forbush for Ring-necks to be an error. It is outside three standard deviations, but within four, of the mean wing length of adult males in this study and is therefore quite unlikely statistically.

The mean tarsus length of Lesser Scaup was found to be larger than that of Ring-necks in this study. Coues (1872), Forbush (1925) and Chapman (1934) found a similar relationship for the two species. However, Phillips (1925) and Delacour (1959) indicate that the tarsus of Ringnecks averages about 10 millimeters longer than the tarsus of Lesser Scaup. The longest individual tarsus among 976 measurements taken during the present study was 38.4 millimeters and this individual was an adult male Lesser Scaup. In fact, the

52 longest tarsi were all from Lesser Scaup. The largest Ring-neck tarsus was 37.1 millimeters. The relationship between the tarsus of the two species as presented by Phillips and Delacour constitutes some type of error.

There is general agreement between measurements of the culmen that we found for the two species and those of Ridgway (1896), Forbush (1925) and Chapman (1934). Coues (1872) indicates that the two species have the same culmen length. This is misleading as cursory examination reveals that Ring-necks average longer culmens.

Additional measurements have very infrequently been given by other authors. The tail measurement is sometimes given, but we consider this the least accurate of the measurements that we took because of the oily condition of the birds. For this reason, we have not included comparisons of our findings with the findings of others.

DISCUSSION

The fact that yearlings average smaller in body, skeletal and gonadal measurements indicates that at least some of them have not quite reached adult size by their first spring of life. Whether these slight differences are biologically significant cannot be answered by the present investigation. Some of the least developed yearling males might not be reproductively mature until the third summer of life. There is some evidence that many yearling females are reproductively active in their second summer of life (McKnight and Buss, 1962).

The difference in the size of the left and right testes could reflect a difference in the rate of recrudescence of the two.

What is the significance of differences in the size of two closely related sympatric species of vertebrates? Detailed study sometimes reveals correlations between morphology and utilization of the habitat. Such correlations have been made, for example, among the Hawaiian Honey-creepers (Amadon, 1950) and Darwin's finches (Lack, 1947).

The food gathering organ (the bill of birds) is closely related to the ecological niche. Where closely related species are sympatric the bill is frequently very different in shape and size when compared to each other than it is in areas where no closely related species occur (Lack, 1947; Hutchinson, 1959; Klopfer and MacArthur, 1961; Klopfer, 1962). Recently Schoener (1965) has given support to Hutchinson's (1959) theory that where congeneric species are sympatric the ratio of bill size of the smaller to the larger is between 1.2 and 1.4.

Schoener states that in the Anatidae, bill sizes may not be sufficiently correlated with preferred food sizes for divergence to occur. For this reason and because of lack of specimens he did not present data on this group. The ratio of the smallest to the largest sympatric congeners of North American *Aythya* does, however, fit the hypothesis very closely. The average bill size of the smallest congener to the largest, the Lesser Scaup to the Canvasback (*Aythya*

valisineria), shows a ratio of 1.5 (based on 25 Canvasback specimens). Furthermore, bill sizes of Lesser Scaup and Ring-necked Ducks differ more than any other measurement. All Lesser Scaup can be distinguished by culmen size from 78 percent of the Ring-necks. The precise biological significance of this among waterfowl is not entirely clear.

There is a difference in size between the sexes of the two species, the males being two to four percent larger. Amadon (1950) explains that this sexual dimorphism is often the result of competition among males in selection of a mate. In such struggles the larger and stronger than average will have an advantage. Since size is hereditary the larger individuals will leave more offspring. This tendency is, of course, balanced if it interferes with other activities such as flying and feeding.

SUMMARY

This report presents measurements for the age-sex classes of a large sample of Lesser Scaup and Ring-necked Ducks. A review of the morphological relationships between the two species presented by other authors and this study is presented and discrepancies are pointed out.

Yearlings of both sexes and species were found to average about one percent smaller than adults for body, skeletal and gonadal measurements.

It was found that the ratio of the bill size of the smallest sympatric congener (Lesser Scaup) to the largest sympatric congener (Canvasback) is 1.5. This closely fits the thesis that the ratio of bill size of the smallest sympatric congener to the largest is between 1.2 and 1.4.

ACKNOWLEDGEMENTS

Mr. Robert Jessen and Mr. John Lindmeir of the Minnesota Conservation Department are gratefully acknowledged for their great efforts in collecting and making available the birds killed by the oil pollution.

Drs. Tauno E. Ketula and Eugene LeFebvre gave many helpful suggestions during the preparation of manuscripts.

The assistance of Miss Barbara Spross and Mr. S. Peter Getman is gratefully acknowledged.

Funds for transportation, storage and laboratory assistance were made available by the James Ford Bell Museum of Natural History, University of Minnesota, Minneapolis.

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Received June, 1968.