

SEX RATIO IN WILD BIRDS

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ORNITHOLOGISTS generally concede that there is considerable variation in the sex ratio of some species of wild birds. The cause of this variation from the normal 50-50 ratio to be expected in vertebrates has never been determined. My observations of birds in the field, of birds trapped in large numbers for banding, and of young birds before they leave the nests, lead me to believe that positive determination of the sex ratio can only be obtained by a thorough study of the nestlings, and then only where the full, average complement of eggs is hatched and the sex of the entire brood established. Determinations of this character are difficult with most birds, for, generally speaking, there is little or no external difference between the sexes as nestlings.

The object of this paper is to present definite data gathered through a five-year period showing: first, that there is a wide difference in the sex ratio of certain birds trapped and banded in large numbers at Avery Island, with but little variation in this ratio from year to year; second, that there is a large variation between the sexes in two species nesting and resident in the Avery Island territory in which the sex can be easily distinguished in the young birds long before they leave the nests. While no definite conclusion can be stated at this time as to why these unequal sex ratios exist, it is here very definitely proved that they do exist, and the information given may assist the laboratory biologists in reaching a definite conclusion.

Both of the species in which the sex determination was made as nestlings, belong to the family Icteridae. One is non-pairing, and has a surplus of females; the other is monogamous, and has a surplus of males. In both of these species it is easy to distinguish the sex by sight, five or six days after hatching.

One of the unsolved problems of genetics is what determines sex. In vertebrates, the expected sex ratio is 50% males and 50% females. There are, of course, exceptions to this general rule, but why there should be any wide deviation from it is a mystery. In order to simplify the comparisons presented at this time, let us classify them into two groups: primary and secondary. The primary group relates to the sex of the individual at the time of hatching. The secondary group covers the sex of the birds after leaving the nest and during adult life. The primary comparison is definite. The secondary comparison tends to prove the primary comparison, but may be full of errors, as will be shown later.

For more than twenty-five years I have operated a bird-banding station at Avery Island, Louisiana, using, first, the bands of the American Bird-

banding Society, and, when that organization and its records were taken over by the Biological Survey in 1921, then using the bands furnished by this bureau of the United States Government. The objects of bird banding are: (1) through the retaking of banded birds to learn their migration routes; (2) to learn their span of life; (3) to learn the proportion of the sexes of the birds banded.

A daily record of all birds banded at my station, giving the number of the band affixed, the date, species, and sex, is sent to the Biological Survey on Monday of each week, covering the banding of the preceding week. Complete duplicate records are kept in my office in two sets of books: one for wildfowl and gamebirds, and one for non-gamebirds. It is, therefore, quite easy to record a return band in the right book, in the right place, within a few minutes after the return record is received. As my records show full data on more than 150,000 birds banded, and record more than 15,000 returns, there is available a vast amount of valuable material concerning certain phases of the life history of birds that have been banded in large numbers yearly over a considerable number of years. All comparisons recorded here, tabulated, cover the five-year period 1934-38 inclusive, and no record is made where less than 500 birds of a species have been banded.

Although the utmost care may be taken by field observers in making comparative estimates of the sex ratio in birds as they see them, such observations are liable to be in error because of conditions unknown to the observer, for there is at times a segregation of the sexes in some species, and there often is a very close similarity of plumage of both sexes in the juvenal stage. For instance: if one were observing bird life on the Arctic coast of Alaska in the early summer, great numbers of female Red Phalarope (*Phalaropus fulicarius*) would be seen along the beaches and in flocks along the tundra lagoons. Very few males would be observed, and these only in small groups by themselves or as scattered individuals. One not understanding the habits of this bird would naturally think the females greatly exceeded the males. The reason for this seeming difference in sex is that the phalaropes arrive at the Arctic coast mated, and at once proceed to the tundras where nesting sites are selected. The female deposits her clutch of eggs, and at once turns the nest and eggs over to the male, who, from that time on, takes sole charge. The females go to the beaches of the ocean and large lagoons, where they gather in great numbers. The males are almost all inland, bringing up the family. The females leave for the south before the young are able to fly. The males and young make their southern migration a considerable time after the females. There is no mingling of the sexes until the next mating season.

A similar case arises with the King Eider (*Somateria spectabilis*). As soon as the females have deposited their clutch of eggs, the male birds leave

their mates and congregate in great numbers in the Arctic Ocean above shoals on which small clams abound, that, at this season, are the only food of these birds. The males lose, at this time, all flight feathers, and may be seen in flocks of many thousands covering comparatively small areas, with almost no females in evidence. From my observation I would judge there would not be ten females to a thousand males in one of these great flocks. At this time, the females are far out on the tundra raising their families.

Generally, in the observations of the field naturalist and sportsman, the male bird attracts more attention than does the female. This is especially true in ducks, where there is a wide difference in plumage. During many years of active duck-shooting, I have always killed males almost to the exclusion of females. I have done this so continuously, and for such a long time, that when hunting ducks and a flock comes within range, I actually do not see the females. My attention is riveted on the male or males that I expect to shoot. Anyone seeing the bags of ducks killed by my gun would naturally suppose that the males greatly outnumber the females. This, however, is not always the case. I remember on one occasion when shooting Mallards (*Anas platyrhynchos platyrhynchos*), the sex ratio of which is very even, I made a bag of fifty males and one female. This one female was killed by accident, as it crossed the line of fire intended for a male. I could have just as easily killed all females.

It is also a fact that in a number of our smaller birds, migration of the males and females occurs at different times, and in some species flocks of migrating individuals are composed of one sex or the other almost entirely. This is especially true of Bobolinks (*Dolichonyx oryzivorus*), Cowbirds (*Molothrus ater ater*), and the smaller grackles (*Quiscalus quiscula quiscula* and *Quiscalus quiscula aeneus*). Sight determination of sex ratio in birds, therefore, is likely to be faulty.

The most definite sex ratio I have been able to determine up to now is the primary ratio found in an examination of a large number of nestlings of species in which the young birds show a marked sex difference a few days after hatching, and several days before they are strong enough to leave the nest. Fortunately, we have here at Avery Island two resident birds, both of which not only nest in this vicinity in large numbers, but are present at all seasons in almost unbelievable numbers. These two birds are of unusual interest for a comparison of their sex ratio: first, because both belong to the family Icteridae; second, because the normal clutch of eggs laid by both is three; third, because in one, the females outnumber the males, and in the other, the males outnumber the females; fourth, because both are resident at the place of comparison, and abundant at all times; fifth, because the sex of the young is easily distinguishable five days after hatching; sixth, because the males in both species do not breed until the second year after hatching;

seventh, because the females in both species breed the first year after hatching; eighth, because both species have been banded as nestlings for many years, and a record was kept of the sexes; ninth, because both species have been trapped and banded every month in the year for many years; tenth, because in every instance where these birds banded as nestlings have been retrapped, or retaken by other means, the sex of the retakes has proved correct when checked with the recorded sex as nestlings. These two birds are Boat-tailed Grackle (*Cassidix mexicanus major*) and Gulf Coast Redwing (*Agelaius phoeniceus littoralis*).

The nests of *Cassidix* are easy to locate, as this bird breeds in colonies of sometimes more than two hundred nests. The nests of *Agelaius* are more difficult to locate because they are scattered, but my game keeper has no trouble in finding fifty or more each spring in the rushes along the edges of my shooting ponds. A conspicuous white card is tied to the grass or foliage at each nest under observation, and on this card all interesting observations for the particular nest are kept.

In my paper 'Life History of the Boat-tailed Grackle in Louisiana' (Auk, 54: 291, 1937) I gave the sex determination of the young in 89 nests of this bird, all observed during 1936. Of these nests, only 37 contained full complements of three young each. I now give the sex determination of 137

PRIMARY SEX DETERMINATION OF NESTLING BOAT-TAILED GRACKLE

Year	No. of Nests	No.		Percentage		Ratio	
		Male	Female	Male	Female	Male	Female
1935.....	14	12	30	28.5+%	71.4+%	1	to 2.5+
1936.....	37	34	77	30.6+%	69.3+%	1	to 2.26+
1937.....	29	24	64	27.2+%	72.7+%	1	to 2.66+
1938.....	31	30	63	32.2+%	67.7+%	1	to 2.06+
1939.....	26	25	53	32+%	67.9+%	1	to 2.12+
Total....	137	125	287	30.3+%	69.6+%	1	to 2.51+

There can be no error in the sex determination of these nestlings, as the sex of the young can be easily distinguished long before they leave the nests.

SECONDARY SEX DETERMINATION OF TRAPPED AND BANDED BOAT-TAILED GRACKLE

Year	No.		Percentage		Ratio	
	Male	Female	Male	Female	Male	Female
1934.....	115	225	33.8+%	66.1+%	1	to 1.36+
1935.....	416	609	40.5+%	59.4+%	1	to 1.46+
1936.....	419	770	35.2+%	64.7+%	1	to 1.83+
1937.....	299	1052	22.1+%	77.8+%	1	to 3.51+
1938.....	519	909	36.3+%	63.6+%	1	to 1.75+
Total.....	1768	3565	33.1+%	66.8+%	1	to 2.01+

COMPARISON OF TOTALS AND AVERAGES

	Male		Female		Percentage		Ratio	
	Male	Female	Male	Female	Male	Female	Male	Female
Primary	125	to 287	30.3+	69.6+	%	%	1	to 2.29+
Secondary	1768	to 3565	33.1+	66.8+	%	%	1	to 2.01+

nests in which the full complement of three young matured, as recorded in the five-year period 1935 through 1939, both inclusive.

The comparison of sex in the trapped birds shows a considerably lower percentage of males than that proved by the records of the nestlings examined. This is an error, and one that would not be known to anyone studying the comparison as recorded month by month. This is where the field observations, if properly analyzed, are of great value. At certain times of the year, flocks of *Cassidix* are composed entirely of males or of females. If a full-plumaged male is left in the trap to act as a decoy, nothing but males will go to that trap. If a female is left in the trap for a decoy, both males and females go to the trap.

During sixteen days in 1935, sixteen days in 1936, sixteen days in 1938, and four days in 1939, male birds were used for decoys. During those days, 940 males and 1,025 females were banded or one male to 1.06 females,

PRIMARY SEX DETERMINATION ON NESTLING GULF COAST RED-WING

Year	No. of Nests	Male		Female		Percentage		Ratio	
		Male	Female	Male	Female	Male	Female	Male	Female
1935	12	28	8	77.7+	22.2+	%	%	3.54+	to 1
1936	26	61	17	78.2%	21.8%			3.58+	to 1
1937	29	67	20	77%	23%			3.34+	to 1
1938	38	87	27	76.3+	23.6+	%	%	3.21+	to 1
1939	35	79	26	75.2+	24.7+	%	%	3.04+	to 1
Total	140	322	98	76.9+	23.3+	%	%	3.3+	to 1

There can be no error in the sex determination of these nestlings as the sex of the young can easily be distinguished from the time they are *five days old*.

SECONDARY SEX DETERMINATION ON TRAPPED AND BANDED GULF COAST RED-WING

Year	Male		Female		Percentage		Ratio	
	Male	Female	Male	Female	Male	Female	Male	Female
1934	448	66	87.1+	12.8+	%	%	6.78+	to 1
1935	629	161	79.6+	20.3+	%	%	3.9+	to 1
1936	968	239	80.2%	19.8%			4+	to 1
1937	1821	282	86.5+	13.4+	%	%	6.46+	to 1
1938	1607	259	86.1+	13.8+	%	%	6.2+	to 1
Total	5473	1007	84.4+	15.5+	%	%	5.43+	to 1

COMPARISON OF TOTALS AND AVERAGES

			Percentage		Ratio	
	Male	Female	Male	Female	Male	Female
Primary	322	98	76.9+%	23.3+%	3.3+	to 1
Secondary	5743	1007	84.4+%	15.5+%	5.43+	to 1

causing an apparent error in the sex ratio of the banded birds for the days during which males only were used for decoys in the banding traps.

The primary ratio shows an excess of three males to one female. The secondary ratio shows 5.43 males to one female. The only way this excess of males recorded as banded birds can be accounted for is, that great numbers of Red-wings come to the Gulf Coast during the winter from their breeding grounds in the North, and the excess of males in the northern breeding birds may be greater than that of those nesting on the Gulf Coast. Another cause may be due to the habit of Red-wings to flock at times according to sex. Often the banding traps catch nothing but males, but at no time have I found a surplus of females in the traps.

Both *Cassidix* and *Agelaius* belong to the family Icteridae, both have many common characteristics, such as food, nesting, number of eggs to clutch, and habits, but differ widely in sex ratio. They are excellent examples for the laboratory biologist to study, in an attempt to solve the reason for the unequal sex ratio in birds.

Other of the smaller birds banded in numbers as adults during the five-year period 1934-38, both inclusive, in which the sexes are distinguishable at sight are Eastern Cowbird (*Molothrus ater ater*) and Louisiana Cardinal (*Richmondia cardinalis magnirostris*). In this period a total of 4,281 Cowbirds were banded with a sex ratio of 73.8+% males to 26.1+% females or 2.82+ males to one female. This comparison is likely to be in error because at times flocks of Cowbirds are composed of either all males or all females.

Of 319 Cardinals banded, 209 were males and 110 females, or 65.5+% males to 34.4+% females or 1.9+ males to one female. The sexes of these two birds are so easily distinguished that there is no chance for error in the banding record.

I also annually band large numbers of Blue Jays (*Cyanocitta cristata florincola*), Meadowlarks (*Sturnella magna argutula*), Starlings (*Sturnus vulgaris vulgaris*) and others, and make no attempt to divide the sexes, as it is impossible, with any degree of accuracy, to distinguish the male from the female in birds of the year.

A study of the sex ratio for the five years 1934-38, both inclusive, of such ducks as have been banded in considerable numbers at my station indicates that males outnumber females in all but one species.

A comparison of the records by months shows there is definite seasonal variation in the sex ratio; for the proportion of females to males is greater in the early autumn than later.

A study of the birds as trapped points to the conclusion that the females and young come south in advance of the adult males. The return of banded birds also tends to prove this difference in migration.

COMPARISON IN SEX OF AMERICAN PINTAIL (*Dafila acuta tzitzihoa*) TRAPPED AND BANDED AT AVERY ISLAND, DURING THE YEARS 1934-38

Months	Male	Female	Percentage		Ratio	
			Male	Female	Male	Female
January	2774	1271	68.5%	31.5%	2.18+	to 1
February	1339	562	70.4+%	29.5+%	2.38+	to 1
October	535	358	59.9+%	40.+%	1.47+	to 1
November	4744	3163	60%	40%	1.5	to 1
December	6129	2527	70.8+%	29.1+%	2.3+	to 1
All other months	188	84	69.1+%	30.8+%	2.23+	to 1
Total	15709	7965	66.35+%	33.64+%	1.98+	to 1

COMPARISON IN SEX OF RING-NECKED DUCK (*Nyroca collaris*) TRAPPED AND BANDED AT AVERY ISLAND, DURING THE YEARS 1934-38

Months	Male	Female	Percentage		Ratio	
			Male	Female	Male	Female
January	1456	409	78+%	21.9+%	3.55+	to 1
February	578	184	75.8+%	24.1+%	3.14+	to 1
October	0	0				
November	675	325	67.5%	32.5%	2.07+	to 1
December	1972	476	80.5+%	19.4+%	4.14+	to 1
All other months	30	11	73.1+%	26.8+%	2.72+	to 1
Total	4711	1405	77%	22.9+%	3.35+	to 1

COMPARISON IN SEX OF LESSER SCAUP DUCK (*Nyroca affinis*) TRAPPED AND BANDED AT AVERY ISLAND, DURING THE YEARS 1934-38

Months	Male	Female	Percentage		Ratio	
			Male	Female	Male	Female
January	370	192	65.8+%	34.1+%	1.92+	to 1
February	83	57	59.2+%	40.7+%	1.45+	to 1
October	2	2	50%	50%	1	to 1
November	2092	1143	64.6+%	35.3+%	1.83+	to 1
December	3016	1068	73.8+%	26.1+%	2.82+	to 1
All other months	198	133	59.8+%	40.1+%	1.48+	to 1
Total	5761	2595	68.9+%	31.0+%	2.22+	to 1

COMPARISON IN SEX OF BLUE-WINGED TEAL (*Querquedula discors*) TRAPPED AND Banded AT AVERY ISLAND, DURING THE YEARS 1934-38

Months	Male		Female		Ratio	
	Male	Female	Male	Female	Male	Female
March.....	204	100	67.1+%	32.8+%	2.4	to 1
April.....	1729	481	78.2+%	21.2+%	3.5+	to 1
May.....	380	150	71.69+%	28.3+%	2.53+	to 1
September.....	438	318	57.93+%	42+%	1.3+	to 1
October.....	1577	1182	57.13+%	42.86+%	1.33+	to 1
November.....	385	320	54.6+%	45.4+%	1.2+	to 1
All other months	449	314	58.84+%	41.16+%	1.43+	to 1
Total.....	5162	2865	64.3+%	35.6+%	1.8+	to 1

The Blue-winged Teal is one of the few ducks breeding in North America that winter principally south of our borders. A study of the sex proportion by months, and a study of the individual birds when banding indicate that females and young come south in the autumn before the males, and that the females go north in April as soon as paired, leaving the surplus males to follow later. These facts in the seasonal movement of this bird cause an error in the ratio of sex determination, but the total figures indicate clearly that the males largely exceed the females.

We now come to the sex comparison of two closely allied ducks, the sex ratio of which differs widely. Of the Common Mallard (*Anas platyrhynchos platyrhynchos*) I have banded during the five-year period 1934-38, both inclusive, 3,441 individuals. Of these, 1,728 were males, and 1,713 females, or 50.2+% males to 49.7+% females—almost the ideal ratio of 50% males to 50% females. This is the only duck coming to southern Louisiana in which the sex ratio is so nearly even.

We will compare the sex ratio of the Mallard with that of its near relative, the Mottled Duck (*Anas fulvigula maculosa*). This duck, although a resident of the Louisiana coastal marshes, does not come in considerable numbers to my traps. I have, however, banded 332 of them, of which 220 were males, and 112 females. This small number banded gives a percentage of 66.2+% males to 33.7+% females, or, 1.96 males to 1 female. Why there should exist this wide difference in the sex ratio of these two closely allied birds is a mystery, for which I can find no explanation.

A number of other ducks banded in considerable numbers during the five years 1934-38, both inclusive, show a liberal excess of males over females. The following table will show the sex ratio tabulated in form easy of comparison:

ANALYSES AND COMPARISONS OF TOTALS AND AVERAGES

Species	Male	Female	Percentage		Ratio	
			Male	Female	Male	Female
American Pintail.	15709	7965	66.35+%	33.64+%	1.98+	to 1
Ring-necked Duck	4711	1405	77%	22.9%	3.35+	to 1
Lesser Scaup Duck	5761	2595	68.9+%	31.0+%	2.22+	to 1
Common Mallard	1728	1713	50.2+%	49.7+%	1+	to 1
Mottled Duck . . .	220	112	66.2+%	33.7+%	1.96+	to 1
Wood Duck	594	354	62.6+%	37.3+%	1.67+	to 1
Green-winged Teal	315	135	70%	30%	2.33+	to 1
Canvas-back	343	197	63.5+%	36.4+%	1.74+	to 1
Blue-winged Teal.	5162	2865	64.3+%	35.6+%	1.8+	to 1

A comparison of the sex ratio in the nine species of ducks I have banded in considerable numbers, shows a predominance of males in all except Mallards, with an average ratio of slightly more than two to one. This comparison is not accurate; nor can any banding record give the exact sex ratio for reasons of likely errors as explained above. I think, however, that the records given prove there is undoubtedly a considerable surplus of males in the species of ducks tabulated, excepting the Mallard.

In order to determine whether there was a difference in the longevity of the different sexes, a check was made of the number of individual returns of three species of ducks banded in large numbers that were shown, by the return records, to have been alive four years after the bands were affixed. Of Pintails, a total of 381 males and 149 females were alive at four years after banding, or, 2.5— males to one female; this does not differ greatly from the banding ratio of 1.96 males to one female. Of Lesser Scaup, four-year-old returns were: 123 males and 37 females, or 3.0— males to one female; the banding ratio for this species was 2.22— to one. The four-year-old returns for Ring-necks were: 129 males to 26 females, or 4.9 males to one female; the banding ratio for this species was 3.35— to one. All three of these comparisons show that a considerable percentage of males live longer than the females, indicating that the females have more hazards to overcome than the males.

Avery Island
Louisiana