WEIGHTS AND WEIGHT VARIATIONS IN SUMMER BIRDS FROM GEORGIA AND SOUTH CAROLINA

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For most of the southeastern United States, Georgia and South Carolina included, relatively few data on weights of birds have been collected and fewer still have seen the light of publication. Accordingly, it seems desirable to place on record a summary of weights of approximately 576 individuals, representing 97 species, which were taken in the summers of 1947, 1948, 1951, 1955, and 1956, in southern parts of Georgia and South Carolina. All the weights pertain to collected specimens, of which the majority are deposited in collections of the Department of Zoology, University of Georgia, Athens; the Museum of Vertebrate Zoology, University of California, Berkeley; the Malarial Investigations Station, Newton, Georgia; and the Department of Biology, Mercer University, Macon, Georgia. Most of the birds were collected on the Upper Coastal Plain of south-central and southwestern Georgia. Some were taken as far north and east as Macon, Bibb County, Georgia, and the Savannah River Plant area, Aiken and Barnwell counties, South Carolina. Nearly all the specimens were from areas less than 400 feet above sea level, but occasional ones came from elevations as high as 600 feet. Thirty-odd individuals were obtained along the Georgia coast from Chatham to Camden counties, these being mainly littoral or coast-dwelling species. On the whole the region in which the birds were taken was rather uniform and may be regarded as a satisfactory unit within which one would expect to find very little geographic variation in bird weights.

Methods

Most of the weights were taken with double-beam balances. A few were taken with a more sensitive triple-beam balance. Individual weights were recorded to the nearest tenth gram for birds weighing less than 100 grams, and to the nearest gram for larger birds. The specimens were collected with shotguns and carried in paper cones, and only rarely was there considerable loss of blood. Practically all were obtained between 9:00 a.m. and 4:00 p.m. Weight variations due to normal daily fluctuations, in which weights are lightest in the early morning and heaviest in the late afternoon (see Baldwin and Kendeigh, 1938:424–430), were thus held to a minimum or at least restricted somewhat. We believed there was little weight loss following death because the birds were usually weighed within two or three hours after they were collected. When there were longer delays, they were usually placed in a refrigerator as soon as possible.

Because of the paucity of recorded weights from the southeastern United States we are in certain instances presenting weight values for single specimens. It is true that one might ask, "Is it worth while publishing a single weight of, say, a Black Skimmer?" We think so. So far as we know, no one besides ourselves has weighed a skimmer in either Georgia or South Carolina, and it seems unlikely that anyone, including ourselves, will weigh another for some time to come. Hence we feel this single record and others like it should be made available.

The best way to present data here is by sex and age, both of which were determinable for the majority of our specimens. Thus, in Table 1, "M" refers to male, "F" to female, "a" to adult, and "i" to immature. Very few of the weights pertain to females containing large or full-sized eggs. Immaturity in passerine species was ascertained not only by external characters but also by the thin, unossified areas in the skull. All the immatures were out of the nest and were in full feather, and essentially all were independent of their parents. Age could not always be determined in migrant non-passerine species.

For each category an average or mean weight value is given, whether it represent one or be based on two or more individuals. Parentheses enclose data for single specimens. Where two or more specimens are involved in a sample, the average is followed by the standard error of the mean. In a sample of two this standard-error value is equivalent to one-half the range between the two weight values, or to the difference between the mean and either of those values. In larger samples this simple relationship does not obtain. In order to present the data in brief yet useful fashion, we chose the standard error, as opposed to the standard deviation, as the best single statistic or parameter to be given with the mean.

The summer period in which a given sample was collected has been handled in a similar way. For a given sample in Table 1, the numerical values *following* the semicolon refer, first, to the "mean day" of the summer period in which the sample was taken and, second, to the standard error of the mean in whole days. These statistics were ascertained on the basis of the following scale: June 1 to 30 (numbers 1 to 30), July 1 to 31 (numbers 31 to 61), August 1 to 31 (numbers 62 to 92), and September 1 to 15 (numbers 93 to 107). Even though the days on which a sample was collected are distributed as a non-normal statistical array, it nevertheless seems justified to employ the same statistics for a given summer period as we have for a sample of weights. In doing so we not only insure brevity but also enable one to determine, if necessary, whether two samples, which one might wish to compare closely, were indeed obtained at strictly comparable times of summer. A fairly rigorous check could be accomplished by an ordinary t-test which, according to one conventional formula (Arkin and Colton, 1939:121), would employ the difference between the respective mean values as well as the standard-error values (specifically, the square root of the sum of their squares).

For small samples, at least, the *t*-probability scale (which may be found in elementary books on statistics) is justified and may be used "even if the population varies very considerably from normal" (a conjecture of E. S. Pearson's confirmed by Gayen, 1950).

TABLE 1

STATISTICAL ANALYSIS OF WEIGHTS OF SUMMER BIRDS FROM GEORGIA AND SOUTH CAROLINA

Pied-billed Grebe. *Podilymbus podiceps*.—2 Ma: 438.0 ± 3.0; 56 ± 3.
Anhinga. *Anhinga anhinga*.—Ma (1326; 75).
Little Blue Heron. *Florida caerulea*.—Mi (348; 36).—Fa (352; 56).—Fi (296; 53).
Green Heron. *Butorides virescens*.—Fa (229; 71).—Fi (173; 75).
Snowy Egret. *Leucophoyx thula*.—M (342; 62).
Louisiana Heron. *Hydranassa tricolor*.—Fi (402; 43).
Yellow-crowned Night Heron. *Nyctanassa violacea*.—2MF?i: 426.5 ± 35.5; 33 ± 1.
Red-tailed Hawk. *Buteo jamaicensis*.—Fi (1134; 39).
Broad-winged Hawk. *Buteo platypterus*.—Ma (349; 60).
American Kestrel. *Falco sparverius*.—2 Fa: 97.55 ± 1.95; 43 ± 8.
Bobwhite. *Colinus virginianus*.—2 Ma: 152.0 ± 1.0; 54 ± 18.
Purple Gallinule. *Porphyrula martinica*.—Ma (220; 30).—Fa (200; 75).
Common Gallinule. *Gallinula chloropus*.—Fi (259; 74).
American Coot. *Fulica americana*.—2 Fa: 556.0 ± 23.4; 72 ± 0.
Thick-billed Plover. *Charadrius wilsonia*.—2 Ma: 64.90 ± 1.10; 45 ± 39.
Killdeer. *Charadrius vociferus*.—2 Ma: 75.60 ± 3.60; 44 ± 16.—Fa (85.5; 37).
Spotted Sandpiper *Actitis macularia*.—Fa (40.5; 43).
Solitary Sandpiper. *Tringa solitaria*.—3 M: 61.30[4] ± 2.58; 74 ± 0.
Willet. *Catoptrophorus semipalmatus*.—Ma (222; 48).
Least Sandpiper. *Erolia minutilla*.—M (21.1[2]; 85).—F (18.6; 80).
Semipalmated Sandpiper. *Ereunetes pusillus*.—F (28.1[5]; 86).
Least Tern. *Sterna albifrons*.—Ma (50.5; 58).—Fi (48.6; 48).
Black Tern. *Chlidonias niger*.—Ma (50.6; 59).
Black Skimmer. *Rhynchops nigra*.—Ma (373; 48).
Mourning Dove. *Zenaidura macroura*.—3 Ma: 126.7[2] ± 3.2; 80 ± 4.
Ground Dove. *Columbigallina passerina*.—MF?a (40.7; 23).
Yellow-billed Cuckoo. *Coccyzus americanus*.—M (54.6; 59).—F (61.2; 62).
Common Nighthawk. *Chordeiles minor*.—Fa (57.8; 23).
Chimney Swift. *Chaetura pelagica*.—2 M: 22.50 ± 0.35; 89 ± 0.
Red-bellied Woodpecker. *Centurus carolinus*.—6 Ma: 73.08 ± 2.61; 66 ± 5.—5 Mi: 68:52 ± 2.91; 66 ± 7.—6 Fa: 65.50 ± 2.04; 63 ± 6.—2 Fi: 62.75 ± 1.15; 86 ± 2.
Hairy Woodpecker. *Dendrocopos villosus*.—Ma (58.7; 45).—2 Fa: 50.15 ± 1.75; 79 ± 1.
Downy Woodpecker. *Dendrocopos pubescens*.—Ma (23.2; 47).—4 Fa: 21.30 ± 0.44; 64 ± 15.
Red-cockaded Woodpecker. *Dendrocopos borealis*.—2 Ma: 48.00 ± 1.00; 32 ± 4.—Mi (42.8; 37).—Fa (39.0; 62).
Eastern Kingbird. *Tyrannus tyrannus*.—3 Ma: 37.17 ± 1.18; 61 ± 5.—Mi (35.7; 63).—2 Fa: 35.60 ± 0.60; 64 ± 6.—Fi (38.4[1]; 80).
Crested Flycatcher. *Myiarchus crinitus*.—2 Ma: 37.65 ± 0.15; 46 ± 45.—4 Mi: 33.40 ± 1.14; 60 ± 8.—Fa (30.8; 51).—Fi (30.5; 47).

Acadian Flycatcher. *Empidonax virescens.*—2 Ma: 14.05 ± 0.75; 61 ± 20.—2 Fa: 11.95 ± 0.35; 64 ± 17.
Eastern Wood Pewee. *Contopus virens.*—4 Ma: 13.82 ± 0.29; 50 ± 4.
Bank Swallow. *Riparia riparia.*—Ma (14.2^{4}; 92).
Rough-winged Swallow. *Stelgidopteryx ruficollis.*—M (18.8^{2}; 51).
Barn Swallow. *Hirundo rustica.*—Ma (20.9; 76).—Mi (16.7; 105).
Purple Martin. *Progne subis.*—Mi (44.0; 47).
Blue Jay. *Cyanocitta cristata.*—12 Ma: 77.22 ± 2.23; 60 ± 6.—7Mi: 79.81 ± 3.62; 60 ± 7.—Fa (75.5; 77).—2 Fi: 72.90 ± 7.50; 72 ± 19.
Common Crow. *Corvus brachyrhynchos.*—6 Ma: 460.3 ± 13.5; 35 ± 15.—8 Fa: 395.4 ± 6.2; 25 ± 6.—3 Fi: 395.0 ± 13.3; 46 ± 18.
Fish Crow. *Corvus ossifragus.*—3 Ma: 305.7 ± 10.9; 13 ± 13.—Mi (293; 38).—2 Fa: 278.5 ± 9.5; 72 ± 19.
Carolina Chickadee. *Parus carolinensis.*—5 Ma: 9.44 ± 0.20; 60 ± 11.—4 Fa: 8.58 ± 0.25; 60 ± 9.
Tufted Titmouse. *Parus bicolor.*—5 Ma: 20.62 ± 0.84; 61 ± 13.—8 Mi: 21.11 ± 0.57; 71 ± 8.—2 Fa: 18.80 ± 1.00; 38 ± 5.—3 Fi: 18.80 ± 0.69; 64 ± 16.
White-breasted Nuthatch. *Sitta carolinensis.*—Mi (19.1; 39).
Brown-headed Nuthatch. *Sitta pusilla.*—17 Ma: 10.11 ± 0.19; 58 ± 6.—11 Mi: 10.26 ± 0.29; 48 ± 6.—10 Fa: 9.86 ± 0.18; 56 ± 7.—6 Fi: 9.58 ± 0.27; 56 ± 10.
Carolina Wren. *Thryothorus ludovicianus.*—3 Ma: 20.57 ± 1.79; 44 ± 14.—3 Fa: 16.77 ± 0.56; 39 ± 13.
Long-billed Marsh Wren. *Telmatodytes palustris.*—M?i (10.9; 85).—Fa (8.9; 50).—Fi (9.0; 86).
Mockingbird. *Mimus polyglottos.*—8 Ma: 50.20 ± 1.17; 52 ± 5.—6 Mi: 51.05 ± 1.08; 60 ± 10.—4 Fa: 47.48 ± 2.19; 48 ± 5.—5 Fi: 48.62 ± 1.41; 59 ± 6.
Catbird. *Dumetella carolinensis.*—Ma (40.0; 44).
Brown Thrasher. *Toxostoma rufum.*—Mi (75.5; 68).—3 Fa: 69.80 ± 0.23; 81 ± 5.—Fi (64.5; 29).
Wood Thrush. *Hylocichla mustelina.*—Fa (44.5; 74).
Eastern Bluebird. *Sialia sialis.*—Ma (30.5; 40).—Mi (23.4; 58).—2 Fa: 25.45 ± 0.05; 57 ± 2.
Blue-gray Gnatcatcher. *Polioptila caerulea.*—Ma (5.2; 47).—3 Mi: 5.87 ± 0.39; 39 ± 7.—2 Fa: 6.20 ± 1.00; 52 ± 20.—Fi (6.2; 53).
Loggerhead Shrike. *Lanius ludovicianus.*—4 Ma: 51.48 ± 0.85; 74 ± 8.—Mi (53.5; 50).—Fa (45.9; 73).—4 Fi: 45.20 ± 2.16; 52 ± 9.
Common Starling. *Sturnus vulgaris.*—2 Mi: 82.65 ± 2.55; 39 ± 0.
White-eyed Vireo. *Vireo griseus.*—8 Ma: 12.64 ± 0.31; 74 ± 7.—8 Mi: 12.51 ± 0.36; 69 ± 8.—4 Fa: 12.92 ± 0.36; 60 ± 9.—Fi (12.7; 85).
Yellow-throated Vireo. *Vireo flavifrons.*—3 Ma: 16.06 ± 0.56; 50 ± 15.—Mi (17.9; 71).
Red-eyed Vireo. *Vireo olivaceus.*—Ma (14.3; 48).—3 Mi: 18.77^{3} ± 1.16; 59 ± 11.—Fa (17.9^{3}; 53).—2 Fi: 17.10^{2} ± 0.40; 67 ± 14.
Black-and-white Warbler. *Mniotilta varia.*—Mi (13.8^{5}; 85).—Fa (10.9; 76).
Prothonotary Warbler. *Protonotaria citrea.*—Ma (13.2; 25).—3 Mi: 13.70^{1} ± 0.38; 47 ± 17.—Fa (12.7; 43).
Swainson's Warbler. *Limnothlypis swainsonii.*—2 Ma: 16.60^{1} ± 0.11; 63 ± 7.
Worm-eating Warbler. *Helmitheros vermivorus.*—3 Mi: 13.50^{2} ± 0.49; 69 ± 0.—Fi 12.9^{1}; 78).
Golden-winged Warbler. *Vermivora chrysoptera.*—2 Mi: 9.20^{2} ± 1.00; 95 ± 0.
Blue-winged Warbler. *Vermivora pinus.*—Fi (9.1^{2}; 85).

Parula Warbler. *Parula americana.*—6 Ma: 7.81 ± 0.25; 41 ± 10.—Mi (7.6^{2}; 53).—Fa (8.4^{3}; 70).—6 Fi: 7.38 ±0.19; 56 ± 7.

Cerulean Warbler. *Dendroica cerulea.*—Ma (12.4^{5}; 90).—Mi (9.4^{2}; 74).—5 Fi: 10.82^{4} ± 0.73; 80 ± 4.

Yellow-throated Warbler. *Dendroica dominica.*—4 Ma: 10.35 ± 0.22; 76 ± 7.—4 Mi: 10.60 ± 0.38; 72 ± 10.—2 Fa: 10.75 ± 0.45; 86 ± 4.—6 Fi: 10.23 ± 0.26; 79 ± 9.

Chestnut-sided Warbler. *Dendroica pensylvanica.*—F?i (10.2^{2}; 90).

Pine Warbler. *Dendroica pinus.*—2 Ma: 12.40 ± 1.70; 60 ± 18.—5 Mi: 13.25 ± 0.20; 68 ± 3.—2 Fa: 12.20 ± 0; 64 ± 4.—2 Fi: 12.60 ± 0.10; 73 ± 5.

Prairie Warbler. *Dendroica discolor.*—2 Ma: 7.25 ± 0.55; 71 ± 6.—Fa (7.3; 47).—3 Fi: 7.20^{2} ± 0.45; 70 ± 11.

Ovenbird. *Seiurus aurocapillus.*—Mi (19.0^{1}; 90).

Northern Waterthrush. *Seiurus noveboracensis.*—3 Mi: 18.60^{4} ± 2.05; 89 ± 3.

Louisiana Waterthrush. *Seiurus motacilla.*—Mi (20.2; 74).—Fa (21.6; 47).

Kentucky Warbler. *Oporornis formosus.*—3 Ma: 14.23^{2} ± 0.76; 72 ± 20.—4 Mi: 14.18^{1} ± 0.74; 48 ± 7.—Fi (14.6^{2}; 62).

Common Yellow-throat. *Geothlypis trichas.*—2 Ma: 10.65 ± 0.65; 28 ± 6.—3 Mi: 9.63 ± 0.48; 58 ± 13.—2 Fi: 10.10 ± 0.80; 46 ± 1.

Yellow-breasted Chat. *Icteria virens.*—3 Ma: 25.57 ± 0.61; 50 ± 3.

Hooded Warbler. *Wilsonia citrina.*—3 Ma: 10.47 ± 0.07; 60 ± 12.—4 Mi: 12.78^{3} ± 0.96; 72 ± 4.—Fa (9.5; 43).—2 Fi: 11.95^{1} ± 0.45; 64 ± 8.

American Redstart. *Setophaga ruticilla.*—Ma (9.7^{3}; 81).—3 Mi: 9.60^{4} ± 0.83; 87 ± 10.

Eastern Meadowlark. *Sturnella magna.*—6 Ma: 104.8 ± 2.8; 66 ± 7.

Red-winged Blackbird. *Agelaius phoeniceus.*—3 Ma: 52.8 ± 2.56; 42 ± 6.—Mi (51.2; 89).—4 Fa: 35.60 ± 0.87; 61 ± 7.—2 Fi: 36.15 ± 0.55; 79 ± 0.

Common Grackle. *Quiscalus quiscula.*—Ma (107; 36).—Fi (76.6; 45).

Brown-headed Cowbird. *Molothrus ater.*—Ma (52.2; 103).

Summer Tanager. *Piranga rubra.*—3 Ma: 30.20 ± 0.91; 59 ± 19.—3 Fa: 28.87 ± 0.34; 33 ± 7.

Cardinal. *Richmondena cardinalis.*—7 Ma: 39.31 ± 0.50; 61 ± 9.—8 Mi: 39.52 ± 0.56; 61 ± 4.—10 Fa: 38.03 ± 0.86; 47 ± 5.—3 Fi: 34.86 ± 0.77; 66 ± 9.

Blue Grosbeak. *Guiraca caerulea.*—6 Ma: 29.13 ± 0.46; 71 ± 11.—2 Mi: 28.80 ± 1.30; 92 ± 2.—3 Fa: 26.30 ± 0.68; 60 ± 3.—Fi (24.5; 66).

Indigo Bunting. *Passerina cyanea.*—2 Ma: 13.30 ± 0.70; 44 ± 18.—2 Fi: 13.95^{2} ± 0.05; 86 ± 3.

Painted Bunting. *Passerina ciris.*—2 Ma: 15.75 ± 0.25; 50 ± 2.—2 Mi: 15.15 ± 1.05; 84 ± 1.—2 Fi: 14.15 ± 0.05; 94 ± 14.

American Goldfinch. *Spinus tristis.*—2 Ma: 11.40 ± 0.40; 67 ± 13.

Rufous-sided Towhee. *Pipilo erythrophthalmus.*—11 Ma: 45.54 ± 0.53; 59 ± 7.—4 Mi: 42.35 ± 1.01; 50 ± 15.—6 Fa: 44.10 ± 1.86; 38 ± 3.—3 Fi: 41.47 ± 0.72; 81 ± 4.

Grasshopper Sparrow. *Ammodramus savannarum.*—Ma (16.0; 56).

Seaside Sparrow. *Ammospiza maritima.*—5 Ma: 24.08 ± 0.96; 71 ± 9.—2 Mi: 20.20 ± 0.60; 50 ± 0.—2 Fa: 24.45 ± 2.25; 68 ± 18.

Pine-woods Sparrow. *Aimophila aestivalis.*—7 Ma: 19.08 ± 0.14; 49 ± 7.—2 Mi: 18.65 ± 1.65; 70 ± 18.—2 Fa: 19.20 ± 0.80; 56 ± 28.—2 Fi: 16.45 ± 0.35; 58 ± 5.

Chipping Sparrow. *Spizella passerina.*—4 Ma: 11.62 ± 0.02; 65 ± 5.—Fa (10.4; 67).—Fi (11.1; 76).

Field Sparrow. *Spizella pusilla.*—3 Ma: 12.30 ± 0.15; 56 ± 15.—2 Mi: 12.80^{2} ± 0.60; 84 ± 4.—4 Fa: 11.15 ± 0.30; 56 ± 14.—6 Fi: 11.55^{1} ± 0.42; 59 ± 11.

Some of the specimens were migrants and were more or less fat. Degree of fatness, which ought to be considered in appraising bird weights (see Johnston and Haines, 1957), is indicated by superscript numbers given in conjunction with mean values. The numbers refer to the McCabe scale of fat classes (McCabe, 1943), thus: (0) no fat, (1) little fat, (2) moderate fat, (3) fat, (4) very fat, and (5) excessive fat. Mean values lacking superscripts can be assumed to pertain to relatively lean specimens (classes 0 to 1); in other cases, the average fat value (usually an approximation) for the sample determines the value of the superscript. For instance, the five immature female Cerulean Warblers were, on the average, "very fat." In some species fat condition was assessed by weighing subcutaneous fat, expressing this as percentage of body weight, and setting up a scale of values in which the McCabe classes were related to those based on relative amount of subcutaneous fat (Norris, 1957). In most examples, however, fat classes were determined in a visual, semi-quantitative way as has been done by McCabe (*op. cit.*), Wolfson (1945), and others.

Except for purposes of analysis of regional variation in weights of certain species (Table 5), we think it better to omit subspecific designations. In nearly all instances the geographic populations represented in a given sample in Table 1 refer to but one subspecies or race. Certain transients, such as the Northern Water-thrush, provide exceptions, but since data on these are very few they hardly warrant segregation as to race here. Furthermore, it has been demonstrated that insofar as fat migratory birds are concerned, weight variations attributable to subspecific differences are obscured by more pronounced variation in fat content (Johnston and Haines, *op. cit.*). For birds that breed in southern Georgia and adjacent parts of South Carolina, one can determine the geographic race by consulting Greene *et al.* (1945), Sprunt and Chamberlain (1949), Norris (1951), and Burleigh (1958). In this paper our principal aim is to present available data on weights of bird specimens taken in a rather limited geographic and physiographic region of the southeastern United States, without placing emphasis, except as noted above, on variation associated with different subspecies or geographic regions. It is probable that a number of studies in the future will focus on racial and regional variations in bird weights, as have in point of fact a number of studies already published (examples being Behle, 1943; Amadon, 1944; and Davis, 1951:6–8).

Acknowledgments

For their encouragement and material aid at one time or another in the course of our field work, we are grateful to the following persons: Col. Melvin H. Goodwin (U. S. Public Health Service) and Mr. Lea Richmond of the Malarial Investigations Station, Newton, Georgia; Dr. Alden H. Miller, Museum of Vertebrate Zoology, Berkeley, California; and Dr. Eugene P. Odum, in charge of ecological studies being carried out by staff members and students of the University of Georgia in the Savannah River Plant area in South Carolina. In the summer of 1956, financial support enabling part-time work on studies of bird weights was provided through the Division of Biology and Medicine, U. S. Atomic Energy Commission, and by a grant-in-aid for the junior author from the Southern Fellowships Fund.

Sex and Age Differences in Weights

As illustrated in Table 2, there were in most instances relatively small differences in weights attributable to sex. These are shown in terms of simple differences between mean weights, expressed as percentage of weights of males, and in terms of standard statistics, or *t*- and P-values. Judging from the latter values, only three of the species in Table 2, the Common Crow, Carolina Chickadee, and Red-bellied Woodpecker, seem to show decidedly significant differences of weights between males and females. As is brought out in a subsequent paragraph, Hartman's (1955) data likewise reveal important sex differences in weight of the two last-mentioned species, as well as the Hairy Woodpecker. Information provided by Baldwin and Kendeigh (1938:422) points up comparable significant sex differences in the Black-capped Chickadee (*Parus atricapillus*) and the Hairy Woodpecker. The difference between the male and female of the Brown-headed Nuthatch (Table 2) is not significant in the adult sample but is fairly significant in the sample of immatures. The female averages heavier, although not significantly so, in only one species, the White-eyed Vireo. This seeming "reversal" might have been due to the fact that changes in reproductive organs may add more to the "standard weight" of females than to that of males. Baldwin and Kendeigh (*loc. cit.*) list four species, the Catbird, House Wren (*Troglodytes aëdon*), Bob-white, and Robin (*Turdus migratorius*), in which females appear in late spring and summer to be significantly heavier than males. It may well be that these birds, like the White-eyed Vireo, undergo reversals of this sort only because of physiological changes associated with reproduction. This surmise is in fact supported in some degree by Stoddard's (1931: 75, 76) data on Bob-whites. Consequently, sex differences in weights of adults included in Table 1 may in some instances be minimized and may be expected to be somewhat greater, the females being relatively lighter, in samples obtained in the non-breeding season. It is also possible that heavy deposits of fat associated with migration tend to mask differences which would be more apparent in weights of more or less lean specimens. As reported by Tordoff and Mengel (1956:34) for birds killed in nocturnal migration, however, data for several species "indicate a generally greater weight of males than of females. . . ."

In comparing weights of males and females, Baldwin and Kendeigh (1938: 421) state that "after a careful examination of the data, an arbitrary limit of 3.0 per cent of the male's weight was selected as representing the lowest

TABLE 2
SEX VARIATIONS IN BIRD WEIGHTS

Species	Female: per cent difference from male	Degrees of freedom[1]	Significance of difference (t)	(P)
	(a) Adults			
Common Crow	—14.6	13	4.37	<.01[2]
Carolina Chickadee	—9.0	8	2.69	<.05[2]
Red-bellied Woodpecker	—10.4	11	2.59	<.05[2]
Cardinal	—3.2	16	1.29	.19
Mockingbird	—5.4	11	1.06	.27
Brown-headed Nuthatch	—2.6	27	0.96	.32
Rufous-sided Towhee	—3.2	16	0.75	.42
White-eyed Vireo	+2.3	12	0.58	.50+
	(b) Immatures			
Brown-headed Nuthatch	—6.6	15	1.72	.10[3]
Mockingbird	—4.7	10	1.36	.16
Yellow-throated Warbler	—3.4	9	0.80	.42

[1] Sum of number of specimens in pair of samples under comparison, minus one; e.g., $N_a + N_b - 1$.
[2] Significant difference.
[3] Fairly significant difference.

amount of difference between the weight of the sexes that could be considered significant." It would seem that the validity of this arbitrary lower limit could be tested fairly adequately by establishing a relationship between per cent values thus derived from, say, samples A and B, and *t*- or P-values derived from comparison of the same samples. A relationship is suggested in Tables 2 and 3. If the data in these tables (excluding the Common Crow because of its unusually large size) are plotted as a scatter diagram, one can draw a line of regression which links, in approximate fashion, the per cent values with corresponding *t*-values. The approximate relationships for small samples (degrees of freedom ranging from 7 to 27) are as follows:

Per cent value	*t*-value	Per cent value	*t*-value
1	0.2	9	2.5
2	0.5	10	2.8
3	0.8	11	3.0
4	1.1	12	3.3
5	1.4	13	3.6
6	1.6	14	3.8
7	1.9	15	4.1
8	2.2	16	4.3

Assuming comparable variability, the larger the samples being compared, the larger the *t*-values relative to the per cent values. As is evident from the P-values (Tables 2 and 3) corresponding to *t*-values, a rather high degree of statistical significance ($P = .10$ or less) pertains to sample pairs whose means differ by about 7 per cent (or more). It is our belief, then, that a difference between means of the sexes should equal or exceed 7 per cent, approximately, rather than 3 per cent, of the weight of the male if it is to be considered significant. This would seem to hold for small- to medium-sized passerine birds, except in cases of very large samples. Regardless of sample size, however, it would seem better (data permitting) to use standard tests of significance instead of more or less arbitrary per cent values in the assessment of weight differences in compared samples. The standard tests take into account not only differences between means but also both size and variability of samples, whereas the method employing per cent differences neglects the last-mentioned factors.

A number of workers have applied statistical tests to weight data. For example, Stegeman (1954) analyzed data from an unusually large series of winter-collected Common Starlings and found males to be heavier than females by a highly significant margin ($t = 10$). Baumel (1957), in comparing weights of male and female Fish Crows collected in Florida, provides both a *t*-value and a "coefficient of divergence," or per cent difference, using the former value ($t = 4.3$) as proof that the males are significantly heavier. In this respect the Fish Crow bears close resemblance to the Common Crow (Table 2). Hartman's data (1955) enable one to calculate comparable values for male versus female samples (age groups combined) in many species, including the Carolina Chickadee in Ohio ($t = 3.4$), Red-bellied Woodpecker in Ohio ($t = 5.0$), and Hairy Woodpecker in Maine ($t = 5.6$). We should like to emphasize the fact that Hartman's paper contains a wealth of statistical information, much of which will lend itself to further analyses, on both heart weights and total weights of Nearctic and Neotropical birds.

Whereas four out of 11, or 36 per cent, of the groups included in Table 2 display significant sex differences in weight (the males being heavier as a rule) only one out of 11, or 9 per cent, reveal significant age differences (Table 3). This rather pronounced age difference obtains in male Rufous-sided Towhees; a comparable weight difference in adult and immature towhees, the adults being heavier, is given by Baldwin and Kendeigh (1938: 423). In our samples, immatures average slightly heavier than adults in all but three groups (male towhees, male Red-bellied Woodpeckers, and female Brown-headed Nuthatches). By contrast, Baldwin and Kendeigh (*ibid.*) found immatures to average heavier than adults in only two species, the Cardinal and Catbird, the opposite being true of 16 additional species. Because our data are comparatively few, we cannot as yet be sure whether this seeming discrepancy, in which immatures tend to weigh more than adults, is

TABLE 3
AGE VARIATIONS IN BIRD WEIGHTS

Species	Immature: per cent difference from adult	Degrees of freedom[1]	Significance of difference (t)	(P)
	(a) Males			
Rufous-sided Towhee	—7.1	14	2.80	<.02[2]
Red-bellied Woodpecker	—6.2	10	1.17	.23
Blue Jay	+3.3	18	0.61	.50+
Yellow-throated Warbler	+2.4	7	0.57	.50+
Mockingbird	+1.8	13	0.53	.50+
Tufted Titmouse	+2.3	12	0.49	.50+
Brown-headed Nuthatch	+1.4	27	0.43	.50+
White-eyed Vireo	—0.8	15	0.26	.50+
	(b) Females			
Field Sparrow	+3.6	9	0.78	.42
Brown-headed Nuthatch	—2.8	15	0.56	.50+
Mockingbird	+2.3	8	0.41	.50+

[1] Sum of number of specimens in pair of samples under comparison, minus one; e.g., $N_a + N_b - 1$.
[2] Significant difference.

in fact a reality or whether it will become less evident, and thus accord better with Baldwin and Kendeigh's findings, after additional weights of southern birds will have been gathered and analyzed. Baldwin and Kendeigh (*ibid.*: 424) report other inconsistencies in published data on weights of adults as compared with immatures, pointing out that these "may indicate either a faulty method of analysis or an inadequate amount of data or both." We venture to add that samples, aside from being of adequate size, need to be comparable on seasonal and perhaps even sub-seasonal bases (taking into account, for instance, whether females are laying, how long immatures have been independent, or whether molting or migration are under way), if analyses are to embody sufficient refinements yielding valid and convincing results.

With respect to nocturnal migrants, it is of interest that Tordoff and Mengel (1956:34) indicate that in some species there is little difference in weight according to age, whereas in some others immatures seem to average a little heavier than adults.

VARIABILITY AND MONTHLY VARIATION IN WEIGHTS

Coefficients of variability (CV), as computed for all samples containing four or more individuals, are summarized in Table 4. The weights of males are on the average slightly less variable than those of females, but the difference between the sexes is not significant for either age group. The weights of adults are a little less variable than those of immatures, the difference being fairly significant ($P = .10$) for both sex groups. The most variable samples pertain to more or less fat transients or pre-migratory birds (immature Cerulean, Hooded, and Kentucky warblers). Comparatively high variability is also shown by breeding female Rufous-sided Towhees (CV = 10.4) and by immature male Blue Jays (CV = 12.4) and immature male Brown-headed Nuthatches (CV = 9.4). The fact that adult females were on the whole only slightly more variable than adult males suggests that few samples, if any, were vitiated by unusually heavy, egg-laden individuals; this fact is further substantiated by data on breeding condition in our field catalogs. Group coefficients of variability, based on CV's for different species and computed for each of the four sex–age categories, were quite high (31.5 to 43.6). The lowest group coefficient pertained to the adult females (another indication of relative homogeneity in samples of this group), whereas the highest pertained to the sample of immature males.

Table 4
Summary of Variability of Bird Weights

Sex and age group	Number of samples (= number of species)[1]	Coefficient of variability: Average with standard error	Coefficient of variability: Extremes
Male, adult	19	5.89 ± 0.25	2.58 — 9.96
Female, adult	11	6.18 ± 0.35	4.15 — 10.32
Male, immature	13	7.70 ± 0.87	3.35 — 14.94
Female, immature	7	8.50 ± 1.20	6.28 — 15.06

[1] Total sample includes 27 different species.

The high variability in some of the immatures is due in part to weight increase from June and early July to August. In this summer period the increase shown by young male Brown-headed Nuthatches is, for example, about 16 per cent. For young male jays it is about 10 per cent. On the basis of abundant data from many species of birds, Baldwin and Kendeigh (*ibid.*: 446), in connection with a searching discussion of monthly variation in weights, state that "the rapid rise in body weight from July to October is even more pronounced in the immatures than in the adults, 13.1 per cent compared with 5.2 per cent." According to these authors, this rise is due partly to maturing and partly to the same environmental conditions affecting the adults. It seems to us that the young of single-brooded or earlier nesting birds, as Brown-headed Nuthatches or Blue Jays, tend to show relatively sharp weight increases from June to August. Contrariwise, double-brooded or later nesting birds, as Cardinals and Rufous-sided Towhees, tend to show but small increases (if any at all) from early to late summer. An explanation would seem to lie in the fact that a sizable sample of immatures of the last-mentioned species taken in middle and late summer would contain relatively more individuals that were recently fledged than would a sample of the earlier nesting species.

Regional and Racial Variations in Weights

For the eastern United States there have been few comparisons of weights involving northern and southern, intraspecific populations. Preliminary data on three species (the Blue Jay, Common Grackle, and Cardinal) have been assembled by Amadon (1944). In each species, particularly the grackle, the northern population or subspecies (represented by samples from Michigan and Ohio) averaged heavier than the southern populations (samples, mostly small, from Florida).

In most of the birds included in Table 5, the same sort of trend is evident. The Rufous-sided Towhee provides a noteworthy exception in that populations from the Coastal Plain of Georgia and adjacent parts of South Carolina are significantly heavier than those from Ohio and New England. The northern towhees represent the race *Pipilo e. erythrophthalmus*; the southern, *P. e. canaster* and *P. e. rileyi* (Dickinson, 1952:350; Norris, 1951:65). With other species in Table 5 we cannot be certain of strict seasonal comparability in all instances, but we believe most of the trends indicated will be borne out by subsequent comparisons involving series both larger and more exactly pinpointed as to season of collection. It is of interest that Cardinals from the Georgia–South Carolina region are not significantly lighter in weight than ones from Ohio, whereas those from Florida, as suggested by males, do appear to be significantly lighter. This correlates well with nomenclatural subdivisions of the species, inasmuch as Ohio, South Carolina, and Georgia (except the extreme southeastern part) are included within the range of *Richmondena c. cardinalis* (American Ornithologists' Union Checklist, 1957; Greene *et al.*, 1945), whereas peninsular Florida is occupied by *R. c. floridana* (Howell, 1932:438). Carolina Chickadees in Ohio may be referred to *Parus c. extimus* (cf. Lunk, 1952:15, 17). They appear to be significantly heavier than those collected in southwestern Georgia, where the population seems intermediate between *P. c. carolinensis* and *P. c. impiger* (Norris, 1951:19, 20). According to Burleigh and Lowery (1944), the Red-bellied Woodpecker is represented by the race *Centurus c. zebra* in Ohio and by *C. c. carolinus* in the eastern United States east of the Alleghenies (with an additional race *perplexus* in southern Florida). In this woodpecker the comparisons point to an inconsistency, with larger males but smaller females in the sample of *zebra* as compared to that of *carolinus* from the southern United States. Although this inconsistency may in fact exist, it may on the other hand disappear once larger, seasonally comparable samples are available for comparison. If the data from Ohio reflect accurately the real situation, the dimorphism exhibited by male and female Red-bellied Woodpeckers in that region is indeed remarkable (the per cent difference in mean weight being almost 20 per cent). Two

TABLE 5

COMPARISON OF WEIGHTS OF NORTHERN AND SOUTHERN SAMPLES OF SEVEN BIRD SPECIES

Species	Region	Season (months)	Average weights in samples		Per cent difference from northern sample		Source of data[1]
Rufous-sided Towhee	Mass., Conn.	M:4:10; F:5–8	8M: 42.0	6F: 39.3			(1)
	Ohio	———	16M: 42.0	2F: 38.0			(2)
	Ohio	M:6–8; F:7–8	20M: 41.1	4F: 38.5			(3)
	Average		44M: 41.6	10F: 38.8			
					M(+9.4)[2]	F(+13.7)[2]	
	Ga., S. C.		11M: 45.5	6F: 44.1			(x)
Cardinal	Ohio	6–8	11M: 41.2	14F: 39.2			(3)
					M(—4.6)	F(—3.1)	
	Ga., S. C.	6–8	7M: 39.3	10F: 38.0			(x)
					M(—8.2)[2]	——	
	Fla. (penin.)	——	4M: 37.8	——			(2)
Carolina Chickadee	Ohio	——	13M: 10.6	24F: 9.8			(2)
					M(—11.3)[2]	F(—12.2)[2]	
	Ga.	7–8	5M: 9.4	4F: 8.6			(x)
Red-bellied Woodpecker	Ohio	——	9M: 76.0	10F: 61.4			(2)
					M(—3.8)	F(+6.7)	
	Ga., S. C.	7–8	6M: 73.1	6F: 65.5			(x)
Downy Woodpecker	Ohio	7–8	——	19F: 24.8			(3)
					——	F(—14.1)[2]	
	Ga.	7–8	——	4F: 21.3			(x)
Eastern Wood Pewee	Ohio	——	8M: 14.2	——			(2)
					M(—2.8)	——	
	Ga.	6–8	4M: 13.8	——			(x)
Red-winged Blackbird	Ohio	——	——	7F: 43.0			(2)
					——	F(—17.2)[2]	
	Ga., S. C.	7–8	——	4F: 35.6			(x)

[1] Sources: (1) Wetherbee, 1934; (2) Hartman, 1955; (3) Baldwin and Kendeigh, 1938; (x) this paper.

[2] Differences considered to be significant.

subspecies of Downy Woodpecker, *Dendrocopos p. medianus* and *D. p. pubescens*, respectively, are involved in the northern and southern samples (American Ornithologists' Union Check-list, 1957; Greene *et al.*, 1945). Similarly, populations that may be designated *Agelaius p. phoeniceus* and *A. p. phoeniceus* x *mearnsi* figure in the compared samples of Red-winged Blackbirds (Hartman, 1955; Norris, 1951:25). Significant weight differences are apparent in both these species. The Eastern Wood Pewee is not subdivided into geographic races and seems to vary only slightly in size from more northern to more southern regions.

Most of the samples in Table 5, as well as those treated by Amadon (1944), tend to support "Bergmann's rule," which holds that in species with extensive geographic ranges the size of individuals, which is reflected by their weights, tends to be greater at higher latitudes and altitudes (colder regions). The fact that towhees form a rather conspicuous exception appears to be tied in with the apparent hybrid origin of the *canaster–rileyi* complex (cf. Dickinson, 1952:334, 340). Most of the northern and southern samples which show significant contrasts in weight represent distinct, nomenclaturally-recognized geographic populations or races. Hence certain racial differences, which in the past have been based principally on differences in color, color pattern, or linear measurements, are gaining support, if only in small measure, from preliminary sets of data on weights.

Summary

Statistical data are presented on weights of 576 specimens representing 97 species of birds. All were collected in summer, from 1947 to 1956, in southern Georgia and adjacent parts of South Carolina. The general procedure and manner of presentation of data are explained. The data are broken down into three categories: species, sex, and age (adults versus fully fledged immatures). For each category represented by more than one weight, the mean value with the standard error is given both for weight and for sub-seasonal period of collection. For more or less fat specimens, semi-quantitative indications of fat condition are provided; these aid in the interpretation of certain weight values. Data for certain species are subjected to further analysis. In four species, males are significantly heavier than females; in four others there is no significant difference between the sexes. By our criterion (the validity of which is discussed), the difference between the means of compared samples, if it is to be regarded as significant, must equal or exceed 7 per cent of the weight of the male, or the difference must show a P-value that is no greater than .10. Among compared samples, immatures in most instances average slightly heavier than adults. The coefficients of variability of weight samples, if compared sex for sex, are on the whole significantly higher (P = .10) for immatures than for adults. This marked variability is due in part

to increase in weight of young birds from early to late summer, a phenomenon well demonstrated by Baldwin and Kendeigh (1938). Northern representatives of seven bird species tend to weigh more, in some instances significantly more, than southern representatives of the same species. An exception is provided by the Rufous-sided Towhee, in which specimens from our series are significantly heavier than ones from Ohio and New England. This may be due to the hybrid origin of the southern population (Dickinson, 1952). In several species in which the northern birds are significantly heavier than the southern, the compared populations represent different subspecies or geographic races.

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