NOTES ON VARIATION IN THE CAROLINA CHICKADEE

BY WILLIAM A. LUNK

RECENTLY I undertook to identify an Oklahoma series of Carolina Chickadees (*Parus carolinensis*) in Dr. George M. Sutton's collection, and to clarify the limits of that portion of the species' range. Extended far beyond the scope of the original problem, the work finally entailed not only rather exhaustive comparison of material from Oklahoma and neighboring states, but also study of considerable series from the eastern part of the range. In all, well over 450 specimens of *P. carolinensis* and about 100 of *P. atricapillus* were examined. I assembled data which it seems desirable to present without further delay, outlining some tentative conclusions but fully recognizing the incompleteness of many parts of the study.

For the use of material I am indebted to Herbert Friedmann, John T. Zimmer, M. Dale Arvey, E. R. Hall, A. I. Ortenburger, Arthur C. Twomey, and others; special thanks are due J. L. Peters for examining some specimens for me and loaning others, Josselyn Van Tyne and R. W. Storer for suggestions both in the study and in preparation of this paper, Richard and Jean Graber for collecting a number of specimens, W. H. Brudon for assistance in preparation of the figures, and above all to Dr. Sutton for generously placing his series at my disposal and assisting throughout the work.

Northwestern Range of the Species

The literature indicates no very clear understanding of the northwestern limits of the Carolina Chickadee's range. I find that the species occurs throughout Oklahoma, exclusive probably of the panhandle, westward at least to Lipscomb County in the northeastern corner of the Texas panhandle, and across southern Kansas from Meade County northeastward to Greenwood and Douglas counties.

Included in Dr. Sutton's fine series (mostly of breeding males) are birds from Ellis (Sutton, 1936:433), Roger Mills, Caddo, Payne, Noble, Oklahoma, and Murray counties, Oklahoma. Nice (1931:131) has given additional data on the species in Oklahoma, including the report of specimens from Woodward County. Material I have examined from other collections adds a number of other Oklahoma localities. The Lipscomb County, Texas, bird is an unsexed immature (U.S.N.M. No. 186735) taken in June. Most of the 31 Kansas specimens examined, taken by various collectors, are in the University of Kansas collection. Two from Douglas County, however, are at the University of Oklahoma; and the single one from Meade County, collected in the summer of 1950, by Graber, is in the Sutton collection.

I wish to point out that the northern limit of *P. carolinensis* in this region, as here outlined, very nearly coincides with the southern limit of *P. atricapillus*. I have made no attempt to locate all Kansas specimens of the latter species; but among those collected by Graber and now in the Sutton collection are examples from as far south as Hamilton, Meade, and Butler counties. The occurrence of *P. atricapillus* in Oklahoma has been reported (Nice, *loc. cit.*) but I have seen no specimen, or other published record of a specimen, of this species from the state.

Methods and Scope of Study

In studying the specimens, I first considered variation in size and color, temporarily disregarding present subspecific distinctions. Size data I have treated statistically and graphically; but only direct comparisons were employed for color, with no attempt at precise quantitative treatment.

Measurements were made with dividers, and wing-measurements are of the chord; tail-lengths were taken by visually placing one tip of the divider at the point where the middle rectrices meet the skin, and measuring to the tip of the longest feather (unless this obviously was loosened and extended beyond its normal position in the tail).

Juvenile chickadees are recognizable by texture of body plumage, dullness of coloration, and other features, and were not considered in any of the tabulations. Recognition of first-winter and one-year-old birds presents more of a problem. Few series included enough accurately aged specimens to be of use in this connection (a notable exception being the large series of *P. a. septentrionalis* collected by Wetmore at Lawrence, Douglas County, Kansas). There are probably enough differences so that a technique for age-determination could be perfected; but thus far I do not feel I can make accurate and clear-cut distinctions. Finding, furthermore, no demonstrable difference in size or color between comparable series of adults and known immatures, I eliminated only a few clearly labelled immatures of *P. carolinensis*, and treated the remainder of the samples as composed for all practical purposes of adult birds.

As I shall show later, size disparity is so great in chickadees that proper determination of sex is of prime importance. Any birds with sex questioned or not indicated were eliminated from the tabulations. Even so, it is probable that a certain amount of error was introduced by incorrectly sexed specimens.

In color comparisons, birds were carefully separated on a seasonal basis. In treating measurements, however, the undoubted discrepancies caused by differing amounts of (normal) wear were considered impractical to eliminate. The distributional picture, furthermore, may be confused somewhat by seasonal movements of the birds. Chickadees are comparatively sedentary; but

there is ample evidence of some migratory movement, which in some cases might be considerable.

Individual and seasonal variation is striking in series from any given locality. Study skins of chickadees are made difficult to work with by the marked effects of poor preparation, dirty plumage, wear, fading, and foxing and discoloration of some older specimens. I would stress the need not only for more, but for better, material: namely, clean, well made skins, particularly in fresh fall plumage, with as much detailed ecological data as possible.

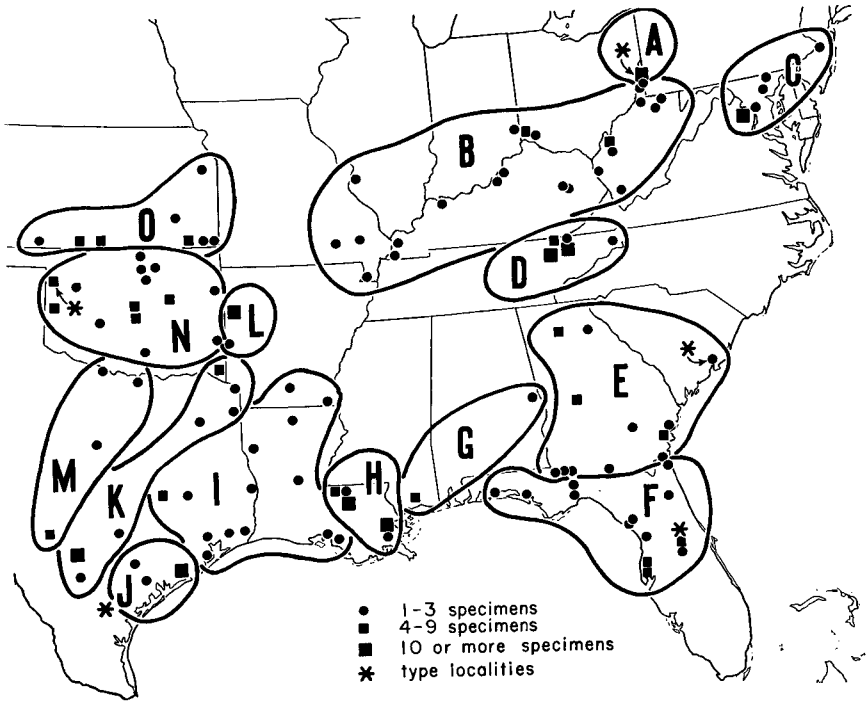

FIG. 1. Locations and grouping of samples of *P. carolinensis* treated. Lettered areas A-O, outlined in bold black: arbitrary groupings of specimens used, for statistical purposes. Species range is virtually continuous; only its southern and northwestern limits are approximately suggested by the black lines; blank areas within the range denote merely regions from which no specimens were used in this study.

GEOGRAPHIC VARIATION

For comparative treatment I found it necessary to group in some way the scattered samples used. Figure 1 shows the arrangement of my 15 groups, arrived at after consideration of geographic separation, size of samples, and differences shown, and after elimination of unsuitable specimens as explained

above. Solid outlines and bold-face letters (A-O) indicate merely these arbitrary groupings; and for the sake of brevity the samples will be referred to usually by the letter designations only. Actual boundaries of the specific and subspecific ranges are not intended to be indicated on the map. It will be seen that the alphabetical series of samples run generally from northeast to southeast, then west and southwest, and then north. The samples cover, in a scattering fashion, the greater part of the range of the Carolina Chickadee.

Size

Variations in wing and tail measurements have been most useful. These values lend themselves well to statistical treatment, the results of which are given in Table 1. I assembled only a small part of the material available from eastern states, and many of the samples both there and in the west are admittedly small. Samples of less than ten individuals, I did not analyze beyond the calculation of a simple mean. However, the trends in size are unmistakable; I believe the figures will be useful not only in connection with the present remarks but as a basis for comparison in further studies.

Keeping in mind the generally clockwise geographical progression of the samples, we see in Table 1 a steady decrease in mean dimensions of *P. carolinensis* from the northeast to the southeast of the species' range (A-F), then relatively little change across its southern portions (F-J), and a marked increase again to the northwest (J-O). Even the smallest samples give means that fit in well with this pattern. The trends are closely similar for wing-length and tail-length, and for the two sexes. I have used most of the wing-length figures, which tend to show less variability, to illustrate in somewhat clearer fashion the nature of the variation, making use of the so-called Dice squares (Fig. 2). Figure 2 shows what appears to be a smooth clinal gradation from northern West Virginia, Ohio, and neighboring states (A-B), where the wing-length of males averages close to 64 mm., to Georgia and Florida (E-F), where it averages about 60 mm. There is little change in size through the states to the west along the Gulf, until we come to coastal Texas and western Louisiana (I-J), where the mean wing-length of males appears to be something under 61.5 mm. Then passing north and west into the higher elevations of central and north-central Texas (K-M) we find indications of a very marked increase in size, until over a wide area through Oklahoma and Kansas (N-O) males seem to have a wing-length averaging well over 65 mm. The general direction of size increase then seems to be from south to north, or somewhat from southeast to northwest. The magnitude of the change is apparent from Table 1 and Figure 2.

I have not fully treated the measurements of bill and tarsus. Some of the

TABLE 1

MEASUREMENTS OF SAMPLES OF *P. carolinensis*. (See map, Figure 1 for localities.)

Locality	WING					TAIL				
	No.	Range	Mean	σ	V	No.	Range	Mean	σ	V
				MALES						
A	10	62 -66	64.0±.38	1.2	1.9	10	54 -58	55.9±.40	1.3	2.3
B	21	59.5-67	63.4±.39	1.8	2.8	21	53 -62	55.5±.52	2.4	4.3
C	11	60 -64.5	62.9±.36	1.2	1.9	11	52 -57.5	54.2±.51	1.7	3.1
D	24	59 -67	62.6±.43	2.1	3.4	24	50.5-58	53.9±.37	1.8	3.4
E	19	56.5-65	60.2±.45	2.0	3.3	19	48 -54.5	52.0±.42	1.8	3.5
F	23	56 -63	59.9±.35	1.7	2.8	24	48.5-55	51.0±.32	1.6	3.0
G	5	59 -63	61.0 —	—	—	4	48.5-53	50.3 —	—	—
H	34	56 -63	59.7±.32	1.8	3.1	34	48.5-55	50.8±.26	1.5	3.0
I	15	59 -66	61.4±.44	1.7	2.8	15	47.5-56.5	52.7±.64	2.5	4.7
J	21	58.5-64.5	61.0±.32	1.5	2.4	21	50 -56	53.1±.31	1.4	2.6
K	14	60.5-68	63.1±.45	1.7	2.7	14	50 -59	54.6±.51	1.9	3.5
L	10	60.5-67	63.8±.63	2.0	3.1	10	52 -59	55.8±.65	2.0	3.7
M	7	62 -65	63.6 —	—	—	7	55 -59	56.7 —	—	—
N	32	62 -69	65.5±.33	1.9	2.9	32	54.5-62	57.8±.33	1.9	3.2
O	15	62 -67.5	65.1±.36	1.4	2.1	15	54 -63.5	58.7±.57	2.2	3.7
IJ	36	58.5-66	61.2±.27	1.6	2.6	36	47.5-56.5	52.9±.32	1.9	3.6
MNO	54	62 -69	65.2±.24	1.8	2.7	54	54 -63.5	57.9±.27	2.0	3.5
				FEMALES						
A	16	57 -64	61.2±.44	1.8	2.9	16	52 -58	54.7±.39	1.5	2.8
B	18	58 -65	61.2±.38	1.6	2.7	18	48.5-57.5	53.8±.63	2.7	5.0
C	9	58.5-62	60.3 —	—	—	9	50.5-54.5	52.5 —	—	—
D	13	56 -65	60.1±.67	2.4	4.0	13	50 -58	52.6±.64	2.3	4.4
E	10	57 -62	58.4±.49	1.6	2.7	10	47.5-52.5	49.8±.63	2.0	4.0
F	14	54 -59	57.0±.34	1.3	2.2	14	46 -51	48.8±.35	1.3	2.6
G	5	56.5-61.5	58.5 —	—	—	5	46.5-51.5	49.3 —	—	—
H	17	55 -61.5	57.7±.35	1.5	2.5	17	47.5-52.5	49.4±.37	1.5	3.1
I	8	56 -59	57.8 —	—	—	8	47 -52.5	49.8 —	—	—
J	22	57 -62	59.3±.32	1.5	2.6	22	48 -55.5	51.2±.38	1.8	3.5
K	10	58 -62	60.4±.32	1.0	1.7	10	48.5-54.5	51.7±.53	1.7	3.3
L	7	57.5-65	61.1 —	—	—	7	52.5-58.5	55.0 —	—	—
M	3	60.5-63	61.5 —	—	—	3	51 -57	54.0 —	—	—
N	7	60.5-66	63.8 —	—	—	7	55 -62	57.7 —	—	—
O	7	59 -66	62.4 —	—	—	7	54 -61.5	57.2 —	—	—
IJ	30	56 -62	58.9±.28	1.5	2.6	30	47 -55.5	50.8±.35	1.9	3.7
MNO	17	59 -66	62.8±.48	2.0	3.2	17	51 -62	56.9±.64	2.6	4.6

MEASUREMENTS OF SAMPLES OF *P. atricapillus*.

Locality	WING					TAIL				
	No.	Range	Mean	σ	V	No.	Range	Mean	σ	V
				MALES						
W. Va.	7	64 -67.5	65.9 —	—	—	7	58 -64.5	61.6 —	—	—
*Kan.	37	62 -71.5	66.9±.36	2.2	3.3	37	61.5-70.5	65.4±.38	2.3	3.5
				FEMALES						
W. Va.	5	61 -66.5	64.3 —	—	—	5	56.5-64	61.1 —	—	—
*Kan.	42	61.5-68	64.5±.23	1.5	2.3	42	58 -66.5	63.0±.32	2.1	3.3

* Series taken by Wetmore, near Lawrence, and in U. S. Natl. Mus. collection.

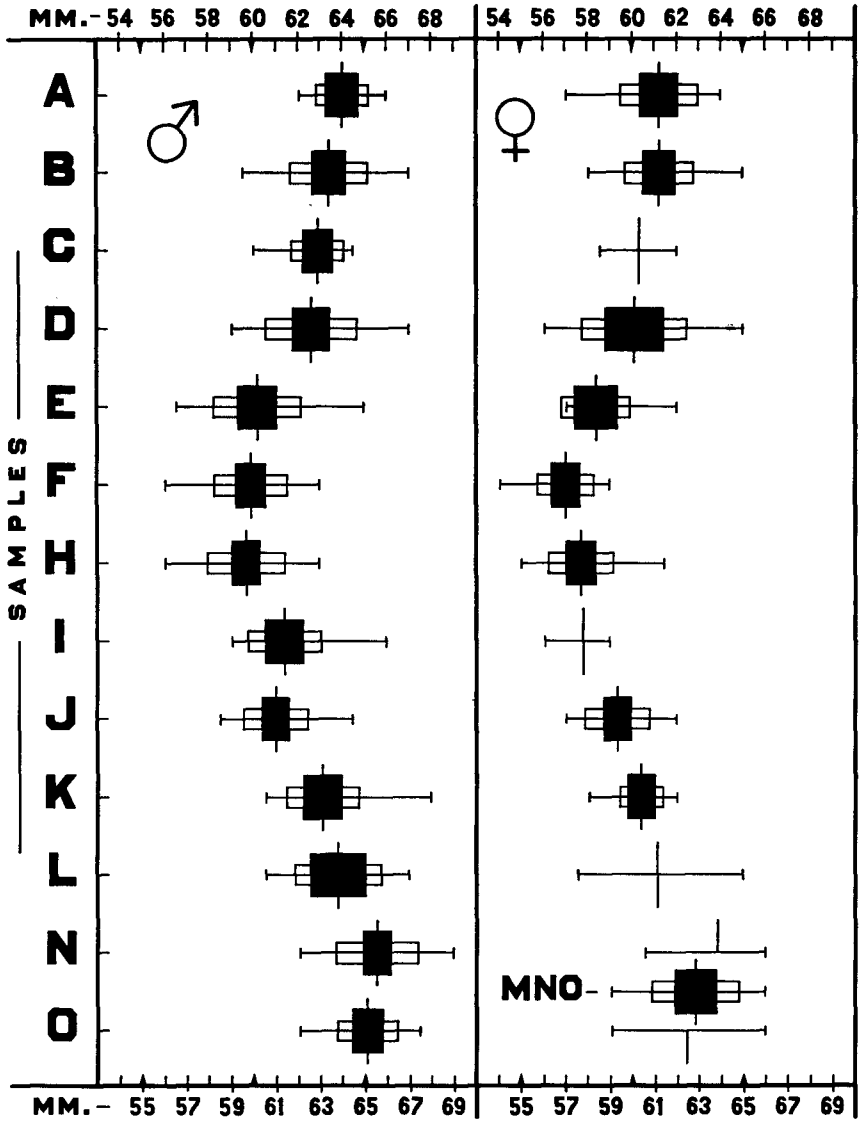

FIG. 2. Size variation (wing-length) among populations of *P. carolinensis*. (See Fig. 1 for location of samples.) In each diagram, horizontal line extends from the lowest to highest observed extreme; vertical line marks calculated mean (M); narrow rectangle represents standard deviation (σ) on each side of mean; and shaded rectangle represents twice standard error of mean ($2\sigma_M$) on each side.

larger specimens appear strikingly big-billed; but this character may well be correlated simply with over-all size.

Relative Tail-length

Since the tail/wing ratio is usually regarded as diagnostic in separating *P. carolinensis* from *P. atricapillus*, I thought it deserved special attention. Rather than present an orthodox statistical treatment of the ratios as such, I have chosen to use a diagram (Fig. 3), in which I have plotted mean wing-length against mean tail-length for males of each sample considered (open circles). We see shown, not actually a constant ratio, but rather one that

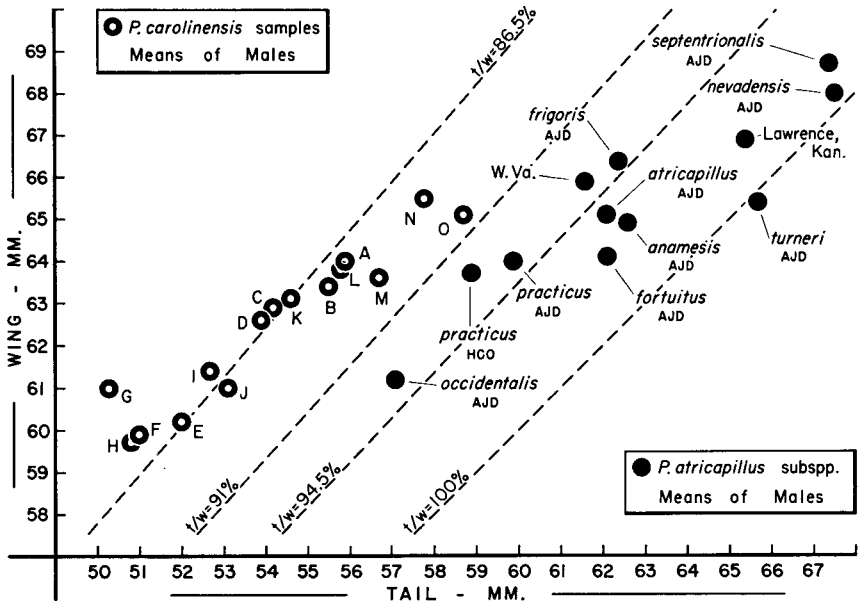

FIG. 3. Tail/wing ratios (based on mean measurements of males) of populations of *P. carolinensis* and of *P. atricapillus*. Data for most races of *atricapillus* from Duvall (1945 - AJD); that for one sample of *practicus* from Oberholser (1937: 220 - HCO); the rest from my Table 1. (For locations of lettered samples, see map Fig. 1.)

increases somewhat with over-all size of the birds. (Absolute size increases along a diagonal from lower left to upper right, while a proportionately longer- or shorter-tailed condition is indicated by a trend to lower right or to upper left respectively. For reference some lines of constant ratio have been added.) The general curve suggested is seen to lean decidedly to the right, the smaller (southern) populations averaging distinctly shorter-tailed, relatively, than the larger (northern) ones. (Plot "G", however, is further displaced because of the very small sample used.) I do not regard the differences as sufficient to be of much taxonomic importance within the species.

For comparison, I have plotted some mean measurements for populations of *P. atricapillus* on the same graph (solid circles—see details in legend).

For this purpose I have borrowed some figures given by Duvall (1945), and used a few of my own from Table 1. The interesting and somewhat disturbing feature is the way in which the largest *P. carolinensis* (those in West Virginia, etc., A-B, and especially those in Oklahoma and Kansas, N-O) seem to approach the smallest *P. atricapillus* (note *practicus* and *occidentalis*) not only in absolute mean measurements, but to some degree in proportions. The graph shows one almost continuous band of variation rather than the two parallel bands that might be expected. Furthermore, it must be remembered that Figure 3 is based on *mean* measurements. If we were to plot all individuals we would be dealing with a series of broadly overlapping ellipses (cf. Fig. 4, which is drawn to the same scale and shows two populations so plotted). The conclusion is that some individuals must occur which cannot be assigned to one or the other species on the basis of tail/wing ratio alone. Such individuals do occur, and precisely in the areas where either species might be expected (cf. Duvall, 1945:56). I have identified as *P. carolinensis* a number of remarkably long-tailed individuals, both from the east and from the west. Several of the more puzzling ones, mostly females (in the University of Kansas collection), fall within the size range even of *P. a. septentrionalis* from neighboring areas. The tendency of *P. atricapillus* to average shorter-tailed in the southern part of its range, while less pronounced, is evident, particularly in the east. From the foregoing it will be clear that I have relied heavily upon coloration for specific identification of material. There may be considerable convergence in coloration also, but my data indicate that it is more likely to be valid than size and proportion in deciding doubtful cases.

I do not suggest that hybridization or intergradation necessarily exists. I do infer, however, that there is a correlation, adaptive and/or genetic, between size and relative tail-length, which appears to apply in some manner to both species considered. Careful studies in areas where both species occur, to determine just how constant the various morphological characters are in relation to call-notes, breeding behavior, and general habits, would certainly strengthen our understanding of the distinctions.

Color

For the study of coloration features, I selected series of *P. carolinensis* males from various localities representing most of the sample areas, one group consisting of fall birds (Sept. 1 to Dec. 1) and another of spring specimens (Feb. to June). In general, the brown color of the upper parts characteristic of some of the populations is due to brownish tips on the fresh feathers, and tends to disappear first as wear progresses. On the underparts as well the buffy or rufous wash is reduced by wear and fading. Thus some of the best distinctions between the populations are all but lost in spring and summer

TABLE 2

GENERAL COLOR VARIATION IN SAMPLES OF *P. carolinensis*: a rough comparison only, disregarding seasonal change and minor variations. (See Figure 1 for location of samples.)

SAMPLE	DORSAL COLORATION	GENERAL TONE	BROWNISH WASH ON SIDES	PALE EDGINGS OF FLIGHT FEATHERS
A	very brown	medium	strong	strong
B	brown - variable to west	medium	strong	strong
D	brown	dark	fairly strong	moderate
E	brown	dark	strong	weak
F	brown	dark	strong	weak
H	rather gray - variable	medium	moderate	weak
I	gray	pale	weak	moderate
J	gray	pale	weak	moderate
L	rather gray - variable	medium	fairly strong	strong
N	gray	pale	rather weak	strong
O	gray	pale	rather weak	strong

specimens, in which we must turn to the somewhat nebulous matter of general darkness or paleness, at the risk of being misled by dirt or fading.

I would want to examine much more material, particularly from eastern areas, before attempting detailed tabulations or any sort of quantitative treatment. Basic trends in coloration, however, are not difficult to detect. Table 2, while deliberately brief and general, is an attempt to show simply the most evident of these trends, which are in fact about as expected on the basis of published descriptions.

Fresh-plumaged fall birds from Bethany, West Virginia (A), are very buffy brown above, especially in the region of the scapulars, and have a heavy wash of pale rufous along the sides, extending in most cases well back along the flanks and even to the under tail coverts. These characters are shared by the birds to the south (B-H), which are on the whole not quite so brightly washed on the sides, but are nearly as brown above, and often darker in general tone. This coloration is less well marked, but still apparent, in spring birds. In contrast, the western populations (I-O) average much grayer above and in general paler, with little color on the sides even in fall; spring and summer birds may be nearly white below. Oklahoma and West Virginia birds can be separated almost perfectly on the basis of either dorsal or ventral coloration alone. Seemingly increased variability, as well as intermediacy, is evident in the samples from the Mississippi Valley area (H,L), where the sharpest change in color occurs. The tendency toward gray dorsal coloration comes well to the east along the Gulf coast, at least to eastern Louisiana (H), where

fall birds are even grayer than those (also of intermediate color) from western Arkansas. I have seen no fall specimens from extreme western Oklahoma, which individuals, by inference from the summer ones at hand, would be the grayest of all. The brown on the sides is evident farther to the west than that on the upper parts (cf. western Arkansas birds, L), perhaps because of the paler ground color below. In the west, as in the east, it is slightly more noticeable in specimens from northern areas.

The pale feather-edgings in wings and tail are very prominent and developed to about an equal degree in the northeastern (A,B) and northwestern (L,N,O) samples, though in the latter associated with generally paler coloration. In the southwestern samples (I,J) these edgings are somewhat less well developed; and in the southeast (E,G, and especially F), they are usually quite inconspicuous.

By far the most marked color variation within *P. carolinensis*, then, appears to be a cline of decreasing brownness from east to west, both as regards dorsal coloration and washing on underparts. This cline seems to break sharply in the Mississippi Valley area. The color-change is coupled with a similar trend toward general paleness of tone. Secondarily, the light feather-edgings prominent in northern specimens tend to become narrower to the south, and very much so in the southeast, where the birds are darker generally. The brownish wash on the sides tends to become stronger, or at least brighter, from south to north, although the major trend here is from west to east. From my present data I am unable to detect that these latter changes are other than a matter of smooth clinal variation.

Subspecific Treatment

It must be stressed that this is in no sense a full-scale revision, and that some conclusions herein can be no more than tentative. I have viewed the problem primarily from the population standpoint, and have not been concerned with assigning a trinomial to every specimen examined. But with the considerable amount of data before me, it still seems justifiable to comment on the broader aspects of the taxonomic situation, which are often unavoidably neglected in systematic and distributional papers involving series from only one or a few localities.

P. c. extimus (Todd and Sutton).—

This race appears to be recognizable as described (Todd and Sutton, 1936: 70). The series of 10 males and 16 females from Bethany are exact topotypes of this race. The characters of very distinct pale edgings of flight feathers, strong washing of rufous below, and marked buffy veiling dorsally of this

northeastern population have been discussed. In addition I consider the large size to be of more importance taxonomically (at least if sizeable series are treated) than have some earlier writers (cf. Wetmore, 1939:208). The measurements, particularly of sample A, in Table 1 are of interest. I consider samples A, B, C, and probably D to be representative of this form. Birds from the western portions of the range become progressively grayer and paler, and those to the south show a decrease in size and otherwise tend to intergrade with *carolinensis*.

P. c. impiger Bangs.—

The above data suggest to me that further work might prove this race a very tenuous one, if recognizable at all. Writers to date have had divergent views as to the northern limits of its range; from the specimens examined I can detect no change in size from one part of Florida to another, and very little between Florida and Georgia (see Table 1 and Figure 2). Bangs' two specimens (the female type and a male topotype) are both smaller than *any* chickadee I have measured; Mr. J. L. Peters kindly checked the measurements for me, and finds those given in the type description (Bangs, 1903:1) essentially correct. Peters writes: "type ♀ : wing, 51.5 mm.; tail, 43.5. Topotype ♂ : wing, 52.3 mm.; tail, 45.3" (letter). I cannot escape the conclusion that these are very abnormal birds, and that even if such individuals do occur more or less regularly they represent merely the extreme of the small size characteristic of all the southern population. Extremes of brownness and darkness, to be expected in this area, have not impressed me as striking in the series I have seen.

P. c. carolinensis Audubon.—

The nominate race, with (restricted) type locality at Charleston, S. C., seems to me unduly compressed between neighboring races to the north and south, and for that matter to the west, unless we somehow enlarge our concept of it. It is partly for this reason that I suggest the possibility of uniting with it the present *impiger*. Trautman (1940:311–312) feels also that "there are only two eastern races of this species"; but advocates retention of *impiger* and *carolinensis*. My comparisons, including (only two) topotypes from Charleston and specimens from many Georgia and Florida localities, lead me thus far to favor the other course. We would then be able to use the well defined characters of smaller size, reduced feather-edgings, general darkness and brownness of dorsal coloration, and (to a lesser extent) decreased brownish washing below for recognition of the southern race. My samples of this race have, however, been particularly scanty; I consider samples E, G, and probably H (though the latter average decidedly grayer above) as *P. c. carolinensis*, and am strongly tempted to include F.

P. c. agilis Sennett.—

I believe the characters and distribution of this race have been misunderstood from the time of its description (Sennett, 1888:46). If we consider the type locality, Bee County, Texas, near the very southern extremity of the species range, examine the type description, and compare the type itself with material from various parts of the western range of the species, inconsistency is at once apparent.

I have examined Sennett's type (A.M.N.H. No. 86395; G.B.S. No. 3894, sex not given). In coloration and size it agrees well with the good series at hand from Matagorda County, Texas (J), which I therefore propose to treat for present purposes as equivalent to topotypes; it shows no evidence of fading, and agrees with Matagorda birds of comparable season in the clear gray upper parts, moderate degree of white wing-edging, and pale underparts with faint buffy wash. The primaries of the type are badly broken on both sides, but in each case one or more of the longest remain, so as to yield approximately correct wing-lengths; one rectrix may have been pulled loose, as it is about 2.5 mm. longer than any other. My measurements of the type are: wing, 59.5, 60.5 mm.; tail, 54.5 mm.; culmen, about 10.0 mm. if measured to base of skull (slight dermestid work makes measurement of exposed part uncertain); and tarsus, 15.5 mm. The wing-measurements given by Sennett check reasonably well with those taken by me if allowance is made for his probably having flattened the wing. His tail-measurement of the type (2.40 in. = 60.96 mm.) is above any I can obtain even by measuring from the end of the oil gland. His figures for another bird ("No. 406 ♀ . . . wing, 2.42; tail 2.52") appear questionable. In no case have I found the tail-length of a specimen from this area to exceed the wing-length, or even to approach it closely. Reference once more to Tables 1 and 2 will show the characters I have found to exist in the Matagorda area (J) and in the area (I) extending northwest from the Gulf coast. Considering the above facts it appears clear that Sennett's type, if not all of his unfortunately few and scattered specimens, represent this extreme southwestern population. If we accept the evidence, then *agilis*, described as large and generally so considered, is pale and very gray, but in fact quite small, males averaging under 61.5 mm. in wing-length. In this restricted sense, it occurs in southeastern Texas, southern Arkansas, and most of Louisiana (I,J). In a sense Oberholser (1938:425–428) has expressed the size and color relationships as I find them, though I think his *P. c.* "*guilloti*" must be considered an intergrading population, occupying much of the range of *agilis* to the west and the western edge of the range of *carolinensis* to the east.

I have already called attention to the decided size gradation from the coastal area toward the north and west, which is actually about equivalent to

that throughout the whole range of the species in the eastern states. As a result of this great discrepancy in size, and minor variations in color already discussed, I am unable to assign to any described race the specimens from Kansas, Oklahoma, and central Texas (M,N,O), which I therefore propose to call

Parus carolinensis atricapilloides, new subspecies

TYPE.—Adult male, presumably breeding, No. 6735, G. M. Sutton, collected by him 10 miles south of Arnett, Ellis County, Oklahoma, May 13, 1936. Measurements of type: wing, 66.5 mm.; tail, 60 mm.; tarsus, 16.5 mm.; exposed culmen, 9.5 mm.

DIAGNOSIS.—Averaging larger than any other described race of *P. carolinensis,* in wing and tail measurements. Fifty-four males measure: wing, 62-69 mm. (65.2±.24); tail, 54-63.5 mm. (57.9±.27). Seventeen females measure: wing, 59-66 mm. (62.8±.48); tail, 51-62 mm. (56.9±.64). Distinguished from *P. c. extimus* by decidedly grayer dorsal coloration at all seasons, comparative obsolescence of rufous or buffy washing on sides and flanks, generally paler coloration, and even larger average size. Most like *P. c. agilis* (as above restricted), but distinguished by much larger average size (see Table 1, Fig. 4, etc.); also by slightly stronger buffy washing on sides, and somewhat more conspicuous pale edgings on flight feathers; tail/wing ratio averaging somewhat higher, and in a few specimens considerably higher, than in *agilis.* Distinguished from *P. c. carolinensis* both by paler and grayer coloration, with much more conspicuous pale edgings on flight feathers, and by decidedly larger size.

RANGE.—The northwestern section of the species' range; from southern and eastern Kansas (Meade, Greenwood, and Douglas counties) south through nearly all of Oklahoma to central Texas. Intergrades with *P. c. extimus* to the east, probably in western Arkansas and southwestern Missouri. Intergrades with *P. c. agilis* to the south and southeast; the zone of intergradation is undoubtedly of considerable width (see Fig. 1, and discussion below), and more material is needed to establish any positive dividing lines.

To indicate the distinctness of the new race, I have set up the "scatter-diagram" shown in Figure 4, in which wing-length is plotted against tail-length for each male specimen in the samples M, N, and O (*P. c. atricapilloides*—indicated by open circles), and for those in samples I and J (*P. c. agilis*—indicated by solid triangles). This method is suggested as a convenient rough test for separation on the basis of two partially correlated characters. We see that the diagonal AB separates all but 6 of the northern birds (89%) from all but 2 (94.5%) of the southern ones, in the observed samples. This diagonal is located by the intersection of the vertical and horizontal dash lines

shown; these in turn were established by taking the point of statistically best separation on the basis of each measurement alone, as indicated. I have arbitrarily selected a line following roughly the 500-foot contour, from west of San Antonio to extreme southeastern Oklahoma and western Arkansas, which on the basis of the scattered material at hand may represent roughly the region of sharpest size-gradation. Samples K and L from this zone of intergradation, I have not used in Figure 4. The few birds in sample M average smaller than those in N and O, and thus still tend toward *agilis;* one

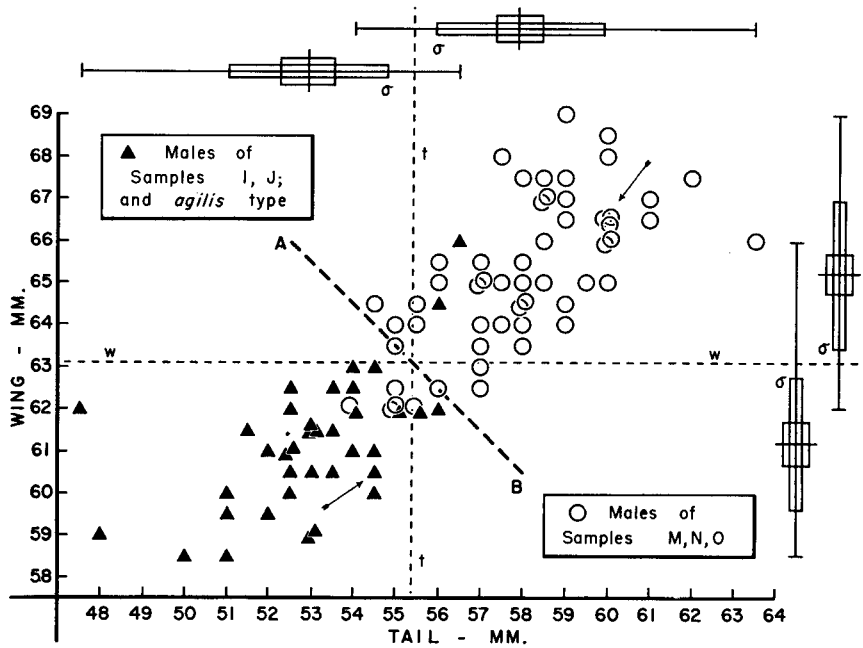

FIG. 4. Degree of distinctness on basis of wing- and tail-length between *P. c. agilis* (triangles) and *P. c. atricapilloides* (circles). AB: line of best separation, based on lines *tt* and *ww*, for each measurement alone, located by the standard deviations. Arrows indicate types. (See Fig. 1 for location of samples.)

of 7 males falls below the dividing line and another on it; they were nevertheless treated with the northern samples, in a deliberate attempt to make the test as rigorous as possible with the material available. As is clear from Table 1 and Figure 2, there is no significant difference between samples N and O. For added comparison, the collective statistics for MNO and for IJ have been added to Table 1.

SUMMARY

On the basis of specimens examined, I have outlined some slight extensions of the range of *P. carolinensis* to the northwest. My comparative data demon-

strate some of the major variational trends within this species. The most prominent of these are a cline of increasing size from south to north, and one of increasing brownness from west to east. On this basis the most logical treatment appears to me to be the recognition of four races: *extimus* (large and brown) in the northeast; *carolinensis* (small and brown) in the southeast, of which *impiger* may be considered an extreme; *agilis* (small and gray) in the southwest; and *atricapilloides* (described above—large and gray) in the northwest. This can be done without radical change in our present concepts, save for the splitting of *agilis* into two forms; additional characters serve for further separation of the several races. No very precise range limits have been outlined here for any of the subspecies and I feel that this is neither possible nor necessary at the present time, considering the clinal nature of much of the variation.

Of secondary concern, and presented only as a basis for further investigation, is the matter of general increase in tail/wing proportion in the larger populations of *P. carolinensis* (especially noticeable in *P. c. atricapilloides*), which tends to approach the reduced ratio of the smaller races of *P. atricapillus*. I have indicated the need for care in identification, and for much careful field work in critical areas.

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