Journal of the Arkansas Academy of Science

Volume 39 Article 41

1985

Identifying Perplexing Chickadee Specimens From Skeletal Material

Douglas A. James
University of Arkansas, Fayetteville

James D. Rising
University of Toronto

General Notes

IDENTIFYING PERPLEXING CHICKADEE SPECIMENS FROM SKELETAL MATERIAL

Although the Black-capped Chickadee *(Parus atricapillus)* is not known to occur in Arkansas (American Ornithologists' Union. 1983. Check-list of North American birds, 6th edition. Allen Press, Lawernce, Kansas, 877 pp; James D. A. and J. C. Neal. 1987. Arkansas birds—their distribution and abundance. Univ. Arkansas Press. Fayetteville, in press) there were two skeletal specimens bearing this name in the Museum of Natural History, University of Kansas (KU 19725 ♂ and 19728 ♀). Both were collected by J. D. Black near Winslow in Washington County, the male bird on 31 December 1931, the female on 2 January 1932. We suspected a cataloging error because when asked, Black (pers. comm.) could not recall collecting Black-capped Chickadees in Arkansas, adding that he did not include the species in his avifaunal study of the Winslow area (Black, J. D. 1935. Birds of the Winslow, Arknasas region. Am. Midl. Nat. 16:154-176).

The closely related Carolina Chickadee *(Parus carolinensis)* is common in Arkansas (American Ornithologists' Union. 1983. Check-list of North American birds, 6th edition. Allen Press, Lawerence Kansas, 877 pp; James, D. A. and J. C. Neal, 1987. Arkansas birds—their distribution and abundance. Univ. Arkansas Press, Fayetteville, in press). Therefore, it became necessary to determine whether the skeletal remains were those of the expected Carolina Chickadee or of vagrant Black-capped Chickadees. However, separating the two species is difficult when encountered in the field (except by song), and even when identifying study skins in the hand. Criteria for identifying skeletons had not been established. We decided to try to identify the skeletal specimens using multivariate statistics.

To establish criteria for identifying skeletal specimens of *Parus,* the junior author measured 25 variables on 68 specimens of both species from the collections at the University of Kansas, Museum of Natural History, and Royal Ontario Museum, Department of Ornithology. Only adult, sexed specimens were measured (21 male and 14 female *atricapillus,* 19 male and 14 female *carolinensis*). Given these restrictions, all of the *P. carolinensis* that were available were used. The great majority of these were from extreme southeastern Kansas, northwestern Arkansas, eastern Oklahoma and northeastern Texas, but single specimens also came from each of Delaware, Indiana, Louisiana and Mississippi. The specimens of *P. atricapillus* used were from Kansas, many from near the southernmost extreme of the species' range in the eastern Plains. We selected these specimens primarily because they were available, but also because it is reasonable to assume that a Black-capped Chickadee in Arkansas would most likely have come from an area just north of the state. Additionally, given the paucity of specimens from Arkansas, Carolina Chickadees from southeastern Kansas, and eastern Oklahoma and Texas would be most like those in Arkansas. Based on J. D. Black's opinion noted above the two KU specimens in question were *a priori* assumed to be Carolina Chickadees and are included in the totals for that species stated previously. This decision would have little overall affect on the clustering of specimens if in fact they were Black-capped Chickadees except to mark them as misclassified by the analysis with respect to species, plus making the overall species separation more difficult.

The 25 variables included measurements of all of the long bones, the sternum, synsacrum, and skull, including five measures of bill size (Table 1). Fifteen of the variables differed significantly among groups (Table 1), although there was considerable overlap among groups for all variables. To maximize the separation among groups, we used Discriminant Functions Analysis (DFA) from SPSS Subroutine DISCRIMINANT (Hull and Nie, 1981. SPSS update 7-9. McGraw-Hill, New York, 402 pp). In DFA it is necessary to use fewer variables than there are individuals

Table 1. Skeletal characters measured arranged according to univariate significance levels among chickadee groups.

Not significant at $\alpha = 0.05$	Significant differences at $P \leq 0.01$	Significant differences at $P \leq 0.001$
Skull length (1)	Skull width	Scapular length
Culmen length (2)	Culman depth (4)	Femur length
Culmen length (3)	Hallux length	Tibiotarsus length
Nasal bone width		Tarsometatarsus length
Premaxilla width		Humerus length
Interorbital width		Ulna length
Mandibular length		Carpometacarpus length
Gonys length		Sternum length
Mandibular depth (5)		Sternum depth
Coracoid length		Keel length
		Synsacrum width (6)
		Synsacrum length

(1) back of skull to hinge at posterior edge of upper bill, not including bill length, (2) from skull, (3) from anterior edge of nostril, (4) widest place, (5) deepest part, (6) across antitrochanters.

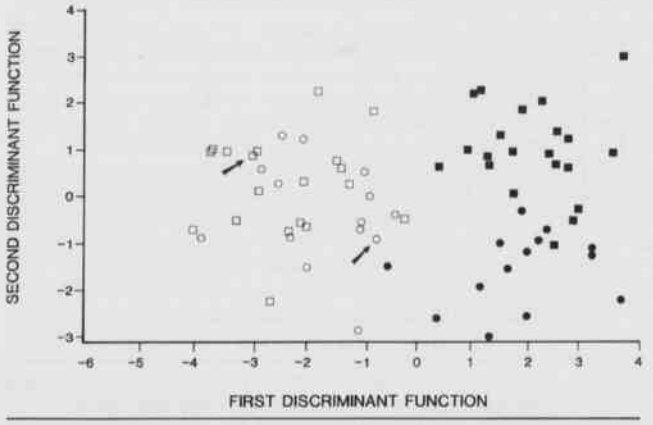

Figure. Ordination with respect to the first two discriminant functions of 68 skeletal specimens of Black-capped and Carolina Chickadees. (Darkened symbols represent Black-capped Chickadees, open ones Carolina Chickadees. Squares are male birds, circles, females. Arrows indicate the specimens in question.)

Table 2. Skeletal characteristics and standardized discriminant function coefficients that maximize the discrimination among 68 male and female Black-capped and Carolina Chickadees from the Central Plains and Ozark Plateaus regions.

Skeletal characteristic	Discriminant function	
	First	Second
Femur length	0.75	-0.25
Humerus length	0.42	-0.36
Ulna length	-1.02	0.81
Carpometacarpus length	0.25	0.46
Keel length	0.15	0.68
Synsacrum width	0.47	-0.40

in the smallest group. Because we had only 14 female Black-capped and Carolina Chickadees, it was necessary to *a priori* reduce the number of variables used to 13. Only the 15 variables that showed univariate significance were considered (Table 1), and from these culmen depth and scapula length were omitted (the former because it is difficult to measure accurately, the latter because of great variation within groups). The 13 variables were used in a step-wise DFA, using the criterion of maximizing the Mahalonobis distance among the 4 groups (males and females of both Black-capped and Carolina Chickadees). The infrequent missing values were estimated using the mean values for the appropriate group (e.g., Carolina female). The whole analysis was repeated using 75 chickadees by adding specimens from a wider geographical range. The results of the two analyses were essentially similar to those described below, which are based on the one using the 68 specimens.

The step-wise DFA identified 6 variables that maximized the separation among the 4 groups of chickadees. These variables, and their standardized discriminant functions coefficients are listed in Table 2. As can be seen from the Figure, the two species are separated along the first discriminant function axis (DF-1), accounting for 82.4% of the variance among the four groups.

Ulna length is the variable that contributes most to the separation between species with femur length and synsacrum width being of secondary and tertiary importance (Table 2). In total, Black-capped Chickadees, which have relatively large positive values on DF-1, have a combination of a relatively short ulna, long femur and humerus, and wide synsacrum. The measures of wing length, other than ulna length, interestingly are positively correlated to DF-1. The second DF (accounting for an additional 17.4% of the variation among the groups) separates male and female Black-capped Chickadees but not the sexes of Carolina Chickadees (Figure). Ulna length, again, is the most important variable on the axis, with male *atricapillus* having longer ulnae and keels, but relatively narrower synsacra and shorter humerae than females (Table 2).

In evaluating the precision of the discriminat function analysis, 82% of the specimens (56 out of 68) were correctly categorized as to group affinity. Eleven of the misidentifications were with regard to sex within species, and only one specimen was grouped with the wrong species. This was the female Black-capped Chickadee from Phillips Co., Kansas (KU 61722 ♀), that is clustered with the Carolina Chickadees in the Figure. The analysis identified it as a female Carolina Chickadee. Thus 99% of the specimens were correctly positioned with respect to species.

The two specimens in the Kansas collection that were suspect as to identification were both identified by the analysis as being Carolina Chickadees (marked by the two arrows in the Figure). As is shown in the Figure, the male specimen clearly is a Carolina Chickadee whereas the female specimen is close to the misclassified Black-capped Chickadee. In fact this female bird was identified with a rather high probability of being a Carolina Chickadee. It had a 69% probability of being a female Carolina (which it is), and 26% probability of being a male Carolina, which leaves only a 5% probability of being a Black-capped Chickadee.

In summary, Black-capped and Carolina Chickadees are readily identified from skeletal material and two suspect skeletal specimens labeled Black-capped Chickadees from Arkansas were indeed Carolina Chickadees. Thus, there are still no records of the Black-capped Chickadee in Arkansas.

(In completing this study, Rising's contribution was supported by the Natural Sciences and Engineering Research Council of Canada. Jim Dick of the Royal Ontario Museum, and Marion Mengel and Steven Johnson, of the University of Kansas Museum of Natural History, were very helpful in making specimens available. Thanks are due Janet Mannone for managing the data. J. D. Black was especially helpful for his comments.)

DOUGLAS JAMES, Department of Zoology, University of Arkansas, Fayetteville, AR 72701, and JAMES D. RISING, Department of Zoology, University of Toronto, Toronto, Ontario M53 1A1, Canada.

DEMONSTRATION OF A HEAT-STABLE CYCLIC GMP PHOSPHODIESTERASE IN THE MEDIUM OF *PHYSARUM FLAVICOMUM*

Although the role of cyclic AMP in cellular regulation has been well characterized during the last two decades, the function of cyclic guanosine monophosphate (cyclic GMP) remains vague. Cyclic GMP phosphodiesterase is the enzyme responsible for degrading cyclic GMP to 5′GMP and thus is of major importance in maintaining cellular levels of cyclic GMP. We have identified an extracellular cyclic GMP phosphodiesterase in