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AGE DETERMINATION OF BLACK-CAPPED CHICKADEES

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Age can be determined accurately in many passerines by the degree of cranial pneumatization (Miller 1946). This technique becomes unreliable during the fall, when the skulls of most immatures become fully pneumatized (Wood 1969, Yunick 1980). In some parids, however, tail feather differences provide an alternate method to estimate age (Laaksonen and Lehikoinen 1976). The purpose of this paper is to report on the reliability of the tail feather approach for determining age in the Black-capped Chickadee (*Parus atricapillus*).

METHODS

Black-capped Chickadees were caught in mist nets or potter traps in Williamstown, Berkshire County, Massachusetts from 27 September 1980 to 13 January 1981 and from 7 September to 6 December 1981. Chickadees were divided into two categories. First, a proportion of birds was assigned to a known-age category using the Miller (1946) technique. Birds with incompletely pneumatized skulls were classified as immatures in their first fall, and those with completely pneumatized skulls were classified as adults if caught between 1 September and 15 October. Second, birds with fully pneumatized skulls caught after 15 October were considered of unknown age.

To study age-related differences in tail feathers, the right outer rectrix of each bird was collected and analyzed for shape, color pattern, and extent of wear. The shape of the feather tip was quantified by placing the rectrix flat on a 1 mm grid with the rachis oriented along one grid line (Fig. 1). The location that the outer and inner feather edges crossed the grid line 1 mm to each side of the tip and parallel to the rachis was then determined. From this the angle of each feather edge with respect to the rachis was calculated. The sum of these two angles (θ, or rectrix tip angle) was used as a measure of feather shape. All measurements were made under a 10X dissecting microscope.

Calculations and statistical analyses were performed on a Univac 1100 computer using SPSS (Nie et al. 1975). Discriminant function analysis, which we used to classify birds by feather shape, is described by Nie et al. (1975) and by Morrison (1976).

RESULTS

Feather measurements were obtained from 199 chickadees. These included 82 birds in which age was determined by the Miller (1946) technique and 117 birds of unknown age.

Immature and adult chickadees differed significantly in rectrix shape. Immature rectrices were more sharply pointed than those of adults (tip angles (mean ± SD): 100.7° ± 9.7°, n = 59 in immatures, 127.7° ± 10.4°,

n = 23 in adults; $T_{80} = 11.09$, $P < 0.001$). In addition, the two age classes differed in rectrix wear and color pattern. Immature rectrices were more worn, and whereas immatures lacked a white border on the inner vane near the tip of the feather, the tips of adult rectrices were often completely bordered with white (Fig. 1). Feather observations were also obtained from numerous immature chickadees which had lost their first basic rectrices; their regenerating outer rectrices were similar in shape and color pattern to those of adults.

Feather shape distinguishes most immature and adult chickadees. According to discriminant function analysis, the rectrix tip angle which best separates immatures and adults in the Williamstown population is 117.7°; birds with greater angles are primarily adults and those with smaller angles are primarily immatures. If rectrix tip angle is used to assign age to the 82 birds previously determined by the Miller (1946) technique, only 6 (7%) of the chickadees are assigned to the incorrect age category, indicating that tip angle alone is an accurate age criterion for over 90% of the birds.

Measurements of rectrix tip angles indicate that the age composition of chickadees in Williamstown shifts during the late fall. The average rectrix tip angle of birds captured after 15 October is intermediate between the averages of immature and adult chickadees of known age, but the variance is higher than either ($\bar{x} = 120.4°$, SD = 15.8°, n = 117). The birds of unknown age are therefore a mixture of both age classes. According to the rectrix tip angle criterion, only 30% of the 122 late fall and early winter chickadees are immatures, compared to 61% of the 77 chickadees in the September and early October sample; this difference is statistically significant ($\chi^2 = 17.9$, $P < 0.001$).

DISCUSSION

Our analysis suggests that differences in outer rectrix shape can be used to age Black-capped Chickadees with approximately 90% accuracy. This finding, based on birds aged by other means, confirms that the tail feather method can be applied to the Black-capped Chickadee, and it provides a quantitative measure of the method's reliability. We have used the technique to show a seasonal change in age composition of a local chickadee population. The shift in age structure probably results from emigration of immatures, and it is in accord with the high proportions of immature chickadees that are reported on migration in coastal Massachusetts in the fall (T. Lloyd-Evans, pers. comm.). This pattern would not have been detected in our local population had the Miller (1946) technique been the only age-determination method available.

The difference in rectrix shape between adults and immatures may in part be due to feather wear. Immature chickadees grow their first rectrices in June and carry these feathers through the winter, whereas adults obtain new rectrices during the pre-basic molt in July and August (Dwight 1900). However, the rectrices of juveniles in other parids are

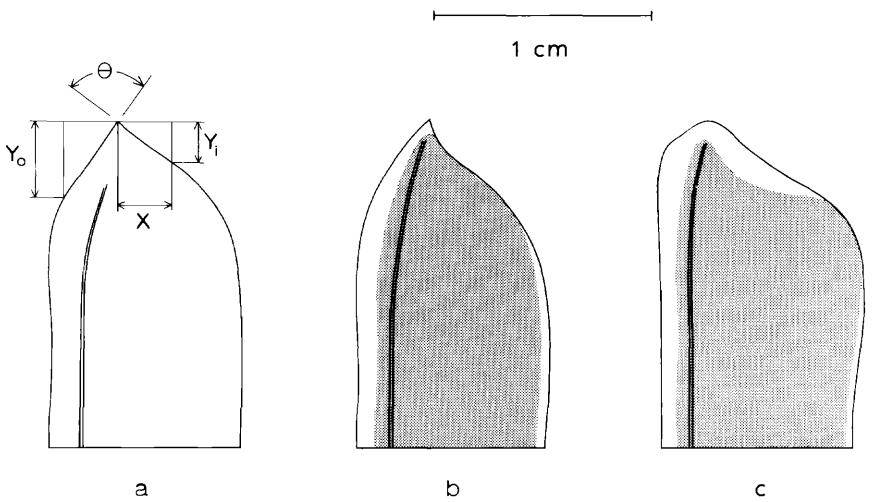

FIGURE 1. Chickadee rectrix tips: A. Measurement of tip angle, θ. Tip angle is calculated from the measurements of X, Y_i, and Y_o, using the equation:

$$\theta = 180 - (\mathrm{Tan}^{-1}(Y_i/X) + \mathrm{Tan}^{-1}(Y_o/X)).$$

B. A representative immature (first basic) outer rectrix. The feather is pointed and worn, showing no white on the tip of the inner vane. C. A representative adult (basic) outer rectrix. The feather is less worn than that of an immature, and usually shows some white on both edges of the feather tip.

more pointed than those of adults in basic plumage, and the more pointed feathers of immatures are presumably caused by developmental differences in feather shape between age classes (Laaksonen and Lehikoinen 1976).

The rectrix tip angle method may be applied to other species; other passerines, including other parids, possess differences in rectrix shape that correlate with age (Svenson 1970, Laaksonen and Lehikoinen 1976). However, parids and other passerines vary among species in the extent to which rectrices are lost in the pre-basic molt, and there may also be geographic variation within species in molt pattern and in feather shape. To determine age by the rectrix tip angle method in other populations of chickadees, a group of birds of known age should therefore be sampled to confirm the molt pattern and to determine for the local population the rectrix tip angle that partitions immature and adult birds. In addition, replicate measurements should be performed on a small set of feathers to make certain that results are reproducible. We found that collection of the feather and gentle smoothing of the tip were necessary to obtain consistent results. For some populations, it may be more appropriate to measure the rectrix tip angle to a point greater than 1 mm from the rachis.

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NOTES AND NEWS

In memoriam: Charles H. Blake.—On 6 December 1981, Dr. Charles H. Blake, a Past-President of NEBBA, died after a brief illness. Born 11 June 1901 in California, Dr. Blake received undergraduate and doctoral degrees with specialization in zoology at Massachusetts Institute of Technology, where he was a teacher for 32 years. Additional biographical details have been presented by C. N. Rose in *North American Bird Bander* 7: 33 (1982). Dr. Blake published many important contributions in ornithology including numerous papers in *Bird-Banding*. He will be missed.