

PLUMAGE VARIATION IN BLACK-CAPPED CHICKADEES: IS THERE SEXUAL DIMORPHISM?

BY MICHAEL GOCHFELD

Variability in plumage of Black-capped Chickadees (*Parus atricapillus*) has been described by Mosher and Lane (*Bird-Banding*, 43:139-40, 1972) who reported categories of "cap" and "bib" shape that seemed to indicate sexual dimorphism. They were successful in using these characters to determine the sex of 21 museum specimens as well as live birds whose sex had been determined by behavior. Using their illustrations, however, I was able to assign to sex only 10 of 33 chickadees captured in winter in Westchester County, New York. These birds did indeed show variability in cap and bib shape, but the characters were not covariant consistently. It seemed possible that in a heterogeneous winter population one might not find consistent characters. I did note that for at least four chickadees the features remained unchanged from year to year.

To clarify patterns of variation I examined specimens of *P. a. atricapillus* in the collection of the American Museum of Natural History. For the first analysis I used only specimens taken from March to June in the northeastern United States and Canada, by collectors known to have sexed birds by gonadal examination (W. E. Lanyon, pers. comm.). Although examination of subtle plumage characters is complicated when one has specimens prepared by many different collectors, I was fortunate in having a large number of specimens prepared by Dr. Jonathan Dwight. Specimens were grouped geographically to determine whether there might be consistent geographic variation. Since age and sex classes of birds differ in their conspicuousness and in their appeal to collectors, museum collections cannot be considered a random sample of any population. However, since collectors would probably not be able to distinguish sex or age of chickadees in the field, I assume that collector bias did not operate, and that the sample available to me represents the relative frequencies and conspicuousness of the sex and age samples. For the second analysis I examined additional specimens taken in all months to determine whether seasonality might influence plumage variability.

METHODS

I examined five features of the plumage (as follows): (a) bib wide and triangular vs. pinched inward below the bill, (b) caudad margin of bib smooth and sharply-defined vs. rough or irregular, (c) lateral "horns" on caudad margin of bib present vs. absent, (d) caudad margin of cap truncate vs. pointed, (e) cap short, covering only the crown, or long, extending onto hindneck. Mosher and Lane, using features a, b, and d, found that males tended to have pointed caps and wide triangular bibs with irregular margins, whereas females had truncated caps and pinched bibs with smooth margins. On examination of both live-trapped and museum

specimens I found that none of these features was strictly dimorphic, there being some intermediate examples for each. I disregarded specimens where I could not confidently force myself to assign each feature to one of the extreme character states, either because of intermediacy or because the "make" of the skin precluded adequate examination. I arbitrarily defined the breeding season as 15 April to 15 September, and specimens taken in this interval included a number of birds designated as juvenal plumage or juveniles by the collectors, presumably based on skull condition or molt. The plumage pattern analysis was based on 52 male and 38 female specimens in the American Museum of Natural History collection, including both the adult (= AHY) and young (HY) birds obtained during the "breeding" season.

The five dichotomous plumage features proved essentially independent, and resulted in 32 plumage combinations to which birds could be assigned. For each feature males and females were compared for independence using 2×2 contingency tables and the Fisher Exact Probability test (two-tailed, designated) (FEP2). The significance level chosen was $P = .05$.

Finally I measured the wing arc, tail length (insertion of central rectrices to tip of longest rectrix) and in some specimens bill length (anterior angle of nostril to bill tip) to shed further light on sexual dimorphism. I measured some specimens obtained in winter, and also some of the breeding season birds that had been disregarded in the plumage analysis.

RESULTS

Age seemed to have little influence on characters, except that among females more juvenal than adult birds had short-truncated caps (difference not significant). I subsequently combined age classes. There was a suggestion of sexual dimorphism in length of crown feathers because 22 of 38 females had long cap feathers compared with only 24 of 53 males, but the difference proved non-significant (FEP2 = .34). Similarly 19 of 38 females and 19 of 53 males (50% vs. 38%) had pinched bibs which is consistent with the report of Mosher and Lane but the difference was not significant (FEP2 = .34). There was no suggestion of sexual dimorphism in the other characters.

Because of the small cell sizes, I eliminated characters c and e, and Table 1 shows the number of birds in the 8 plumage combinations based on the three features illustrated by Mosher and Lane. Birds with pointed caps and wide bibs with irregular margins (putative males) included only 3 birds (2 adult males and 1 adult female). The combination of truncated caps and pinched bibs with smooth margins (putative females) included 14 birds, 4 adult and 3 juvenile males and 4 adult and 3 juvenile females.

The second analysis, for seasonality, involved 4×3 and then 2×3 contingency tables to look for independence among the four age and sex categories. There was no evidence of seasonal variability in any of the three features (a, b, d) for any of the geographic areas.

TABLE I
Plumage categories of Black-capped Chickadees¹

Bib Shape	Bib Margin	Cap Margin	Males		Females	
			Adult	Juvenile	Adult	Juvenile
Wide	Rough	Truncate	6	1	5	2
		Pointed	2	0	1	0
	Smooth	Truncate	11	2	2	3
		Pointed	8	3	6	0
Pinched	Rough	Truncate	4	1	5	1
		Pointed	3	1	1	1
	Smooth	Truncate	4	3	4	3
		Pointed	2	1	4	0

Statistical Comparison (adult & juveniles combined)

	Males	Females		Males	Females
Wide	33	19	Rough	18	16
Pinched	19	19	Smooth	34	22
	FEP2 > .30			FEP2 > .50	
	Males	Females		Males	Females
Truncate	32	25	Wide-pointed	12	7
Pointed	20	13	Pinched-truncate	13	13
	FEP2 > .30			FEP2 > .30	

¹Mid-April to mid-September

Measurements (Table 2) show that there is sexual dimorphism in size, the means of wing and tail length for females falling consistently below the 95% confidence limits around the means for males. Moreover, in some samples (e.g., New York breeding birds) the 95% confidence limits show no overlap. However, examination of the ranges of values reveals that it will be difficult to sex many chickadees by measurements. In the total sample, all but one chickadee with wing length greater than 67 mm were males, but one winter bird sexed as a female (perhaps incorrectly) had a wing of 71 mm. At the lower limit, there were many males and females with wing lengths of only 60 mm. Tail length also showed only small zones of non-overlap. Specimens with tails less than 55 mm were females, those with tails greater than 63 mm were males. There was also consistent geographic variation in size. Male chickadees from New England and Canada had significantly longer bills and tails ($P < .05$) and slightly longer wings than males from New York area.

TABLE 2
Measurements of adult Black-capped Chickadees

Location	Sex	Season	Sample Size	Wing Length		Tail Length		Bill Length	
				Range Mean \pm SD	95% Con. L.	Range Mean \pm SD	95% Con. L.	Range Mean \pm SD	95% Con. L.
New York	♂♂	breeding	15	63-70 66.5 \pm 2.14	65.4-67.7	57-64 61.4 \pm 1.38	60.6-62.1	6.2-7.7 7.12 \pm 0.38	6.93-7.33
Long Island	♂♂	breeding	17	61-69 66.2 \pm 1.80	65.3-67.1	56-64 59.4 \pm 2.33	58.3-60.6	6.3-7.5 6.83 \pm 0.43	6.61-7.06
northeast ¹	♂♂	breeding	9	62-70 66.9 \pm 1.79	65.7-68.2	61-73 66.6 \pm 4.59	63.4-69.8	6.8-7.9 7.51 \pm 0.33	7.28-7.74
northeast ¹	♂♂	winter	12	60-68 63.8 \pm 2.87	62.0-65.7	57-66 60.6 \pm 2.54	59.0-62.2		
New York	♀♀	breeding	13	60-66 63.2 \pm 1.82	62.2-64.3	54-62 57.9 \pm 2.08	56.7-59.0	6.1-7.4 6.92 \pm 0.35	6.72-7.13
northeast ¹	♀♀	breeding	17	61-67 63.5 \pm 1.94	62.5-64.5	54-60 57.9 \pm 1.99	56.9-58.9		
northeast ¹	♀♀	winter	11	61-65 63.7 \pm 2.80	61.9-65.6	53-61 58.0 \pm 2.64	56.2-59.8		
all	♂♂		53	60-70 65.6 \pm 2.53	64.9-66.3	56-73 61.0 \pm 3.63	60.0-61.9	6.2-7.9 7.09 \pm 0.47	6.95-7.23 ¹
all ¹	♀♀		41	60-65 63.5 \pm 2.14	62.8-64.1	53-62 57.8 \pm 2.08	57.2-58.5	6.1-7.4 6.92 \pm 0.35	6.72-7.13 ²

¹Includes specimens from New England and the Canadian maritime provinces

DISCUSSION

Sexual dimorphism in birds is of considerable practical as well as theoretical interest. Accurate determination of sex is crucial for most field studies of bird behavior and ecology, and in relatively monomorphic species like chickadees it may require examination of many characters before reliable sexing can be done on a plumage or mensural basis. Reyment (*Bull. Geol. Instit. Univ. Upsala*, N. S. 4:97-119, 1969) provides a detailed illustration and discussion of a multivariate statistical approach to sexual dimorphism.

My examination of chickadee plumages indicated that Black-capped Chickadees in the northeastern United States cannot be reliably sexed by cap and bib shape. This does not preclude the possible existence of other characters, perhaps some subtle cues that are more readily recognized in live birds.

Mosher and Lane have pointed out important aspects of plumage variation that remain unexplained and tempt further examination. In view of the considerable interest relating plumage variation to behavioral traits such as dominance hierarchies in bird flocks (e.g., Rohwer, *Evol.*, 29:593-610, 1975) the plumage variants of chickadees might be examined in the same light.

SUMMARY

The cap and bib shape of Black-capped Chickadees were found to be variable in a sample of 90 specimens obtained in the northeastern United States and the Canadian maritime provinces during breeding season. There was no evidence that age, sex, or locality were related to the observed variation, and it was not possible to confirm the report of Mosher and Lane of sexual dimorphism in plumage. Measurements of wing, tail, and bill revealed significant average differences between males and females, but there was relatively little area of non-overlap which would allow sexing of birds by measurements.

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Department of Ornithology, American Museum of Natural History, New York, N. Y. 10024 (Present address: Field Research Center, Rockefeller University, Millbrook, N. Y. 12545). Received 2 September 1976, accepted 17 December 1976.