Problems In Using Morphometrics to Sex Monomorphic Birds: An Example Using Black-capped Chickadees

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ABSTRACT

Black-capped Chickadees (*Parus atricapillus*) were used to assess the ability of morphometrics to sex monomorphic passerines. I compared three wing chord methods and multivariate discriminate analysis with sex identification based on presence of a brood patch or cloacal protuberance in breeding chickadees. Percent agreement between breeding morphology and wing chord methods ranged from 12.5% to 70%. The multivariate discriminate analysis was unable to assign gender based on morphometric measures. Several problems with using morphometrics to sex monomorphic birds are discussed.

INTRODUCTION

Accurate sex identification of birds is important in studies of sex-specific differences in breeding behavior, ecology, and energetics. There are a number of methods used to identify the sex of passerines. The most accurate method is laparotomy, a surgical procedure in which an anesthetized bird is cut open and the gonads examined (Risser 1971). However, this procedure is invasive, may alter metabolic rates, and might result in infection or even death.

In the sexually monomorphic Black-capped Chickadee many methods have been used to identify gender. During the breeding season, female chickadees develop a brood patch and males develop a cloacal protuberance (Odum 1941). Breeding behavior has also been used to identify gender in chickadees; for example, Weise (1979) classified a begging bird as a female and a bird showing territorial behavior as a male. The disadvantage of these methods is that after breeding, it is not always possible to follow known birds year-round in order to identify gender.

Plumage variation has also been used to determine the sex of chickadees. According to Mosher and Lane (1972), male Black-capped Chickadees have bibs that are broad and not well-defined at the posterior margin, and caps that are pointed posteriorly. Female chickadees have narrow bibs that have fairly well defined posterior margins and caps that are shorter and squared at the ends. However, Weise (1979) and Desrochers (1990) described difficulty in using this method. In addition, Gochfeld (1977) demonstrated that variability in the bib and cap was not correlated with sex differences in the Black-capped Chickadee.

The use of morphometric measurements offers perhaps the best potential to identify the sex of birds outside the breeding season. Several researchers have used wing chord measurements to identify the gender of Black-capped Chickadees (Odum 1943, Glase 1973, Weise 1979). The criteria for gender classification and the time of year birds were captured has varied between these studies.

The objectives of this study were twofold. First, I wanted to calibrate methods of sex identification for chickadees using morphometric characteristics in known-sex birds, as determined by brood patch or cloacal protuberance. I assumed that if a method accurately predicts sex during the breeding season, it should also be valid during the non-breeding season. Second, I wanted to provide banders with guidelines on the use of morphometrics to sex Black-capped Chickadees.

METHODS

Black-capped Chickadees were captured by mist-net before 1100 hr in summer and winter near Vermillion, Clay County, South Dakota, in 1991 and 1992. Body mass to the nearest 0.1 g was determined immediately upon capture with a Pesola spring balance (0-50 g with 0.5 g gradations). Wing chord length, tarsus length, and tail length were measured to the nearest 0.1 mm using the techniques recommended by Pyle et al. (1987). Birds measured from 5 June to 31 August were designated "breeding birds," and those measured from 14 September to 20 February were designated "non-breeding birds." Non-breeding birds and breeding birds represented independent samples.

Breeding birds were sexed by brood patch (females) or cloacal protuberance (males) (Odum 1941). Age was determined for birds by skulling and by outer rectrix shape and pattern (Meigs et al. 1983). All morphometric measures are presented as means $\pm$ SD. Statistical significance was accepted at $p<0.05$.

In this study I used three different methods to assess gender in chickadees based on wing chord measurements. Odum's (1943) method was based on breeding birds, Glase's (1973) method of 95% probability was based on museum study skin measurements, and Weise's (1979) method for 90% probability was based on non-breeding adult birds (Table 1).

Sex identification based on brood patch and cloacal protuberance was also compared with morphometrics using multivariate discriminant analysis (DesRochers 1990). Multivariate discriminant analysis uses predictor variables to yield a linear function that separates groups to be distinguished. I used mass, wing chord, tail length, and tarsus length as my predictor variables. Morphometric measures from a reference sample of known males and females must be used in order to yield a predictor equation to distinguish the two groups. I used summer birds sexed by breeding morphology as my reference sample.

RESULTS

In breeding birds, there were no significant differences between sexes in any morphometric measurements (Table 2). The stepwise discriminant analysis also indicated that no morphometric measure significantly contributed to the discrimination of sex (Wilks' lambda = 0.9204). Overall agreement (males and females) of wing chord sex identification and breeding morphology was 34.1% (Odum 1943), 36.4% (Glase 1973), or 38.6% (Weise 1979) (Table 3).

Table 1. Wing chord measurement criteria used to identify gender in the Black-capped Chickadee.

Reference	Wing Chord (mm)		
	Females	Males	Unknowns
Odum 1943	≤63	≥66	63.1 - 65.9
Glase 1973	≤65.1	≥67.1	65.2 - 67.0
Weise 1979	≤63	≥65	63.1 - 64.9

Table 2. Morphometric measurements of male and female Black-capped Chickadees from southeast South Dakota (summer 1991).

	Males			Females			t-test
Variable	Mean	SD	n	Mean	SD	n	P
Mass (g)	13.4	0.76	20	13.0	0.67	24	0.06
Wing Chord (mm)	65.8	2.0	20	65.9	2.2	24	0.87
Tarsus (mm)	19.5	0.8	17	19.3	0.9	22	0.44
Tail (mm)	65.9	3.2	20	65.0	3.0	24	0.33

Table 3. Wing chord sex identification compared with breeding morphology (brood patch = BP or cloacal protuberance = CP) sex identification of Black-capped Chickadee (summer 1991). (Numbers are percent agreement: n=24 females; n = 20 males.)		
Wing Chord Method	Breeding Morphology	
	Same as BP	Same as CP
Odum 1943	12.5%	60.0%
Glase 1973	25.0%	50.0%
Weise 1979	12.5%	70.0%

DISCUSSION

In this study I found no significant differences in morphometric measures between breeding males and females. These non-significant morphometric differences explain the inability of a multivariate analysis to yield a linear function distinguishing the two genders. Furthermore, wing chord data did not correlate with values from three previous studies (Odum 1943, Glase 1973, Weise 1979). There are several potential problems with using morphometrics to sex chickadees in general. Although the sample size of this study (20 males, 24 females) was rather small, Glase's (1973) wing chord method was developed using museum specimens of 36 known females and 35 known males. It seems unlikely that small sample size adequately explains the large overlap in measurements between males and females in this study. Another problem with using wing chord data is that chickadees' wings get longer with age (Blake 1956, Stewart 1963, Glase 1973). This may be more problematic during the breeding season than the non-breeding season because a breeding population will have a higher proportion of older birds compared with the fall/winter. However, breeding birds with older and more worn primaries would likely have wing chords averaging 1-2 mm shorter than non-breeding birds, measured after completion of the summer molt (Pyle pers. com.).

Subspecies differences in wing chord length is a complication in sex determination using the wing chord methods described in this paper. The three wing chord methods described were each based on eastern Black-capped Chickadees, *Parus atricapillus atricapillus* (AOU 1957). My study was based on southeastern South Dakota chickadees which may be Long-tailed Chickadees, *Parus atricapillus septentrionalis*, or represent birds in a zone of intergradation with *P. a. atricapillus* (AOU 1957). However, summer measurements of the wing chords of chickadees in this study are much closer to measurements of *P. a. atricapillus* than those of *P. a. septentrionalis* recorded by Duvall (1945; see Table 4). In addition, the average wing chord length and the range in measurements among the nine subspecies recognized by the AOU 1957 (Table 4) demonstrate the difficulty in using morphometrics to sex chickadees without consideration of subspecific variation in size.

Table 4. Black-capped Chickadee subspecies differences in mean wing chord length (mm) and range in wing chord lengths (mm). Subspecies are arranged by ascending wing chord length. Measurements are from Duval (1945), except for *garrinus*, recorded by Behle (1951).

	Females			Males		
Subspecies	Mean	Range	n	Mean	Range	n
P.a. occidentalis	60.0	57.5-63.5	35	61.2	57.5-64	41
P.a.practicus	63.0	59.5-65.5	12	64.0	61.5-67	12
P.a.fortuitus	63.2	59-67	23	64.1	60-67	23
P.a.atricapillus	63.4	60-67	31	65.1	60-67.5	36
P.a.bartletti	62.3	61-64.5	6	66.4	65-68	7
P.a.turneri	63.6	61-66.5	15	65.4	61-68	20
P.a.nevadensis	66.9	63.5-70.5	13	68.0	64-72.2	22
P.a.septentrionalis	67.2	64-71	30	68.7	64.5-73	62
P.a.garrinus	67.6	63.4-76.7	10	68.6	64.3-70.6	10

Unfortunately, my data indicate that even if a bander has an adequate sample size and is capturing *P. a. atricapillus*, morphometric wing chord methods still are not adequate to accurately sex a large percentage of individuals.

Black-capped Chickadees from southeast South Dakota appear to lack morphometric dimorphism described in other populations of North American Black-capped Chickadees. This study demonstrates potential difficulties in assigning gender to birds that lack sexual dimorphism in plumage. The results of this study also indicate that banders should use caution when assigning sex to Black-capped Chickadees based on wing chord measurements.

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