Morphometrics of Prothonotary Warblers in Oklahoma

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ABSTRACT

A paucity of published morphometric data exists for the Prothonotary Warbler (*Protonotaria citrea*) in the western portion of this species' range. From 2003 to 2006, I measured wing length, tail length, and body mass of 156 adult Prothonotary Warblers (72 males; 84 females) at the Tishomingo National Wildlife Refuge in south-central Oklahoma. Males had significantly greater wing and tail length than females, but females weighed significantly more than males. Among males and females, no differences were detected between age classes for wing length, tail length, or body mass. Prothonotary Warblers from Oklahoma had shorter wing and tail lengths compared to birds from Indiana and Michigan, but similar to Tennessee (Kowalski 1986). Warblers from Oklahoma weighed less than warblers from Indiana, Michigan, and Tennessee (Walkinshaw 1941, Kowalski 1986). Prothonotary Warblers appear to follow Bergmann's Rule with lower body mass than warblers at northern latitudes. Warblers at the periphery of the species' range may also be lighter than conspecifics in core population areas at the same latitude (e.g., Tennessee). Prothonotary Warblers do not appear to follow Allen's Rule, as the Oklahoma population has shorter wing lengths than warblers at northern latitudes.

INTRODUCTION

Morphometric data (e.g., wing length, tail length, and body mass) are used frequently to determine age and sex for a bird species during banding (Pyle 1997). Although no subspecies have been recognized for the Prothonotary Warbler (*Protonotaria citrea*; Petit 1999), there is broad scale variation within this species. Walkinshaw (1941) and Kowalski (1986) documented that Prothonotary Warblers had greater wing lengths and mass in northern latitudes than in southern latitudes. Kowalski (1986) suggested that Prothonotary Warblers may follow Bergmann's Rule, which describes a pattern of variation in which animals within a species have greater body mass in areas with lower ambient temperatures. More specifically, animals with a smaller surface area to volume ratio conserve heat better and therefore have better survivorship at lower temperatures or higher latitudes. Bergmann's Rule is often evident within species as increases in size with latitude, and latitude is usually correlated with climate variables. James (1970) documented that Downy Woodpeckers (*Picoides pubescens*) and 11 other bird species showed patterns of variation correlated with temperature and humidity and fit Bergmann's Rule. Allen's Rule is another description of geographic variation which states that animals at southern latitudes (i.e., higher ambient temperatures) should have longer appendages (i.e., wing length) than animals at northern latitudes (i.e., lower ambient temperatures).

One way to test the fit of Bergmann's and Allen's rules in describing geographic variation is to obtain morphometric data from museum specimens. Petit (1999) studied Prothonotary Warbler morphometric data from museum specimens and reported no evidence for Prothonotary Warblers following Bergmann's Rule or Allen's Rule; however, she only measured males and her choice of some measurements was suspect (e.g., flattened wing chord). Flattened wing chord is not a reliable measurement as it can vary by how firmly the wing chord is flattened (Pyle 1997).

Several studies have provided measurements for Prothonotary Warblers in the core of the species' range (Walkinshaw 1941, Kowalski 1986). My objectives were to obtain morphometric data on different ages and sexes of Prothonotary Warblers at the western margin of the species' range and to compare my field data with previously published

Prothonotary Warbler morphometric data to determine if this species followed Bergmann's Rule and Allen's Rule.

METHODS

Prothonotary Warbler morphometric data were collected at the Tishomingo National Wildlife Refuge (34° 11' N, 96° 38' W), Johnson County, in south-central Oklahoma during the 2003 - 2006 breeding seasons. Warblers were mist netted on territory or target captured at nest boxes (Wood and Reasor 2006). To guarantee that I was sampling only resident Prothonotary Warblers, I captured and measured only individuals holding territories or incubating eggs. Un-flattened wing chord and tail length were measured with a standard wing rule (Pyle 1997). Body mass data were obtained using a 50 g Pesola spring scale. Measurements were rounded to the nearest 1 mm or 1 g. JUMP© software was used for all statistical analyses.

RESULTS

From 2003 to 2006, I netted and measured 156 Prothonotary Warblers (Table 1). After combining data from different years for statistical analysis, the data failed Shapiro-Wilk tests for normality. Thus, I used Wilcoxon nonparametric tests, with an *a priori* alpha level of 0.05, to detect differences in wing length, tail length, and body mass between males and females. I also tested for differences within age classes for males and females. In two cases, wing length between after-second-year (ASY) males and ASY females and tail length between second-year (SY) males and SY females, the data exhibited a normal distribution and one-way analysis of variance tests were used to detect differences.

Wing length - Overall, male Prothonotary Warblers had significantly longer wing length than females ($\chi_1^2 = 94.1$, $P < 0.001$; Table 1). ASY males had greater wing length than ASY females ($F_{1,91} = 125.7$, $P < 0.001$) and SY males had greater wing length than SY females ($\chi_1^2 = 30.4$, $P < 0.001$; Table 1). No significant differences in wing length were detected between ASY and SY males ($\chi_1^2 = 1.53$, $P = 0.22$) nor between ASY and SY females ($\chi_1^2 = 0.05$, $P = 0.83$; Table 1).

Tail length - Overall, male Prothonotary Warblers had greater tail length than females ($\chi_1^2 = 56.5$, $P < 0.001$; Table 1). ASY males had greater tail length than ASY females ($\chi_1^2 = 36.7$, $P < 0.001$) and SY males had greater tail length than SY females ($F_{1,60} = 21.1$, $P < 0.001$; Table 1). No differences were detected between ASY and SY males ($\chi_1^2 = 3.55$, $P = 0.06$) nor between ASY and SY females ($\chi_1^2 = 0.01$, $P = 0.92$; Table 1).

Body mass - Overall, female Prothonotary Warblers weighed more than males ($\chi_1^2 = 23.1$, $P < 0.001$; Table 1). ASY females weighed more than ASY males ($\chi_1^2 = 15.8$, $P < 0.001$) and SY females weighed more than SY males ($\chi_1^2 = 9.6$, $P = 0.002$; Table 1). No significant differences were detected between ASY and SY males ($\chi_1^2 = 1.50$, $P = 0.22$) nor between ASY and SY females ($\chi_1^2 = 1.94$, $P = 0.16$).

Table 1. Prothonotary Warbler Morphometric Measurements from the Tishomingo National Wildlife Refuge, Oklahoma 2003-2006. Values given are mean ± SE, range.

Sex	Age (n)	Wing (mm)	Tail (mm)	Mass (g)
Females	SY (43)	67.5 ± 0.24, 64 - 71	43.2 ± 0.24, 40 - 46	14.6 ± 0.20, 12 - 17
	ASY (41)	67.6 ± 0.24, 64 - 71	43.3 ± 0.24, 40- 46	15.0 ± 0.20, 12 - 17
	Combined (84)	67.5 ± 0.17, 64 - 71	43.2 ± 0.17, 40 - 46	14.8 ± 0.14, 12 - 17
Males	SY (20)	70.9 ± 0.37, 68 - 74	45.1 ± 0.33, 43 - 48	13.6 ± 0.27, 12 - 17
	ASY (52)	71.5 ± 0.25, 68 - 76	46.0 ± 0.26, 42 - 50	14.0 ± 0.16, 12 - 17
	Combined (72)	71.3 ± 0.21, 68 - 76	45.7 ± 0.21, 42 - 50	13.9 ± 0.14, 12 - 17

Table 2. Morphometrics of Prothonotary Warblers from Oklahoma (this study), Tennessee - 1 (Walkinshaw 1941), Tennessee - 2 (Petit and Petit 1996), Indiana (Kowalski 1986), and Michigan (Walkinshaw 1941, L.H. Walkinshaw in Kowalski 1986). Values are mean ± SE (if available).

Measurement	Oklahoma	Tennessee - 1	Tennessee - 2	Indiana	Michigan
MALES:					
n	72	13	60	110 - 112	14
Wing	71.3 ± 0.21	70.96	72.4	72.90 ± 0.18	73.71
Tail	45.7 ± 0.21	-	-	47.10 ± 0.17	-
Mass	13.9 ± 0.14	14.27	14.2, 80	15.49 ± 0.11	14.9
FEMALES:					
n	84	33	80	23 - 24	20
Wing	67.5 ± 0.17	67.5	68.1	68.96 ± 0.36	69.40 ± 0.43
Tail	43.2 ± 0.17	-	-	45.38 ± 0.34	-
Mass	14.8 ± 0.14	125.45	-	16.09 ± 0.34	17.32 ± 0.38

DISCUSSION

Morphometric measurements of Prothontary Warblers in Oklahoma were within the average ranges across the species' geographic distribution (Pyle 1997); however, mean measurements for some characteristics were different among geographic locations (Table 2). Some of my results for morphometric differences between female and male Prothonotary Warblers are similar to published measurements by Walkinshaw (1941) and Kowalski (1986). Namely, males have longer wings and tails, but females have higher body mass (Table 2). Although female warblers were measured after clutch completion, females may have had higher body mass because they were in breeding condition.

Prothonotary Warblers in Oklahoma had shorter wing and tail lengths than Prothonotary Warblers from Indiana and Michigan (Kowalski 1986; Table 2). Prothonotary Warblers in Oklahoma shared similar wing and tail lengths with warblers in Tennessee (Walkinshaw 1941; Table 2), which is at a similar latitude and climate as Oklahoma. Allen's Rule states that animals at southern latitudes and higher temperatures (i.e., Oklahoma) should have longer appendages than animals at northern latitudes and cooler temperatures (i.e., Indiana and Michigan). Prothonotary Warblers do not appear to follow Allen's Rule because wing lengths were shorter in Oklahoma compared to warblers from Indiana and Michigan.

I did not measure tarsus length, but this measurement may be valuable in examining Allen's Rule, because tarsus length is a less subjective measure of body size than wing length. Wing length can be affected by feather wear or measurement methodology.

Prothonotary Warblers in Oklahoma weighed less than warblers in Indiana, Michigan and Tennessee (Table 2). My results corroborate Kowalski and Walkinshaw's assertion that Prothonotary Warblers follow Bergmann's Rule. However, one might expect that warblers banded at similar latitudes in Oklahoma and Tennessee should have similar body mass, but they did not. Because Oklahoma warblers weighed less than warblers in Tennessee (Kowalski 1986), this means that other factors may affect body mass for conspecifics at similar latitudes. Warblers at the periphery of the species' range (e.g., Oklahoma) may be lighter than conspecifics in core areas of habitat at the same latitude (e.g., Tennessee) or other factors may influence body mass such as nesting season habitat quality, prey availability, age, stopover habitat quality, winter habitat quality, or selection pressure (Murphy 1985, Smith et al. 1986).

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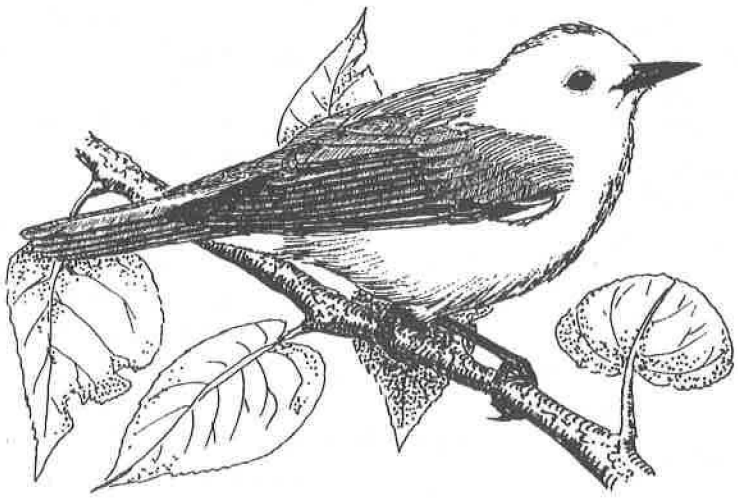

Prothonotary Warbler (pen&ink) by George West