Morphometrics of Tree Swallows in Southeastern Oklahoma

Douglas R. Wood[1], *David M. Eason*, and *Ross G. Anderson*
Southeastern Oklahoma State University
PMB 4068, 1405 North Fourth Avenue
Durant, OK 74701-0609

[1]Corresponding author email: dwood@se.edu

ABSTRACT

*A lack of published morphometric data exists for Tree Swallows (*Tachycineta bicolor*) in the southern portion of this species' range (Winkler et al. 2011). We collected wing length, tail length, and body mass data from 185 Tree Swallows in southeastern Oklahoma during the 2009-2012 breeding seasons. Males had significantly longer mean wing and tail length, but females had greater body mass than males. After-second-year females had significantly longer mean wing and tail length and greater body mass than second-year females. Between-year differences occurred within sexes for wing length, tail length, and body mass. Tree Swallows in southeastern Oklahoma demonstrated smaller wing, tail, and body mass measurements than Tree Swallows in higher latitudes. Male Tree Swallows followed Bergmann's Rule, but females did not.*

INTRODUCTION

In the last 30 years, Tree Swallows (*Tachycineta bicolor*) have expanded their geographic distribution southward, including southeastern Oklahoma (Neeld 1993, Long and Long 1997, Heck 1999, McCurdy 2007). The Breeding Bird Survey suggests that Tree Swallow populations in North America are increasing by 0.33% per year since 2002 (Sauer et al. 2014).

Published Tree Swallow morphometric data have been collected primarily in northern, eastern, and western North America. Wing length, tail length, and body mass data have been published from Ontario (Dunn et al. 1994, Rendell and Robertson 1994, Kempenaers et al. 1999), New York (McCarty 2001), Alberta (Dunn and Hannon 1992), British Columbia (Burness et al. 1998), and Wyoming (Johnson et al. 2003). However, a paucity of morphometric data exists for Tree Swallows in the southern portion of this species' range.

Males tend to have longer wings, tails and greater body mass than females (Pyle 1997, Kempenaers et al. 1999, Burness et al. 2001). Oberholser (1974) reported that adult males have a mean wing length of 119.4 mm (range 115.1 - 124.5 mm) compared to adult female mean wing length of 115.3 mm (range 110.0 - 119.9 mm). However, adult male mean tail length of 55.6 mm (range 53.1 - 57.9 mm) and female mean tail length of 55.1 mm (range 53.1 - 57.9 mm) were similar. Second-year females tend to be smaller than after-second-year females (Burness et al. 2001).

Oberholser (1974) suggested that a subspecies for Tree Swallows (*T. b. vespertina*) may occur along the Pacific Coast, but Browning (1978) documented only slight wing chord length variation among Tree Swallows on the West Coast. Several studies have documented similar wing length, tail length, and body mass for Tree Swallows (Dunn et al. 1994, Wiggins and Pärt 1995, Kempenaers et al. 1999, Burness et al. 2001) supporting the conclusion that Tree Swallows lack subspecies. However, no published morphometric data exists for Tree Swallows in the southern portion of the species' range for comparisons to northern Tree Swallows. If differences occur along a latitudinal gradient, then Bergmann's Rule may apply to Tree Swallows.

Bergmann's Rule states that a species' body mass should increase with an increase in latitudinal distribution (James 1970). Namely, individuals with higher body mass in northern latitudes tolerate colder annual temperatures better than smaller individuals in southern latitudes. Other North American cavity nesters, like Downy Woodpeckers (*Picoides pubescens*) and Carolina Chickadees (*Poecile carolinensis*), adhere to Bergmann's rule (James 1970). Tree Swallows in Oklahoma and other states at the southern extent of the species' range may be smaller in body mass than individuals at northern latitudes as an adaptation to warmer climate.

Our research objectives were to determine if differences in morphometrics occur between male and female Tree Swallows as well as between second-year and after-second-year females. We also sought to determine if Tree Swallows follow Bergmann's Rules.

METHODS

Tree Swallow morphometric data were collected at the Red Slough Wildlife Management Area, McCurtain County, OK (33°44' 58.92" N, 94°39'14.32" W) during the 2009-2012 breeding seasons. Adult Tree Swallows were captured from 22 Apr-7 Jul 2009, 23 Apr-13 Jul 2010, 22 Apr-4 Jul 2011, and 21 Apr-2 Jul 2012. Tree Swallows were target captured at the nest box (Wood and Reasor 2006). To guarantee we sampled summer residents nesting at Red Slough, we captured and measured only individuals holding territory or incubating eggs (Wood 2007). We measured un-flattened wing chord on the right wing and length of the longest retrix to the nearest one mm with a standard wing rule (Pyle 1997). We used a 100-g Pesola spring scale to measure body mass to the nearest 1 g. Males were only aged to after-hatch-year (AHY); whereas, females were aged to second year (SY) or after second year (ASY), based on plumage characteristics (Pyle 1997).

IBM SPSS Statistics 20 software was used for all statistical analyses, with an *a priori* alpha level of 0.05. Shapiro-Wilk tests for normality indicated morphometric data were normally distributed; thus, we used independent samples t-tests to test individual null hypotheses that wing length, tail length, and body mass were not different between males and females, as well as between SY and ASY females. One-way ANOVAs were used to test between-year differences in morphometrics for both male and female Tree Swallows. When a significant difference among years was detected, *post hoc* LSD tests were used to compare between individual year combinations.

RESULTS

Males versus females — Males had significantly longer mean wing length than females ($t = -13.43$, $df = 184$, $P < 0.01$; Table 1). Males also had significantly longer tail length than females ($t = -7.3$, $df = 184$, $P < 0.01$; Table 1). However, females had greater mean body mass than males ($t = 3.26$, $df = 183$, $P = 0.001$; Table 1).

ASY versus SY females – ASY females had significantly longer mean wing length than SY females ($t = -2.83$, $df = 118$, $P = 0.005$; Table 1). ASY females also had significantly longer mean tail length than SY females ($t = -3.59$, $df = 118$, $P < 0.001$; Table 1). ASY females had greater mean body mass than SY females ($t = -3.09$, $df = 118$, $P = 0.003$; Table 1).

Between years by sex – Mean wing length was significantly different between years for adult male Tree Swallows ($F_{3,62} = 5.9$, $P = 0.001$), with males in 2009 showing shorter wing lengths than in 2010

Table 1. Tree Swallow morphometric data from the Red Slough Wildlife Management Area, Oklahoma 2009-2012. Values given are mean ± SD range.

Sex	Age (*n*)	Wing (mm)	Tail (mm)	Mass (g)
Male	AHY (65)	116.9 ± 2.6, 112 - 123	55.3 ± 2.0, 50 - 60	19.9 ± 1.4, 16 - 24
Female	SY (50)	110.7 ± 2.6, 103 - 116	52.6 ± 1.8, 48 - 57	20.2 ± 2.2, 15 - 24
Female	ASY (70)	112.0 ± 2.5, 106 - 116	53.7 ± 1.5, 51 - 57	21.3 ± 1.9, 15 - 25
Female	Combined (120)	111.5 ± 2.6, 103 - 116	53.3 ± 1.7, 48 - 57	20.9 ± 2.1, 15 - 25

($P < 0.001$) and 2011 ($P = 0.007$), but not different than 2012 ($P > 0.05$, Table 2). No significant differences occurred for mean tail length ($F_{3,62} = 2.35$, $P = 0.08$) and body mass ($F_{3,61} = 1.02$, $P = 0.39$) between years for male Tree Swallows (Table 2). For SY females, mean body mass exhibited between-year differences ($F_{3,46} = 3.98$, $P = 0.013$), with females in 2010 significantly lighter than females in 2012 ($P = 0.001$, Table 2); whereas no other pairwise comparisons were significantly different. No significant differences were detected for mean wing length ($F_{3,46} = 0.70$, $P = 0.56$) and tail length ($F_{3,46} = 2.38$, $P = 0.082$) for SY females (Table 2). Mean wing length was significantly different between years ($F_{3,66} = 3.03$, $P = 0.035$) for ASY females, with significantly shorter wing lengths in 2009 than in 2010 ($P = 0.011$) and 2012 ($P = 0.005$, Table 2). No significant differences were detected between years for mean tail length in ASY females ($F_{3,66} = 0.643$, $P = 0.59$; Table 2). Mean body mass was significantly different between years ($F_{3,66} = 5.1$, $P = 0.003$); ASY females had lower body mass in 2009 than 2012 ($P = 0.008$), similarly ASY females in 2010 had lower body mass than in 2012 ($P = 0.002$, Table 2). No other significant pairwise comparisons were significant.

DISCUSSION

Male wing length – In southeastern Oklahoma, male mean wing length varied between years; however, the overall mean (116.9 mm) and range (112 - 123 mm) were similar to previous studies. Notably, Tree Swallow mean wing length in Oklahoma was at the lower end of the range of mean wing lengths reported in other studies. In Ontario, Kempenaers et al. (1999) reported a mean wing length of 119.7 - 120.2 mm and Rendell and Robertson (1994) reported male mean wing lengths of 119.3 - 119.7 mm. Dunn et al. (1994) documented male mean wing length of 120.2 mm (range 116 - 124) in Ontario and Wiggins and Pärt (1995) reported male mean wing length of 121.1 mm (range 117 - 127) in British Columbia. Similarly, in Wyoming, Johnson et al. (2003) documented male mean wing length of 122 mm. Our estimates most closely relate to mean wing length (115.9 - 117.3 mm) of Tree Swallows in Michigan (Lombardo and Thorpe 2000).

Female wing length – Some variation existed between years for female Tree Swallows; however, female mean wing length (111.5 mm) and range (103 - 116 mm) in southeastern Oklahoma were the lowest values compared to reported means

Table 2. Tree Swallow morphometric data by gender and year from the Red Slough Wildlife Management Area, Oklahoma 2009-2012. Values given are mean ± SD, range.

Sex	Age	Year (*n*)	Wing (mm)	Tail (mm)	Mass (g)
Males	AHY	2009 (16)	115.0 ± 1.8, 112 - 121	55.1 ± 1.4, 52 - 57	20.2 ± 1.4, 18 - 23
		2010 (22)	118.1 ± 2.0, 115 - 123	55.9 ± 09, 55 - 59	19.5 ± 1.7, 16 - 24
		2011 (11)	117.5 ± 2.9, 113 - 122	55.8 ± 2.6, 52 - 60	20.2 ± 1.0, 19 - 22
		2012 (16)	116.6 ± 2.5, 112 - 120	54.4 ± 2.4, 50 - 59	19.8 ± 0.6, 18 - 21
Females	SY	2009 (14)	110.7 ± 3.3, 103 - 116	53.1 ±1.6, 51 - 57	20.1 ± 1.8, 15 - 22
		2010 (13)	111.5 ± 2.5, 106 - 115	53.4 ±1.6, 50 - 55	18.8 ± 2.8, 15 - 23
		2011 (8)	109.8 ± 2.3, 107 - 115	52.1 ± 2.3, 48 - 55	20.1 ± 0.9, 19 - 22
		2012 (15)	110.5 ± 1.9, 107 - 114	51.8 ± 1.5, 48 - 54	21.5 ± 1.6, 19 - 24
	ASY	2009 (8)	109.8 ± 2.3, 106 - 113	53.6 ± 1.5, 51 - 56	20.1 ± 1.2, 18 - 22
		2010 (12)	112.6 ± 1.9, 110 - 115	53.3 ± 1.4, 51 - 56	20.1 ± 2.4, 15 - 25
		2011 (13)	111.8 ± 3.2, 106 - 116	54.2 ± 1.3, 52 - 57	21.3 ± 1.4, 18 - 23
		2012 (37)	112.4 ± 2.1, 106 - 116	53.7 ± 1.5, 51 - 57	22.0 ± 1.7, 18 - 25

and ranges of female Tree Swallows in other regions. In British Columbia, Wiggins and Pärt (1995) reported mean female wing length of 115.8 mm (range 110 - 121 mm). In Ontario, Kempenaers et al. (1999) documented female mean wing lengths of 115.9 - 116.8 mm, which was similar to Rendell and Robertson (1994) that reported female mean wing lengths of 115 - 116.2 mm. Similarly, Johnson et al. (2003) documented female mean wing length of 115 - 118 mm in Wyoming. ASY females had longer mean wing length (112.0, range 106 - 116) than SY females (110.7, range 103 - 116) in southeastern Oklahoma. Winkler et al. (2011) also reported that SY females have shorter wings than ASY females.

Male versus female wing length – Males had significantly longer mean wing length (116.9, range 112 - 123 mm) than females (111.5, range 103 - 116) in southeastern Oklahoma. This result concurs with other published estimates in the literature. In Wyoming, Johnson et al. (2003) reported that adult males had significantly greater mean wing length (122 versus 118 mm) than adult female Tree Swallows. Similar significant differences were documented by Rendell and Robertson (1994), Kempenaers et al. (1999), and Wiggins and Pärt (1995).

Male tail length – Male Tree Swallows in southeastern Oklahoma demonstrated shorter mean tail length (55.3, range 50 - 60 mm) than Tree Swallows in other studies. In Ontario, Dunn et al. (1994) reported male mean tail length of 57.5 - 57.8 mm (range 53 - 62 mm) which is larger, although similar to swallow data in southeastern Oklahoma. However, in Ontario, Kempenaers et al. (1999) reported significantly longer mean tail lengths (62.0 - 62.1 mm) for male Tree Swallows.

Female tail length – Female mean tail length (53.3) and range (48 - 57) in southeastern Oklahoma were shorter than other previously reported estimates. Kempenaers et al. (1999) reported female mean tail lengths of 59.4 - 59.6 in Ontario, which are significantly longer than swallow estimates in southeastern Oklahoma. ASY females had longer mean tail length (53.7, range 51 - 57) than SY females (52.6, range 48 - 57) in southeastern Oklahoma. We were unable to find previously published estimates for female tail length with regard to age class.

Male versus female tail length – Male mean tail length (55.3, range 50 - 60 mm) in southeastern Oklahoma was 2 mm longer than adult females (53.3, range 48 - 57 mm). In Ontario, Kempenaers et al. (1999) documented a similar difference; adult male mean tail length (62 mm) was 3 mm longer than in adult females (59 mm). Although there appear to be differences between southern and northern subpopulations of Tree Swallows, they exhibit the same proportional differences among age and gender as in other studies.

Male body mass – Mean body mass (19.9, range 16 - 24 g) of adult male Tree Swallows in southeastern Oklahoma was smaller than in most previously published studies. Three studies from Ontario all reported similar mean body mass estimates. Kempenaers et al. (1999) reported mean body mass of 21 - 21.4 g, which was similar to Rendell and Robertson's (1994) estimate of 21.1 g for adult male body mass. Dunn et al. (1994) reported male mean body mass of 21.5 g (range 20 - 23 g). In British Columbia, male mean body mass was less than our estimates from southeastern Oklahoma; however, Tree Swallows in their study were measured under laboratory conditions, not in the field (Burness et al. 1998).

Female body mass – In southeastern Oklahoma, adult female mean body mass (20.9, range 15 - 25 g) was also smaller than in previously published studies. In Ontario, Rendell and Robertson (1994) reported mean female body mass of 20.8 - 21 g and Kempenaers et al. (1999) reported a similar mean female body mass of 20.5 - 21 g. In Alberta, Dunn and Hannon (1992) reported the heaviest mean female body mass of 21.1 g, although all three studies have consistent estimates. Burness et al. (1998) documented female mean body mass of 16.95 g, although this was collected under laboratory conditions, so we are hesitant to compare these estimates directly with field data. ASY females in southeastern Oklahoma averaged 1 g heavier than SY females (21.3 and 20.2 g, respectively). Winkler et al. (2011) reported a similar relationship among females of different age classes in Tree Swallows.

Male versus female body mass – Adult female mean body mass (20.9 g) was greater than male mean body mass (19.9 g) in southeastern Oklahoma. Although Burness et al. (1998) reported lower body mass for females than males, other studies report similar mean body masses for females (20.5 - 21.1 g) and males (21 - 21.5 g; Dunn and Hannon 1992, Dunn et al. 1994, Rendell and Robertson 1994, Kempenaers et al. 1999). However, since we measured body mass of females at the onset of incubation (i.e., post-egg laying), this may explain why female body mass estimates were greater than males. Ovary size increases during the breeding season which would cause them to be heavier than during the non-breeding season.

Bergmann's Rule – Bergmann's Rule states that, within a species, body mass should increase with an increase in latitude. Male Tree Swallow mean body mass (19.9 g) averaged 1 - 1.5 g lighter than Tree Swallows in Ontario (21 - 25 g; Dunn et al. 1994, Rendell and Robertson 1994, Kempenaers et al. 1999). Our data suggests that male Tree Swallows follow Bergmann's Rule. In southeastern Oklahoma, female Tree Swallow mean body mass (20.9 g) was nearly identical to female Tree Swallows in northern latitudes (20.5 - 21.1 g; Dunn and Hannon 1992, Rendell and Robertson 1994, Kempenaers et al. 1999). This indicates female Tree Swallows do not follow Bergmann's Rule; however, some secondary cavity nesters follow Bergmann's Rule. Wood (2007) documented that male and female Prothonotary Warblers (*Protonotaria citrea*) follow Bergmann's Rule.

ACKNOWLEDGMENTS

We thank the U.S. Forest Service, the Prairie and Timbers Audubon Society, and the Organized Research Fund at Southeastern Oklahoma State University for financial support. We thank Robert Bastarache, U.S. Forest Service, for his support of this project. We gratefully acknowledge David Arbour of the Oklahoma Department of Wildlife Conservation for his logistical support and local knowledge. We thank Glenda Friend and Bob Heinemann from the Kiamichi Forestry Research Station for providing housing during the project. We are deeply grateful to all Southeastern Oklahoma State University students and Murray State College faculty that served as field volunteers during this research including: Aaron Elmer, Michele Elmer, Heather Guy, Joey McAllister, Paden Minor, Zach Motley, Chance Phillips, and Gabby Solis.

LITERATURE CITED

Browning, M.R. 1978. An evaluation of the new species and subspecies proposed in Oberholser's Bird Lifeof Texas. *Proceedings of the Biological Society of Washington* 91: 85-122.

Burness, G.P., R.C. Ydenberg, and P.W. Hochachka. 1998. Interindividual variability in body composition and resting oxygen consumption rate in breeding Tree Swallows. *Physiological Zoology* 71: 247-256.

Burness, G.P., R.C. Ydenberg, and P.W. Hochachka. 2001. Physiological and biochemical correlates of brood size and energy expenditure in Tree Swallows. *Journal of Experimental Biology* 204:1491-1501.

Dunn, P.O. and S.J. Hannon. 1992. Effects of food abundance and male parental care on reproductive success and monogamy in Tree Swallows. *Auk* 109:488-499.

Dunn, P.O., R.J. Robertson, D. Michaud-Freeman and P.T. Boag. 1994. Extra-pair paternity in Tree Swallows: Why do females mate with more than one male? *Behavioral Ecology and Sociobiology* 35: 273-281.

Heck, B.A. 1999. Breeding record of the Tree Swallow in McCurtain County, Oklahoma. *Bulletin of the Oklahoma Ornithological Society* 32:6-7.

James, F.C. 1970. Geographic size variation in birds and its relationship to climate. *Ecology* 51:365-390.

Johnson, L.S., L.E. Wimmers, S. Campbell and L. Hamilton. 2003. Growth rate, size, and sex ratio of last-laid, last-hatched offspring in the Tree Swallow *Tachycineta bicolor*. *Journal of Avian Biology* 34: 35-43.

Kempenaers, B., B. Congdon, P. Boag and R.J. Roberston. 1999. Extrapair paternity and egg hatchability in Tree Swallows: evidence for the genetic compatibility hypothesis? *Behavioral Ecology* 10:304-311.

Lombardo, M.P. and P.A. Thorpe. 2000. Microbes in Tree Swallow semen. *Journal of Wildlife Diseases* 36: 460-468.

Long, M.P. and C.I. Long. 1997. Breeding records of Tree Swallows at Grand Lake, Oklahoma. *Bulletin of the Oklahoma Ornithological Society* 30:21-23.

McCarty, J.P. 2001. Variation in growth of nestling Tree Swallows across multiple temporal and spatial scales. *Auk* 118:176-190.

McCurdy, K. 2007. First nesting of Tree Swallows in Comanche County and Fort Sill, Oklahoma. *Bulletin of the Oklahoma Ornithological Society* 40:2-4.

Neeld, F. 1993. Tree Swallows nesting in Stephens County, Oklahoma. *Bulletin of the Oklahoma Ornithological Society* 26:40-41.

Oberholser, H.C. 1974. The bird life of Texas. University of Texas Press, Austin, TX.

Pyle, P. 1997. Identification guide to North American birds, Part 1. Slate Creek Press, Bolinas, CA.

Rendell, W.B. and R.J. Roberston. 1994. Defense of extra nest-sites by a cavity nesting bird, the Tree Swallow *Tachycineta bicolor*. *Ardea* 82:273-285.

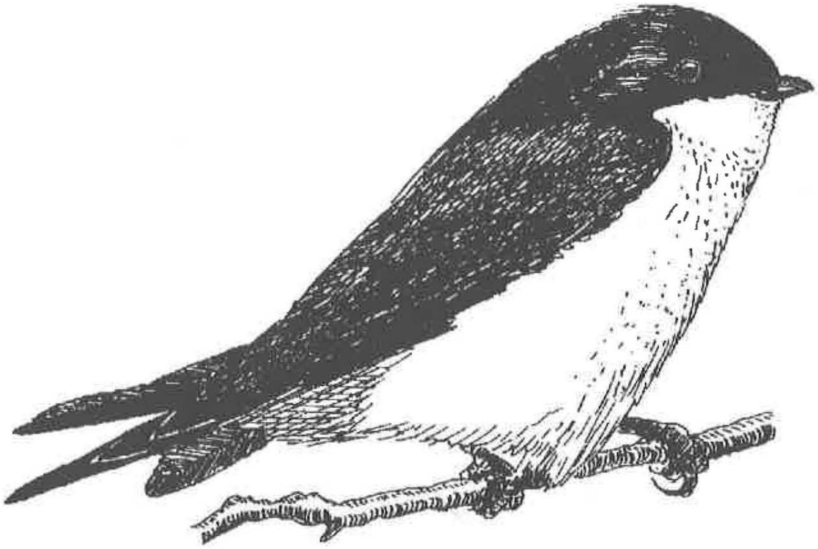
Sauer, J.R., J.E. Hines, J.E. Fallon, K.L. Pardieck, D.J. Ziolkowski, Jr. and W.A. Link. 2014. The NorthAmerican breeding bird survey, results and analysis 1966-2012. Version 02.19. 2014 USGS Patuxent Wildlife Research Center, Laurel, MD.

Wiggins, D.A. and T. Pärt. 1995. Sexual dimorphism and breeding success in Tree Swallows and Collared Flycatchers. *Condor* 97:267-271.

Winkler, D.W., K.K. Hallinger, D.R. Ardia, R.J. Robertson, B.J. Stutchbury and R.R. Cohen. 2011. Tree Swallow (*Tachycineta bicolor*). *The birds of North America online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.bnaproxy.birds.cornell.edu/bna/species/011.

Wood, D.R. 2007. Morphometrics of Prothonotary Warblers in Oklahoma. *North American Bird Bander* 32: 64-67.

Wood, D.R. and J. Reasor. 2006. Prothonotary Warbler reproductive success and site fidelity in a fragmented Oklahoma landscape. *North American Bird Bander* 31:5-9.



Tree Swallow
by George West