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Analysis of a Sample of Tennessee Warblers Window-killed During Spring Migration in Manitoba

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Large numbers of passerine birds killed in collision with lighted structures during night migration flights, particularly in the fall, have yielded important information on the timing of migration of individuals of different ages and gender, route selection and geographic origins of migrants, and molt (e.g., Tordoff and Mengel 1956, Payne 1961, Kemper *et al.* 1966, Crawford 1978, Raveling and Warner 1978). Large, single samples of birds killed in this manner during the spring migration have been less frequenty reported (but see Hatler and Campbell 1975), although weather-caused mortality in spring occurs frequently (e.g., Green 1962, Whitmore *et al.* 1977, Zumeta and Holmes 1978).

Prolonged below-normal temperatures in late April through May, 1974, and stormy weather in mid-May, caused mortality of many spring migrant birds, particularly passerines, in southern Manitoba (Serie and Jones 1976, McNicholl and Goossen 1980). During mid-day on 22 May 1974, about 150 passerines, most of them wood warblers (Parulinae), struck the glass wall of an arboretum that joins two apartment buildings in Winnipeg, Manitoba. Seventy-one of the birds killed were Tennesse Warblers (*Vermivora peregrina*). These specimens are examined in the present paper, and the span of the migratory movement of Tennessee Warblers in spring in southern Manitoba is determined from mist netting of individuals at a stopover site along the southern shore of Lake Manitoba.

Methods

Each salvaged bird was sexed on the basis of plumage characteristics and weighed to the nearest 0.1 g on a triple-beam balance before being frozen. Later, the exposed culmen, flattened wing, and longest rectrix were measured to the nearest 0.1 mm. Each individual's sex was determined by dissection and the amount of subcutaneous fat in the interclavicular fossa (often called the furculum or furcular cavity) was estimated using a qualitative scale of 0-4, where 0 = no fat, 1 = solid sheet of fat decurved down into the fossa, 2 = fat filling fossa, 3 = fat bulging out of fossa but not meeting layer of fat from abdomen, and 4 = fat bulging out of fossa and meeting layer of fat from the abdomen.

The spring migratory period of Tennessee Warblers in southern Manitoba was determined by mist netting individuals at a stopover site, the dune-ridge forest along the southern shore of Lake Manitoba (see MacKenzie 1982), about 120 km NW of Winnipeg, Manitoba. Mist netting was conducted daily, as weather permitted, during the spring migration periods in 1976, 1977, and 1984 and all Tennessee Warblers captured in the approximately 2-m high nets set at ground level, were sexed on the basis of plumage characteristics, banded, and released.

Results

Sex ratio. - Seventy of 71 individuals in this sample were sexed correctly based on plumage characteristics; one male was mistakenly called a female. There were significantly more males than females (51 males:20 females; $x^2 = 13.53$, $p < .001$).

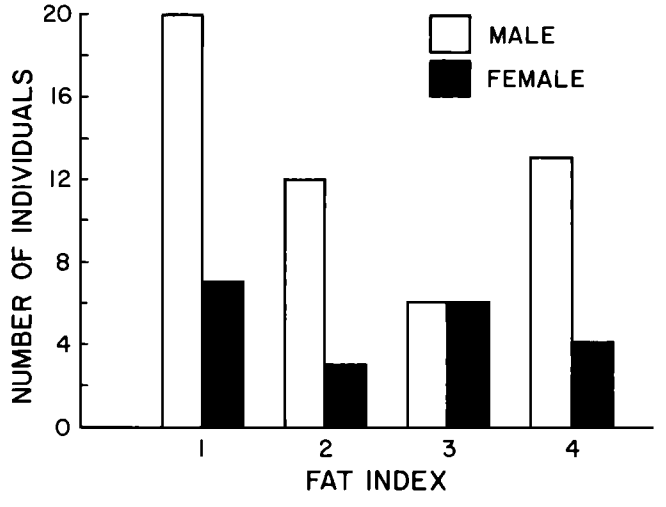
Measurements and body mass. - Statistical analyses of measurements and body mass are summarized in Table 1. Males were significantly heavier than females (t = 3.035, df = 68, $p < .005$) and had longer wings (t = 7.927, df = 69, $p < .0001$) and longer tails (t = 2.074, df = 69, $p < .05$). The exposed culmen averaged longer in females before being rounded off, but the difference was not significant (t = 0.535, df = 67, $p < .30$). The upper and lower ranges for all characters, except culmen length, were greater in males.

Table 1. Mean measurements (mm±SD) and body mass (g±SD) of Tennessee Warblers window-killed on 22 May 1974 in Winnipeg, Manitoba.

	Males	n	Females	n
Mass	9.4 ± 0.64	50	8.9 ± 0.65	20
Culmen	9.9 ± 0.38	49	9.9 ± 0.36	20
Wing	65.9 ± 1.81	51	62.3 ± 1.38	20
Tail	39.3 ± 2.02	51	38.2 ± 1.94	20

Fat class. - Figure 1 reveals that all individuals had some visible subcutaneous fat. Fat load was positively correlated with body mass; this relationship was significant for males (r = 0.533, df = 49, $p < .01$) but not for females (r = 0.363, df = 18, $p \geq .05$). Thus, the amount of subcutaneous fat and body mass of the birds tended to vary together, as revealed by a Kruska-Wallis test where mean body mass for each fat class was compared for both males and females. This held for males (H adj. = 21.50, $p < .001$) and for females (H adj. = 10.84, $p < .02$).

Figure 1. Distribution of fat classes in a sample of 71 Tennessee Warblers killed during spring migration in southern Manitoba.



Spring migration of Tennessee Warblers in Manitoba. - The Tennessee Warbler is one of the less common species of wood warblers that stopover in spring in the dune-ridge forest. For example, 698 individuals of 19 species of migrant warbers (i.e., species that do not nest in or near the ridge forest) were netted during the 1984 spring migration. Of this total, 3.9% of the individuals were Tennessee Warblers. Nevertheless, the few Tennessee Warblers that have been mist netted in spring in the dune-ridge forest reveal that this movement occurs in the second half of May, with individuals netted on the extreme dates of 14 May [1977] and 28 May [1976, 1984]. Sixty percent of the individuals, however, passed through between 20 and 28 May, and males and females migrated synchronously (Table 2), with females in the samples outnumbering males almost 2 to 1.

Table 2. Total numbers of Tennessee Warblers mist netted and banded at 5-day intervals in the springs of 1976, 1977, and 1984 on the forested dune ridge, Delta Marsh, Manitoba.

	Number of individuals mist netted	
5-day periods[1]	Males	Females
May 10-14	2	1
15-19	5	14
20-24	8	12
25-29	4	9
30-3	0	0
June 4-8	0	0
Total	19	36

[1]Mist netting began on the study area on 19 May 1976, 10 May 1977, and 10 May 1984.

Discussion

The sex ratios in the window-killed and mist-netted samples are contradictory, and no conclusions can be drawn. Males outnumbered females in the kill sample, females outnumbered males in the mist-net sample.

Several criteria have been used to identify the gender of Tennessee Warblers. Raveling and Warner (1965) presented two alternative methods of sexing Tennessee Warblers based on the length of the flattened wing of fall specimens (i.e., individuals with newly grown, unworn plumage):

Method A.	63 mm or less	female
	64 mm	unknown
	65 mm or above	male
Method B.	64 mm or less	female
	65 mm or above	male

These authors concluded that method A was preferable. This is supported by the analysis of wing-lengths of birds of known sex in the Manitoba sample (Table 3). Sex of individuals with flattened wings 64 mm long should not be recorded. For experienced observers, however, plumage characteristics remain the most effective way to sex Tennessee Warblers in spring, because 98.6% accuracy was attained using this method with the Manitoba sample. Raveling and Warner (1965) cautioned against using wing and tail lengths of Tennessee Warblers in spring to separate individuals of different ages. They asserted that only gender can be identified reliably because differences in the measurements of individuals of different ages likely are disguised by differential wear of the feathers. The slightly lower accuracy obtained in identifying males, using both methods in the present study, probably is related to the inclusion of yearling males and feather wear of spring birds.

Table 3. Accuracy of sexing AHY Tennessee Warblers in a spring sample using 2 different criteria: Method A, wing length 64 mm = unknown, 63 mm or less = females, 65 mm or more = males; Method B, 64 mm or less = females, 65 mm or more = males.

	Total	Correctly Identified	Unknown	Incorrectly Identified	% Accuracy
Method A					
Male	51	39	8	4	90.7
Female	20	16	4	0	100.0
Total	71	55	12	4	93.2
Method B					
Male	50	39	—	12	76.5
Female	20	20	—	0	100.0
Total	71	59	—	12	84.5

Single samples of birds may contain individuals which breed in widely scattered areas. This probably increases variation in measurements within a sample (Raveling 1965, Raveling and Warner 1978). The geographic destinations of individuals in the Manitoba sample, of course, are not known. Although the mean wing length of males in this sample corresponds most closely to that of males that breed in southern Manitoba and Ontario, region 6 of Raveling (1965), this character is not a useful one for estimating geographic variation, as it is similar over a large part of the species' range (Raveling 1965).

The mean body mass (g ± SD) of 209 male and 164 female Tennessee Warblers, weighed during the spring migrations of 1961-1974 in Pennsylvania, was 10.2 = 0.22 (range = 7.3 - 18.4 g) and 9.8 = 0.31 (range = 7.8 - 13.4 g), respectively (Clench and Leberman 1978). These means are 0.8 g and 0.9 g higher for males and females, respectively, than the means in the Manitoba sample (see Table 1). The single Tennessee Warbler that Serie and Jones (1976) weighed during spring migration in 1974 in southern Manitoba was 19.6% less than the mean mass (11.2 g) of unsexed individuals they captured in 1971-1973, springs with so-called normal weather conditions. The mean masses of individuals in the window-killed sample, also from the 1974 spring migration, were similarly lower than the average mass of Tennessee Warblers recorded during the previous three years.

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Books

Birds of Southern California's Deep Canyon. Wesley W. Weathers. 1983. University of California Press, Berkeley. x^{s}266 pp. $35.00.

The title of this book may suggest an annotated local status list, but the volume is instead a combination of a popular account of local birds in the Colorado Desert - Santa Rita Mountains area of southwestern California and an essay on adaptations of desert birds. Rarer species are barely mentioned and some accounts of families do not even list which species have been recorded. The usual local avifaunal data are partially relegated to an Appendix which lists each species according to "life zone," season of occurrence (by month), and known or suspected nesting.

Three introductory chapters present an overview of the area, its climate and weather, and of bird studies conducted there. Differences in climate with altitude are emphasized as are microclimatic effects, such as the temperature difference a desert sparrow might experience on the ground vs. when perched on a shrub. Chapters 4 through 12 treat the birds of various habitat types or life zones, based partly on Emlen-style transects and partly on general observations. More than half the book is comprised of Chapter 13 "species" accounts, some of which are really general family accounts. Species actually treated include information on synonomy, general range, local status, and comments on biology at Deep Canyon and/or elsewhere. Physiological adaptations are often highlighted, especially as related to desert stresses.

Details of a color-banded Black Phoebe that nested in the same locality for 5 years are the only original banding data presented, although the results of the Andersons on Cactus Wrens are also summarized. Banders in the southwestern U.S. may find some of the plumage details helpful (e.g. differences between Chipping and Brewer's Sparrows), but most of this is also available elsewhere. Some problems, such as the difficulty in distinguishing resident Ash-throated Flycatchers on the valley floor from migrants, could be resolved through banding.

Although the text is aimed at both a lay audience and desert ecologists, much of it will be too technical for readers without at least some background in ecology, and desert ecologists will find it useful mainly as a general background reference rather than as a source of original data. Apart from a few minor flaws in the literature citations, proof-readers seem to have missed little, and the writing also flows well. The statement that flickers and sapsuckers are the only migratory woodpeckers in North America overlooks Red-headed and probably White-headed Woodpeckers, and Saskatchewan can be included in the range of Pinon Jay only as part of the hypothetical list. While it is true that the call of the Western Screech Owl is not appropriately labeled a screech, neither is that of the Eastern species, as implied. Reference to the graph in Fig. 35 as depicting a House Finch on its nest (p. 212) is obviously in error. These few minor errors are too insignificant to detract from the overall quality of the book. The text is enhanced by black-and-white photographs, sketches, graphs and color plates, but the choice of some of the latter is odd, as three species (Swainson's Thrush, Townsend's Warbler and MacGillivray's Warbler) depicted are not treated in the text, but relegated to the list in the Appendix. Readers interested in a semi-technical reference to desert birds and/or birds of the southwestern U.S. should enjoy this book, although the rather steep price will deter more casual buyers.

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Small birds of the New Zealand bush. Elaine Power. 1970, reprinted 1981. Collins, Aukland and London. approx. 50 pp., no price given.

North American visitors to New Zealand will find a delightful introduction to part of an unfamiliar avifauna in this slim volume. Twenty species, some with such familar names as Rock Wren and Brown Creeper, but very unfamiliar plumage, are depicted, either in a 1½-page color painting, or a one-page painting and half-page black-and-white sketch. Three or four accompanying paragraphs briefly outline some of the bird's habits under both English and Maori names. This is not a book from which to learn detailed life history, but simply one to enjoy.

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