GEOGRAPHIC VARIATION AND MEASUREMENTS OF TENNESSEE WARBLERS KILLED AT A TV TOWER

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INTRODUCTION

Samples of passerine species from television tower and ceilometer beam mortalities in many parts of the country are yielding much information on weights, mensural characters, and migration potentials. (See especially, Tordoff and Mengel, 1956; Sawyer, 1961; Graber and Graber, 1962; Odum, 1960; Connell, et al., 1960; Odum, et al., 1961). While there has been much effort in determining the potential for further flight from the point of collection, little if any attention has been devoted to the problem of where samples of migrants may have originated. Some attempts at subspecific identification have been made (Tordoff and Mengel, 1956; Johnston and Haines, 1957; Stoddard, 1962). In most cases these subspecific identifications have been made on too few specimens to be truly revealing and descriptions of subspecies for many of the species involved in these mortalities are highly inadequate, especially for fall plumage specimens. Before any attempt to assign fall migrants, especially of the warbler group, to subspecies or areas of origin a better understanding of the geographic variation of the species in question will in most cases be necessary.

The Tennessee Warbler (*Vermivora peregrina*) has no described sub-species and occupies a very wide breeding range (American Ornithologists Union, 1957: 481-2). Large samples have been collected at the WEAU TV tower, Eau Claire, Wisconsin, each fall. This paper compares measurements of samples of Tennessee Warblers killed in fall migrations at this TV tower in 1961 and 1962 with measurements of samples of Tennessee Warblers that were collected on the breeding grounds, in an attempt to estimate the area(s) of origin of the TV killed migrants.

METHODS AND MATERIALS

Adequate samples of Tennessee Warblers were collected from television tower kills that occurred on 3-4, 11-12, and 13-14 September, 1961, and 9-10, 10-11 September and 2-3 October, 1962 at Eau Claire, Wisconsin. The individuals of all species were gathered either while the kill was in progress or the morning after a kill, and the total samples were sorted by species and frozen as soon as possible.

The following measurements were recorded from the 1961 TV tower killed birds:

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Total Length—from the tip of the bill to the tip of the tail to the nearest millimeter with the specimen stretched as tautly as possible.
Wing Spread—from one wing tip to the other to the nearest millimeter with the bird on its back and the wings stretched as tautly as possible.

I found the above measurements to be more reproducable by stretching the birds tautly rather than applying any intermediate tension. These two measurements are still quite variable and the error is to be kept in mind.

Tail Length—with a divider from the point of insertion of the central two tail feathers to the tip of the longest tail feather, rounded to the nearest millimeter.
Wing Length—on a wing gauge to the nearest millimeter from the carpometacarpus to the tip of the longest primary feather with the wing pressed flat and straight.

Again, I found that a tautly stretched method of measuring was more reproducable and also this method allows for a better comparison of wing measurements taken from fresh birds to wing length measurements taken from museum skins whose wings may be dried and curved in different positions, an artifact largely done away with by measuring the wing as flat and straight as possible.

Tarsus Length—with a divider from the joint between the tarsometatarsus and tibiotarsus to the joint at the base of the middle toe, estimated to the nearest one-tenth of a millimeter.
Bill Length—with a divider from the anterior edge of the nostril to the tip, estimated to the nearest one-tenth of a millimeter.

Only tarsus and bill lengths were measured on the 1962 TV tower killed birds.

To determine if there were significant differences in any of the measurements within each age-sex class among kills from different nights in each Autumn an analysis of variance was made (Completely random design with unequal replication; Steel and Torrie, 1960: 112-115). Age was determined by the degree of skull ossification; sex was determined by gonadal examination.

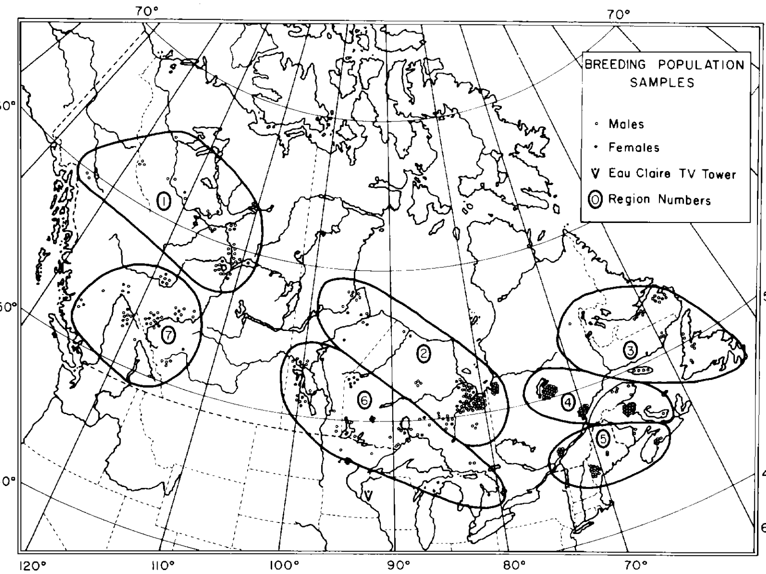
Bill, wing, and tail measurements were measured as described above from borrowed museum specimens that were collected on the breeding grounds. Tarsus length measurements were not taken from museum skins. I found that I could not measure the tarsus with the consistency desired on the dried skins.

GEOGRAPHIC VARIATION

Fig. 1 shows the collection localities of the specimens examined in the analyses of geographic variation. The seven regions were outlined on the basis of whether the specimens collected were from the northern or southern one-half of the breeding range. The numbers of specimens available from west of the mountain ranges in British Columbia are small, and these individuals are included in Region 7, rather than being considered separately.

To exclude possible migrants from the sample, only adults collected during June and July were included in the analyses of geo-

Fig. 1. Localities at which Tennessee Warblers used in analyses of geographic variation were collected.



graphic variation. Roberts (1936) noted that migrations of Tennessee Warblers through Minnesota begin in early August. Banding records and museum collections show that migrants may be "common" in early August. Also, some migration occurs before the postnuptial molt is completed. The Chicago Natural History Museum has adult Tennessee Warblers that were collected in North Dakota and Illinois that were in heavy molt. There have been adult Tennessee Warblers killed at the Eau Claire TV tower in August that were in general body molt and had not yet replaced their primaries.

Color: Eaton (1957) used some specimens in fresh fall plumage in his study of geographic color variation in the Northern Waterthrush, *Seiurus noveboracensis*. Because Tennessee Warbler migrations may begin in August and some individuals apparently move considerable distances before acquiring their fresh fall plumage, specimens in fresh fall plumage were not used for determining geographic variation of color.

During June and July, adult males may exhibit a completely gray-white ventral surface or have some buffiness or some yellow present on the breast and flanks. The crown may be completely gray, barely tipped with green or have distinct green present. The ventral coloration of females shows a complete range from very pale buffy (almost white) surface to heavy yellow, with all intergrades in between. A more complete description is forthcoming (Raveling and Warner, 1965). The percentages of specimens from the different regions exhibiting these differences were calculated, but the data are not presented here. No variation of a geographic or clinal nature was evident. Also, these data are not included because the specimens had been collected over a period of eighty years with associated problems of faded and dirty plumages, and because of differences in color as a result of more feather wear in late July versus early June specimens.

Tail Feather Spotting: Table 1 shows the percentages of individuals that exhibited obvious white spots at the tips of the inner webs of the outer retrices. Spotting is more often present in males, except in the one sample of females (Region 7). Females from Region 7 also have a significantly longer tail length (Table 3). Samples of males from Regions 6 and 7 show a lower incidence of spotting than most other samples of males. Samples of males from the eastern portion of the breeding range show a progressively higher incidence of spotting from north to south, 54% in Region 3, 67% in Region 4 (significant difference from Region 3, Chi-square, 0.074 level), and 78% in Region 5 (non-significant difference from Region 4, Chi-square, 0.10 level; significant difference from Region 3, Chi-square, 0.025 level).

TABLE 1. GEOGRAPHIC VARIATION IN THE OCCURRENCE OF WHITE SPOTS ON THE TIPS OF THE INNER WEBS OF THE OUTER RETRICES OF TENNESSEE WARBLERS.

REGION NUMBERS CORRESPOND TO AREAS IN FIG. 1.
SAMPLES LESS THAN TEN ARE EXCLUDED

Percent Exhibiting Spots in Each Geographic Area

Sex	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
Male	55.9 (N = 34)	66.6 (N = 75)	53.8 (N = 26)	66.7 (N = 48)	78.3 (N = 23)	50.0 (N = 30)	48.2 (N = 36)
Female		33.3 (N = 12)		45.4 (N = 11)		33.3 (N = 15)	68.7 (N = 16)

Mensural Characters: Tables 2 and 3 show the variations in bill, tail and wing length measurements. Tail and wing lengths of these samples show remarkable uniformity across the continent, with the exception of tail lengths in Region 7 females. Variation in bill length showed the best correlation with geography. The small samples of females prohibit definite conclusions, but bill lengths of females appear to show less geographic variation than in males. Males from Regions 1 and 2 have significantly smaller bills than males from Regions 6 and 7. Males from the east, Regions 3, 4, and 5, appear intermediate, with a slight increase in size in the south-eastern most sample. There is individual overlap in all samples and actual differences are small, but I believe the differences exhibit a true geographic trend of being smaller in the north and larger in the south in conformance with Allen's Rule. There is no sample in any of the measurements taken that is even close to subspecific status by the 75% Rule (Amadon, 1949).

VARIATION IN MENSURAL CHARACTERS OF THE AGE-SEX CLASSES KILLED ON DIFFERENT NIGHTS

Unfortunately there are no banding results available to indicate any migratory patterns of the Tennessee Warbler. I have assumed that birds killed in the fall at the Eau Claire TV tower could have come from Regions 1, 2, and 6 (from northern Minnesota, Wisconsin, through Ontario to the Northwest Territories, Fig. 1). If widely separated populations from the breeding grounds migrate as distinct units and do not become mixed with other populations in the "staging" of, or during, migration, it should be possible to find significant differences in bill measurements of adult males killed at the TV tower on different nights. Bill measurements on many species taken in fall or winter would not be comparable to measurements taken from summer breeding birds, probably due to changes in food habits (Davis, 1954, 1961). However, this bias would not appear to be true for Tennessee Warblers collected in September as they are still largely insectivorous.

Adult Males: There were significant differences in total length, bill and tarsus length measurements of adult male Tennessee Warblers that were killed on different nights in the fall of 1961 (Table 4).

TABLE 4. MEASUREMENTS OF ADULT MALE TENNESSEE WARBLERS FROM THREE SAMPLES (FALL 1961)

Character	No.	3-4 Sept. Mean $\pm s_{\bar{x}}$	No.	11-12 Sept. Mean $\pm s_{\bar{x}}$	No.	13-14 Sept. Mean $\pm s_{\bar{x}}$
Total length*	17	128.9 ± 0.37	60	130.7 ± 0.32	28	130.5 ± 0.40
Wing spread N.S.	16	209.4 ± 0.71	58	211.0 ± 0.51	27	209.8 ± 0.76
Tail length N.S.	17	44.9 ± 0.33	62	44.5 ± 0.16	28	44.7 ± 0.34
Wing length N.S.	17	66.9 ± 0.33	63	66.8 ± 0.16	29	66.5 ± 0.29
Tarsus length*	17	17.06 ± 0.12	81	17.34 ± 0.06	28	17.05 ± 0.11
Bill length*	17	7.97 ± 0.12	77	8.03 ± 0.03	27	7.83 ± 0.06

N.S. = Non-significant difference (0.05 level)
* = Significant at the 0.05 confidence level.

While total length measurements show a significant difference from night to night, I do not believe there is any biological significance. This measurement is highly variable and difficult to take and I believe the differences exhibited are not useful or practical. I believe significant differences in bill and tarsus length measurements are meaningful, at least in broad terms of where migrants may have originated. Both measurements show the same pattern, i.e., largest on 11-12 September, and smallest on 13-14 September.

If one considers the geographic differences in bill length shown in Table 2 to indicate differences in general populations, then from bill

TABLE 2. GEOGRAPHIC VARIATION IN BILL, WING, AND TAIL LENGTHS OF MALE TENNESSEE WARBLERS. REGION NUMBERS CORRESPOND TO AREAS IN FIG. 1.

		Geographic Area						
Character	Statistic*	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
	N	34	74	26	44	23	29	35
	$\bar{x}$	7.87	7.91	7.99	7.98	8.08	8.17	8.15
Bill	s	0.39	0.28	0.33	0.29	0.26	0.38	0.32
Length	$s_{\bar{x}}$	0.07	0.03	0.06	0.04	0.05	0.07	0.05
	R	7.2–8.9	7.2–8.8	7.3–8.7	7.3–8.7	7.6–8.6	7.4–9.0	7.5–8.8
	N	34	75	26	49	23	31	36
	$\bar{x}$	65.7	65.8	65.4	66.0	65.5	65.7	65.4
Wing	s	1.6	1.3	1.1	1.5	1.2	1.3	1.8
Length	$s_{\bar{x}}$	0.3	0.1	0.2	0.2	0.3	0.2	0.3
	R	63–70	63–69	63–67	63–69	63–67	63–68	62–69
	N	34	73	25	48	23	30	37
	$\bar{x}$	43.9	43.7	43.4	43.8	43.4	43.8	44.1
Tail	s	1.3	1.5	1.3	1.5	1.6	1.7	1.7
Length	$s_{\bar{x}}$	0.2	0.2	0.3	0.2	0.3	0.3	0.3
	R	42–47	41–47	41–47	40–47	41–47	41–48	41–49

*N = sample size; $\bar{x}$ = mean; s = standard deviation; $s_{\bar{x}}$ = standard error of the mean; R = range.

TABLE 3. GEOGRAPHIC VARIATION IN BILL, WING, AND TAIL LENGTHS OF FEMALE TENNESSEE WARBLERS. REGION NUMBERS CORRESPOND TO AREAS IN FIG. 1.

Geographic Area

Character	Statistic*	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
	N	6**	10	4**	11	4**	16	16
	$\bar{x}$	8.08	7.88	8.00	7.93	7.95	7.93	8.00
Bill	s		0.33		0.33		0.33	0.36
Length	$s_{\bar{x}}$		0.10		0.10		0.08	0.09
	R		7.2–8.3		7.2–8.4		7.4–8.5	7.3–8.6
	N	6**	12	4**	11	4**	16	16
	$\bar{x}$	62.3	61.7	62.8	61.3	62.3	61.7	61.8
Wing	s		1.2		1.6		1.6	1.6
Length	$s_{\bar{x}}$		0.4		0.5		0.4	0.4
	R		60–64		58–63		59–64	58–64
	N	6**	12	4**	10	4**	16	16
	$\bar{x}$	40.5	40.9	41.25	40.7	42.5	40.9	42.7
Tail	s		1.4		1.6		1.6	1.7
Length	$s_{\bar{x}}$		0.4		0.5		0.4	0.4
	R		38–43		38–43		38–44	41–47

*N = sample size; $\bar{x}$ = mean; s = standard deviation; $s_{\bar{x}}$ = standard error of the mean; R = range.
**Variation about the mean not calculated for samples less than ten.

length measurements in Table 4 it may be concluded that adult male migrants on the night of 13-14 September originated farther north or northwest than migrants on the other two nights. The mean bill measurements of 7.83 mm. for the 13-14 September 1961 sample of adult male migrants agrees very closely to the 7.87 mm. mean bill measurement for adult males from Region 1. Measurements of 3-4 and 11-12 September 1961 samples of adult male migrants agree most closely with measurements of males from Region 2, and it is possible that these birds originated from somewhere in the general area of Hudson's Bay, central Manitoba or central Ontario. These measurements may also indicate a general mixing of northern and southern breeding birds during migration.

The mean tarsus length is nearly identical for adult males from the 3-4 and 13-14 September 1961 samples, the significant difference being in the larger mean measurement of the 11-12 September sample of adult males. Since tarsal lengths were not measured on museum specimens from the breeding grounds, the measurements from the TV tower killed birds cannot be compared to birds from a known geographical area; however, it is logical to assume that tarsus length may vary as does bill length, according to Allen's Rule, smaller in the north and larger in the south. Since Tennessee Warblers are so homogeneous in their mensural characters (within each sex, Tables 2 and 3), it would be unlikely that the tarsus and bill lengths would vary in the same degree from region to region. But the fact that significant differences did occur in both bill and tarsus measurements, and in a similar trend, supports the idea that these differences may have real value in determining broad areas of origination of migrants if adequate samples are available. Measurements on any individual could not be used even to guess where an individual had originated.

TABLE 5. MEASUREMENTS OF ADULT MALE TENNESSEE WARBLERS FROM THREE SAMPLES (FALL 1962)

	9-10 Sept.		10-11 Sept.		2-3 Oct.	
Character	No.	Mean $\pm s_{\bar{x}}$	No.	Mean $\pm s_{\bar{x}}$	No.	Mean
Tarsus length N.S.	39	17.03 ± 0.07	57	17.16 ± 0.08	4**	17.13
Bill length N.S.	34	7.90 ± 0.06	56	7.93 ± 0.06	4**	7.83

N.S. = Non-significant difference (0.05 level).
** = Omitted from analysis of variance because of insufficient sample size.

Table 5 shows that there were no significant differences in tarsus or bill measurements of adult males killed on different nights in the fall of 1962 and that both samples were "small" billed birds, thus indicating they had come from Regions 1 or 2.

It appears that all samples of adult males from both 1961 and 1962 apparently originated from the northern parts of the breeding range, Region 1 or 2. I believe that large kills of Tennessee Warblers at the Eau Claire, Wisconsin TV tower would generally involve birds from the northern parts of their breeding range. Eau Claire is in position to intercept migrants from vast areas in the northern parts of the Tennessee Warbler breeding range, but would draw from a far smaller portion of the southern breeding populations.

Immature Males: Table 6 shows the variations in measurements of immature male Tennessee Warblers from the kills in 1961. The small sample from the night of 13-14 September did not allow comparisons with the other nights, and 13-14 September was the night

TABLE 6. MEASUREMENTS OF IMMATURE MALE TENNESSEE WARBLERS FROM THREE SAMPLES (FALL 1961)

	3-4 Sept.		11-12 Sept.		13-14 Sept.	
Character	No.	Mean ± $s_{\bar{x}}$	No.	Mean ± $s_{\bar{x}}$	No.	Mean
Total length N.S.	16	127.9 ± 0.60	28	127.9 ± 0.47	4**	128.3
Wing spread N.S.	15	208.1 ± 1.24	25	206.5 ± 0.97	4**	206.8
Tail length*	16	44.1 ± 0.32	30	43.1 ± 0.29	4**	42.3
Wing length*	16	66.3 ± 0.36	30	65.1 ± 0.34	4**	64.8
Tarsus length*	17	16.92 ± 0.12	41	17.27 ± 0.09	4**	17.35
Bill length N.S.	16	8.08 ± 0.07	39	8.00 ± 0.04	4**	7.93

N.S. = Non-significant difference (0.05 level).
* = Significant at the 0.05 confidence level.
** = Omitted from analysis of variance because of insufficient sample size.

that adult males were "smaller". However, age and sex ratios of the kills (unpublished data; Minnesota Museum of Natural History) show that there is no reason to believe that immatures are migrating with adults from the same broad region of origination.

The bill measurements for immature males in the fall of 1961 indicate they originated in Region 2 or 6, if it is assumed that growth of the bill is completed, which may not be true. Tarsus measurements show a significant difference between 3-4 and 11-12 September. The interpretation of the measurements of immatures is even more subjective than for adults. However, I would conclude that these birds did not originate from Region 1. I do not consider the significant differences in tail and wing length measurements to be important as an indicator of different geographic origin. There is no geographical difference in tail or wing lengths of adult males (Table 2). Immature Tennessee Warblers in the fall have not attained adult size in wing and tail measurements (Raveling and Warner, 1965) growth may still be occurring, dependent upon the time of hatching, molting, etc.

TABLE 7. MEASUREMENTS OF IMMATURE MALE TENNESSEE WARBLERS FROM THREE SAMPLES (FALL 1962)

	9-10 Sept.		10-11 Sept.		2-3 Oct.	
Character	No.	Mean ± $s_{\bar{x}}$	No.	Mean ± $s_{\bar{x}}$	No.	Mean ± $s_{\bar{x}}$
Tarsus length N.S.	17	17.05 ± 0.12	29	17.03 ± 0.08	19	16.98 ± 0.14
Bill length N.S.	16	7.90 ± 0.08	30	7.87 ± 0.05	19	7.74 ± 0.08

N.S. = Non-significant difference (0.05 level).

Table 7 shows the measurement variations in immature males from samples in the fall of 1962. There were no significant differences from night to night, and these measurements indicate that these migrants originated from the northern part of the breeding range, Region 1 and/or 2, which was also concluded for the adult males in the 1962 sample.

Adult Females: There were no significant differences in any measurements of adult females killed in both 1961 and 1962 (Tables 8 and 9). While bill and tarsus measurements in 1962 tended to be slightly smaller than in 1961 (the same pattern as for adult males),

TABLE 8. MEASUREMENTS OF ADULT FEMALE TENNESSEE WARBLERS FROM THREE SAMPLES (FALL 1961)

Character		3-4 Sept.		11-12 Sept.		13-14 Sept.
	No.	Mean $\pm$ $s_{\bar{x}}$	No.	Mean $\pm$ $s_{\bar{x}}$	No.	Mean $\pm$ $s_{\bar{x}}$
Total length N.S.	19	125.1 $\pm$ 0.51	77	125.6 $\pm$ 0.27	23	126.6 $\pm$ 0.47
Wing spread N.S.	16	200.9 $\pm$ 0.84	76	201.3 $\pm$ 0.52	28	200.6 $\pm$ 0.71
Tail length N.S.	20	42.2 $\pm$ 0.37	81	42.0 $\pm$ 0.16	28	41.4 $\pm$ 0.23
Wing length N.S.	20	62.6 $\pm$ 0.34	81	62.8 $\pm$ 0.18	28	62.7 $\pm$ 0.15
Tarsus length N.S.	20	17.08 $\pm$ 0.12	85	17.00 $\pm$ 0.06	28	17.01 $\pm$ 0.08
Bill length N.S.	19	7.87 $\pm$ 0.07	84	7.94 $\pm$ 0.03	27	7.93 $\pm$ 0.07

N.S. = Non-significant difference (0.05 level).

there were not significant differences. There appears to be less geographic variation in the bill lengths of females as compared to males from region to region, based on limited female samples (Table 3). This appears to be substantiated by measurements of adult females killed at the TV tower which do not show significant differences among any samples.

TABLE 9. MEASUREMENTS OF ADULT FEMALE TENNESSEE WARBLERS FROM THREE SAMPLES (FALL 1962)

Character		9-10 Sept.		10-11 Sept.		2-3 Oct.
	No.	Mean $\pm$ $s_{\bar{x}}$	No.	Mean $\pm$ $s_{\bar{x}}$	No.	Mean
Tarsus length N.S.	22	16.89 $\pm$ 0.11	47	16.90 $\pm$ 0.09	2**	16.85
Bill length N.S.	22	7.83 $\pm$ 0.07	44	7.80 $\pm$ 0.05	2**	7.95

N. S. = Non-significant difference (0.05 level).
** = Omitted from analysis of variance because of insufficient sample size.

Immature Females: There were no significant differences in any of the measurements for the three samples of immature females in 1961 (Table 10). Table 11 shows no significant difference among the 1962 samples in bill and tarsus measurements of immature females. The mean bill length of the combined 11-12 September 1961 and all 1962 samples of immature females (7.87 mm.) is significantly different from the mean bill length of the combined 3-4 and 13-14 September 1961 samples of immature females (8.04 mm.) at the

TABLE 10. MEASUREMENTS OF IMMATURE FEMALE TENNESSEE WARBLERS FROM THREE SAMPLES (FALL 1961)

	3-4 Sept.		11-12 Sept.		13-14 Sept.	
Character	No.	Mean $\pm s_{\bar{x}}$	No.	Mean $\pm s_{\bar{x}}$	No.	Mean $\pm s_{\bar{x}}$
Total length N.S.	21	125.5 ± 0.51	34	125.7 ± 0.53	13	125.9 ± 0.76
Wing spread N.S.	22	199.4 ± 0.88	35	201.1 ± 0.67	13	199.2 ± 1.69
Tail length N.S.	22	41.5 ± 0.29	36	41.6 ± 0.26	13	40.5 ± 0.42
Wing length N.S.	22	62.3 ± 0.33	37	62.7 ± 0.24	14	61.9 ± 0.36
Tarsus length N.S.	22	17.02 ± 0.09	42	17.00 ± 0.09	13	17.05 ± 0.21
Bill length N.S.	21	8.05 ± 0.05	41	7.92 ± 0.04	13	8.02 ± 0.08

N.S. = Non-significant difference (0.05 level).

0.05 level (analysis of variance, comparisons involving sample variances; Steel and Torrie, 1960). The ranges of variation about the means in the geographical analyses of female bill lengths (Table 3) prohibit any conclusions on geographical origin of females killed at the TV tower. Also, as pointed out for the immature males, growth may not be complete, a factor which could make any conclusions about geographic origin completely erroneous. Note that measure-

TABLE 11. MEASUREMENTS OF IMMATURE FEMALE TENNESSEE WARBLERS FROM THREE SAMPLES (FALL 1962)

	9-10 Sept.		10-11 Sept.		2-3 Oct.	
Character	No.	Mean $\pm s_{\bar{x}}$	No.	Mean $\pm s_{\bar{x}}$	No.	Mean $\pm s_{\bar{x}}$
Tarsus lengthN.S.	18	16.84 ± 0.13	44	16.87 ± 0.08	15	16.91 ± 0.15
Bill length N.S.	16	7.88 ± 0.08	42	7.87 ± 0.05	15	7.72 ± 0.08

N.S. = Non-significant difference (0.05 level).

ments for both immature males and females killed on 2-3 October 1962 are the smallest of any sample. Age ratios of kills in 1961 and 1962 (unpublished data; Minnesota Museum of Natural History) indicate that immatures precede adults and that one would expect a higher proportion of adults in a kill of Tennessee Warblers in October. But the 2-3 October 1962 kill was composed of 85 per cent immature birds. Possibly these may represent late hatched birds and as such, their measurements may be even less reliable than measurements of the other samples of immature birds.

Since Tennessee Warblers exhibit so little geographic variation, it is difficult to attempt to estimate the origin of migrants killed at the TV tower. However, the significant differences exhibited in bill lengths of samples of adult males killed on different nights of migration and the significant differences, even though small, of bill lengths of Tennessee Warblers from different parts of the breeding range indicate the possibilities of identifymg large samples of migrants as to their area(s) of origin. Subsequent work at the Museum of Natural History on samples of Northern Waterthrushes and Yellow Warblers (*Dendroica petechia*) killed at TV towers, two species which exhibit considerably more geographic variation than Tennessee Warblers, do indeed show the possibilities of relating migrants to their breeding grounds and that these attempts may be very fruitful. Eventually migration patterns of many species may be worked out based on a knowledge of variation and flight potential. A preliminary attempt at estimating the migration pattern of Tennessee Warblers killed at Eau Claire has been made (Raveling and LeFebvre, 1964 MS).

SUMMARY

Geographic variation in Tennessee Warblers was determined from June and July collected museum skins. Bill length of males was the only character that exhibited significant geographic variation. Bill lengths of males from the Northwest Territories, N. Alberta, N. Manitoba and Ontario along the Hudson's and James Bay coastal areas were significantly smaller than bill lengths of males fromMinnesota, S. Ontario and Manitoba, Alberta and British Columbia.

Variation in several mensural characters was calculated for all age-sex classes of six samples of Tennessee Warblers killed at a television tower during fall migration in 1961 and 1962. There were significant differences between some of these samples within an age-sex class. It is believed that significant differences exhibited by samples of males in bill lengths allows one to estimate their area(s) of origin from the breeding grounds by comparing the measurements to that already established in the analyses of geographic variation. Subsequent analyses of species that exhibit considerably more geographic variation than the Tennessee Warbler show that future work in comparing migrant samples with known geographic variability should indeed enable one to estimate the area(s) of origin of migrants. With a knowledge of geographic variation and of flight potential it should become possible to estimate migratory patterns of several species.

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