

the area before the first individual was caught, and again, some might remain in the area for some time after the last capture. Evidence that they were captured in random fashion during the period in which they entered the traps would not give information on this point.

The test thus applies specifically to those individuals which are vulnerable to trapping, and provides no information about those which refuse to enter the traps for any one of various reasons.

For another example we may consider trapping reports on the Cardinal, *Richmondena cardinalis*, for a period extending from Jan. 4, 1953 to May 24, 1953. During this time the average number of cardinals caught per day was 1.6. Analysis by this "runs" method showed a random pattern of captures. However, further analysis (Young, 1958), which considered recaptures, showed that the individual birds did not repeat in random fashion.

The techniques here described would seem to be of value in preliminary consideration of small sample data. Where indications are that the sampling technique *per se* was selective, i.e., non-random (and this is often the case), the use of data drawn from the sample must be made with due caution.

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*Dept. of Biology, Wisconsin State College, LaCrosse, Wisc.*

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**REPORT ON THE CAUSE OF MORTALITY AND THE  
MORPHOMETRY OF SEVENTY RUBY-CROWNED KINGLETS  
KILLED AT THE WENH-TV TOWER IN DEERFIELD,  
NEW HAMPSHIRE**

BY PHILIP J. SAWYER

The University of New Hampshire began use of the educational TV channel 11 in 1959 in conjunction with other educational institutions in New Hampshire. Part of the installations constructed to activate the station consist of a supported tower 360 feet high topped by a 12 bay antenna, one foot in diameter and 76 feet high. This structure was erected at a point about 1100 feet in elevation on Saddleback Mountain in Deerfield, N. H. The tower is guyed at three points equi-

distant from each other. There are four cables running from the ground up to the tower from each of these three areas. They are attached at the 100, 200, 300 and 400 foot levels of the tower. This makes the total unit consist of the 436 foot structure plus its 12 supporting guy wires. Several papers have appeared in past years concerned with bird mortality at various types of structures associated with radio, television and air bases. (Howell, Laskey and Tanner, 1954, Johnston and Haines, 1957, Kemper, 1958.) With this information in mind, advantage was taken of the opportunity to study any possible mortality that might be associated with this new obstruction near the Atlantic Coast. This investigation began in April, 1959, during the first spring the tower was present on the mountain. This paper is concerned with part of the mortality that occurred on the night of October 13-14, 1959. Seventy-four Ruby-crowned Kinglets were found among the 130 birds killed that night. Seventy of these specimens were in good enough condition to be used for the purposes of this investigation.

The dimensions of the Ruby-crowned Kinglet are known, of course, but a search of the literature failed to uncover measurements of a group of kinglets similar to the one discussed here. The sample included mature and immature males and females, all collected at once, and taken at random from a fall-migrating flock.

#### METHODS

The measurements recorded consisted of weight, total length, bill length, wing length, tarsus length, extent and tail length. These dimensions were taken as described in Pettingill, 1956. The age of the birds was determined by search for the Bursa of Fabricius in the cloaca. If it was found to be present, the bird was called immature, if absent, the individual was considered adult (Pettingill, 1956). It was impossible to distinguish adults from immatures by their plumage, except in a few cases. Some juvenile males had only two or three red feathers in their crown and were properly called immature before their large bursae of Fabricii were dissected out. The maturity of the females could not be judged externally. The postjuvinal molt is accomplished before the bird migrates. It involves the contour plumage and the wing coverts, but not the rest of the wings and tails. This produces a first winter plumage which is practically indistinguishable from that of the adult in each sex (Bent, 1949).

#### WEATHER ASSOCIATED WITH THE MORTALITY PERIOD

Weather conditions are very often responsible for migratory accidents and Devlin and Wykoff (1957) have shown diagrammatically how mortality may be associated with weather fronts. A certain amount of information concerning the weather conditions during the night of October 13-14, 1959 is available even though no meteorological equipment was installed on Saddleback Mountain. The engineer in charge of transmission at the tower recorded a temperature of 48°F on the mountain top early in the evening of October 13, 1959 and one of 32°F early in the morning of October 14, 1959. This data is not precise, but it does show a drop of air temperature of 16°F which might well accompany a change of air mass. More authoritative in-

formation was obtained from Mr. Robert E. Lautzenheiser, State Climatologist, Weather Bureau, U. S. Department of Commerce, Boston, Massachusetts (personal communication). He was able to describe, from records available to him, an area of light rain that occurred around 2:00 A.M. and a little later on October 14, 1959, just south of Saddleback Mountain. I quote from his letter: "Though Saddleback appears to be in the area of no rain that night, the extra elevation of the mountain may possibly have caused locally some small amount of rain. Height of the clouds also may have been lower at the Mountain. Ceiling or cloud height at 2 A.M. Daylight time was reported as 2700 feet at Boston and 3500 feet at Concord. Horizontal visibility was good at both places, 8 and 20 miles, respectively, at that time."

When he considered temperature his comments were as follows: "The maxima on the 14th were only slightly lower, by 4 to 8° or so, than the maxima of the previous day. This would not indicate an important cold front in the area, but rather a gradual influx of cooler air from the high pressure area to the west as the rain area moved out."

Mr. Lautzenheiser requested comments from Mr. Richard Fay, Research Forecaster, Weather Bureau Airport Station, East Boston on the weather of that night. Mr. Fay described the storm that brought rain to the area south of Saddleback Mountain corroborating Mr. Lautzenheiser's statements. Some of his other remarks regarding weather about the area in question were interesting. "Low level winds (not over 2000 feet) were NW about 15 knots at 7 P.M., N 5 to 10 at 1 A.M. and NE 10 at 7 A.M. Mt. Washington temperatures ranged from 18 to 12°, where the station was in the clouds until 1 A.M. but where it cleared by morning. A guess on the lapse rate indicates that the freezing level might have been as low as 900 feet in southern N. H."

The facts quoted above seem to be meteorological bases for a speculation that conditions aloft might have been sufficiently inclement to have caused these birds to have flown at a lower than normal elevation. The 1536 foot total height of the mountain plus the tower could have extended upward into their migratory path. Therefore, the combination of weather and the occurrence of a TV antenna seem to be responsible once again for bird mortality.

#### MORPHOMETRY OF THE KINGLETS AND ITS STATISTICAL INTERPRETATION

Table 1 summarizes the weight and body measurements made on each bird. Examination of these data shows that adult and immature males were similar in size. The dimensions recorded for the adult and immature females show likewise the similarity between those two age groups. More obvious differences may be noted when the dimensions of the males and females are compared. The weight and measurement data were subjected to the analysis of variance. A randomized block design was used. Results of these analysis appear in Table 2.

Table 2 shows that the differences between males and females are statistically significant for body weight, total and wing length, extent, tarsus and tail measurements. The males were larger for each characteristic. Neither the sex difference in bill length nor the age difference in any of the six other traits were significant. The measurement differences between the two age groups were in no instance significant.

Table 1. Weight and linear body measurements of 70 Ruby-crowned Kinglets by age and sex.

Trait measured and measurement unit	Adult			Immature		
	Males (26) <sup>a</sup>		Females (20)	Males (13)		Females (11)
	Av.	Range	Av.	Range	Av.	Range
Weight (gms)	7.16	6.3-7.9	6.74	5.9-7.3	7.16	6.2-7.7
Total Length (mm)	105.6	102-111	103.2	98-108	105.0	101-108
Bill (mm)	8.8	8-10	9.0	8-10	9.0	8-10
Wing (mm)	57.1	54-60	54.1	52-58	56.8	52-59
Extent (mm)	174.0	169-180	166.7	158-174	170.9	160-182
Tarsus (mm)	18.5	17-19	17.9	17-19	18.5	18-20
Tail (mm)	44.6	42-47	41.7	39-46	44.3	41-47

<sup>a</sup> Number of specimens

Table 2. Analysis of variance of different measurements made on the Kinglets

Source of Variation	d.f.	Weight	Total Length	Bill Length	Wing Length	Extent	Tarsus Length	Tail Length
		M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.
Sex	1	704.59**	56.0*	0.18	168.41**	5.19**	7.08**	138.85**
Age/Sex	2	42.27	6.0	0.18	1.32	0.23	0.20	0.44
Individuals	66	21.53	8.6	0.23	2.38	0.16	0.39	1.87

\* = significant at the .05 confidence level

\*\* = significant at the .01 confidence level

M.S. = mean square or variance — a measure of variation

This table summarizes the results of a statistical analysis of the comparative measurements made on the Kinglets. The object of the analysis was to test the likelihood that differences between sexes and between ages within a sex were greater than one would expect from chance alone. In conjunction with Table 1, Table 2 shows for weight, wing length, extent, tarsus, and tail length (traits with a double asterisk) that the odds are 99 to 1 that the sex differences were real. Similarly it indicates for total length (single asterisk) odds of 20 to 1 that the sex differences are real. Since an asterisk does not appear after the bill length mean square for sex, nor after any of the mean squares for age within sex, this indicates that differences found in these measurements were in all probability due to chance. Individuals mean square was used for testing sex and age within sex sources of variation for statistical significance.

## SUMMARY

A partial analysis of the meteorological conditions present on the night of October 13-14, 1959, at the WENH-TV tower in Deerfield, N. H., seems to indicate that inclement weather was responsible for causing 130 birds to collide with the tower and its guy wires. Seventy Ruby-crowned Kinglets found among the casualties were grouped by sex and age. Body weight, total length, extent, wing, tail and tarsus length were greater in males than in females by a difference which was statistically significant. The sex difference in bill length was not significant. No significant difference was shown between immature and adult specimens.

## ACKNOWLEDGMENTS

The Central University Research Fund of the University of New Hampshire provided the necessary funds to support this project. It is with pleasure that I acknowledge its support. Mr. Walter J. Swenson, transmitter engineering supervisor at the WENH-TV transmitter, and Mrs. Swenson collected faithfully all the birds killed at the tower. They recorded the locality at which they found the specimens, and deposited them in a deep freeze. Without their help this paper could not have been written. University of New Hampshire faculty members, Professor Owen B. Durgin, Sociology Department, and Dr. Walter M. Collins, Poultry Department, provided statistical help for which I am very grateful. Dr. Collins also made many helpful suggestions concerning the presentation of the statistical interpretation. Dr. Wilbur L. Bullock, Parasitologist, Zoology Department, University of New Hampshire, determined the presence or absence of the *Bursae of Fabricii* during his search for parasites in the digestive tract of the kinglets. I am pleased to acknowledge his help. Dr. John F. Reed, Dean of the College of Liberal Arts and Dean of the Graduate School of the University of New Hampshire, suggested originally that bird mortality be investigated at the TV tower.

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Appendix A — Measurements of 70 Ruby-crowned Kinglets  
Adult Males in grams and millimeters

Weight	Total Length	Bill	Wing	Wing Span	Tarsus	Tail
7.8	105	8	60	173	19	46
7.9	105	9	58	171	19	45
6.9	103	8	59	174	18	47
7.5	104	9	59	175	19	45
7.3	103	8	55	167	18	44
7.1	108	9	56	167	18	45
7.2	102	9	58	170	19	44
6.9	105	8	57	171	19	44
6.5	107	9	55	175	19	45
7.7	111	8	58	174	19	45
7.1	103	9	56	171	19	43
7.1	105	9	59	180	18	47
7.5	109	9	58	177	18	47
6.7	105	8	56	174	18	45
7.8	101	9	55	174	19	44
7.1	101	9	54	168	18	45
6.6	103	9	55	175	19	42
6.3	108	9	56	178	18	44
7.2	109	9	59	180	18	44
7.4	104	9	56	177	19	44
7.3	105	10	58	172	18	45
7.2	105	9	59	180	19	45
7.1	108	9	57	172	18	44
7.4	110	10	58	179	18	44
7.1	110	9	58	178	18	44

## Immature Males

Weight	Total Length	Bill	Wing	Wing Span	Tarsus	Tail
6.9	105	8	59	160	19	43
7.3	105	9	54	165	19	43
7.7	104	9	58	173	18	44
7.5	106	9	57	174	18	45
7.4	108	9	57	175	18	43
7.1	101	9	58	170	19	45
6.7	107	9	58	171	19	45
7.1	104	9	58	171	18	44
6.9	101	9	52	160	18	41
7.3	107	10	57	175	18	46
6.2	107	9	58	182	20	46
7.7	103	9	55	170	18	44
7.4	107	9	58	176	18	47

## Adult Females

7.3	107	8	58	172	17	46
7.1	107	10	54	175	17	41
7.0	101	9	54	162	18	42
6.9	108	8	53	167	19	40
7.3	108	9	55	171	19	43
6.4	100	9	52	159	19	39
6.6	102	9	54	161	18	42
6.4	105	9	53	162	18	39
6.8	104	9	54	168	17	41
6.8	98	9	52	165	17	42
6.6	103	9	52	158	18	42

## Adult Females (cont.)

Weight	Total Length	Bill	Wing	Wing Span	Tarsus	Tail
6.9	100	9	53	159	17	40
6.9	100	9	54	167	19	42
6.9	105	9	55	174	19	43
6.4	104	9	54	170	17	42
6.8	99	9	54	166	18	41
6.8	99	9	55	172	18	42
6.6	107	9	55	170	18	42
6.4	100	9	55	170	17	41
5.9	107	9	55	166	17	43

## Immature Females

6.2	106	9	53	163	18	40
6.8	107	8	54	167	18	43
7.1	108	9	55	171	17	42
6.5	102	10	55	166	18	42
6.8	103	9	54	169	18	43
5.8	108	9	54	168	18	42
6.7	103	9	53	170	17	42
6.4	100	10	53	165	18	41
6.1	100	9	53	162	18	42
6.3	105	9	53	165	18	42
5.6	105	9	53	165	18	40

*Dept. of Zoology, University of New Hampshire, Durham, N. H.*

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## GENERAL NOTES

**Life History of a Ten-Year-Old Chimney Swift**—Several years ago the writer published a detailed account of the life history of a ten-year-old female Chimney Swift (*Auk*, 73: 276-280, 1956). Since then, another female Chimney Swift has completed ten years of life on the campus of Kent State University, in Kent, Ohio, and its life history is outlined here. The pattern is similar to the previous study, but there are many interesting variations.

This bird, wearing band no. 48-164510, will be referred to throughout this report as —10 for simplicity. This bird was banded as a juvenile in air shaft B1 on the roof of Kent Hall on August 4, 1949. Three other juveniles were banded at the same time and place, all being trapped with the parent birds which had nested in B1. However, these adults were not the parents of the newly banded juveniles, since their own offspring were at that time roosting at the bottom of the shaft where they had been living since their nest had fallen from the wall during a heavy rainstorm on July 31. (The survival of birds from fallen nests has been discussed by the writer in the following references: *Auk*, 69: 289-293. 1952, and 77: 352-354. 1960.)

No. —10 was retrapped as a return on May 18, 1950, from shaft A4 and was taken with another return, no. 48-164517, which will subsequently be designated as —17. These two soon moved into the adjoining shaft A5 where they remained for the nesting season. They started building on June 1. Five days later, they started a second nest foundation a few inches above the first one. After two more days, they constructed a third foundation beside the first one. The birds

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