ANALYSIS OF MASS BIRD MORTALITY IN OCTOBER, 1954

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IN recent years there have come to the attention of ornithologists an increasing number of instances of mass bird mortalities in the eastern and southern United States. These instances have occurred at airport ceilometers, radio and television antennae, and tall buildings, and have been associated primarily with nocturnal autumnal migration. Various climatological, biological, and physical aspects of the mortalities have been investigated by ornithologists, especially in Tennessee, where instances of mass mortalities in the autumn have been more frequent than in other states (see Howell *et al.*, 1954). The most noticeable and widespread series of mortalities occurred in the fall of 1954 when, between October 5 and 8, twenty-five instances were reported from New York to the South Atlantic states; many of them claimed prominent places in newspaper and magazine accounts. Although these unprecedented mortalities are in a sense unfortunate, a compilation of the records and analysis of the data will help to supplement our present knowledge of nocturnal autumnal migration, inasmuch as each occurrence is a small sample, literally snatched from the air, from a flock of migrants. Furthermore, the largest kill in recorded history occurred at Warner Robins Air Force Base near Macon, Georgia, during this time, and a detailed study of this event has furnished intensive qualitative and quantitative data, thus complementing the extensive data revealed by a survey of the total mortality incidents over the eastern and southern states during this period.

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CAUSES

Most of the details of ceilometer mortality causes have been reviewed by Howell *et al.* (*op. cit.*) and are in agreement with the generalities set forth here. The late summer and autumn of 1954 was unusually hot and dry in the eastern and southern states; this protracted spell was virtually unbroken until the season's first cold front moved from New England (October 5) to the gulf states (October 8). Appearing immediately after the prolonged hot and dry season, the sudden change in weather conditions associated with the advancing front was rather severe: increased winds, decreased temperatures, drizzle or light rains, and lowered cloud ceilings. As the front advanced southward, it caught up with many of the migrants that were being pushed ahead of it. This was more noticeable at the southernmost locations (see Table 1). The sounds of migrants flying overhead were unusually noticeable on these nights, whereas on previous, clear nights, they were rarely heard. In fact, on the basis of the weather conditions mentioned above, ceilometer mortalities can be predicted rather accurately (see Laskey, 1956).

The precise role of each of the climatic conditions has not been determined, but, as far as mortalities were concerned, a lowered cloud ceiling had drastic effects on the migrants. As the cold front progressed southward, weather stations reported a ceiling sometimes as low as 800 feet, and apparently the nocturnal migrants were flying at or below this level. If they had been flying higher, they would not have collided with the various radio and television antennae mentioned below. Bartlett (*fide* Howell *et al.*, *op. cit.*) observed that birds fluttering around in the ceilometer beam must have come from higher elevations, but other observers reported that birds which passed through the ceilometer (apparently unaffected by it) were in level flight.

Thus the stage was set, as it were: a large mass of migrating birds was flying at night at unusually low heights. This being the case, at least three types of physical obstructions beset the migrants. The most potent of these was the airport ceilometer, which is an intense, narrow beam of light used commercially to detect the height of the cloud ceiling. It was this lighted "sky trap" which took the largest toll of birds; fifteen of the mortality instances were at ceilometers.

We believe that birds are attracted to this powerful beam of light and some fly on through it, but others become temporarily blinded and/or disoriented so that they either fly into each other or, more commonly, dash themselves against the ground, low buildings, or other objects. Indeed, an observer at Warner Robins Air Force Base noted birds flying straight downward in the beam and bouncing off a concrete runway! In addition to the mortality instances at the ceilometers, eight instances were reported at radio and television antennae, varying in height from 200 to 1062 feet. It is probable that birds are not attracted by the lights on these towers to the same extent that they are attracted by ceilometer beams; otherwise, more birds would have been killed at the towers. Rather, these towers serve primarily as physical obstructions to the low-flying birds. Finally, in at least three other instances birds struck tall buildings, and at Oak Ridge, Tennessee, the birds were apparently killed by striking high tension wires around a brightly illuminated parking area. In the final analysis, the innumerable instances of hemorrhages and broken bones now provide undisputed evidence that death came as the result of collisions with solid objects.

ANALYSIS OF RECORDS

Table 1 lists the twenty-five localities at which incidents of mortality were reported between October 5 and 8, 1954. The data from Dannelly Field and Maxwell Air Force Base at Montgomery, Alabama, have been combined, and the total number of individuals counted is not precise because the air base records were given in percentages. From six of the localities (Topeka, Greensboro, Shelbyville, Johnson City, Charleston, and Hunter Air Force Base) only the totals as indicated in the table were obtainable, but from the other nineteen localities, in the samples which were counted, the total number of each species was obtained.

From these figures plus an examination of the raw data from each station, several significant facts are noticeable. More instances of mortality and more birds were recorded in the southern states than in the northern states. On the night of October 5–6 at the five northernmost localities, at least 61 species and 2756 individuals were reported. The ten southern localities where mortalities occurred on October 6–7 recorded 51 species and 4478 individuals, and on October 7–8, the eleven southernmost localities reported 68 species and about 99,340 individuals.

In order to give the data from the nineteen localities as concisely as possible, a list of the species involved is presented. Following the

TABLE 1
LOCALITY DATA FOR MASS BIRD MORTALITY, OCTOBER, 1954

Locality	*Night of mortality*	*Number of species counted*	*Number of individuals counted*	*Total number estimated or counted*
Hempstead, N. Y.	Oct. 5–6	34	230	plus "others"
Westhampton, N. Y.	Oct. 5–6	48	596	2000
New York, N. Y.	Oct. 5–6	27	123	400
Allentown, Pa.	Oct. 5–6	38	210	210
Topeka, Kans.	Oct. 5–6	31	146	146
Topeka, Kans.	Oct. 6–7	29	147	147
Winston-Salem, N. C.	Oct. 6–7	21	198	plus "others"
Greensboro, N. C.	Oct. 6–7			30
Nashville, Tenn.	Oct. 6–7	21	255	255
Shelbyville, Tenn.	Oct. 6–7			300
Oak Ridge, Tenn.	Oct. 6–7	22	453	1000
Knoxville, Tenn.	Oct. 6–7	26	267	267
Johnson City, Tenn.	Oct. 6–7	30		1000
Smyrna, Tenn.	Oct. 6–7	18	100	600
Chattanooga, Tenn.	Oct. 6–7	35	681	plus "others"
Atlanta, Ga.	Oct. 7–8	28	327	600
Charleston, S. C.	Oct. 7–8	23		"many hundreds"
Birmingham, Ala.	Oct. 7–8	36	1283	1600
Montgomery, Ala.	Oct. 7–8	22	500	18650
Augusta, Ga.	Oct. 7–8	12	81	200
Warner Robins, Ga.	Oct. 7–8	53	2552	50000
Savannah, Ga.	Oct. 7–8	22	289	289
Travis Field, Ga.	Oct. 7–8	19	73	2000
Hunter Field, Ga.	Oct. 7–8	26		25000
Turner Field, Ga.	Oct. 7–8	14	101	101
Okefinokee Swamp, Ga.	Oct. 7–8	31	883	900
Totals	Oct. 5–8	ca. 88	ca. 9495	ca. 106804

species name is the total number recorded at the nineteen localities, and the number in parentheses is the frequency of occurrence, in per cent, for that species in these localities. In all, 86 species and 9136 individuals are enumerated. The number of individuals in the list differs from the total in Table 1 because of incomplete data from some localities.

Pied-billed Grebe, 2 (11); Green Heron, 1 (5); King Rail, 2 (11); Clapper Rail, 1 (5); Virginia Rail, 6 (21); Sora, 35 (42); Yellow-billed Cuckoo, 6 (16); Black-billed Cuckoo, 4 (16); Whip-poor-will, 3 (16); Flicker, 4 (11); Crested Flycatcher, 1 (5); Phoebe, 1 (5); Yellow-bellied Flycatcher, 5 (11); Acadian Flycatcher, 5 (11); Alder Flycatcher, 1 (5); Least Flycatcher, 2 (5); Wood Pewee, 7 (11); White-breasted Nuthatch, 1 (5); Red-breasted Nuthatch, 1 (5); Brown Creeper, 1 (5); House Wren, 1 (5); Winter Wren, 1 (5); Long-billed Marsh Wren, 2 (11); Catbird, 117 (63); Wood Thrush, 120 (63); Hermit Thrush, 1 (5); Olive-backed Thrush, 530 (68); Gray-cheeked Thrush, 175 (47); Veery, 91 (37); Golden-crowned Kinglet, 3 (16); Ruby-crowned Kinglet, 5 (21); White-eyed Vireo, 18 (21); Yellow-throated Vireo, 68 (47); Blue-headed Vireo, 8 (16); Red-eyed Vireo, 821 (95); Philadelphia Vireo, 97 (58); Black and White Warbler, 261 (100); Swainson Warbler, 3 (16); Worm-eating Warbler, 9 (21); Golden-winged Warbler, 6 (21); Blue-winged Warbler, 1 (5); Tennessee Warbler, 576 (79); Nashville Warbler, 18 (26); Parula Warbler,

113 (47); Yellow Warbler, 3 (11); Magnolia Warbler, 995 (100); Cape May Warbler, 19 (47); Black-throated Blue Warbler, 92 (58); Myrtle Warbler, 46 (16); Black-throated Green Warbler, 83 (63); Blackburnian Warbler, 177 (84); Yellow-throated Warbler, 2 (5); Chestnut-sided Warbler, 703 (79); Bay-breasted Warbler, 161 (63); Blackpoll Warbler, 203 (42); Pine Warbler, 106 (21); Prairie Warbler, 7 (21); Palm Warbler, 149 (47); Oven-bird, 1172 (100); Water-thrush, 71 (53); Kentucky Warbler, 18 (42); Connecticut Warbler, 24 (32); Mourning Warbler, 2 (11); Common Yellow-throat, 505 (95); Yellow-breasted Chat, 28 (47); Hooded Warbler, 125 (53); Black-capped Warbler, 3 (11); Canada Warbler, 30 (32); Redstart, 273 (95); Bobolink, 7 (16); Baltimore Oriole, 4 (16); Scarlet Tanager, 330 (84); Summer Tanager, 29 (42); Rose-breasted Grosbeak, 51 (42); Blue Grosbeak, 8 (16); Indigo Bunting, 450 (79); Painted Bunting, 1 (5); Dickcissel, 7 (21); Towhee, 1 (5); Savannah Sparrow, 33 (26); Grasshopper Sparrow, 3 (16); Chipping Sparrow, 3 (5); White-throated Sparrow, 10 (16); Lincoln Sparrow, 4 (5); Swamp Sparrow, 61 (26); Song Sparrow, 3 (16).

The species recorded in the largest numbers usually showed the highest frequencies of locations: Oven-bird 1172 and 100 per cent, Magnolia Warbler 995 and 100 per cent, Red-eyed Vireo 821 and 95 per cent, and Chestnut-sided Warbler 703 and 79 per cent. These figures indicate that the most abundant species were present along the entire front of migrating birds and were not distributed spottily among the various locations. There were 33 species of Parulidae with 5984 individuals, 13 species of Fringillidae with 635 individuals, 5 species of Vireonidae with 1012 individuals, and 5 species of Turdidae with 917 individuals. Of the total number of individuals, the Parulidae comprised 65.5 per cent, the Vireonidae 11.1, the Turdidae 10.0, and the Fringillidae 7.0.

Most of the species were common summer residents or transients at each locality, but proportional abundances were usually higher than local ornithologists would have predicted on the basis of field observations. Furthermore, certain rarities occurred at various localities. The occurrence of only a few individuals of the Whip-poor-will, Yellow Warbler, Golden-winged Warbler, Blue-winged Warbler, flycatchers, and perhaps others would indicate that the bulk of these populations had already migrated, a fact which is substantiated by examination of normal migration dates for these species at a given locality. A few species which normally spend the winter at these localities appeared in the mortality records, and these were primarily in the northern areas, indicating that migration for these species had, for the most part, just begun. Such species would include the Brown Creeper, Hermit Thrush, kinglets, and several sparrows. In addition to the usual conspicuous migratory species, it is of some interest to note among these nocturnal migrants an occasional Clapper Rail, Flicker, Pine Warbler (in the south), and Towhee.

Although we have not compared the number for each species from one locality to another, Howell (1955) has indicated that significantly different groups of migratory birds pass over neighboring localities (Nashville and Knoxville, Tenn.) on the same night. The sample which he examined, however, was relatively small, and the several variables of wind direction and velocity, cloud ceilings, and physical obstructions might throw doubt on the statistical validity of such data.

THE DATA FROM WARNER ROBINS

On the night of October 7–8, 1954, the largest recorded ceilometer kill in history occurred at Warner Robins Air Force Base, a few miles south of Macon, Georgia. It involved 53 species and an estimated 50,000 birds, 2552 of which were examined. This is not only the largest single number of birds yet examined from one location, but it also represents as random a sample as possible from nocturnal migrants at this time of year at this location. We were fortunate in several respects because, even though dead birds were strewn by the hundreds over the runways, taxi strips, grassy plots, and tops of buildings, the sample of 2552 birds which we examined was from one roof (beside the ceilometer) and had been shovelled up and raked together completely at random by the workmen. Had we arrived on the scene first, we might have selected the least damaged, most conspicuous, and rarer species, and the sample might have been less representative.

With this large number of freshly killed birds on our hands overnight, we had to make the most profitable use of them in a short period of time. For those species numbering less than 25, each individual was weighed, sexed, and aged. For those numbering more than 25, we selected about 25 at random from the pile—without respect to size, intensity of coloration, or sexual dimorphism. This small sample of the larger sample was also weighed, sexed, and aged, and notes were kept as to the relative fatness of each bird. The results of some of these calculations are given in Table 2. Only those species for which we had data from more than twenty birds are presented.

The data in Table 2 lend themselves to comparisons with lean weights obtained by other investigators. For example, Catbirds weighed by Baldwin and Kendeigh (1938) in July averaged about 34 grams, a weight which is somewhat lighter than the average given for the fat Catbirds in Table 2 (more than 37 grams). Similarly, comparisons can be made between the weights in Table 2 and body weights of lean birds given by Hartman (1955). In general, the weights of lean birds in summer given by Baldwin and Kendeigh

TABLE 2

WEIGHTS (IN GRAMS) AND PERCENTAGES BY SEX AND AGE OF CERTAIN BIRDS FROM WARNER ROBINS AIR FORCE BASE

Species	*Number dissected*	*Adult males*	*Immature males*	*Adult females*	*Immature females*	*Per cent male*	*Per cent adult*
Catbird	28	16[1]:34.0–42.9 (38.0)[2]	6:35.4–39.0 (37.5)	6:32.9–39.2 (36.4)		78	78
Wood Thrush	27	17:48.0–70.9 (56.0)		8:52.9–65.2 (58.7)	2:54.8–71.5 (63.2)	63	93
Olive-backed Thrush	36	4:35.2–39.9 (37.2)	15:31.8–50.0 (40.0)	3:33.2–41.5 (36.8)	14:34.4–40.7 (37.9)	51	19
Gray-cheeked Thrush	35	4:38.5–41.7	14:29.9–50.5 (42.8)	4:32.3–41.7 (37.3)	14:29.7–45.2 (38.6)	49	22
Yellow-throated Vireo	28	11:19.3–25.0 (23.2)	2:21.6–24.0 (22.8)	12:21.9–25.2 (23.1)	3:21.3–22.0 (21.7)	46	82
Red-eyed Vireo	26	4:19.5–23.9 (21.6)	9:17.7–23.6 (20.2)	11:16.1–25.7 (21.9)	2:20.9–22.5 (21.7)	50	58
Black and White Warbler	24	6:9.8–12.3 (11.6)	4:9.9–11.7 (10.7)	7:10.4–14.1 (12.0)	7:10.0–12.4 (11.0)	42	57
Tennessee Warbler	28	5:10.5–13.8 (12.1)	9:9.0–12.7 (11.4)	1:11.6	13:9.0–12.9 (10.9)	50	21
Magnolia Warbler	29	1:9.9	9:7.0–10.5 (9.1)	6:9.6–11.3 (10.5)	13:7.7–11.9 (9.3)	34	27
Blackburnian Warbler	25	4:11.8–14.9 (13.0)	10:10.2–13.8 (12.2)	3:10.8–12.7 (11.6)	8:9.6–14.9 (11.8)	53	23
Chestnut-sided Warbler	28	5:12.0–14.3 (12.8)	5:12.4–14.0 (13.1)	7:10.7–13.9 (12.0)	11:10.2–13.5 (12.3)	36	41
Bay-breasted Warbler	28	8:13.5–17.1 (15.4)	3:11.5–16.6 (14.6)	8:11.0–16.2 (14.3)	9:10.9–15.1 (13.5)	39	55
Oven-bird	35	8:20.4–23.9 (21.9)	11:20.1–24.8 (22.8)	4:20.0–22.7 (21.9)	12:20.6–24.8 (22.5)	54	33
Yellow-throat	27	13:9.1–12.5 (10.8)	2:10.3	3:8.3–10.2 (9.5)	9:8.6–11.3 (10.0)	57	57
Hooded Warbler	25	8:11.9–13.1 (12.6)	6:9.5–14.3 (12.2)	5:9.8–12.8 (11.7)	6:10.0–13.4 (12.1)	56	54
Redstart	31	8:8.3–9.6 (8.9)	7:7.2–9.3 (8.5)	2:6.9–8.3 (7.6)	14:6.8–9.4 (8.2)	50	33
Scarlet Tanager	27	2:30.5–31.6 (31.0)		25:31.9–44.9 (36.9)		7	100
Indigo Bunting	33	17:13.9–17.3 (15.9)	3:15.8–19.1 (17.5)	8:12.7–18.7 (15.7)	5:14.0–19.0 (17.2)	61	76

[1] Number in this class examined.
[2] Figures in parentheses are means.

(*op. cit.*, Table 5, pp. 442–445) and Hartman (*op. cit.*, pp. 232–234) are appreciably less than the weights for the same species presented in Table 2 for fat birds obtained in October.

A complete list of the 2552 birds has been presented in an earlier paper (Johnston, 1955) and will not be repeated here except in part. Of the 53 species, 25 were Parulidae, 7 Fringillidae, 4 Vireonidae, 4 Turdidae, and so on. These figures are more impressive when one

takes into consideration the number of individuals killed: the Parulidae ranked first with 1380 (54 per cent), the Vireonidae second with 393 (15.4 per cent), the Turdidae third with 378 (14.4 per cent), the Fringillidae fourth with 184 (7.1 per cent), and so on. Of equal interest were the most abundant species: Red-eyed Vireo 346 (13.6 per cent), Chestnut-sided Warbler 320 (12.5 per cent), Magnolia Warbler 301 (11.8 per cent), Oven-bird 236 (9.3 per cent), Olive-backed Thrush 232 (9.2 per cent), Indigo Bunting 171 (6.7 per cent), Scarlet Tanager 148 (5.8 per cent), Tennessee Warbler 121 (4.7 per cent), Blackburnian Warbler 102 (4.0 per cent), and so on. These nine species accounted for 77 per cent of the total birds examined in the sample of 2552. With the exception of the vireo and bunting, all of these species nest north of the Warner Robins area and are primarily birds of the coniferous forest.

Out of 646 birds of 50 species which could be sexed, 322 or 49.9 per cent were males. Out of 658 birds of 49 species whose age could be correctly determined, 309 or 46.9 per cent were adults. These data are significant only in the light of an analysis of the entire migratory group, since there are considerable variations from one species to another. It is of interest to note, however, that the ratio of males to females and of adults to immatures is nearly 50:50. Were it not for the large number of birds examined, a 50:50 ratio of adults to immatures in a fall migratory group would not be expected.

Fat conditions.—As some of the birds were being prepared as study skins, and as the sex and age were being determined from others, notes were kept on the gross estimates of fat deposits. One would expect *a priori* that these birds would be fat, generally speaking, in order to sustain long migratory flights; most of the species involved in the kill were birds which fly overseas to Central and South America for the winter. Such was the case; indeed, of about 600 birds examined for fat content, the majority were classified as "very fat." An occasional bird was somewhat less fat than others of the same species, but small variations in a large sample were to be expected. (Subjective descriptions of fat deposits, of course, were not infallible.) The fact that most birds were "very fat" suggests that they had already begun a long migratory flight which perhaps could have carried them to Central or South America nonstop. This idea is embraced in the concept of the "coastal hiatus" of the southern United States, which proposes that most individuals of certain species migrate over the Coastal Plain of Georgia and Alabama without stopping. This hypothesis originated with ornithologists who noted the general absence of certain migrants on the Coastal Plain, and is further strength-

ened by the recent mortality records, especially from southern Georgia. In reviewing these records, Johnston (1955) has demonstrated the presence in mortality incidents of several species which are not normally recorded at a given locality. Thus, it may well be true that the birds which were migrating over Warner Robins on this night were on their way nonstop to their wintering grounds farther to the south.

Fat deposits were particularly noticeable in subcutaneous and abdominal areas. Most conspicuous were the heavy subcutaneous deposits along the lower part of the spinal feather tract. The area from the base of the tail to the upper back was frequently a solid mass of fat, the removal of which often resulted in tearing the skin badly. From an immature female Water-thrush weighing 22.1 grams, 4.1 grams of fat (18.5 per cent) were removed by scraping the skin alone, and from an adult female Veery weighing 42.5 grams, 8 grams of fat (18.8 per cent) were removed from the skin. Many of the small specimens had to be soaked in white gasoline overnight in order to remove the fat completely, and some which were cleaned only superficially with carbon tetrachloride later became a menace to neighboring skins because of the "running" fat.

Notably lean were the two sparrows, one Savannah and one Swamp, which evidently were near the end of their migratory flight. Neither species winters appreciably south of Georgia. It is reasonable to assume that these had been fat birds at the beginning of their migration.

Considerable variation in weights is seen in Table 2, and one might wonder to what extent this might be due to variation in total fat content. Many of the birds from Warner Robins were given to Odum and Connell, who have extracted chemically and reported (1956) on the total lipids of the birds. In general, they found that fat content varied appreciably and that the heaviest birds were usually the fattest, but this was not always true. For example, five adult female Summer Tanagers had the following data:

Wet Weight	*Per Cent Fat of Wet Weight*
36.2 grams	37.5
36.8 grams	32.9
40.3 grams	34.2
40.4 grams	38.2
47.6 grams	41.2

Similarly, it has been demonstrated in premigratory Ruby-throated Hummingbirds that the heavier birds of both sexes are the fatter ones

(see Norris *et al.*). Thus, there is a rough correlation between fatness and heaviness, with the variations in fat deposits, at least in part, accounting for the variations in weight. Obviously the weights given in Table 2 must be considered in the light of the fatness of the birds.

In order to compare weight variability intraspecifically, the coefficient of variability has been calculated for some of the birds in Table 2. Monotypic species (Red-eyed Vireo) and species occupying relatively small geographic ranges (Blackburnian Warbler) showed at least as much variation in weight as polytypic species (Olive-backed Thrush) and species occupying relatively larger geographic ranges (Oven-bird). For example, immature males showed the following coefficients of variability: Red-eyed Vireo, 14.5; Olive-backed Thrush, 11.0; Oven-bird, 7.6; Blackburnian Warbler, 10.4. The data therefore suggest that insofar as fat migratory birds are concerned, weight variations attributable to subspecific differences are obscured by more pronounced variations in fat content.

Subspecific determinations.—Among the birds killed at Warner Robins were several polytypic species. Specimens of these, identified subspecifically, should indicate, at least roughly, the part of the continent from which the individuals came. Ideally it would be desirable to have specimens of all these polytypic forms, but the large sample (for example, 236 Oven-birds) made this impossible in most instances. Even with the relatively small number of birds prepared for subspecific determinations, we feel that the following data do give a crude indication of the origin of some of the migrants. The specimens were prepared by the senior author and have been identified by Dr. John W. Aldrich (United States Fish and Wildlife Service, Washington, D. C.), with the exception of the Water-thrushes identified by Dr. Alden H. Miller (Museum of Vertebrate Zoology, Berkeley 4, California). Although the following subspecies were definitely identified, this does not preclude the possibility that other subspecies might have been present in the larger portion of the sample which was not examined subspecifically; nor do the small proportions of subspecies within a given species necessarily reflect in an absolute fashion the proportions in the larger sample.

Hylocichla ustulata.—Three specimens were *swainsoni* and four were *incana*. According to Aldrich's interpretations of these subspecies, *swainsoni* is the population ranging in the southern Rocky Mountains, Great Basin, and Prairie Provinces of Canada, whereas *incana* is the bird from the Yukon and probably the northern Rocky Mountains. Olive-backed Thrushes from the eastern United States and Canada (*crymophila*) were absent from our sample of prepared specimens.

Hylocichla minima.—Seven specimens were referred to *minima*. The absence of *bicknelli* is perhaps significant.

Hylocichla fuscescens.—Three subspecies were found: 3 *fuscescens*, 1 *salicicola*, and 1 *fuliginosa*. An additional specimen was intermediate between *fuscescens* and *fuliginosa*. Thus, we obtained specimens from widely-spaced populations: the eastern (*fuscescens*) and western (*salicicola*) United States and Newfoundland (*fuliginosa*).

Dendroica petechia.—Although we obtained only two specimens of this late migrant, they represented extremely different-looking races: 1 *rubiginosa* and 1 *amnicola*.

Dendroica caerulescens.—Five specimens were identified as the nominate race *caerulescens*. We noted with interest the absence of *cairnsi*, which is known to breed in and migrate through Georgia.

Dendroica virens.—All eleven specimens represented the race *virens*. The absence of *waynei* at Warner Robins is significant.

Dendroica palmarum.—Ten specimens were *palmarum* and three *hypochrysea*. In the Warner Robins area during the winter *palmarum* far outnumbers *hypochrysea*.

Seiurus aurocapillus.—Seven specimens were *cinereus*, representatives of a western population, and three were *aurocapillus*, from more easterly populations. We obtained no *canivirens*, the breeding form from the southern Appalachian region.

Seiurus noveboracensis. One specimen was *notabilis* and four were *noveboracensis*. It is of some interest that the proportion of the more westerly form to the more easterly one was 1 : 4.

Geothlypis trichas. Four specimens represented the race *brachidactyla*.

Setophaga ruticilla. Two females have been identified as the western form, *tricolora*, but two males could not be identified subspecifically.

Passerculus sandwichensis. The one specimen of this early migrant was clearly *savanna*.

Ammodramus savannarum. This was probably a late migrant and was of the eastern race *pratensis*.

Melospiza georgiana. This early migrant was of the race *georgiana*.

These data, considered *in toto*, indicate that the mass of migrating birds flying over Warner Robins on this night was composed of typically eastern species and subspecies, either from the United States or Canada. Some of the birds, however, came from more widely-scattered points. Some evidently came from Alaska, central Canada, Newfoundland, and the western United States, thus presenting something of a convergence on the southern region from more northeasterly, northerly, and westerly points.

SUMMARY

Between October 5 and 8, 1954, twenty-five instances of mass bird mortality were recorded in the eastern and southern United States. They occurred primarily at airport ceilometers, but also at radio and television antennae and tall buildings. An advancing cold front in the autumn is believed to have precipitated these mass mortalities by bringing together adverse weather conditions (especially a lowered cloud ceiling), nocturnal migrants, ceilometers and/or tall obstructions.

More than 100,000 birds of 88 species were killed at the 25 localities during these three nights. The Oven-bird, Magnolia Warbler, Red-eyed Vireo, and Chestnut-sided Warbler were the most abundant species recorded at the sites. Most of the 88 species were common summer residents or transients at these localities, but a few supposed nonmigrants and winter birds were also killed.

At Warner Robins Air Force Base, Georgia, the largest ceilometer kill in recorded history occurred on October 8, 1954: 53 species and an estimated 50,000 individuals were killed. From these, a sample of 2552 birds was examined. Data on weight, sex, age, fat deposition, and subspecific determination are presented for many of the species. Weight variation among these fat fall migrants is believed to be due primarily to variation in fat deposits. Subspecies recorded in the kill indicate a convergence on this area by migrants from northeasterly northerly, and westerly points.

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