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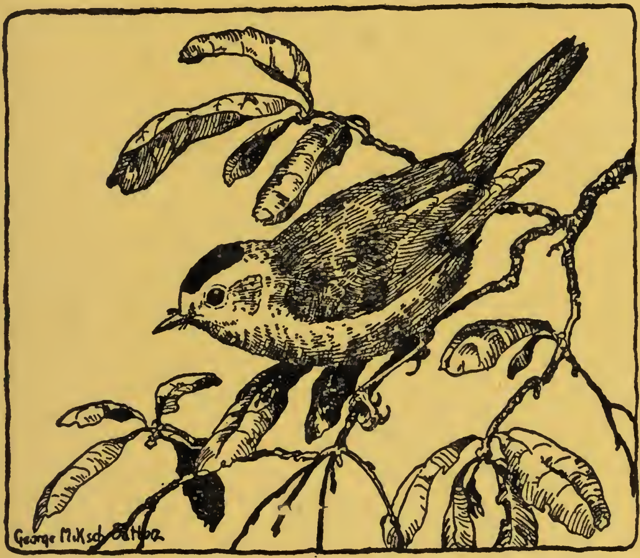

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Founded December 3, 1888

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GROWTH, WEIGHTS, AND PLUMAGES OF THE REDHEAD, *AYTHYA AMERICANA*[1]

BY MILTON W. WELLER

DESPITE the intense interest in waterfowl shown by aviculturists, ornithologists, wildfowlers, and wildlife managers, surprisingly little has been published concerning their growth, weights, and plumage development. Growth and plumage development probably have been studied little because the precocial young are difficult to examine periodically in the wild, and few investigators have reared waterfowl for growth studies. At the Delta Waterfowl Research Station, in southern Manitoba, excellent facilities are available for rearing many species of ducks. This equipment was used during the present study to investigate the growth of the young Redhead (*Aythya americana*). Some of the birds were held in captivity as long as five years in order to observe plumage changes in adults. In addition, data were gathered on plumages and weights of wild adults during a concurrent study of the breeding biology of the Redhead.

ACKNOWLEDGMENTS

I am indebted to Dr. William H. Elder and H. Albert Hochbaum for advice throughout the study. Peter Ward and other staff members of the Delta Station were most helpful. Arthur S. Hawkins, George Dellinger, Thomas Bergerud, and Michael Milonski assisted in various phases of the study. Margaret M. Nice was most helpful in referring me to sources in the literature and Dr. Samuel Brody and Professor Benjamin Frame of the University of Missouri gave advice on statistical methods.

Unpublished field data were provided by Alex Dzubin, Peter Hanson, and Herbert J. Miller (Michigan Federal Aid Waterfowl Research Project 45-R).

I wish to thank Dr. Elder, Dr. Thomas S. Baskett, and John P. Rogers of the Missouri Cooperative Wildlife Research Unit for reading the manuscript.

MATERIALS AND METHODS

Sources of birds and hatchery techniques.—Eggs were collected from nests of wild Redheads and placed in still-air incubators at 99° F. Newly hatched ducklings were held in the incubators until dry. In 1952, the ducklings were put in small, heated pens and later in larger enclosures. In 1953, they were placed in a pen under heat lamps and the pen was enlarged as the birds

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[1] Contribution from the Delta Waterfowl Research Station and the Missouri Cooperative Wildlife Research Unit: U.S. Fish and Wildlife Service, Wildlife Management Institute, Missouri Conservation Commission, Edward K. Love Foundation, and the University of Missouri cooperating. Grants were received from the E. S. Stephens Fellowship Fund, the University of Missouri, and the Delta Station.

grew. At six to seven weeks of age they were moved to an outdoor enclosure large enough to permit flying. Adults were held in a heated building in winter and spent the summer outdoors in large enclosures.

Juveniles were fed turkey pellets and hard-boiled egg until two weeks old, then large poultry pellets and natural foods, such as duckweed (*Lemna minor* and *L. trisulca*). Adults were fed poultry pellets, cereal grains, and duckweed.

Observations of wild juveniles were obtained in two ways. Ducklings were dyed in the egg in the manner described by Evans (1951) and later observed and collected. In addition, ducklings captured in banding traps of the U.S. Fish and Wildlife Service were measured and marked. Birds too small to be banded were toe-punched. Marked Redheads habitually returned to the traps for food and were re-measured when a period of at least one week had elapsed between the original marking and the recapture.

Wild juveniles and adults were obtained in various parts of Manitoba from banding traps of the U.S. Fish and Wildlife Service, the Delta Waterfowl Research Station, and Ducks Unlimited. Nesting females were weighed and examined by the author in Manitoba in 1954 and 1956 and in Utah in 1955. At first they were captured with a drop trap similar to that described by Sowls (1949) and later with an automatic trap with a drop-door released by the hen when she entered (Weller, 1957).

Birds taken by hunters in the Delta Marsh and at Lake Winnipegosis during 1952 and 1953 also were examined.

Measurements.—Sizes of the samples of birds measured are shown by sex and age in Table I. During 1952, the growth of 55 hatchery-reared Redheads was studied. Birds were weighed weekly for the first 10 weeks, and then at 12 and 16 weeks of age. During 1953, Redheads were weighed at weekly intervals until 10 weeks old.

Weights of juveniles were recorded to the nearest one-tenth gram while the birds were under three weeks of age and to the nearest gram thereafter. Birds were weighed when the plumage was dry and at approximately the same time each day to prevent the complication of the pronounced daily variations in weight noted in some species (Baldwin and Kendeigh, 1938; Blake, 1956). Weights of adults were recorded in pounds and half-ounces.

Measurements of the exposed culmen and tarsus of juveniles were made with a thin plastic or metal ruler. This method allowed speedy handling of live birds in the field and in the hatchery and yet gave measurements of suitable accuracy for growth studies. Tests with dividers indicated that accuracy to within one-half millimeter for the culmen and one millimeter for the tarsus was attained. The tarsal measurement included the tarsometatarsus and the condyles of the tibiotarsus and the digits.

Scapular and flank pterylae were measured to the nearest one-half centi-

TABLE 1

SIZE OF SAMPLES OF HATCHERY-REARED REDHEADS MEASURED DURING 1952 AND 1953

		Age in Weeks											
		1	2	3	4	5	6	7	8	9	10	12	16
1952	male	7	14	17	17	17	17	16	27	25	21	18	17
1952	female	9	18	21	21	21	20	20	28	28	23	18	13
1953	male	8	8	25	24	24	25	25	24	24	21	—	—
1953	female	15	14	33	32	30	32	31	32	31	30	—	—

meter from the base of the anterior feathers to the tip of the longest posterior feather of the tract. The longest or ninth primary, the middle or sixth secondary, the longest tertiary, and the center tail feathers, were chosen for measurement and their lengths were recorded in millimeters from the base to tip with curved feathers flattened.

Terminology for plumage is that used by Dwight (1900), Forbush (1925), and Witherby *et al.* (1943), and terminology for color is that advised by Palmer and Reilly (1956).

GROWTH AND SEASONAL CHANGES IN BODY WEIGHT

Weights of newly hatched ducklings and increase in weight were reported for a few European anatids by Heinroth (1928:132–229) and Portmann (1950: 525). A more detailed study of the Tufted Duck (*Aythya fuligula*) was made by Veselovsky (1951), who weighed five ducklings every five days from hatching to 55 days of age. Southwick (1953) recorded weights for eight species of ducks reared in the hatchery of the Delta Waterfowl Research Station but data were not taken after six weeks of age and sexes were not differentiated. Elder (1954) presented data on growth of a small number of Redheads used as controls in his study of the oil gland.

Growth of the embryo.—Data were gathered from 23 embryos of three clutches of eggs. Preserved embryos were weighed immediately after being rolled on a blotter. A typical exponential curve characteristic of early growth in body weight (Brody, 1945: 486–492, and others) is apparent (Fig. 1).

Growth of hatchery-reared juveniles.—Three to four grams were lost during the first 24 hours as the feathers dried. Thereafter, body weight increased rapidly (Fig. 2). Males were heavier than females by the second week and remained so throughout life. The greatest increase in weight occurred during the fourth to sixth weeks.

Growth was slightly more rapid in birds reared in 1952 than in 1953,

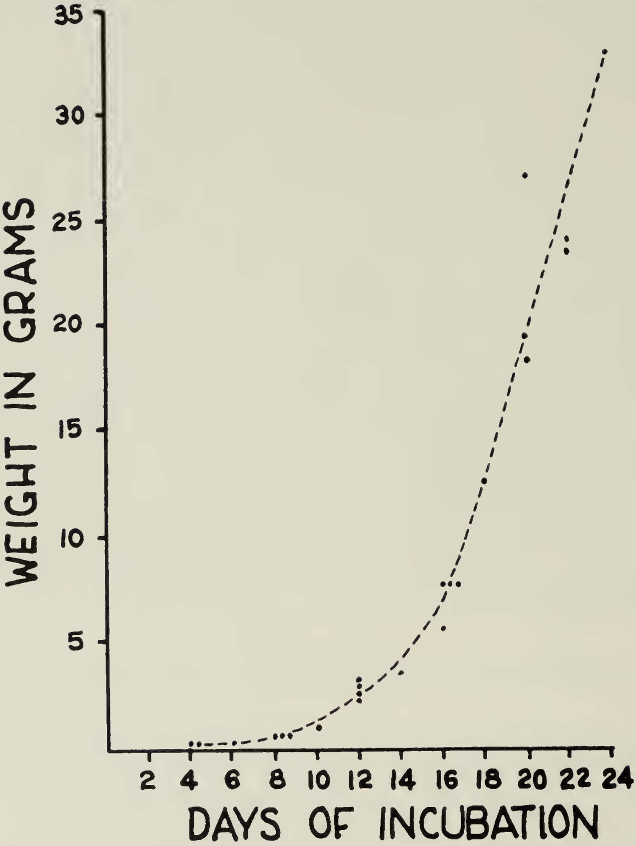


Fig. 1. Scatter diagram of the weights of 23 Redhead embryos.

especially at ages of four to seven weeks. However, during the eighth week of life, weights for the sample in 1952 decreased to the level later reached by birds of the same age in 1953. The larger pen used during the latter year may have permitted more activity and prevented the rapid addition of weight recorded in 1952. Other conditions, such as feeding and pen-cleaning, were identical. The decline in weight observed in 1952 occurred, however, during the period of most rapid growth of the remiges. While the averages for 1953 show no such decline, weights of some individuals did. These data suggest that the period of remex formation is one of great stress. Individuals vary in the amount of weight they lose but few gain during this period. Similar weight losses during fledging in passerines are well known (Edson, 1930). Peters and Müller (1951) and Mrs. Margaret Nice (*in litt.*) have observed such losses in gulls (*Larus* sp.).

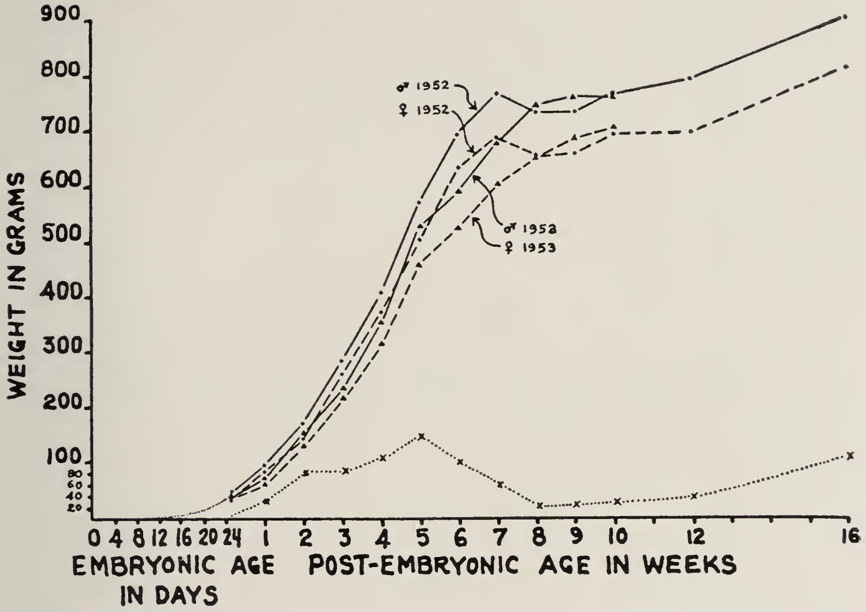


Fig. 2. Average cumulative growth in body weight in hatchery-reared Redheads (upper four curves) and average weekly increment in grams for both sexes and years (lower curve).

In order to determine the effects of handling on growth in weight, a group of 24 hatchery-reared birds was weighed during the first day of life and placed in a pen where they remained undisturbed for eight weeks. A scatter diagram of weights of 19 of these birds and 26 which were handled weekly is shown in Figure 3; there was no obvious effect of handling. A similar comparison was made by Baldwin and Kendeigh (1938); they found no statistical difference between weights of sparrows handled frequently and those trapped only once.

Growth of wild juveniles.—Although embryos in 26 nests were dyed, only six dyed broods were observed and two members of one brood collected. In general, the growth of wild juveniles was quite similar to that of those reared in the hatchery. The two dyed ducklings which were collected differed greatly in size, one (a male, 189 grams) being considerably below and the other (a female, 256 grams) slightly above the hatchery average (Table 2). Additional data were obtained from four birds dyed by Alex Dzubin near Minnedosa, Manitoba; these also are compared with hatchery averages in Table 2. Two weighed slightly more and two less than hatchery average.

Ten males and 17 females were recaptured in banding traps at least once. The increments in body size between periods of capture were compared with the data for hatchery-reared birds (1952), using the initial weight of the

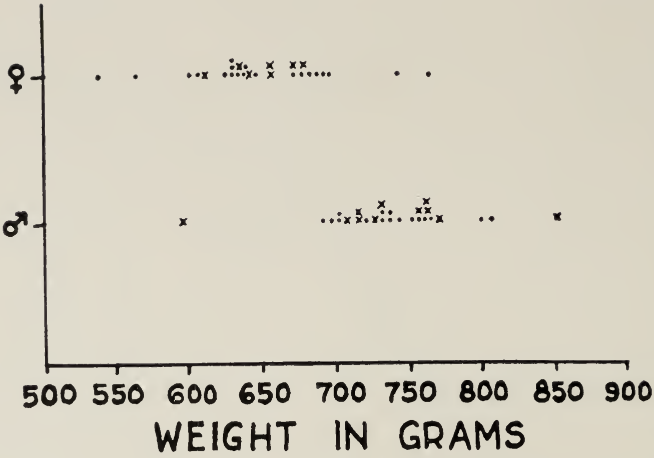


FIG. 3. Scatter diagram of weights of eight-week-old Redheads comparing birds handled each week (●) to those handled only twice (×).

wild bird as a basepoint on the curve for hatchery birds. Wild birds tended to be similar in weight to hatchery birds from two to four weeks and heavier during the eighth and ninth weeks. Because the exact ages of the wild individuals were unknown, the relationship of body weight to culmen length in each group was also compared. Wild birds were slightly heavier than hatchery-reared birds of similar culmen length throughout life. Three of eight wild males and one of five females measured during the fledging period lost weight. Losses were similar in extent to those in hatchery birds and averaged about 50 grams for both groups.

Weights of immature and adult Redheads.—Weights of immature and adult waterfowl have been better studied than those of non-flying juveniles because of the abundance of data obtainable from hunters' bags and banding stations. Notable contributions to our knowledge of duck weights have been made by Leopold (1919, 1921); Phillips (1923–26); Bennett (1938:5–6); Kortright (1943); Bellrose and Hawkins (1947); Mann, Thompson, and Jedlicka (1947); and Nelson and Martin (1953). DuMont and Swenk (1934) and Elder (1946) analyzed the weights of the Canada Goose (*Branta canadensis*) and Elder (1955) presented data on weights of Pink-footed (*Anser arvensis*) and Greylag (*A. anser*) geese.

Weight data from the present study are shown in Table 2 and Figure 4. Only data from wild Redheads are presented because weights of birds housed indoors in winter in Manitoba cannot be considered comparable with those of birds wintering in the southern United States.

TABLE 2

MEASUREMENTS OF SIX KNOWN-AGE REDHEADS COMPARED TO AVERAGES FOR HATCHERY REDHEADS OF EQUIVALENT AGE

	MALES		FEMALES	
	Wild	Hatchery Avg.	Wild	Hatchery Avg.
	(22–23 days)		(22–23 days)	
Weight (grams)	189	277	256	251
Culmen	28[1]	32	31	31
Tarsus	35	47	39	44
Tail	17	21	23	19
	(35 days)		(27 days)	
Weight	495	546	409	325
Culmen	37	39	34	35
Tarsus	50	52	48	48
Tail	37	40	35	31
Scapulars	80	88	55	57
Flank	Complete	Complete	100	108
Primaries	Starting	18	—	—
Secondaries	2	19	—	—
Tertiaries	22	32	5	13
	(47 days)		(32 days)	
Weight	849	733	312	420
Culmen	46	44	32	33
Tarsus	54	54	44	49
Tail	51	53	32	36
Scapulars	135	135	50	70
Flank	Complete	Complete	90	112
Primaries	69	77	—	—
Secondaries	62	65	—	—
Tertiaries	72	77	5	23

[1] All linear measurements are expressed in millimeters.

The average weights of the various age and sex groups observed at Lake Winnipegosis in mid-September (Table 3) showed a pattern similar to that recorded for several other species of ducks by Mann, Thompson and Jedlicka (1947) and Bellrose and Hawkins (1947), and for geese by Elder (1946, 1955): adult males were heaviest, adult females and immature males were similar in weight, and immature females were lightest.

The body weight of the Redhead was greatest prior to migration, as is shown by comparing the average fall weights of Redheads in Manitoba with those in Michigan. Adult birds weighed in Michigan in October averaged seven to eight ounces lighter than Redheads weighed at Lake Winnipegosis, Manitoba, in early October (see Table 3, "post-molt"). These samples are probably from the same population, since many Redheads from Manitoba pass through Michigan during the fall migration (Robbins, 1949; Brakhage, 1953).

Adequate samples of Redhead weights taken south of Michigan in late fall or winter are not available but presumably the weight lost in fall migra-

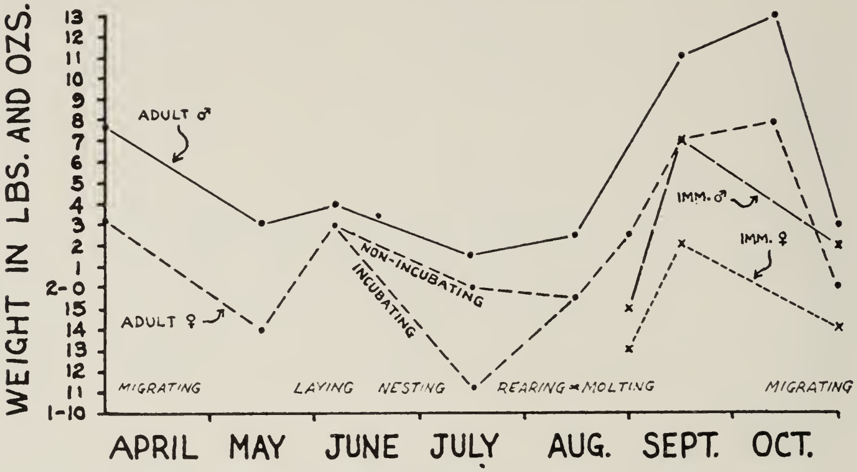


Fig. 4. Average weights of Redheads weighed on or near the breeding grounds.

TABLE 3

SAMPLE SIZE, SOURCE, AND AVERAGE WEIGHTS OF IMMATURE AND ADULT REDHEADS

Age	Area	Source	Stage of Annual Cycle	Average weight Male No.	Male Lbs. Oz.	Female No.	Female Lbs. Oz.
ADULT (Second Summer of Life)							
	Michigan[1]	Banding	Spring Migration	1157	2:7	485	2:3
	Manitoba	Banding	Spring Migration	32	2:3	15	1:14
	Utah	Nest Trap	Parasitic	—	—	40	2:3
	Utah	Nest Trap	Incubating	—	—	6	1:11
	Manitoba	Collected	Courtship	7	2:4	—	—
	Manitoba[2]	Banding	Pre-Molt	33	2:1	71	2:0
	Manitoba	Banding	Early Molt	10	2:2	41	1:15
	Manitoba	Bagged	Post-Molt	51	2:11	19	2:7
	Michigan[1]	Bagged	Fall Migration	40	2:3	52	2:0
IMMATURE (Flying young of the year)							
	Manitoba	Banding	Fall Concentration	148	1:15	172	1:13
	Manitoba	Bagged	Fall Concentration	15	2:7	15	2:2
	Michigan[1]	Bagged	Fall Migration	118	2:2	135	1:14

[1] Data from Michigan Federal Aid Project 45-R.
[2] Data from Peter G. Hanson.

tion is regained during winter and spring. An increase in weight is usual at this time among passerines (Wolfson, 1945). During the spring migration through Michigan (April), Redheads averaged three to four ounces heavier than birds weighed there in the fall (Table 3). Birds captured after arrival in southern Manitoba in late April and May averaged four to five ounces lighter than birds weighed in Michigan in April.

After the spring migration, females gained weight rapidly, as was shown by comparing weights of birds captured in nest traps in Utah with those captured in Manitoba in spring. This difference in weight was not due to differences in average size of Utah and Manitoba birds, for culmen measurements of the two groups were the same. Rather, it was due to intensive feeding following migration and to the growth of ovarian tissue. The ovary, oviduct, and eggs of one female collected during the laying period constituted one-eighth of the body weight, while the reproductive tract of a non-breeding female in August was only 1/2000 of its total weight. Witschi (1956:310) presented similar data for the Starling (*Sturnus vulgaris*). During the laying period, the weight of the female Redhead nearly equals that of the male (Fig. 4).

Redhead females laying parasitically in the nests of other birds gradually declined in weight and continued to decline during incubation (Fig. 5). (No birds were captured during normal laying.) A weight loss during the period of laying and incubating was observed in Ring-necked Pheasants (*Phasianus colchicus*) by Kabat, Thompson, and Kozlik (1950) but Richdale (1947) found that Yellow-eyed Penguins (*Megadyptes antipodes*) lost weight during laying, then regained it during incubation.

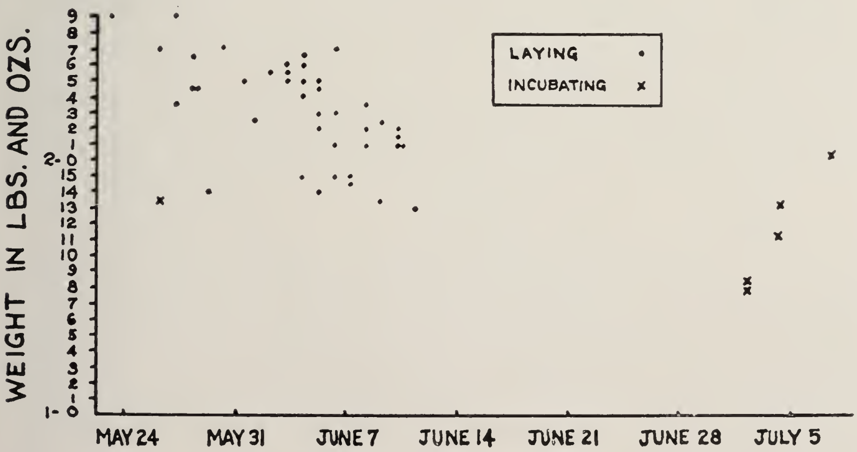


Fig. 5. Scatter diagram of the weights of laying (parasitically) and incubating females captured in Utah in 1955.

Redhead females trapped in July at Lake Winnipegosis averaged three ounces lighter than birds weighed during the laying period in Utah. Some of these birds, examined by Peter Hanson of Ducks Unlimited and myself, had brood patches; others did not and probably were non-breeders. Thus the lowest weight is reached during the period of molt, when environmental temperatures are high. Two flightless females were weighed in the Delta Marsh but their weights were not significantly different from those of other females which were molting only body feathers and which were captured at the same time of the year.

After molting, birds loaf and feed and attain their greatest weight. The heaviest bird recorded was a male taken at Lake Winnipegosis on September 20, 1952, which weighed three pounds, one and one-half ounces.

By mid-September, the average weight of immature birds found in hunters' bags at Lake Winnipegosis was five to eight ounces greater than that of immature birds at Delta during August and early September. Many of the birds shot at Lake Winnipegosis probably were early-hatched young which had flown north from their place of rearing to isolated northern lakes to loaf and feed.

Growth of the Culmen and Tarsus

Data on the growth of the culmen and the tarsus were collected from hatchery-reared birds and from wild juveniles and adults. The growth curves of these parts in hatchery juveniles are shown in Figure 6.

The tarsus grew more rapidly than did the culmen, as it does in most birds (Huggins, 1940). A sex difference in the size of tarsus was apparent by two weeks of age. Because the tarsus reached full size when the bird was in its sixth or seventh week of life, it was not a good criterion of age and was measured only in one season.

The culmen reached nearly full size by the tenth week of life. The table below shows that there was no increase in culmen size after 16 weeks of age.

	16 weeks old		*9 months or older*	
Male	47.6	(16 birds)	47.7	(18 birds)
Female	45.3	(13 birds)	45.0	(95 birds)

Similar data presented by Hanson (1951*a*) for the Canada Goose showed that the culmen was no larger in adults than in birds in their first autumn.

Measurements of culmen and tarsus of known-age, dyed, wild juveniles are compared to those of hatchery-reared birds in Table 1 and show close agreement. However, when data secured from wild birds which were marked and recaptured were compared with hatchery data from hatchery-reared birds, the latter seemed to have grown faster than wild birds. This may be a result of small sample size.

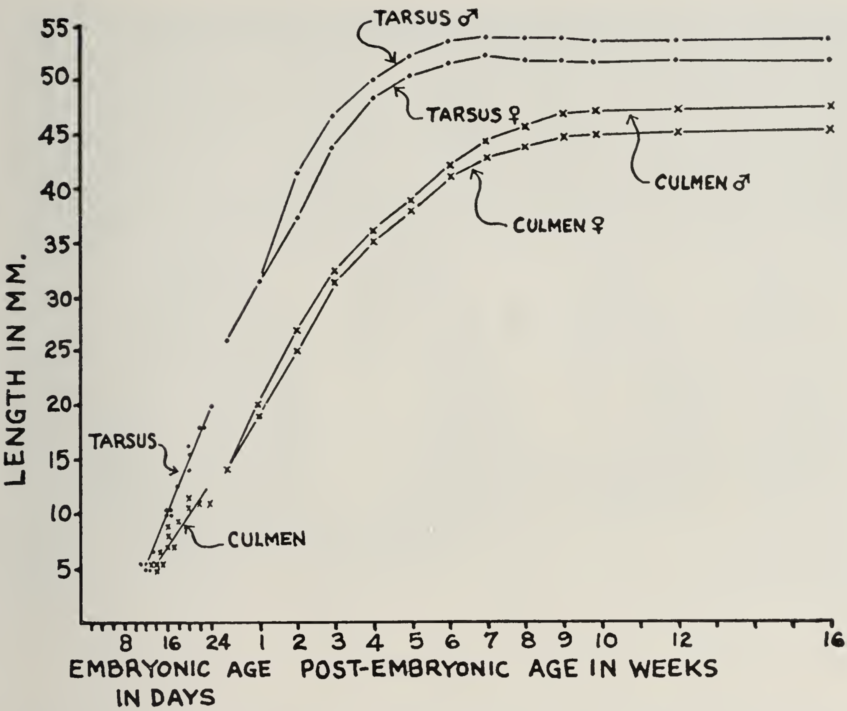


Fig. 6. Cumulative growth in size of culmen and tarsus in juvenal Redheads, and scatter diagram of measurements of embryos.

A comparison of culmen measurements of adult females from Manitoba and Utah showed no significant difference in these populations: 46 females from Utah averaged 44.9 millimeters and 49 from Manitoba averaged 45.1 millimeters. Little geographic variation in size is to be expected because of the mingling and pairing of birds from different areas on wintering grounds, a factor which limits subspeciation in many species of ducks, according to Mayr (1942:241–242).

Development of Natal and Juvenal Plumages

Bent (1923; 1925) was one of the earliest workers to report observations on sequence of feathering in juvenal waterfowl. He included data on Mallard (*Anas platyrhynchos*), American Widgeon (*Anas americana*), Cinnamon Teal (*Anas cyanoptera*) Pintail (*Anas acuta*), and the Canvasback (*Aythya valisineria*). Less extensive notes on other species, and comparisons between species, such as the Redhead and Canvasback, also were presented. While his descriptions were incomplete, general patterns were established.

FIG. 7. Redhead embryos ranging from four to 22 days incubation, photographed at two-day intervals.

More detailed information has since been published for the Canvasback (Hochbaum, 1944:103); Wood Duck, *Aix sponsa,* (Hanson, 1951*b*); Tufted Duck (Veselovsky, 1951); and Grey Duck, *Anas superciliosa,* (Cunningham and Welch, 1955). Comparative studies of several species have been made by Heinroth (1928:132–229) and Southwick (1953).

Natal plumage.—Figure 7 shows Redhead embryos at two-day intervals from four to 22 days of incubation. Hatching occurs at 24 to 28 days. according to Hochbaum (1944:90), Peter Ward (*pers. comm.*), and my own observations.

The rectrices appear at 12 days, followed by the feathers of the spinal and femoral pterylae at 14 days. The capital feathers and remiges are evident at 16 days and the embryo is completely feathered at 20 days of age.

The appearance of the feathers plus other morphological features, such as size, proportion of head to trunk, and development of limbs and bill, serve as excellent criteria for age determination of embryos. These characteristics are apparent in Figure 7.

Upon hatching, the Redhead duckling is the lightest in color of any diving duck (see Kortright, 1943: Plate 34). Considerable variation in color occurs, however; some ducklings are cream and brownish-olive while others are nearly as dark as Canvasbacks. Leg and bill color usually vary with the

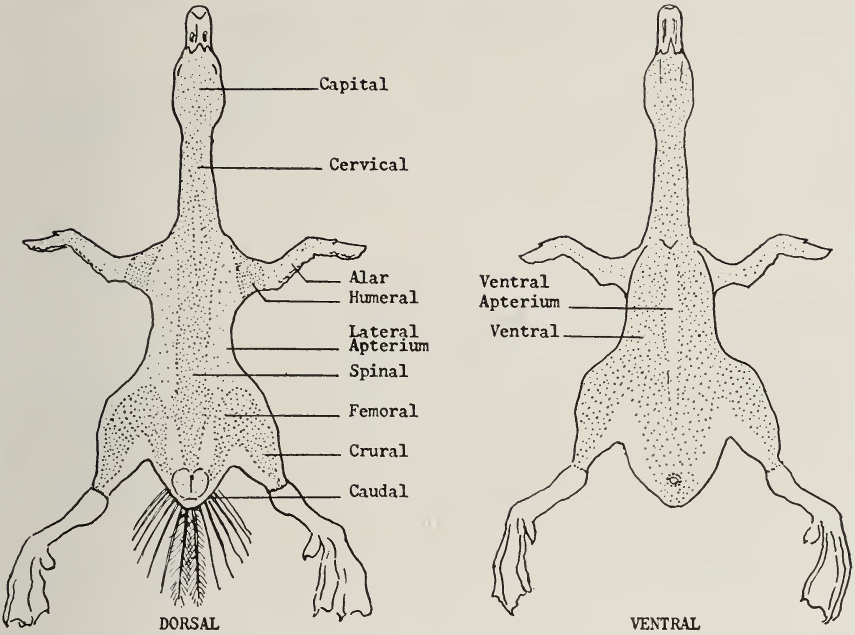


FIG. 8. Pterylography of a downy Redhead.

plumage. Color variation is not widespread, however, and is not due to differences in sexes as reported in the Tufted Duck (Veselovsky, 1951).

Characters for distinguishing Redhead ducklings from those of the Canvasback and Ring-necked Duck (*Aythya collaris*), which they resemble, have been presented by Brooks (1903), Phillips (1925: Plate 59), Todd (1936), Kortright (1943: Plate 34), and Hochbaum (1944:101).

The pterylography of a downy Redhead is shown in Figure 8. In size and position of the apteria of ducklings, the Redhead did not differ noticeably from the Pintail and Mallard.

Color of the natal down gradually fades in the wild. This fading probably varies with weather conditions. Most of the bright color is lost within five to eight days in the wild but remains several weeks in the sheltered, hatchery-reared birds.

Juvenal plumage.—Figure 9 illustrated the sequence of feathering in the juvenal Redhead. These drawings also serve to show the sequence of feathering in the Canvasback, which grows at the same rate as the Redhead (Hochbaum 1944:108). Figure 9 is designed to permit determination of the age of ducklings in the field. The correspondence between the age of the ducklings in weeks and the age classifications commonly used by waterfowl survey personnel (Southwick, 1953; Gollop and Marshall, 1954) is as follows:

Age in weeks	Age classification
1	I a
2	I b
3	I c
4	II a
5	II b
6	II c
7	III a
8	III b

The first feathers of the juvenal plumage are those of the tail, which push out the natal tail feathers at 12 to 14 days after hatching. The natal feathers are continuous with the juvenal feathers and cling to the latter until the teleoptile is partly vaned (Jones, 1907; Beebe and Crandall, 1914; Ewart, 1921), dropping off in wild birds at three to five weeks of age and forming the notched tail feathers useful in determining the age of ducks. The juvenal rectrices are not visible in the field until the birds are nearly four weeks old. Cumulative growth of the tail, as well as the primaries and scapulars, is plotted in Figure 10.

Dyeing ducklings in the eggs was an especially useful technique for rendering conspicuous the changes in down feathering. Juvenal body down develops between the bases of the natal down feathers at two weeks of age. This juvenal down was observed by Veselovsky (1951) in the Tufted Duck. It is not complete in the Tufted Duck until 30 days of age but it completely covers the Redhead by 20 to 25 days. In the Redheard, this down is pale gray on the underparts and medium gray on the upper parts, giving the pattern of the back more contrast than is evident in the natal down.

At two and one-half to three weeks, contour feathers of the auricular region and the flanks and scapulars develop, but these are not usually visible in the wild until the bird is nearly four weeks old. Hatchery birds have a more downy appearance than do wild birds of the same age because down breaks off the juvenal feather earlier in the wild.

At four weeks, the head and back are distinctively marked by the patches of new feathers but most of the upper parts are still downy. The underparts are mostly feathered, only the upper breast and legs remaining downy. The under and upper tail coverts are present, the vanes of the tertiaries are breaking from their sheaths, and the quills of the secondary and primary feathers are breaking through the skin.

By five weeks of age, juveniles of the Redhead are almost completely feathered, with down remaining only on the rump, back, and the base of the neck. The tertiaries and greater, median, and lesser secondary coverts are well developed. The secondaries are present but the vanes are hidden by the overlapping coverts. The primaries are present only as quills.

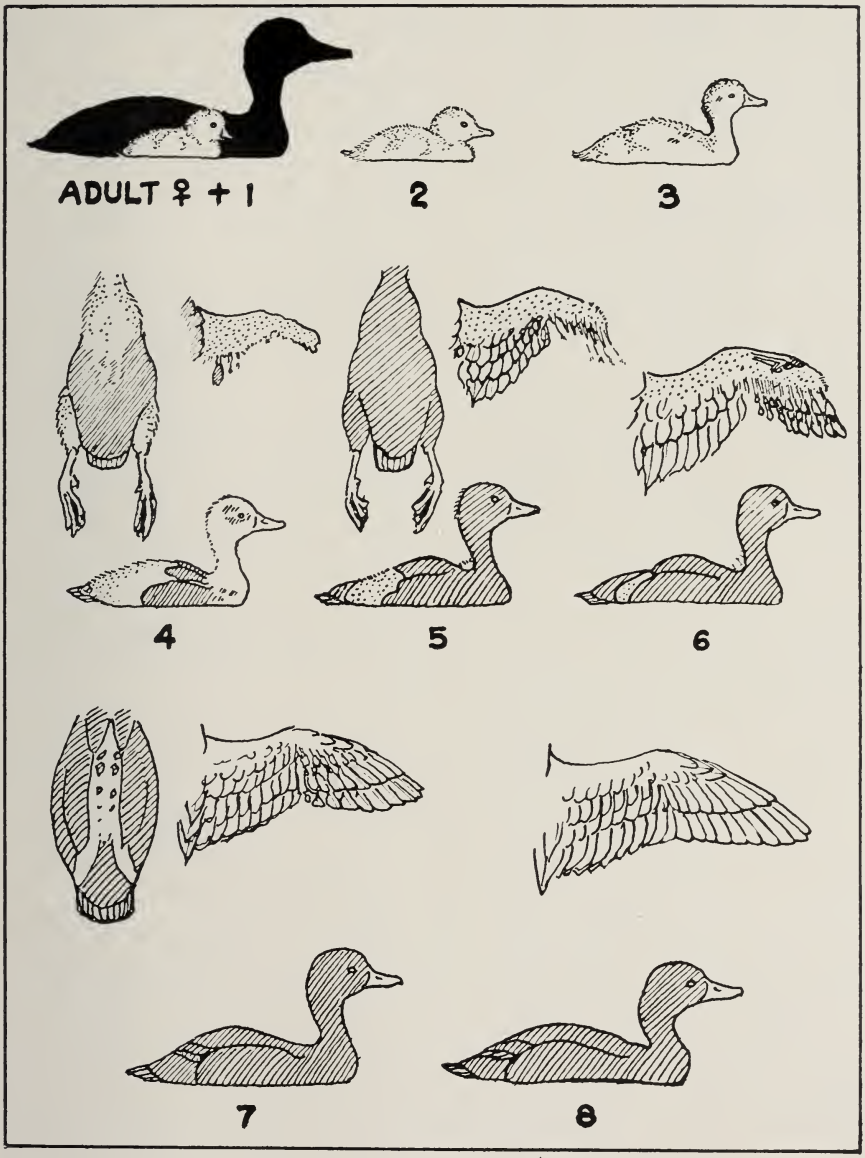


Fig. 9. Sequence of feathering in the Redhead from one to eight weeks old.

At five or six weeks of age, the scapulars and interscapulars of males show delicate white vermiculations or frosting. This is a valuable characteristic for sexing birds and has been used for several years by A. S. Hawkins

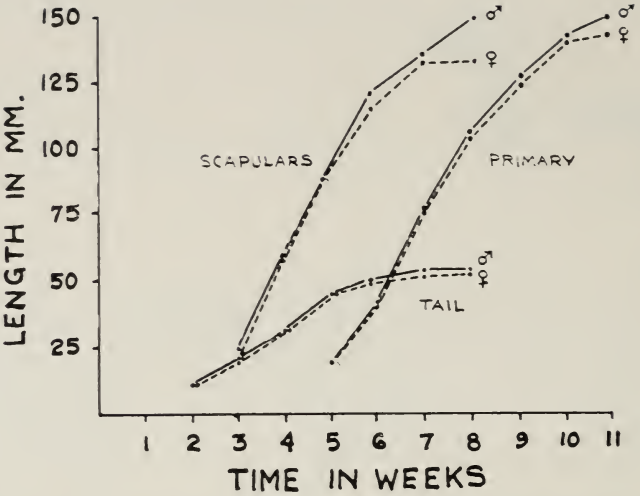


FIG. 10. Cumulative growth of juvenal rectrices, scapulars and primaries.

when banding Redheads. Occasionally females are found with white flecking in this region but only one case was observed which might have been confused with the vermiculations of the male.

Down still remains on the back at six weeks but the rump is well feathered, forming an inverted "V" of feathers pointing toward the head. The primaries are breaking from the tips of the long, bluish quills.

In the seven-week-old Redhead, feathering of the back occurs in two rows from the rump to the interscapular region. The remaining down is covered, however, by the scapulars which now extend beyond their coverts. The white tips of the secondaries are visible when the wing is held loosely in place or flapped but otherwise they are hidden by the scapulars and tertiaries. The sheaths of the primaries and greater primary coverts are still conspicuous.

By eight weeks of age, Redheads are usually completely feathered. A trace of down may remain on the backs of retarded birds. The wing appears complete but the bases of the quills are soft and the feathers not quite fully grown. In advanced birds, as many as half of the primaries may be hardened. Usually the calami of all the secondaries are hard and translucent by this time, as are those of the tertiaries.

Hardening of primaries and the time of flight.—Hochbaum (1944:108) stressed the importance of the age at time of flight to the survival of juvenal waterfowl and presented data for 11 species of hatchery-reared ducks. A summary of published observations of the age at which flight is attained in

TABLE 4

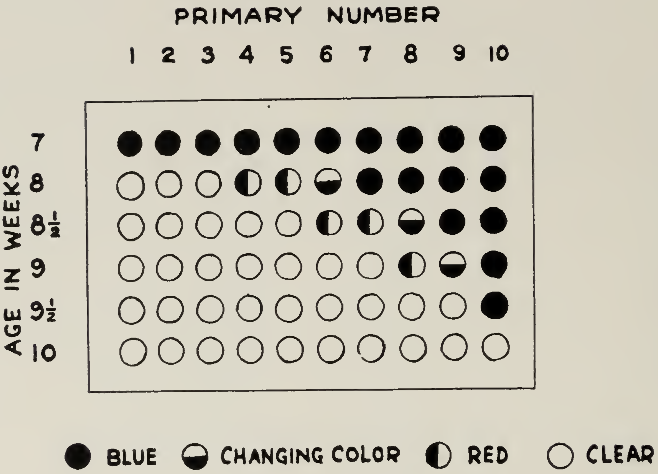
AGE AT WHICH FLIGHT IS ATTAINED BY SOME NORTH AMERICAN DUCKS

Species	Age in Days	Authority
DIVING DUCKS		
Redhead	56	Evans, Hawkins, and Marshall, 1952
Redhead	56–63	Williams and Nelson, 1943MS
Redhead	56–73	Present study
Redhead	63	Dzubin, 1952
Redhead	63–70	Phillips, 1925: 175
Redhead	63–77	Hochbaum, 1944: 108
Redhead	70–84	Low, 1945
Canvasback	54	Evans, *et al.*, 1952
Canvasback	58–65	Dzubin, 1952
Canvasback	63–77	Hochbaum, 1944: 108
Canvasback	70–84	Bent, 1923: 194
Lesser Scaup[1]	56–73	Hochbaum, 1944: 108
White-Winged Scoter[2]	63–77	Hochbaum, 1944: 108
Ruddy Duck[3]	49	Stresemann, 1940
Ruddy Duck	52–66	Hochbaum, 1944: 108
Goldeneye[4]	56	Stresemann, 1940
Goldeneye	62	Millais, 1913
DABBLING DUCKS		
Mallard	49–60	Hochbaum, 1944: 108
Mallard	56	Stresemann, 1940
Mallard	56–70	Ewart, 1921
Gadwall[5]	49–63	Hochbaum, 1944: 108
American Widgeon	45–58	Hochbaum, 1944: 108
American Widgeon	47	Evans, *et al.*, 1952
Pintail	38–52	Hochbaum, 1944: 108
Pintail	49	Stresemann, 1940
Pintail	42	Dzubin, 1952
Blue-winged Teal[6]	38–49	Hochbaum, 1944: 108
Blue-winged Teal	40–47	Dzubin, 1952
Blue-winged Teal	42	Bennett, 1938: 55
Shoveller[7]	39	Dzubin, 1952MS
Shoveller	52–60	Hochbaum, 1944: 108

[1] Aythya affinis
[2] Melanitta deglandi
[3] Oxyura jamaicensis
[4] Bucephala clangula
[5] Anas strepera
[6] Anas discors
[7] Anas clypeata

ducks is shown in Table 4. In general, the divers require longer to reach the flying stage than do the dabblers.

Growth and feathering of geese is rapid. Blue and Snow geese (*Anser caerulescens*) have been reported flying at slightly more than four weeks on Baffin Island by Soper (1930:58) and at five and one-half to six weeks



	1	2	3	4	5	6	7	8	9	10
7	●	●	●	●	●	●	●	●	●	●
8	○	○	○	◐	◐	◒	●	●	●	●
8½	○	○	○	○	○	◐	◐	◒	●	●
9	○	○	○	○	○	○	○	◐	◒	●
9½	○	○	○	○	○	○	○	○	○	●
10	○	○	○	○	○	○	○	○	○	○

Fig. 11. Color changes and hardening of the rachis of primary flight feathers in juvenal Redheads.

on Southhampton Island by Cooch (1953). The somewhat larger Canada Goose has been recorded as flying at 10 to 11 weeks by Heinroth (1928:178) and seven to eight weeks by Moffitt (1931). Balham (1954MS) observed that nine weeks were required to reach the flying stage but that the time of first flight was influenced by family and flock behavior.

It is difficult to determine the time of first flight of individual birds, either in the hatchery or in the wild. Hochbaum's (1944:108) observations on hatchery birds were based on records of individuals over a period of years but this method was not satisfactory for observing large samples of waterfowl. Also, it is doubtful that the stimulus to fly is as great in an enclosure as it is in the wild, and thus records from captivity may be biased. Therefore, the age at time of flight of large groups of captive birds was estimated by observing the hardening of the shafts of the flight feathers. This occurs as follows: The sheathed feathers ("blood quills") are soft and bluish. The sheath cracks off from the tip to the base and the vane unfolds. When the vane is nearly free, the rachis becomes translucent. The color of the rachis changes from a milky-blue to purple or mottled blue and red and then to pure red. Finally the rachis becomes white and then translucent and hard. The hardening of the remiges follows the sequence of their growth, progressing from proximal to distal remex. A typical pattern is shown in Figure 11.

Field observations showed that flight of wild birds was possible before all primaries had reached the clear stage. Since each proximal remex overlaps each succeeding distal remex, the hardened primaries reinforce each of the soft primaries. In addition, the ratio of body weight to wing area is less in the juvenile than in the adult. Juveniles of 10 to 12 weeks of age with all but two primaries clipped from both wings are capable of short flights. Hatchery-reared birds which were released in the wild flew well with three to five soft primaries and wild-trapped birds with an equal number of soft primaries were able to fly when tossed into the air. This by no means indicates that birds of that age are masters of their wings; several weeks of experience are necessary before the birds are good fliers. However, it may be concluded that Redheads are able to fly when five primaries are clear and hard. The information presented in Table 5 is drawn from observations of hatchery-reared Redheads and shows the age at time of flight as indicated by the presence of five hardened primaries.

TABLE 5

AGE OF HATCHERY REDHEADS AT TIME OF FIRST FLIGHT AS INDICATED BY THE HARDENING OF THE PRIMARIES

(Data for 1952 and 1953 combined)

Age	Number of Birds
Eight weeks	2
Eight and one-half weeks	29
Nine weeks	41
Nine and one-half weeks	13
Ten weeks	7
Ten and one-half weeks	1
TOTAL	93

POST-JUVENAL MOLTS AND PLUMAGES

Post-juvenal molt and first winter plumage in the male.—Feathers of the first winter plumage make their appearance before the juvenal primaries are fully hardened. Many males have brownish-red feathers in the lores and cheeks at eight weeks of age; these are present in all males at nine weeks. At 12 to 13 weeks conspicuously vermiculated scapular and flank feathers appear (see Color Plate). At 14 weeks, the male's head is more chestnut than buffy brown, about one-fifth of the flank and scapular feathers are of the winter plumage, and a ring of black feathers encircles the neck. New feathers are evident in the breast and belly. At 16 weeks, the breast is conspicuously mottled with black and the head is usually chestnut but varies from pale fuscous to blackish brown in different individuals. The first winter plumage is nearly full by January or February when the birds are six and one-half to eight months old, as was noted also by Bent (1923:80) and Phillips (1925:

Fig. 12. Adult (left) and yearling Redhead males, showing greater amount of white in the breast in the first winter plumage.

64). A few males are still molting upon arrival on the breeding grounds in April and many retain juvenal plumage of the back and venter until their first post-nuptial molt. Dwight (1914) noted spring molt of yearling male Scoters (*Melanitta* spp.) and recognized that it might be delayed post-juvenal molt. Smalley (1915) believed that spring molt in yearling male ducks was merely delayed post-juvenal molt. The entire juvenal plumage of the wing is retained through the first winter but the juvenal tail feathers are shed at three and one-half to seven months and replaced with new, pointed dark gray feathers. No regular sequence of loss is apparent but tail feathers are replaced as they are lost.

The first winter plumage rarely has the brilliance of later winter plumages, as was noted in the Pochard (*Aythya ferina*) by Millais (1913:15). The light magenta iridescence of the head and the vermiculated feathers of the flank and scapulars are of more subdued coloration than in later years. The juvenal wing is much less frosted with white than is that of the adult, and the white frosting on the greater primary and secondary coverts, median primary coverts, and inner alula feathers is lacking. The line of demarcation between the black breast and white belly is also less clear-cut (Fig. 12).

Post-juvenal molt and first winter plumage in the female.—Color changes in the female are less conspicuous than those in the male because the first winter plumage in females closely resembles that of the juveniles. Plumage changes were observed by parting feathers and clipping them to watch their replacement. Molt and development of the female's first winter plumage is

FIG. 13. Variation in abundance of white feathers on the heads of adult female Redheads.

identical with that of the male.

Distinguishing yearling from adult females is difficult because the adult and juvenal wing feathers are identical. The undertail coverts of yearlings in first winter plumage usually show a pattern of speckled buffy brown on a white background, while those of adults have brownish-olive patches on white. Adults tend to have more frosting of white on the scapulars and usually have white feathers on the back of the head (Fig. 13).

These white head feathers are of particular interest; their numbers seem to increase with age as in hawks (Brooks, 1920), but the most conspicuous change appears to occur during the second fall and winter. Nearly all wild hens have a few white feathers, but captive females rarely do. The location of these feathers suggests that they may develop as a result of damage to the feather follicle when the male pinches the female's head during copulation. However, attempts to induct formation of white feathers in four females by pinching the skin with pliers were unsuccessful.

White head feathers occur less frequently and less abundantly in other members of the genus *Aythya* in North America and in the European Pochard.

Spring molt.—Yearling, as well as older females, undergo a partial molt

FIG. 14. Nest down (left) and winter down feathers of the Redhead.

in late April, May, or early June, just prior to breeding. As a result of this molt, the crown, cheeks, neck, side of the lower neck, flanks, and occasionally scapulars, develop a deep tawny plumage (see Color Plate). Similar feather replacement was noted by Jackson (1915), Smalley (1915), and Schiöler (1921) in several dabbling ducks and by Jackson (1915) and Witherby, *et al.*, (1943:290) in European members of the genus *Aythya.* Jackson also noted that a special nest down was acquired during the spring molt which was "much longer and coarser than the ordinary down." Measurements of 25 down feathers from six Redhead nests and 25 down feathers from various parts of an adult Redhead female collected in October showed that nest down averaged 22 mm. in length while the autumn down averaged 20.1 mm. Of greater significance was the fact that 100 barbules of nest down averaged twice as long as a like number of barbules of autumn down; it is this difference which causes the more plumose appearance of nest down (Fig. 14). The barbules of down feathers from an immature female in fall were likewise very short. The increased growth of breast down in spring may be a result of higher estrogen levels during the breeding period, a causal relationship demonstrated for the Domestic Chicken (*Gallus gallus*) by Juhn, Faulkner, and Gustavson (1931). Down feathers acquired in spring are not conspicuously darker than those acquired at other times of the year, as was noted in dabbling ducks and some diving ducks by Jackson (1915) and Bowles (1917).

Plumage of the incubating female.—Six females trapped during incubation

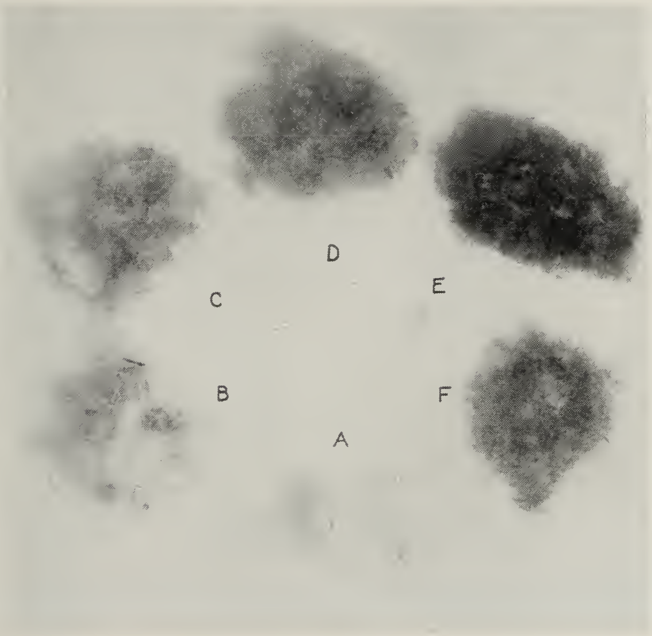


FIG. 15. Variation in color of Redhead nest down feathers (A through D) compared to Canvasback nest down (E) and a nest down feather of a Redhead × Canvasback hybrid (F).

showed no molt or replacement of contour feathers. This was also the case for six Canvasback females captured on the nest. However, some down is continually being replaced. This down has been reported as nearly pure white (Bent, 1925; Hochbaum, 1944; Broley, 1950), but much variation occurs. Individual females had down feathers which varied in color from white to medium gray (Fig. 15). About half of all birds examined had mixtures of white and gray.

Incubation patches have not been reported for members of the Anatidae (Bailey, 1952), but Stresemann (1934:392) wrote that long down develops and is plucked by the female for her nest. This down is probably loosened by physiological changes in the brood patch, such as those demonstrated in sparrows and gulls by Bailey (1952). Preening may then loosen the feathers but I observed no direct plucking by hens. Sufficient down is lost from the abdomen to create an area bare of down (Fig. 16). This condition was apparent in a female captured after nine days of incubation but it probably could be found earlier because most down is added to the nest before incubation begins. In Redheads, the down-free patch may be two to four inches wide and four to five inches long but some Redheads and all

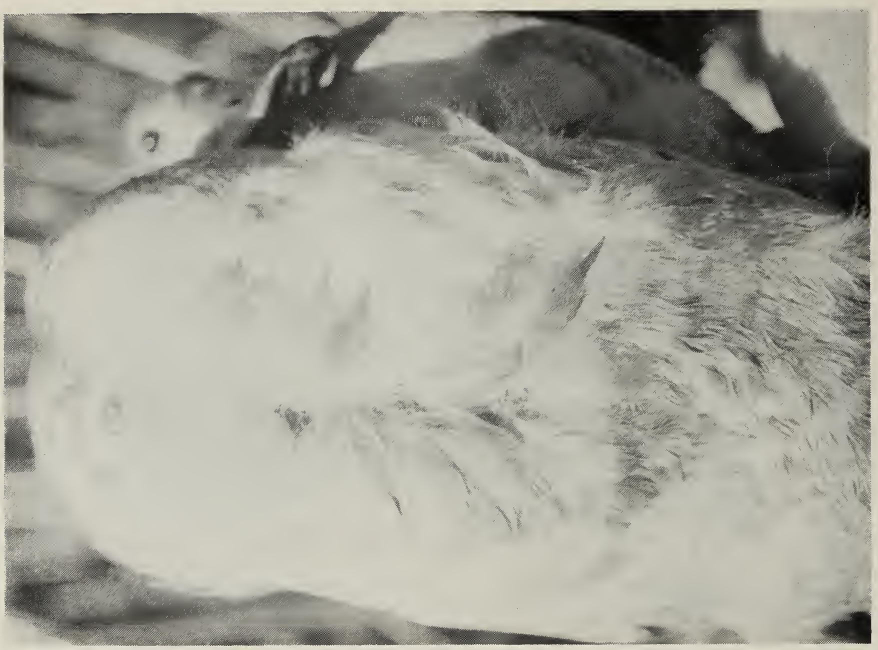


Fig. 16. Incubating Redhead female with ventral feathers parted to show absence of down on abdomen.

Canvasbacks observed were devoid of most down over the entire breast and abdomen.

First-year eclipse and second winter plumage of the male.—The first winter plumage of yearling males becomes dull by late June. In late June or early July, when the bird is about one year old, the post-nuptial molt results in the development of the first eclipse plumage (see Color Plate). Molt and replacement are complete in most birds. The eclipse plumage of the male Redhead more closely resembles its winter plumage than is the case of the eclipse plumage of male dabbling ducks (see Kortright, 1943). Male Redheads become flightless during July and August and renew their body and wing feathers in August and September. The remiges and rectrices are shed and renewed once while the body feathers are molted and renewed twice. I have no evidence indicating that the tail is molted twice as Kortright (1943: 22) states is true of the Mallard. By late September or early October, the males are often in their second winter plumage.

The sequence of molt is as follows: The rectrices are lost irregularly and replaced as they are lost. Thus some feathers are fully grown before others have been shed. Their molt precedes that of the wing and proceeds concurrently with the body molt. The remiges are not lost until the head, neck,

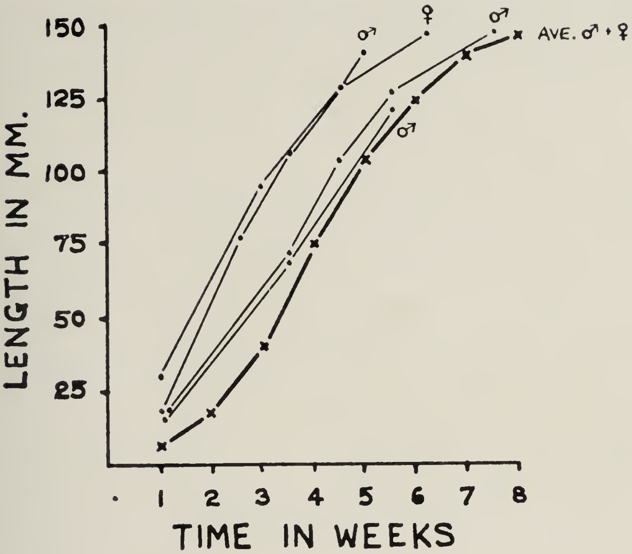


FIG. 17. Growth of the ninth primary in four adult Redheads (fine lines) compared to the average for juveniles (heavy line).

and breast are in nearly full plumage and the flank feathers are being renewed. No definite sequence of molt of the remiges was apparent but all were lost in less than a week. They are renewed in sequence, following the pattern of remige growth in the juvenile—proximal before distal. Remiges of the adult appear to grow at a slightly faster rate than in the juvenile (Fig. 17) and are fully hardened in five to six weeks. The under-wing lining and the axillaries are usually held until the remiges are half grown. The wing coverts are the last to be renewed, the median secondary and central marginal coverts being retained until nearly all other coverts have been replaced. The male wing is then fully adult.

Irregularity of the line of demarcation between black breast and white belly is apparent in the eclipse plumage of yearling birds as it is in the first winter plumage.

Males which desert their females in June in the Delta Marshes fly northward to feeding areas of lakes in northern Manitoba and molt in late July and August. Because some time elapses between the desertion of the female in June and July and inception of the molt and because of the importance of decreasing day-length in regulating molt (Lesher and Kendeigh, 1941), it might be expected that the wing molt would occur at the same time each year. However, there is evidence that the time of molt in the Redhead male is also influenced by seasonal weather patterns and related breeding phenology. This was indicated by the condition of the primaries of adult males shot in Lake Winnipegosis and examined in hunters' bags during 1952, 1953, and 1954. In 1952, 29 per cent of 56 adult males had some soft primaries. The 1953 nesting season was about 10 days later and this was reflected in the molt of the bagged males; 60 per cent of 113 adult males had soft primaries. In addition, the males had much of their eclipse plumage remaining, while most were in nearly full winter plumage in 1952. Nesting was further delayed 10 days in 1954 but the hunting season also was set back 10 days over the previous two years. Nevertheless, an examination of adult males by Game Guardian Sigurdur Oliver of the Manitoba Game and Fisheries Department showed that 68 per cent of 31 males had some soft primaries.

Summer molt of the female.—The female undergoes a single complete molt in late summer that results in the second winter or adult plumage. In Manitoba, females with broods are often in full body molt in August. I have never seen a flightless female with a brood. The nuptial plumage is very faded and worn (see Color Plate) and the new plumage is dark brown. The sequence of the molt occurs as in the male, although perhaps not with the same rapidity. It is usually not complete until October. By dyeing captive birds in midwinter, after the full plumage was acquired, it was found that no main contour feathers were renewed during the winter. Some small feathers, such as those of the head and down feathers, seem to be renewed almost continuously. However, there is no evidence that a double molt occurs in the female in fall as it does in the male.

Adult or second winter plumages.—The adult plumages are shown in the Color Plate and have been described adequately elsewhere. There is little further change once the bird has reached its second winter but the brilliance and distinctness of the winter plumage often improves with age.

The normal cycle of development and sequence of plumages of the Redhead is summarized in Figure 18. The difference between the sexes in the sequence of molt is of special interest. Witherby *et al.* (1943:290) found similar sequences of molt in the European Pochard and suggested that the plumage acquired by females in spring corresponds with the male's eclipse plumage which is acquired in August. Since this spring plumage is a breeding plumage, it seems more likely that it corresponds to the breeding plumage of the male, which is acquired in September and October following the post-eclipse molt. The non-breeding (=winter) plumage of the female is acquired in late summer and is retained until spring, as in passerines. The non-breeding (=eclipse) plumage of the male is retained only about a month, after which the breeding plumage (which is worn throughout the winter) develops.

The sequence of molting in the male Redhead results in avoidance of molting during migration and in winter and yet the male is in full breeding

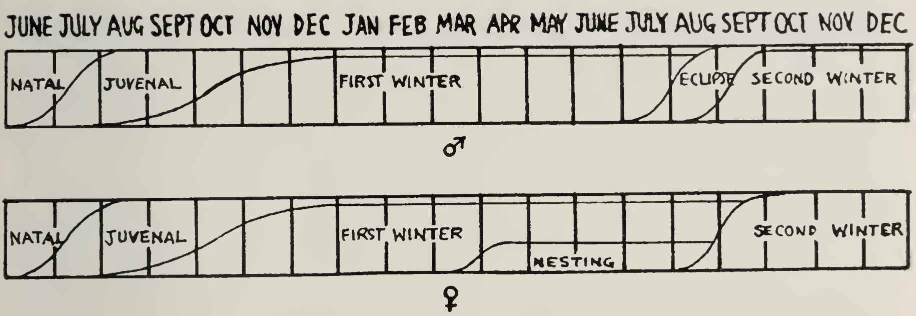


Fig. 18. Sequences of plumages in male (upper) and female Redheads from hatching until the acquisition of the second winter plumage. Height of the curve shows the approximate percentage of the plumage replaced.

plumage when courtship begins on the wintering areas. The evolution and retention of a different sequence in the female is perhaps related to the lesser importance of plumage during courtship and the value of protective coloration and a suitable supply of nest down. Stresemann's (1940) descriptions show that a sequence similar to that of the female Redhead occurs in both sexes of the Ruddy Duck (*Oxyura jamaicensis*) and in the hen Pintail, but the Pintail drake and Mallards and Goldeneyes (*Bucephala clangula*) of both sexes molt in a sequence similar to that described above for the Redhead male.

Development of and Seasonal Changes in Bill and Eye Color

Sexual differences in eye color are apparent as early as eight to 10 weeks: the iris of the male is a dull straw yellow and that of the female is dull yellow-lime with a brownish center. At 12 to 16 weeks of age, the eye of the male is brighter and that of the female is more brown than greenish. These colors brighten throughout the winter and by April the male's iris is yellow and the female's is sepia.

While wearing eclipse plumage, the male's iris becomes a dull yellow-orange but there is no conspicuous change in that of the female at this season.

No distinct difference in leg color is apparent in members of the genus *Aythya* during the eclipse plumage, such as was found in the Black Duck, *Anas rubripes,* (Shortt, 1943) and other members of the genus *Anas.* Legs of adults tend to be less greenish and a darker gray than those of juveniles.

Sex differences in bill color also become apparent at eight to 10 weeks. The tip darkens and a vague, transverse white line forms behind the tip. This is more conspicuous in males than in females but not until the following spring does it approach the distinct condition found in the adults. In the male the remainder of the bill gradually lightens and becomes a pale cobalt. During the eclipse period it loses its bluish coloration and becomes blackish

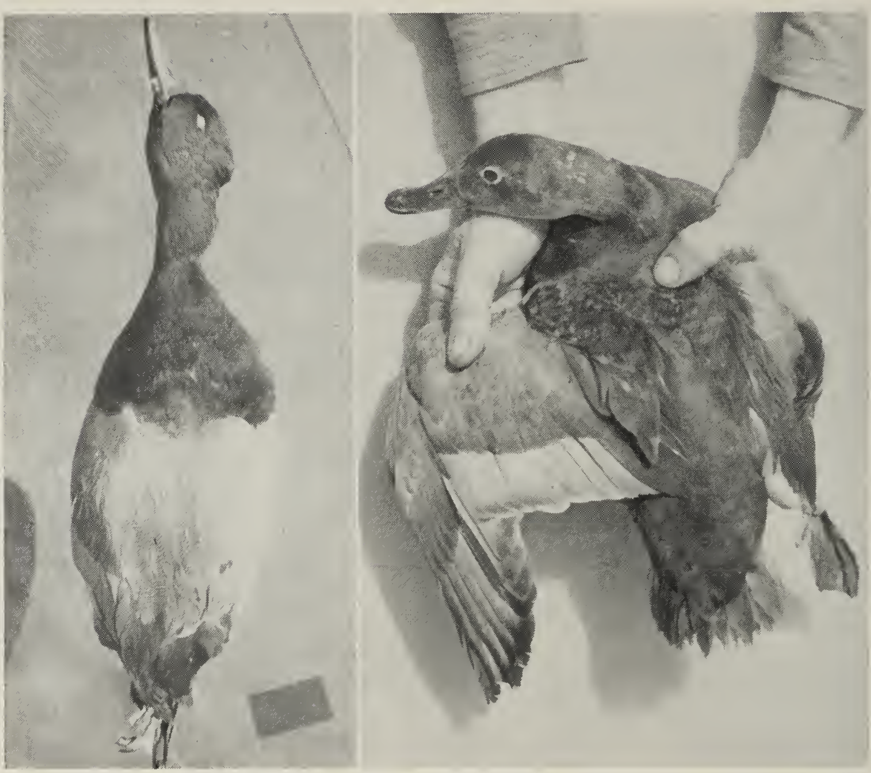


FIG. 19. Male (left) and female Redhead × Canvasback hybrids. Note the profile in each and the white feathers of the nape of the female.

gray like that of the female in spring (see Color Plate). The coloration of the male's bill tends to become brighter with age. The female's bill darkens until it is nearly black during late summer.

PLUMAGES OF SOME HYBRIDS

Cockrum (1952) reported that the Redhead has been known to hybridize in the wild with the Wood Duck, Pintail, and Ring-necked Duck, and McIlhenny (1937) described a bird which apparently was a cross between the Redhead and Canvasback.

Two hybrids were observed in the present study. A wild Redhead male was crossed with a captive Canvasback hen. The offspring were one female and five males but only the female survived beyond the age of one year. Both the male and the female hybrids were intermediate in morphological and plumage characters between the Redhead and Canvasback, resembling

FIG. 20. Male (left) and female Redhead × Ring-necked Duck hybrids. See text for discussion of characters.

the Common Pochard very closely. These hybrids are shown in Figure 19. Of special interest is the white on the head of the female; normally, the Canvasback female has few, if any, white head feathers during adulthood. As is characteristic of the Canvasback, however, the hybrid hen showed much vermiculation on the wing coverts and the scapulars. The first generation hybrid female mated with a Redhead and produced fertile eggs, the young of which resembled downy Redheads. The bills of the second generation hybrids were slightly deformed.

The sexes of the parents of the Redhead–Ring-neck hybrids shown in Figure 20 were unknown. Very apparent in these hybrids were the intermediate body size and voice. The feathers at the base of the culmen were more "V" shaped as in the Redhead rather than "U" shaped as in the Ring-neck (Todd, 1936) and the white ring on the bill was more prominent than in the Redhead. The male's head was brownish black and both the head and the neck had a tinge of chestnut plus a violet iridescence. The back was delicately vermiculated and much darker in color than that of a Redhead. No iridescence was apparent on the secondary coverts of the male as is found in the Ring-neck. The female's plumage contained more gray than is normal for the Redhead, and the lores and eye-ring were whitish as in the Ring-neck. The courtship behavior of the hybrid male was more like that of the Redhead than the Ringneck—very aggressive and with intensive calling and displaying.

SUMMARY

This paper describes the growth and sequence of plumages of young Redhead ducks and the weight changes and sequence of molts and plumages in adults. Information was derived from young Redheads reared at the Delta Waterfowl Research Station, Manitoba, wild juveniles which were dyed while in the egg or which were trapped, banded, and later recaptured. For adults, information was obtained from hatchery birds which were kept captive for as long as five years, from wild females trapped on the nest, from birds captured in banding traps, and from others killed by hunters.

Cumulative curves of growth in weight of embryos and juveniles are presented and show typical sigmoid form. However, a decline in weight was noted during the period of remige formation. Males were heavier than females by the second week and remained so throughout life. Hatchery-reared birds tended to be lighter in weight than wild birds of the same age but other development was comparable. Growth of the culmen and tarsus was also recorded and showed a steadier progression than did weights.

Weights of Redheads were influenced by age, sex, and season. In the fall, adult males were heaviest, adult females and immature males were similar in weight, and immature females were lightest. Birds of both sexes lost weight during migration and molt, and females lost during laying and incubation. Minimum weights were reached during the summer molt and maximum weights during the post-molt and pre-migration periods in fall.

Pterylography and sequences in growth of feathers in juveniles are described. A diagram of feather development at weekly intervals, designed to aid in determining age of juveniles in the field, is presented.

Ability to fly was attained at eight and one-half to nine weeks, although the primaries were not fully hardened until the juveniles were 10 to 11 weeks of age. Development of the first winter plumage started before the young were able to fly and was usually complete by mid-winter. A few birds were still molting in early spring after arrival on the breeding grounds.

Sequence of molt was different in the two sexes. The female attained a breeding plumage by a partial molt in spring and a winter plumage by a complete molt in late summer. The adult male, however, had no spring molt but acquired an eclipse (=winter) plumage in late summer and a breeding plumage in fall.

Some features of the plumages of hybrids between Redhead and Canvasback and Redhead and Ring-necked Duck are described.

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THE RELATIVE MAGNITUDE OF THE TRANS-GULF AND CIRCUM-GULF SPRING MIGRATIONS

BY HENRY M. STEVENSON

RECENT studies of the spring migration of birds, like earlier investigations, indicate the existence of routes both around and across the Gulf of Mexico. The present study attempts to determine which species (if any) utilize one of these routes to the exclusion of the other, which species predominate on each route, and which use the two routes about equally. Evidence pertinent to the problem comes from three sources: (1) direct observation of migrating birds; (2) the comparative abundance of birds around the Gulf in spring; (3) the sequence of spring migration arrival dates. Telescopic observations of birds crossing the face of the moon, since they do not distinguish between species, are not useful in this study.

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EVIDENCE FROM DIRECT OBSERVATION

Trans-Gulf Migration.—Lowery and Newman (1954) listed 73 species of non-pelagic birds which have been seen over the open Gulf, and recent observations of others have added a few more. Circumstantial evidence strongly indicated that the great majority of these were engaging in a true migration across the Gulf of Mexico. Considering the fact that many of them were small land birds which migrate largely at night, and that the opportunities of seeing small birds migrating over water are ordinarily fewer, even by day, than for those following land routes, this list is fairly impressive. (Moderate to large numbers of land birds are regularly present on the Dry Tortugas, Florida, in spring, but I saw only one—a Palm Warbler (*Dendroica palmarum*)—on a 12-hour boat trip from Key West to the Tortugas and return, March 23 and 30, 1951.) There is reason to doubt, however, that the list is an infallible index as to which birds are the most common components of the trans-Gulf spring migration. Moreover, in addition to birds seen offshore, some of those seen from land may be safely classed as trans-Gulf migrants. Among my own records have been two thrushes (*Hylocichla* sp.) flying low over the water, in the face of a strong north wind, toward the Alabama coast on April 26, 1952 (one was later determined to have been an Olive-backed Thrush, *H. ustulata*); a Veery (*H. fuscescens*) at the same place under similar circumstances on April 30, 1955; and a Chimney Swift (*Chaetura pelagica*) coming into Alligator Point, northwestern Florida, April 19, 1954. Similar observations have been reported to me by others.

Some references to trans-Gulf migration have implied a flight originating in Yucatan or Central America, but there is some direct evidence that an important flight also originates from, or crosses, the West Indies and continues across the Gulf in a northwesterly direction. On Loggerhead Key, the outermost of the Dry Tortugas, John DeWeese and I observed an Osprey (*Pandion haliaetus*) approach from the southeast and continue across the island and over the Gulf until it disappeared from sight to the northwest. At dusk that day (March 25) a small flock of Yellow-crowned Night Herons (*Nyctanassa violacea*), calling continuously, followed the same route. Consideration of the winter ranges of certain species, coupled with their distribution in spring, leads me to suspect that this is a widely used migration route. The occasional (or regular?) occurrence as far west as Texas of such species as the Black-poll Warbler (*Dendroica striata*) and the Cape May Warbler (*Dendroica tigrina*) is more logically accounted for in this way than by the supposition that they have followed a land route northward, then westward, around the Gulf.

Another trans-Gulf route, roughly parallel to this one, extends from Yucatan to the Texas coast (Lowery and Newman, 1954). Quantitative data secured in the course of the present study lead me to agree that this route, not often mentioned in the literature, is followed by many birds.

Circum-Gulf Migration.—If this term be used to include all coastwise migration on the Gulf of Mexico, many observations confirm its magnitude. However, it is both logical and patent that birds wintering in the West Indies often move northward along the Florida Peninsula, and that those which winter in eastern Mexico fly along the Texas coast. More pertinent questions are, "To what extent are these routes utilized by birds wintering in Central and South America?" and "Do these migrants continue eastward (from Texas) and westward (from peninsular Florida) around the northern Gulf coast?" In the case of a few species, the second question may be answered in the affirmative. In northwestern Florida, White Pelicans (*Pelecanus erythrorhynchos*) and White Ibises (*Eudocimus albus*) may be seen following the coast westward in spring, and Williams (1945) has cited records of a northeastward movement of Broad-winged Hawks (*Buteo platypterus*), Little Blue Herons (*Florida caerulea*), four species of swallows, and a few other small land birds around Galveston Bay, Texas. Other records of this nature are represented in Table 3. Such direct observations cannot show the entire route followed by an individual bird in its spring migration, nor do they reveal its winter and summer homes. Therefore they fail to solve some of the problems of migration, and other lines of evidence, even through circumstantial, must be sought.

Comparative Abundance of Migrants around the Gulf

The statement has been made that no transient species is more common along the northern Gulf coast than on the Texas or Florida coasts, but only 56 species formed the basis for the statement (Williams, 1945: 103). The basis for this comparison, except in Texas, was information gleaned from such standard reference works as the state bird books, which used such descriptive terms as "common" and "fairly common" instead of numerical data. That these terms are often misleading is exemplified by Howell's (1932) statement that the Wood Thrush (*Hylocichla mustelina*) is a "fairly common migrant in central Florida." Howell cited only a single spring record for the mainland south of the northern tier of counties (where it breeds). The 23 intervening years have produced very few more. Another innocent error committed by Williams in making this comparison was that of treating as units areas which are ornithologically diverse. For example, the region called the "Florida Peninsula and Keys" consists of the following: (1) the Northern Peninsula,

Fig. 1. Regions Represented by Quantitative Data. 1. Western Tennessee; 2. Northwestern Mississippi; 3. Central Tennessee; 4. Northern Alabama; 5. Northern Georgia; 6. Southwestern Virginia (including northeastern Tennessee); 7. Charlottesville, Virginia; 8. Richmond, Virginia; 9. Virginia-North Carolina Coast; 10. Northwestern Louisiana;

in which most species of transient land birds are scarce (Longstreet, 1930 and 1939; Mason, 1937 and 1939; McClanahan, 1935); (2) the Southern Peninsula, where most of these species are less scarce; and (3) the Lower Keys and Dry Tortugas, where the abundance or regular occurrence of certain species is astonishing to a visitor from the mainland.

An inspection of the winter and summer ranges of North American birds shows that, instead of the 56 species tabulated by Williams, at least 200 may be expected on geographical grounds to cross the Gulf of Mexico with some regularity. Whether these be classed as transients, winter residents, or summer residents along the northern Gulf coast, all are to be considered in an exhaustive study of the problem. Discrepancies such as that mentioned for the Wood Thrush made it advisable to conduct a cooperative study of the relative abundance of migrant species in the southern United States. Between 1946 and 1955 cooperators were asked to record the numbers of individuals of all birds seen from early March to late May, as well as the length of time they spent afield. By dividing for each species the total number of individuals seen by the number of observer-hours afield in a given region, a "frequency" was obtained which could be compared with the frequency of that species in other regions. It was requested that these field data represent a balance of the various habitats, weather conditions, and times of spring (Table 1). The role of chance was further reduced by combining the records of several observers and several localities in each region, and by the fact of the large amounts of field work in each region (not less than 150 hours). The latest revision of these data brought about such minor changes in the frequencies of most species that I am convinced of their general significance. In this connection, the *magnitude* of the differences in many of the frequencies on the northern Gulf coast compared with those on the Florida Peninsula, for example, should be cited in support of the conclusions reached. The 24 regions contributing quantitative data are shown on Fig. 1.

Analysis of Inland Regions.—Results are generally consistent except for species requiring special habitats (waterfowl, etc.). Many transients and summer residents are comparatively common at least 200 miles north of the Gulf, illustrating the "coastal hiatus" of Lowery (1945, *et seq.*). Values for transient land birds at Tallahassee, Florida, just 30 miles inland, are particularly low. Very high counts and estimates were made at Rosedale (northern

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11. Brownsville, Texas; 12. Corpus Christi, Texas; 13. Galveston, Texas; 14. Louisiana Coast; 15. Alabama Coast (including northwestern Florida); 16. Tallahassee, Florida; 17. Apalachee Bay, Florida; 18. Northern Florida Peninsula; 19. Southern Florida Peninsula; 20. Dry Tortugas, Florida; 21. West Indies (Western Cuba and Isle of Pines); 22. Southeastern San Luis Potosi, Mexico; 23. Veracruz, Mexico; 24a. British Honduras; 24b. Aguadulce, Panama.

Table 1

Periodic Distribution of Quantitative Spring Data, Texas to Florida

Values Given are the Percentage of the Observers' Time in the Field

Periods	REGIONS: Brownsville	Corpus Christi	Galveston	Southern Louisiana	Alabama Coast	Tallahassee	Apalachee Bay	No. Fla. Peninsula	So. Fla. Peninsula	Dry Tortugas
Mar. 1-15[1]	6.5	7	4	5	8	7.5	7.5	7.5	4.5	3
Mar. 16-31	17	17.5	16	18	14.5	17	15.5	15.5	17	18.5
Apr. 1-15	20.5	20.5	21	20.5	16	19	19	18	20.5	21.5
Apr. 16-30	27	27	27.5	28.5	26	25	27	25.5	25	25.5
May 1-15	22.5	21	22	19.5	23.5	18	18.5	21	20.5	20.5
May 16-31	6.5	7	9.5	8.5	12	13.5	12.5	12.5	12.5	11
TOTAL HOURS	169	311	151	189	158	274	310	166	424	169

[1] Including Feb. 26 in Southern Florida Peninsula.

Mississippi), but this may be due partly to the convergence of the trans-Gulf stream of migrants passing up the Mississippi River with birds veering northeastward from the Texas coast.

Analysis of Gulf Coastal Regions.—The results are believed to be significant for most species, but probably not for certain shore birds on the Louisiana coast. Frequencies are high for most species on the Dry Tortugas, both for trans-Gulf and circum-Gulf migrants. This is due in part to the concentrating effect of small islands, as well as the probable lingering of individuals for several days, with the result that the same birds were counted more than once. The occurrence there of numbers of species that winter in Central America is usually correlated with westerly or southwesterly winds (Bennett, 1909), as these species ordinarily cross nearer the center of the Gulf.

Analysis of Tropical Regions.—Quantitative field data were available from Cuba, the Isle of Pines (Walkinshaw and Baker, 1946), British Honduras, and Veracruz, and semi-quantitative data from eastern Mexico (Sutton and Burleigh, 1940; Sutton and Pettingill, 1942). It is very doubtful whether these data should be freely compared with those from within the United States in view of the great differences in objectives and methods used in the several regions. Furthermore, because of the need of obtaining as much data from the tropics as possible, I have not selected trips to give a balance for the various periods of spring but used all data available, thus invalidating strict comparisons of these sets of data with each other and with those from within the

TABLE 2

PERIODIC DISTRIBUTION OF QUANTITATIVE SPRING DATA SOUTH OF THE UNITED STATES
Values Given are the Percentage of the Observers' Time in the Field

	San Luis Potosi	Veracruz	Central America	Greater Antilles
March	28.5	32	43	41
April	66.5	36	41	34
May	5	32	16	25

United States (Table 2). Especially have I been cautious in using the semi-quantitative data of Sutton *et al.*, since the numbers used in the study were often based on my own inferences from reading the text.

SEQUENCE OF MIGRATION DATES

From state bird books and other regional lists, papers in state and national journals, and unpublished data received from cooperators, the earliest and latest spring records of the species included in this study were determined in each of 25 regions comparable to those from which quantitative data were obobtained (Fig. 2). The significance of this type of data has been the subject of some debate. It has been contended that the sequence of migration dates proves practically nothing. This would indeed be true if each species arrived simultaneously at all points north of its winter range. However, inasmuch as every species appears earlier in some parts of the country than in others, the time of its arrival at various points can indicate the course of its journey.

The danger that lies in the use of migration dates is that of attempting to prove too much from too little. Chance plays so large a part in determining the *recorded* occurrences of species (as opposed to their presence without our knowledge) that data in small amounts actually may prove very little.

In the present study this principle of increasing the amount, and therefore the significance, of the data was applied in several ways. (1) All migration dates from one region have been lumped. For example, the Northern Georgia region includes data from Atlanta, Athens, Dalton, Demorest, Augusta, and Macon. The 25 regions represented cover the entire southeastern United States, eastern Mexico, Central America (including Mexico east of the Isthmus of Tehuantepec), and the West Indies. Even data of this type from the tropics, however, are hardly comparable to those from within the United States. (2) The "average" arrival date was not employed in this study, as it usually consists of representative dates (when the observer was afield frequently) averaged with spurious arrival dates (when opportunities for field work were restricted). Arrival dates used in this study are considered the earliest normal dates for the region. In many instances, perhaps most, they are the earliest of record in that region. Very exceptional records, however, were omitted, as they might represent wintering, might have been based on faulty identification, or might in some way be anomalous. This introduced the problem of determining which early dates to consider exceptional and which representative. For common species a date five days in advance of the next earliest was considered "out of line," but for less common species a difference of a week or more was required to establish abnormality. Normal and abnormal departure dates were determined in much the same way. (3) In view of the fact that the earliest known record of a species is likely to be earlier in a region where it is common than in one where it is rare—and that, similarly, departure dates are usually later in the region where the bird is common—a *median* date was employed wherever possible. This is simply the date which lies half-way between the earliest and latest normal dates. Use of this date often showed a progression of migration that would not have been apparent from a comparison of arrival dates or departure dates alone.

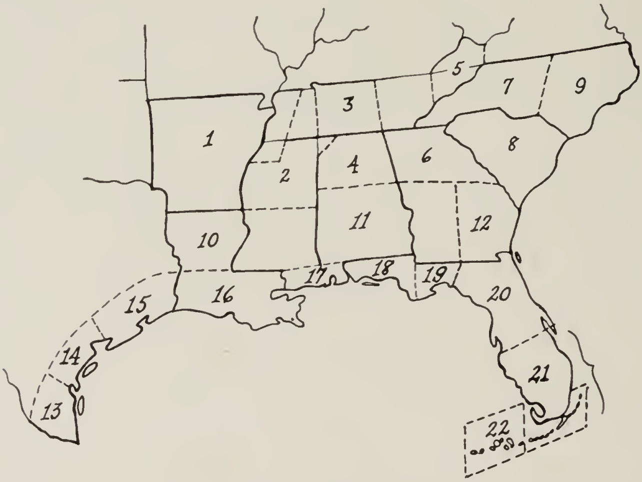

Fig. 2. Regions in the United States represented by migration dates. (Boundaries which do not coincide with state lines are indicated with broken lines.) 1. Arkansas (including western Tennessee and northwestern Mississippi); 2. Northern Mississippi (including northwestern Alabama); 3. Central Tennessee; 4. Northern Alabama; 5. Northeastern Tennessee-southwestern Virginia; 6. Northern Georgia; 7. Western North Carolina; 8. South Carolina; 9. Eastern North Carolina; 10. Northern Louisiana; 11. Central Alabama; 12. Southeastern Georgia; 13. Brownsville, Texas; 14. Corpus Christi, Texas; 15. Galveston, Texas; 16. Southern Louisiana; 17. Mississippi-Alabama Coast; 18. Northwestern Florida; 19. Tallahassee, Florida; 20. Northern Florida Peninsula; 21. Southern Florida Peninsula (including Upper Keys); 22. Lower Florida Keys.

USE OF MAPS

Maps were made (Figs. 3-62) showing the winter and summer ranges of each species, even though distribution south of the United States could not always be accurately determined. The frequencies were then plotted on these (odd-numbered) maps, and isoplethal lines were drawn in. (It is not intended that these lines imply certain frequencies for areas outside that under consideration, however close these areas may be.) Frequencies were enclosed in parentheses if they appeared to be no higher than values for the same species in winter or summer, but this was difficult to determine south of the United States. The symbol ".00+" was used to indicate the spring occurrence of species not recorded in the quantitative data used in the study. Superscript letters following these frequencies convey additional information: "a", May be as frequent in summer; "b", May be as frequent in winter; "c", Probably occurs more frequently (whenever these values were lower than those implied for the species by other workers, or lower than they would have been if all quantitative data received from that region had been used in the study). Appropriate symbols (A+, L–, etc.) compared the status of each species in coastal Mississippi (Burleigh, 1944) to its status on the Alabama or Louisiana coast. The area of maximum abundance was shaded. Also all records of birds seen on the Gulf of Mexico were located on these maps by geographic position, date, and number of individuals.

On similar (even-numbered) maps migration dates were transcribed, whether the arrival, median, or departure date, and isochrones used to show the species' advance. Whenever more than one kind of information was given on a single map, appropriate letters before a date show whether it is an arrival, median, or departure date (A, M, or D). Parentheses were placed around all dates based on six or fewer records, indicating their lesser significance. On these maps, "a" associated with a date indicates that exceptional records were omitted from consideration and "b" that the date probably is not representative.

GENERAL RESULTS

Comparative Abundance.—From this study it was determined that about 40 species of birds occurred more frequently along the northern Gulf coast than on its eastern and western sides. Although some of these may be open to suspicion on the grounds that they are also more common there in summer or winter, at least 16 of these are primarily of transient status. If the Texas coast north of Brownsville be included with the northern Gulf (on the assumption that many birds arrive there from across the Gulf) the list is greatly increased. The abundance on the Texas coast of certain species which

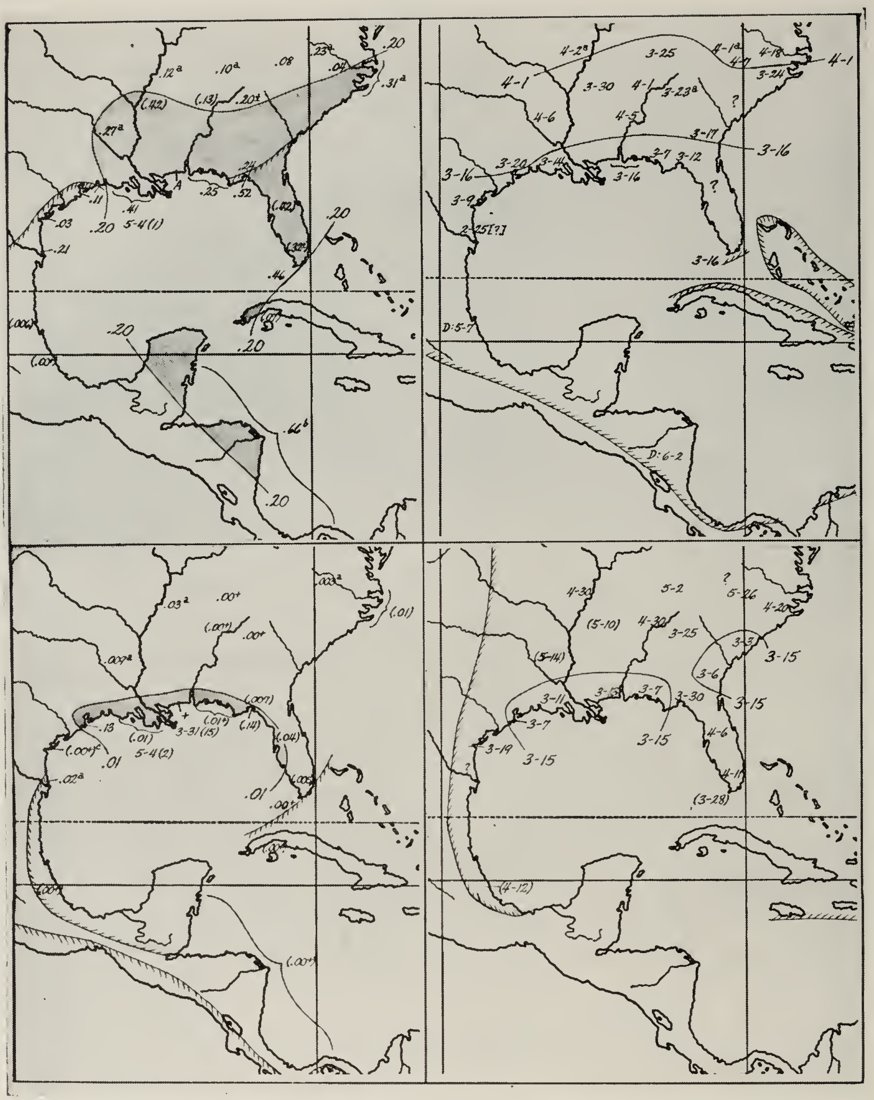

FIG. 3 (upper left) Comparative Abundance and FIG. 4 (upper right) Arrival Dates for the Green Heron.

FIG. 5 (lower left) Comparative Abundance and FIG. 6 (lower right) Arrival Dates for the Least Bittern.

(See text page 47 for further details concerning these maps.)

FIG. 7 (upper left) Comparative Abundance and FIG. 8 (upper right) Arrival Dates for the White Ibis.

FIG. 9 (lower left) Comparative Abundance and FIG. 10 (lower right) Arrival Dates for the Broad-winged Hawk.

breed in the eastern United States is surprising, but their occurrence is probably due in part to the prevailingly easterly winds over the Gulf of Mexico in spring. An observer (DeWeese) stationed on the Tortugas recorded easterly winds on 63 of the 101 days on which observations were made; another (Lockwood) at Rockport, Texas, on 66 of 82 days. Furthermore, some species' breeding ranges extend entirely across North America and their winter ranges lie in South America. Therefore an important segment of the population of such species as the Common Nighthawk (*Chordeiles minor*) and Olive-sided Flycatcher (*Nuttallornis borealis*), and of most species of swallows must cross the Texas coast in a direct flight from wintering to breeding grounds. Although the evidence that many species are less common in eastern Mexico than on the Texas coast may still be inconclusive, it is much better validated now than 10 years ago. I submit that the burden of proof that the two are ornithologically similar, insofar as transient species are concerned, now rests on any who may make the statement.

Sequence of Migration Dates.—If migration across the Gulf of Mexico does not occur, all species which appear on the northern side in spring should arrive there later (or certainly not earlier) than they appear *en route* there on the Texas or Florida coast. Conversely, migration across the Gulf, since it must occur in one continuous flight, would bring some individuals of the species to the northern side earlier than those which follow the longer land route, with its opportunities for frequent stopping. Therefore, trans-Gulf migrants should reach the coastal areas of northeastern Texas, Louisiana, Mississippi, Alabama, and northwestern Florida as early as, or earlier than, individuals of the same species arrive in southern Texas or the Florida Peninsula. Departure dates of species which are common in winter on the northern Gulf coast are difficult to interpret. Although later dates here in spring may seem to support the theory of circum-Gulf passage, I believe that in some cases these belated individuals have crossed the Gulf. Later departure dates on the sides of the Gulf, however, seem indicative of a circum-Gulf migration.

This study of the sequence of migration dates indicated that many species utilize the trans-Gulf migration route to some extent in spring. These include some which are of greatest abundance on the northern Gulf coast in spring, but a number of others which are not (Table 3). I doubt seriously whether any small land birds other than swallows follow the northern Gulf coastline eastward or westward to any appreciable extent in spring.

An incidental result of this phase of the study was the discovery of early arrival (or median) dates along the Atlantic coast of certain species whose winter ranges include parts of the West Indies or South America. Such species were the Least Bittern (*Ixobrychus exilis*), Stilt Sandpiper (*Micropalama himantopus*), Least Tern (*Sterna albifrons*), Chuck-will's-widow (*Caprimulgus* *carolinensis*), Common Nighthawk (*Chordeiles minor*), Cliff Swallow (*Petrochelidon pyrrhonota*), Veery (*Hylocichla fuscescens*), Red-eyed Vireo (*Vireo olivaceus*), Magnolia Warbler (*Dendroica magnolia*), Black-poll Warbler (*Dendroica striata*), American Redstart (*Setophaga ruticilla*), Bobolink (*Dolichonyx oryzivorus*), and Painted Bunting (*Passerina ciris*). (A few of these species also winter in south Florida and may have moved northward from there.) The implication is that some individuals fly across a small part of the western Atlantic. This theory receives some support from the records of many birds (but mostly of other species) in the western Atlantic in spring (Scholander, 1955).

Relationship to Adverse Weather.—The effect of a cold front, with or without rain, in precipitating trans-Gulf migrants is well known, but in my opinion the scarcity of migrants at other times has been overstated. Rain without a cold front precipitates many migrants; and, in fact, even under weather conditions ideal for continued overhead migration a few migrants are nearly always present along the coast. That these invariably are "hold-overs" from the last cold front seems improbable.

SYSTEMATIC ACCOUNT[1]

Explanation of Table 3.—In an effort to summarize the results of this study, evidence favoring each of the two migration routes is presented for 164 species in Table 3. (Data were too inconclusive for species omitted from the table.) Under the heading "Direct Observation," the number of records is given for each species seen over the Gulf ("Trans-Gulf") or flying around some part of the northern Gulf between Galveston Bay, Texas, and Apalachee Bay, Florida ("Circum-Gulf"). In the latter column the letter "w" indicates records of birds flying west and "e" those flying east. Under "Comparative Abundance" and "Sequence of Dates," the letter "x" (or, more doubtfully, "?") is used to symbolize the bulk of the migration.

COLYMBIFORMES AND PELECANIFORMES. The Pied-billed Grebe, a permanent resident over much of the study area, was a difficult subject, but there seems to be no evidence of a trans-Gulf migration. The same is true of the White Pelican and Anhinga. Significantly, all three species are unknown or are virtually so on the Dry Tortugas.

CICONIIFORMES. Most of the waders stick to the mainland in their migrations, but a few individuals of each species may venture across the Gulf. The Green Heron and Least Bittern (Figs. 3–6), however, appear to be chiefly trans-Gulf migrants, and perhaps the Yellow-crowned Night Heron is regularly, though not predominantly, so. All indications point to the exclusively circum-Gulf migration of the White Ibis (Figs. 7 and 8).

ANSERIFORMES. There is no conclusive evidence of trans-Gulf migration in any of the 16 species of ducks and geese included in this study. In fact, the winter ranges of most are largely within the United States and Mexico.

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[1] Scientific names of all species mentioned in this section may be found in Table 3.

TABLE 3
SUMMARY OF EVIDENCE PERTINENT TO MIGRATION ROUTES[1]

Species	Direct Observation		Comparative Abundance		Sequence of Dates	
	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf
Pied-billed Grebe (*Podilymbus podiceps*)	–	—	–	x	–	x
White Pelican (*Pelecanus erythrorhynchos*)	–	3w;1e	–	x	–	x
Anhinga (*Anhinga anhinga*)	–	—	–	x	–	?
Great Blue Heron (*Ardea herodias*)	2	1e	–	?	–	–
Common Egret (*Casmerodius albus*)	–	1e	–	?	–	–
Snowy Egret (*Leucophoyx thula*)	–	1e	–	?	–	–
Louisiana Heron (*Hydranassa tricolor*)	1	2e	–	?	–	–
Little Blue Heron (*Florida caerulea*)	–	3e	–	x	–	?
Green Heron (*Butorides virescens*)	1	—	x	?	?	–
Black-crowned Night Heron (*Nycticorax nycticorax*)	–	1e	–	?	–	–
Yellow-crowned Night Heron (*Nyctanassa violacea*)	1	—	–	–	?	–
American Bittern (*Botaurus lentiginosus*)	1	—	?	–	–	–
Least Bittern (*Ixobrychus exilis*)	2	—	x	–	x	–
White Ibis (*Eudocimus albus*)	–	3w;1e	–	x	–	x
Mallard (*Anas platyrhynchos*)	–	—	?	–	–	?
Gadwell (*Anas strepera*)	–	—	–	?	–	?
Pintail (*Anas acuta*)	–	—	–	?	–	x
Green-winged Teal (*Anas carolinensis*)	–	—	–	x	–	x
Blue-winged Teal (*Anas discors*)	–	3w;1e	–	x	–	x
American Widgeon (*Mareca americana*)	–	—	–	x	–	x
Shoveller (*Spatula clypeata*)	–	1e	–	x	–	x
Redhead (*Aythya americana*)	–	—	–	x	–	x
Ring-necked Duck (*Aythya collaris*)	–	—	–	x	–	?
Canvasback (*Aythya valisineria*)	–	—	–	?	–	?
Lesser Scaup (*Aythya affinis*)	–	1w	–	?	–	–
Ruddy Duck (*Oxyura jamaicensis*)	–	—	–	x	–	–
Turkey Vulture (*Cathartes aura*)	1	—	–	?	–	–
Swallow-tailed Kite (*Elanoides forficatus*)	–	—	–	–	–	x
Mississippi Kite (*Ictinia misisippiensis*)	–	—	–	–	–	–
Sharp-shinned Hawk (*Accipiter striatus*)	–	—	–	x	–	x
Cooper's Hawk (*Accipiter cooperii*)	–	—	–	?	–	x
Broad-winged Hawk (*Buteo platypterus*)	1	1e	?	?	–	x
Marsh Hawk (*Circus cyaneus*)	–	—	–	x	–	x
Osprey (*Pandion haliaetus*)	1	—	–	?	–	x
Peregrine Falcon (*Falco peregrinus*)	1	1w	–	?	?	?
Pigeon Hawk (*Falco columbarius*)	1	—	–	?	?	?
Sparrow Hawk (*Falco sparverius*)	2	—	?	–	–	–
Sora (*Porzana carolina*)	1	—	x	–	x	–
Purple Gallinule[2] (*Porphyrula martinica*)	1	—	–	x	?	?
American Coot (*Fulica americana*)	1	—	–	?	–	–
Semipalmated Plover (*Charadrius hiaticula*)	–	—	–	x	–	–
Wilson's Plover (*Charadrius wilsonia*)	–	—	–	x	–	x

(Continued on next page)

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[1] Omitting species for which data are inadequate or inconclusive.

[2] The Florida Gallinule (**Gallinula chloropus**), omitted from this study, has also been found on the open Gulf (Bullis and Lincoln, 1952).

TABLE 3. — (Continued)

Species	Direct Observation		Comparative Abundance		Sequence of Dates	
	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf
Golden Plover (*Pluvialis dominica*)	–	—	x	–	?	–
Black-bellied Plover (*Squatarola squatarola*)	–	—	–	x	–	–
Ruddy Turnstone (*Arenaria interpres*)	–	—	–	x	–	–
Wilson's Snipe (*Capella gallinago*)	–	—	–	x	–	?
Long-billed Curlew (*Numenius americanus*)	1	—	–	?	–	–
Hudsonian Curlew (*Numenius hudsonicus*)	–	—	–	?	–	x
Upland Plover (*Bartramia longicauda*)	–	1w	x	–	x	–
Spotted Sandpiper (*Actitis macularia*)	–	—	x	x	x	–
Solitary Sandpiper (*Tringa solitaria*)	–	—	x	–	x	–
Willet (*Catoptrophorus semipalmatus*)	–	—	–	x	–	–
Greater Yellow-legs (*Totanus melanoleucus*)	–	—	–	?	–	–
Lesser Yellow-legs (*Totanus flavipes*)	–	—	–	?	–	–
American Knot (*Calidris canutus*)	–	—	–	?	–	x
Pectoral Sandpiper (*Erolia melanotos*)	–	—	x	–	x	–
White-rumped Sandpiper (*Erolia fuscicollis*)	–	—	?	–	?	?
Baird's Sandpiper (*Erolia bairdi*)	–	—	x	–	?	–
Least Sandpiper (*Erolia minutilla*)	1	—	–	x	–	–
Dowitchers (*Limnodromus griseus, L. scolopaceus*)	–	—	–	x	–	–
Stilt Sandpiper (*Micropalama himantopus*)	–	—	x	–	x	–
Semipalmated Sandpiper (*Ereunetes pusillus*)	1	1w	x	–	?	?
Western Sandpiper (*Ereunetes mauri*)	–	—	?	?	–	?
Buff-breasted Sandpiper (*Tryngites subruficollis*)	–	—	x	–	?	–
Marbled Godwit (*Limosa fedoa*)	–	—	–	?	–	–
Hudsonian Godwit (*Limosa haemastica*)	–	—	?	?	–	–
Sanderling (*Crocethia alba*)	–	—	?	–	–	–
Black-necked Stilt (*Himantopus mexicanus*)	–	—	?	?	?	?
Wilson's Phalarope (*Steganopus tricolor*)	–	—	?	?	–	?
Herring Gull (*Larus argentatus*)	2	—	x	–	–	–
Least Tern (*Sterna albifrons*)	–	—	–	?	–	?
Cabot's Tern (*Thalasseus sandvicensis*)	–	—	?	–	–	?
Black Tern (*Chlidonias niger*)	–	—	x	–	?	–
Mourning Dove (*Zenaidura macroura*)	3	—	?	?	–	–
Ground Dove (*Columbigallina passerina*)	–	1w	–	x	–	–
Yellow-billed Cuckoo (*Coccyzus americanus*)	1	—	x	–	x	–
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	–	—	x	–	x	–
Short-eared Owl (*Asio flammeus*)	–	—	–	x	–	x
Chuck-will's-widow (*Caprimulgus carolinensis*)	–	—	–	x	–	x
Common Nighthawk (*Chordeiles minor*)	3	—	x	?	x	x
Chimney Swift (*Chaetura pelagica*)	2	—	–	x	x	–
Ruby-throated Hummingbird (*Archilochus colubris*)	2	—	x	–	x	x
Belted Kingfisher (*Megaceryle alcyon*)	3	—	x	x	–	–
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	–	—	x	–	x	x
Eastern Kingbird (*Tyrannus tyrannus*)	1	1e	x	–	x	–
Gray Kingbird (*Tyrannus dominicensis*)	1	—	–	x	–	x
Western Kingbird (*Tyrannus verticalis*)	–	—	?	–	–	?
Scissor-tailed Flycatcher (*Muscivora forficata*)	–	—	?	–	?	–
Crested Flycatcher (*Myiarchus crinitus*)	–	—	x	–	x	–
Eastern Phoebe (*Sayornis phoebe*)	1	—	–	–	–	?

(Continued on next page)

Table 3. — (Continued)

Species	Direct Observation		Comparative Abundance		Sequence of Dates	
	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf
Yellow-bellied Flycatcher (*Empidonax flaviventris*)	–	—	?	?	?	?
Acadian Flycatcher (*Empidonax virescens*)	–	—	x	–	x	–
Traill's Flycatcher (*Empidonax traillii*)	–	—	?	?	?	?
Least Flycatcher (*Empidonax minimus*)	–	—	x	–	x	–
Empidonax sp.?	–	—	–	x	–	–
Eastern Wood Pewee (*Contopus virens*)	–	—	x	–	x	–
Olive-sided Flycatcher[1] (*Nuttallornis borealis*)	1	—	?	?	–	?
Tree Swallow (*Iridoprocne bicolor*)	3	1w	–	x	–	x
Bank Swallow (*Riparia riparia*)	2	1e;1w	x	–	?	?
Rough-winged Swallow (*Stelgidopteryx ruficollis*)	–	1e	?	?	x	–
Barn Swallow (*Hirundo rustica*)	8	1e;1w	x	–	x	–
Cliff Swallow (*Petrochelidon pyrrhonota*)	2	1e;1w	–	x	–	x
Purple Martin (*Progne subis*)	2	2e	x	–	x	–
House Wren (*Troglodytes aedon*)	–	—	–	x	–	x
Catbird (*Dumetella carolinensis*)	1	—	x	–	x	–
American Robin (*Turdus migratorius*)	1	—	?	–	?	?
Wood Thrush (*Hylocichla mustelina*)	2	—	x	–	x	–
Hermit Thrush (*Hylocichla guttata*)	–	—	?	–	–	?
Olive-backed Thrush (*Hylocichla ustulata*)	1	—	x	–	x	–
Gray-cheeked Thrush (*Hylocichla minima*)	–	—	x	–	x	–
Veery (*Hylocichla fuscescens*)	2	—	x	–	x	–
Blue-gray Gnatchatcher (*Polioptila caerulea*)	–	—	–	?	–	x
Ruby-crowned Kinglet (*Regulus calendula*)	–	—	?	?	–	?
American Pipit (*Anthus spinoletta*)	–	—	?	?	?	–
Cedar Waxing (*Bombycilla cedrorum*)	–	—	x	–	?	–
White-eyed Vireo (*Vireo griseus*)	–	—	?	?	?	–
Bell's Vireo (*Vireo bellii*)	–	—	–	x	–	x
Yellow-throated Vireo (*Vireo flavifrons*)	–	—	x	–	?	?
Blue-headed Vireo (*Vireo solitarius*)	–	—	?	?	?	x
Red-eyed Vireo (*Vireo olivaceus*)	1	—	x	–	x	–
Philadelphia (*Vireo philadelphicus*)	–	—	?	–	?	–
Warbling Vireo (*Vireo gilvus*)	–	—	x	–	x	–
Black-and-white Warbler (*Mniotilta varia*)	4	1w	x	x	x	–
Prothonotary Warbler (*Protonotaria citrea*)	4	—	x	–	x	–
Swainson's Warbler (*Limnothlypis swainsonii*)	–	—	x	–	?	?
Worm-eating Warbler (*Helmitheros vermivorus*)	4	1w	x	?	x	–
Golden-winged Warbler (*Vermivora chrysoptera*)	1	—	?	?	x	–
Blue-winged Warbler (*Vermivora pinus*)	–	—	?	?	x	–
Bachman's Warbler (*Vermivora bachmanii*)	–	—	–	–	x	–
Tennessee Warbler (*Vermivora peregrina*)	–	—	x	–	x	–
Orange-crowned Warbler (*Vermivora celata*)	–	—	?	?	–	x
Nashville Warbler (*Vermivora ruficapilla*)	1	—	–	x	x	–
Parula Warbler (*Parula americana*)	4	1w	x	–	x	x
Yellow Warbler (*Dendroica petechia*)	3	1e;1w	x	?	x	–
Magnolia Warbler (*Dendroica magnolia*)	2	—	x	?	?	?
Cape May Warbler (*Dendroica tigrina*)	4	—	–	x	–	x

(Continued on next page)

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[1] The Vermilion Flycatcher (**Pyrocephalus rubinus**), omitted from this study, has once been found on the open Gulf (Bullis and Lincoln, 1952).

TABLE 3. — (Continued)

Species	Direct Observation		Comparative Abundance		Sequence of Dates	
	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf	Trans-Gulf	Circum-Gulf
Black-throated Blue Warbler (*Dendroica caerulescens*)	1	—	–	x	x	?
Myrtle Warbler (*Dendroica coronata*)	6	1w	x	–	x	x
Black-throated Green Warbler (*Dendroica virens*)	1	—	–	x	?	?
Cerulean Warbler (*Dendroica cerulea*)	1	—	x	–	x	–
Blackburnian Warbler (*Dendroica fusca*)	–	—	x	?	x	–
Yellow-throated Warbler (*Dendroica dominica*)	1	—	x	–	x	x
Chestnut-sided Warbler (*Dendroica pensylvanica*)	1	—	x	–	x	–
Bay-breasted Warbler (*Dendroica castanea*)	1	—	x	–	x	–
Black-poll Warbler (*Dendroica striata*)	2	—	–	x	x	–
Prairie Warbler (*Dendroica discolor*)	–	—	–	x	?	x
Palm Warbler (*Dendroica palmarum*)	1	—	–	x	–	x
Ovenbird (*Seiurus aurocapillus*)	1	—	x	–	x	–
Northern Water-thrush (*Seiurus noveboracensis*)	1	—	x	–	–	x
Louisiana Water-thrush (*Seiurus motacilla*)	2	—	x	–	x	–
Kentucky Warbler (*Oporornis formosus*)	4	—	x	–	x	–
Mourning Warbler (*Oporornis philadelphia*)	1	—	–	x	x	–
Yellow-throat (*Geothlypis trichas*)	4	—	–	x	–	–
Yellow-breasted Chat (*Icteria virens*)	–	—	?	x	–	x
Hooded Warbler (*Wilsonia citrina*)	2	—	x	–	x	–
Wilson's Warbler (*Wilsonia pusilla*)	1	—	?	x	–	–
Canada Warbler (*Wilsonia canadensis*)	–	—	–	x	–	x
American Redstart (*Setophaga ruticilla*)	8	1w	x	x	x	–
Bobolink (*Dolichonyx oryzivorus*)	3	—	x	x	?	?
Orchard Oriole (*Icterus spurius*)	5	—	x	–	x	–
Baltimore Oriole (*Icterus galbula*)	2	—	x	–	x	x
Scarlet Tanager (*Piranga olivacea*)	3	—	x	–	x	x
Summer Tanager (*Piranga rubra*)	3	—	x	–	x	x
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	–	—	x	–	x	x
Blue Grosbeak (*Guiraca caerulea*)	–	—	x	?	x	–
Indigo Bunting (*Passerina cyanea*)	3	1e	x	?	x	–
Painted Bunting (*Passerina ciris*)	1	—	x	?	x	–
Dickcissel (*Spiza americana*)	1	—	x	?	x	x
Savannah Sparrow (*Passerculus sandwichensis*)	–	—	?	x	–	x
Grasshopper Sparrow (*Ammodramus savannarum*)	1	—	–	x	–	x
Lincoln's Sparrow (*Melospiza lincolnii*)	–	—	–	x	–	x

FALCONIFORMES. Turkey Vultures move northward along the Texas and Florida coasts to some extent in spring. Although there seems to be no record of any far from land, Van Tyne and Trautman (1945) witnessed what appeared to be the beginning of a trans-Gulf migration. Swallow-tailed Kites are seldom encountered south of their breeding grounds, but the few migration records are all from land areas. It seems almost certain that the Mississippi Kite follows the coast from Veracruz through Texas in reaching its breeding grounds. Whether the same is true of the Broad-winged Hawk is much less certain, as comparatively few have been reported in Mexico and one was recorded off the Louisiana coast (Figs. 9 and 10). It seems probable that most cross

Fig. 11 (upper left) Comparative Abundance and Fig. 12 (upper right) Median Dates for the Sora.

Fig. 13 (lower left) Comparative Abundance and Fig. 14 (lower right) Median Dates for the Upland Plover.

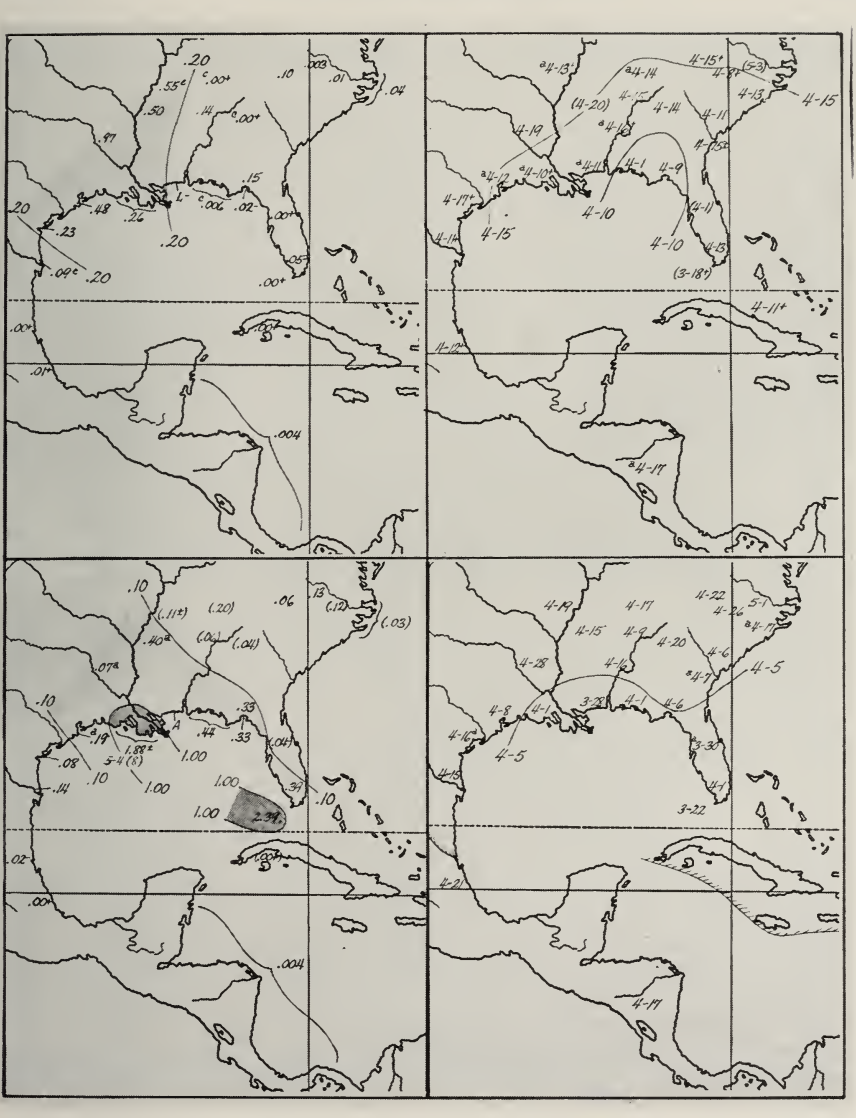


FIG. 15 (upper left) Comparative Abundance and FIG. 16 (upper right) Median Dates for the Pectoral Sandpiper.

FIG. 17 (lower left) Comparative Abundance and FIG. 18 (lower right) Arrival Dates for the Yellow-billed Cuckoo.

from Yucatan to the Texas coast, then turn northward and northeastward. Sharp-shinned and Cooper's hawks follow coastal and inland routes in spring. Marsh Hawks probably do the same, but I would not rule out the likelihood of an occasional individual's crossing the Gulf. Despite my observation on the Tortugas, there is nothing to indicate a regular trans-Gulf flight of Ospreys in spring. Falcons are well known for their coastwise migrations, but each of the three eastern species has been observed on the Gulf one time, and it is not unlikely that a few of these strong flyers make the long flight across.

RALLIDAE. Pertinent data on the Virginia and Black rails are too meagre to be indicative, but there is abundant circumstantial evidence that the Sora crosses the Gulf with regularity (Figs. 11 and 12). This is also true of the Purple Gallinule, which arrives earlier on the northern Gulf than on the Texas coast. Despite the general abundance of the species, only one Coot has been found on the open Gulf and it is only a few miles offshore. Apparently few or none cross the Gulf of Mexico.

CHARADRIIDAE. Piping and Snowy plovers are shore birds of comparatively northerly winter ranges, and presumably few individuals which breed in the United States winter south of the Gulf. There is no reason to doubt that they follow the coast lines in the manner of most shore birds. Quantitative data indicate that most Semipalmated Plovers do also, and there is no record of one far offshore. Wilson's and Black-bellied plovers and the Ruddy Turnstone are more common on the east and west sides of the Gulf, and Wilson's usually arrives there earlier in spring; but each species was encountered much less frequently in Mexico. Comparatively few Killdeer winter south of the Gulf of Mexico, and there is no indication that these cross the Gulf in spring. Golden Plovers must, however, be regarded as trans-Gulf migrants, as significant numbers have not been reported from eastern Mexico. The highest coastal frequencies by far are in Texas and Louisiana.

SCOLOPACIDAE. Most members of this group were more common on the eastern or western Gulf, but values in Mexico were usually low. This was true of Wilson's Snipe, but I believe that the few, out-of-place individuals found on the northern Gulf coast in late spring have flown across. Despite the fact that the Long-billed Curlew is most common in spring on the Texas coast, a record of seven off the Louisiana coast (Lowery, 1946) denotes a Gulf crossing for some. Most Hudsonian Curlews follow coastal routes within the United States, but Mexican records are few at this date. Both the quantitative data and the sequence of migration dates imply a trans-Gulf passage for the Upland Plover, most individuals reaching land in Texas or Louisiana (Figs. 13 and 14). There are, almost surely, important migrations of Spotted Sandpipers both around and across the Gulf. The bulk of the Solitary Sandpipers crosses the Gulf west of the Dry Tortugas, where the species has not been recorded in spring; smaller numbers apparently follow each side of the Gulf northward. Pectoral (Figs. 15 and 16), White-rumped, Baird's, and Buff-breasted sandpipers appear to be trans-Gulf migrants most common on the Texas coast (and Louisiana, in the case of the Pectoral). The Stilt Sandpiper may fall into this category in spite of its wide winter range in Mexico. The Hudsonian Godwit is too rare to appraise at this time, and the Marbled Godwit is often as common in winter as in spring. A large-scale trans-Gulf migration for the remaining members of this family seems improbable, but reliable migration dates were unobtainable on the Gulf for such non-breeding permanent residents as the Dowitchers, Sanderling, and most of the "peeps." There are, however, direct observations both of trans-Gulf and circum-Gulf migration in the Semipalmated Sandpiper.

RECURVIROSTRIDAE AND PHALAROPODIDAE. The Black-necked Stilt is temporarily classified as a chiefly trans-Gulf migrant to the coast of Texas and Louisiana. Until evidence of numbers is forthcoming from Mexico, Wilson's Phalarope must also be reckoned a trans-Gulf migrant even though the center of spring abundance is the *southern* coast of Texas.

LARIDAE. The resident habits of the gulls render them difficult subjects for this study, but there are indications that some Herring Gulls cross the Gulf of Mexico in spring. Because of the difficulties of distinguishing them in the field, Forster's and Common terns have yielded little data of value in this study. Least Terns, unrecorded far offshore in the Gulf, reach the Texas and Florida coasts earlier than the northern Gulf, and hence are primarily circum-Gulf in their spring migration. The same route seems to be followed by other species of terns with the striking exception of the Black Tern, which, for all its abundance on the Texas coast, seems to be entirely lacking in spring in Mexico.

COLUMBIDAE. Although the two common species of doves are resident in most parts of the South, three Mourning Dove records on the Gulf provide direct evidence of the trans-Gulf flight of this species. It appears likely that most of the White-winged Doves appearing in Texas in spring have moved northward from Mexico.

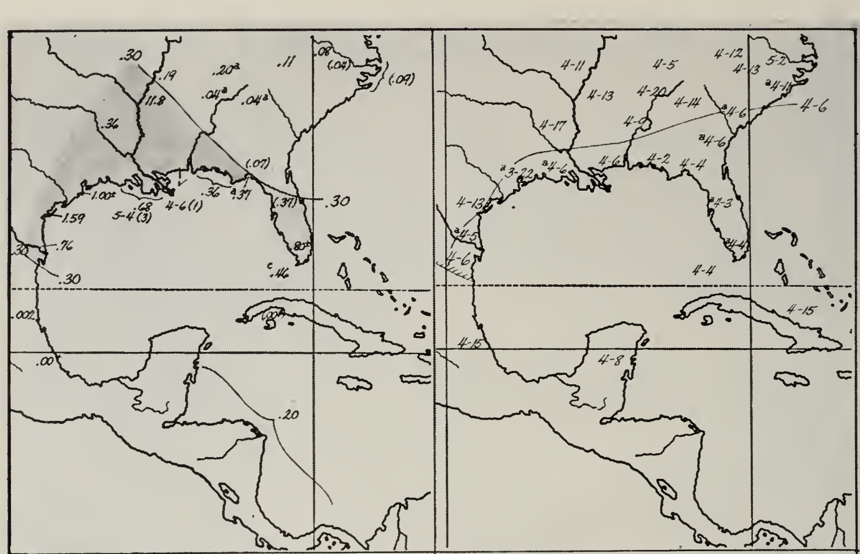
CUCULIDAE. Large numbers of Yellow-billed Cuckoos cross the Antilles (?), Florida Keys, and Gulf of Mexico in spring, the greatest numbers precipitating on or passing over the Louisiana coast (Figs. 17 and 18). Black-billed Cuckoos cross on a more westerly course, appearing in eastern Mexico almost as frequently as from Texas to Alabama.

CAPRIMULGIDAE. All evidence suggests a heavy migration of Chuck-will's-widows northward on the Florida Peninsula, but whether all of those breeding north of the Gulf arrive from this route is doubtful. Data on the Whip-poor-will were inconclusive, but there is every indication that Common Nighthawks arrive almost simultaneously and occur in comparable numbers all around the Gulf in the United States, some having been seen arriving from over the Gulf (F. M. Weston, *fide* Lowery, 1946) (Figs. 19 and 20). By contrast, Mexican records are few in spring and the numbers negligible.

APODIFORMES. Chimney Swifts apparently migrate on a wide front, but the largest coastal numbers appear in Texas. I have seen one arriving from over the Gulf and believe that many follow this course, although Loetscher (1955) describes an important migration along the eastern coast of Mexico. The Ruby-throated Hummingbird, long cited as a trans-Gulf migrant, is uncommon in most of Florida and apparently rather rare in Mexico, but occurs in large numbers on the Dry Tortugas and the coasts of Louisiana and Texas.

ALCEDINIDAE AND PICIDAE. Two records of the Belted Kingfisher on the Gulf of Mexico, along with a high spring frequency on the Louisiana coast, point to the trans-Gulf course followed by some individuals. Although the high frequencies of the Yellow-bellied Sapsucker on the northern Gulf coast may merely reflect its status there in winter, late individuals appearing there after the winter population has departed probably come from across the Gulf, some of them from the West Indies *via* the Dry Tortugas. The Red-headed Woodpecker (*Melanerpes erythrocephalus*), not included in this study because it is not known to winter south of the United States, occurs as a summer resident on islands off the Mississippi coast (Burleigh, 1944) and as a spring transient on Gulf islands off Florida (including a June record for the Tortugas; Howell, 1932).

TYRANNIDAE. The Eastern Kingbird has been cited (Williams, 1945) as a circum-Gulf migrant, and does appear to be unusually common on parts of the Texas coast. The lack of large numbers in Mexico, however, coupled with the earlier migration dates on



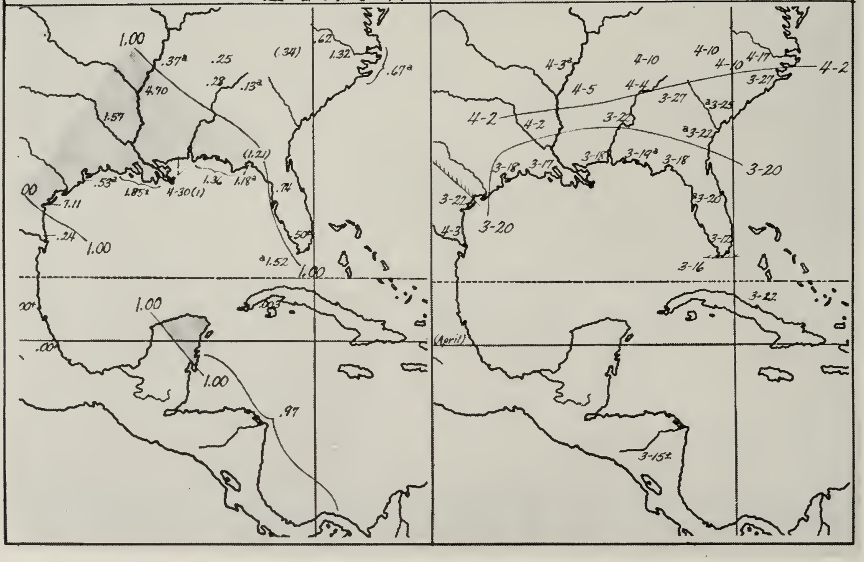


Fig. 19 (upper left) Comparative Abundance and Fig. 20 (upper right) Arrival Dates for the Common Nighthawk.

Fig. 21 (lower left) Comparative Abundance and Fig. 22 (lower right) Arrival Dates for the Eastern Kingbird.

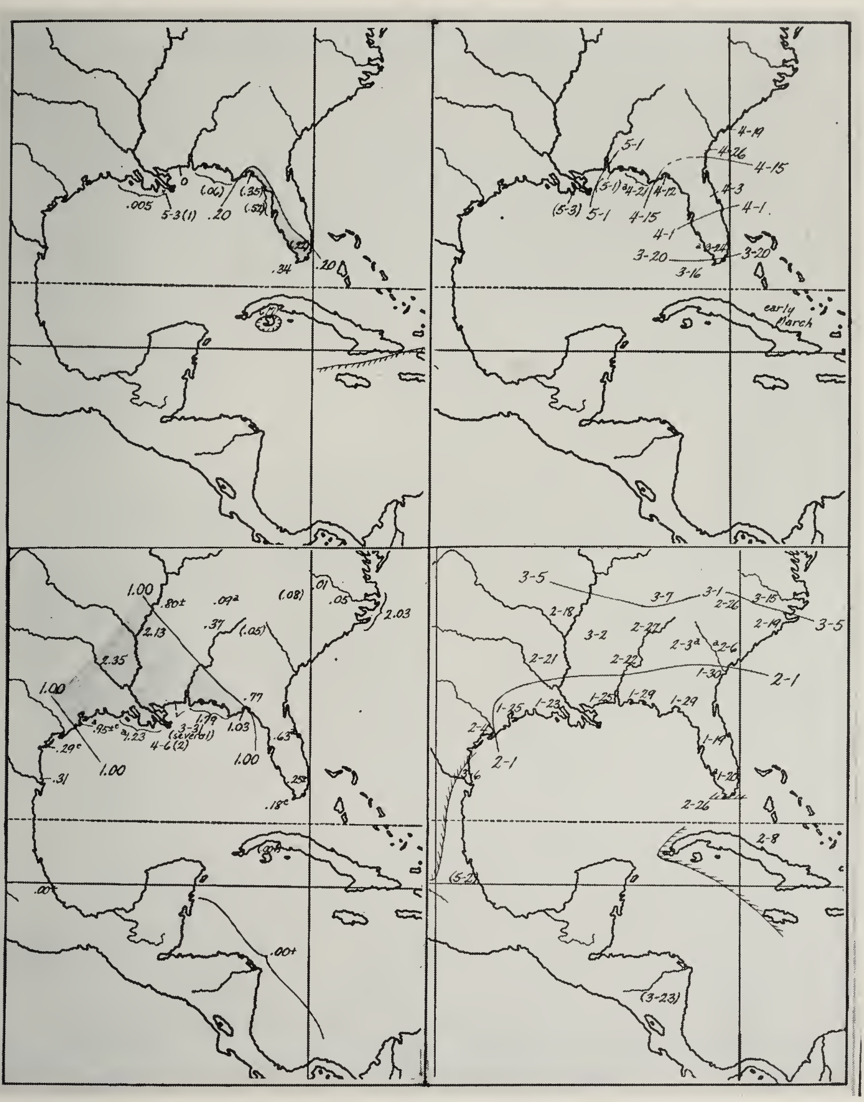


FIG. 23 (upper left) Comparative Abundance and FIG. 24 (upper right) Arrival Dates for the Gray Kingbird.

FIG. 25 (lower left) Comparative Abundance and FIG. 26 (lower right) Arrival Dates for the Purple Martin.

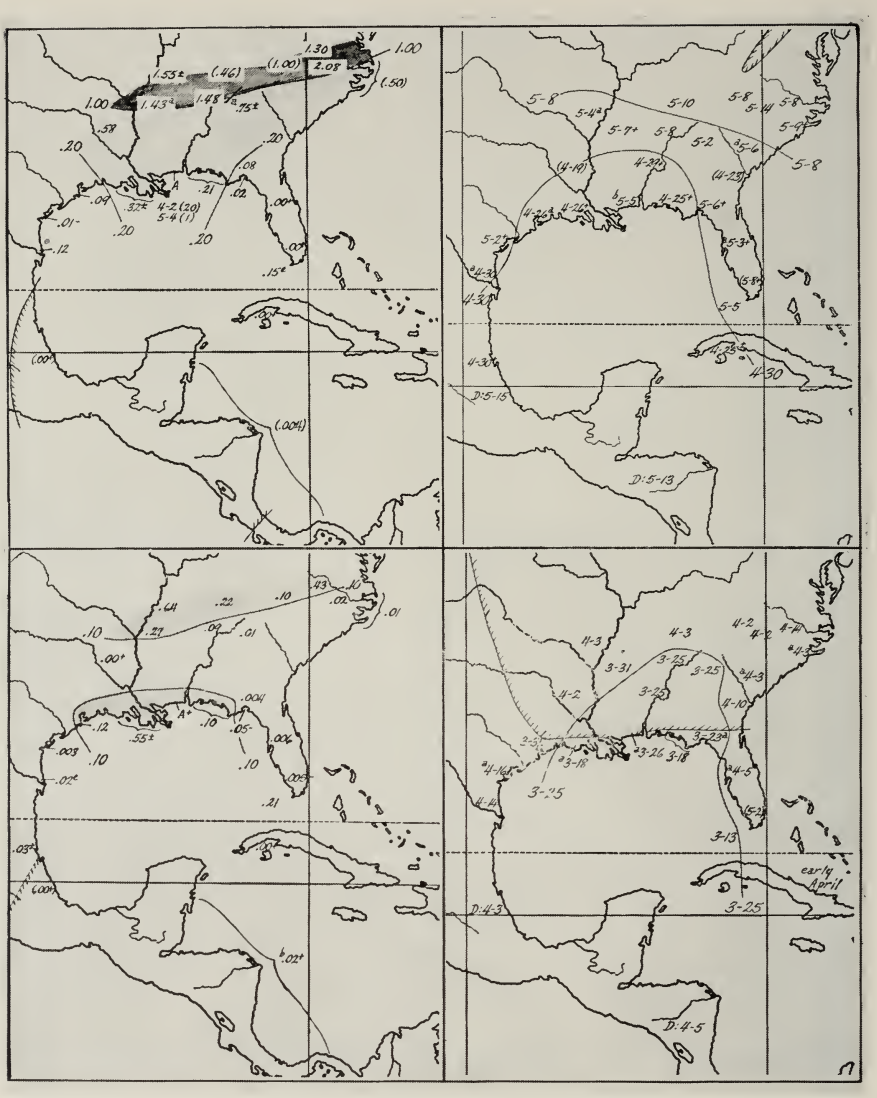


FIG. 27 (upper left) Comparative Abundance and FIG. 28 (*lower* right) Arrival Dates for the Wood Thrush.

FIG. 29 (lower left) Comparative Abundance and FIG. 30 (*upper* right) Median Dates for the Olive-backed Thrush.

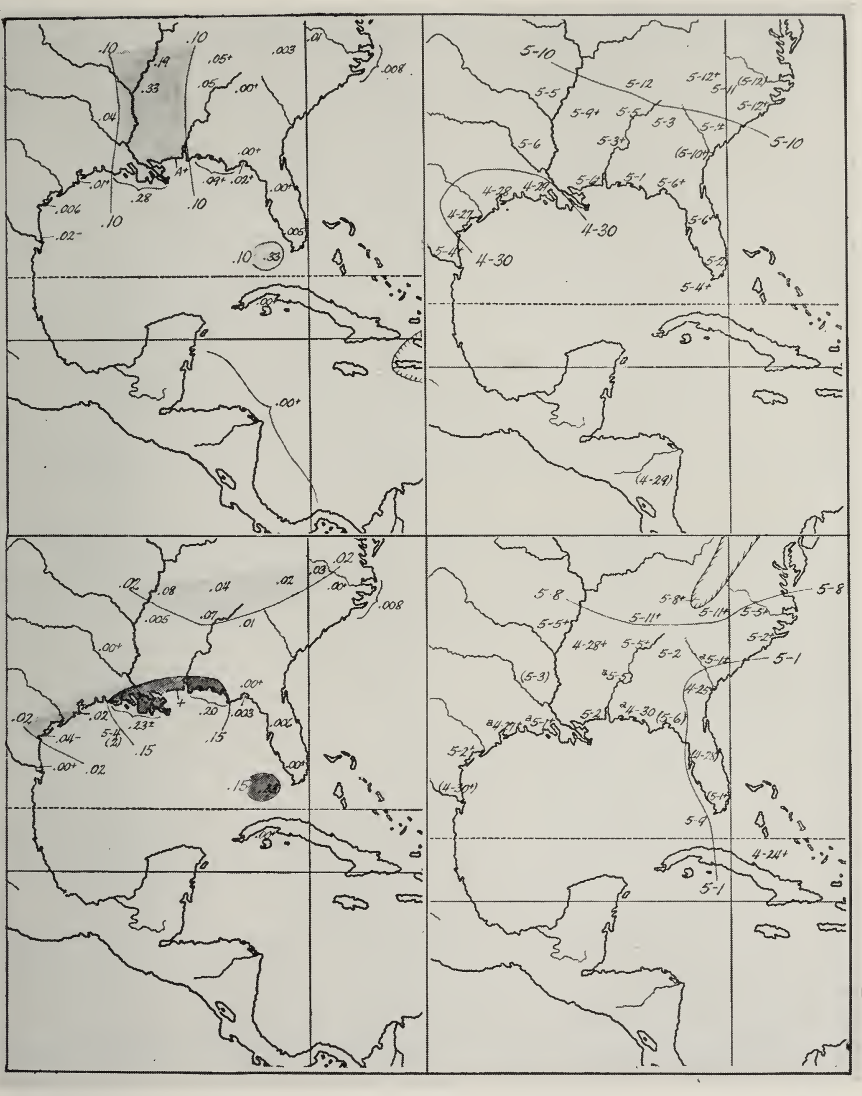


Fig. 31 (upper left) Comparative Abundance and Fig. 32 (upper right) Median Dates for the Gray-cheeked Thrush.

Fig. 33 (lower left) Comparative Abundance and Fig. 34 (lower right) Median Dates for the Veery.

the northern Gulf coast convince me that the chief migration route is across the western Gulf (Figs. 21 and 22). On the contrary, the occurrence of a Gray Kingbird over the Gulf of Mexico (Lowery, 1946) is considered most unusual (Figs. 23 and 24). At present there is no evidence of Gulf-crossing for the Western Kingbird or Scissor-tailed Flycatcher, but it may be expected occasionally. Despite its seeming absence from the Dry Tortugas, the Crested Flycatcher must be considered a trans-Gulf migrant, arriving early on the northern Gulf and being most common in spring from northern Florida to the Mississippi coast. Although there is a spring record of the Eastern Phoebe off the Louisiana coast, its scarcity south of the Gulf in winter makes this occurrence appear unusual. Members of the genus *Empidonax*, difficult to separate in the field, are quite common in spring in eastern Mexico and southern Texas. A record of one on the Gulf, however, as well as early arrival dates of the Acadian and Least flycatchers on the northern Gulf coast, demonstrates that a trans-Gulf passage of these small birds may not be unusual. Two species of pewees occur in spring in eastern Mexico and southern Texas, and identification of silent birds is impossible without collecting. Nevertheless, the highest frequencies and the earliest records are along the northern Gulf coast, leading to the belief that the Eastern Wood Pewee is chiefly a trans-Gulf migrant. Not enough data are available for the Olive-sided Flycatcher to be indicative.

HIRUNDINIDAE. Although the major flight of Tree Swallows passes along the sides of the Gulf, the data suggest that at least a few cross it in spring. Bank Swallows are both trans-Gulf and circum-Gulf migrants, the greatest numbers occurring on the Texas and Louisiana coasts. Early arrival dates show the Rough-winged Swallow to cross the Gulf regularly, although none has been reported offshore; also the numbers reported in eastern Mexico have been comparatively small. Even though Barn Swallows follow parts of the coastline in great numbers, the following facts persuade me that a major flight crosses the Gulf: earliest median dates in Texas and Louisiana; frequencies on the Texas coast several times as high as those in eastern Mexico; at least eight spring records involving hundreds of individuals on the open Gulf. Data for the Cliff Swallow are similar to those for the Barn Swallow, except that there is a progression of migration dates around the Texas and Louisiana coasts; therefore it is probable that most individuals follow at least this part of the coastline, but a few precocious migrants have been seen offshore from Louisiana to Alabama. All three lines of evidence favor the theory that Purple Martins are Gulf-crossing migrants (Figs. 25 and 26).

TROGLODYTIDAE AND MIMIDAE. There is no evidence of a trans-Gulf migration of House Wrens, and their northerly winter range would not suggest such a probability. The two heaviest flights of Catbirds are across the Gulf and northward on the Florida Peninsula, with a fair migration also through eastern Mexico.

TURDIDAE. Members of this family are among the most typical of the trans-Gulf migrants, although the northerly winter ranges of the Robin and Hermit Thrush militate against their total contribution to this phenomenon. The Wood, Olive-backed, and Gray-checked thrushes, and the Veery are much more numerous in spring on the Dry Tortugas and the northern Gulf than in peninsular Florida, Texas, or eastern Mexico; this evidence is fully backed by the sequence of migration dates and by sight records of three of these species on the open Gulf (Figs. 27–34).

SYLVIIDAE. Frequencies of the Blue-gray Gnatcatcher are too irregular to be of value in this study, but the progression of arrival dates implies only circum-Gulf migration. Essentially the same situation holds for the Ruby-crowned Kinglet, which is probably rare south of the Gulf of Mexico even in winter.

MOTACILLIDAE AND BOMBYCILLIDAE. Although there is little *prima facie* evidence for Gulf-crossing in the American Pipit, it is unlikely that the occasional individuals seen on the northern Gulf coast in early May have circled part of the Gulf or lingered so far past the species' normal departure date. Similarly, I am suspicious of large flocks of Cedar Waxwings seen on the northern Gulf coast in spring where they have been chiefly absent in winter.

VIREONIDAE. The White-eyed Vireo is a difficult subject due to its extensive winter and summer ranges, but early arrival dates on the northern Gulf coast suggest that a part of the migration comes across that body of water. Earliest records of Bell's Vireo also extend northeastward from Corpus Christi, Texas, although there is certainly an important migration through eastern Mexico. Yellow-throated Vireos have proven more common in spring along the Gulf from northern Florida to Galveston Bay than farther south, even though most of the former area lies south of its breeding range. It is very likely that there are smaller migrations along the Texas coast and Florida Peninsula. My data on the Blue-headed Vireo are inconclusive, but the Red-eyed Vireo is, without doubt, chiefly a trans-Gulf migrant (Figs. 35 and 36). The Philadelphia Vireo migrates across the Gulf mostly to the Texas coast, and the Warbling Vireo is about equally frequent there and in Louisiana. Probably a few individuals of the latter species follow the coast northward from Mexico.

PARULIDAE. Records of birds on the Gulf and early median dates in Mississippi and Louisiana are signs of a trans-Gulf migration of the Black and White Warbler. Comparative frequencies, however, show the migration on both sides of the Gulf to be just as important. The absence of the Prothonotary Warbler in eastern Mexico and its scarcity in the southern Florida Peninsula leave no room for doubt that it migrates chiefly across the Gulf, as has long been claimed. The sequence of arrival dates and records over the Gulf complete the evidence (Figs. 37 and 38). Present evidence favors the same view for Swainson's Warbler, although it is so rare at some places on the northern Gulf coast that the significance of quantitative data are open to question. The trans-Gulf and circum-Gulf highways are utilized about equally by the Worm-eating Warbler, but the Golden-winged and Blue-winged warblers evidently cross from Central America to Texas and Louisiana in greatest numbers. Early spring records of Bachman's Warbler in Louisiana and Mississippi suggest a direct flight from Cuba, but data are too scarce to be conclusive. Most Tennessee Warblers fly directly from their winter home to (or beyond) the shoreline stretching from Texas to Alabama, but a smaller migration passes through eastern Mexico (Figs. 39 and 40). It does not appear geographically probable that many Orange-crowned Warblers would cross the Gulf of Mexico in spring, nor is there direct evidence that they do so. Most Nashville Warblers reach the Texas coast from eastern Mexico, but a few apparently take a short cut from Yucatan to points as far east as Louisiana. Although the major migration of Parula Warblers passes through the Florida Peninsula, many individuals cross from Yucatan (and Cuba?) to the northern Gulf as far west as Galveston Bay. The principal migration routes of the Yellow Warbler extend up the Mexican-Texas coast and across the western Gulf. The statement that it is "less numerous in spring" than in fall in Florida (Howell, 1932) is extremely conservative, as it is decidedly rare in the Peninsula at that season. The case of the Magnolia Warbler is similar, but it is even scarcer in Florida. Notwithstanding the fact that the Cape May Warbler is a regular transient in peninsular Florida, it appears that a fairly important part of its spring flight carries northwestward across southern Florida and the eastern Gulf to northwestern Florida, coastal Alabama, and inland localities. This helps to explain the presence of a few on the open Gulf

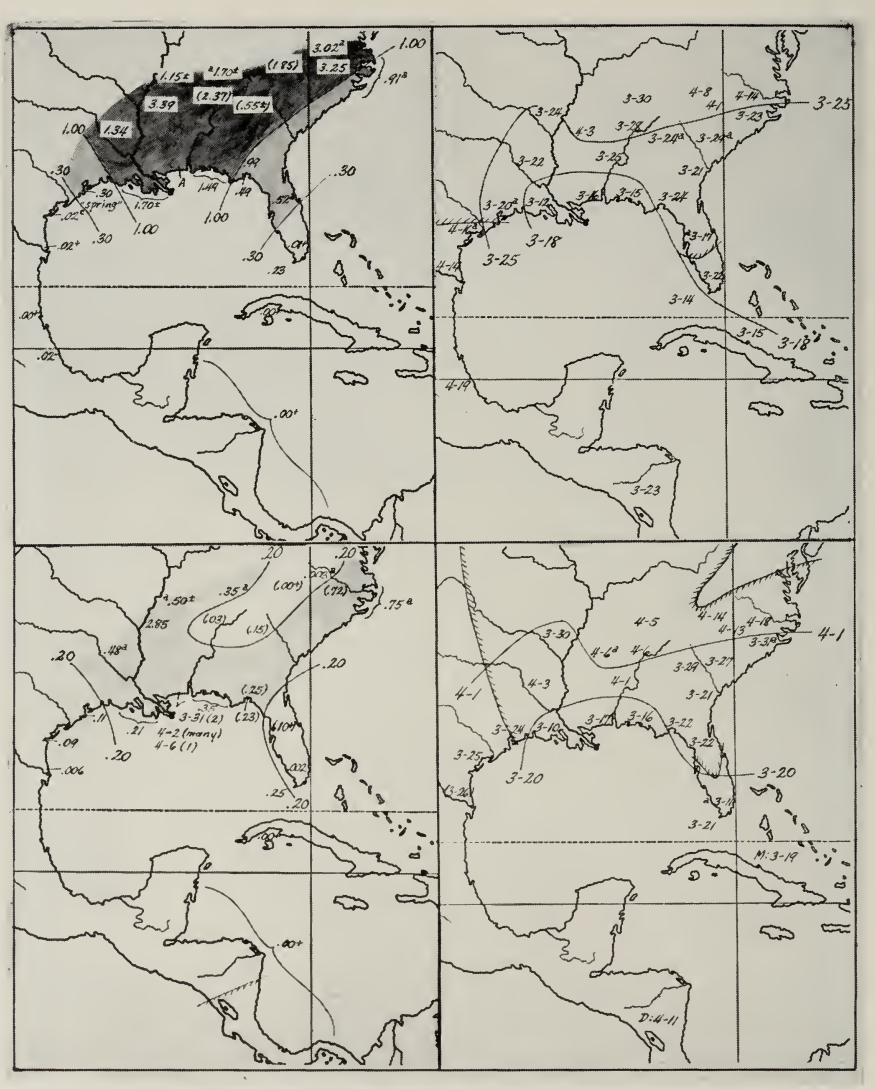


FIG. 35 (upper left) Comparative Abundance and FIG. 36 (upper right) Arrival Dates for the Red-eyed Vireo.

FIG. 37 (lower left) Comparative Abundance and FIG. 38 (lower right) Arrival Dates of the Prothonotary Warbler.

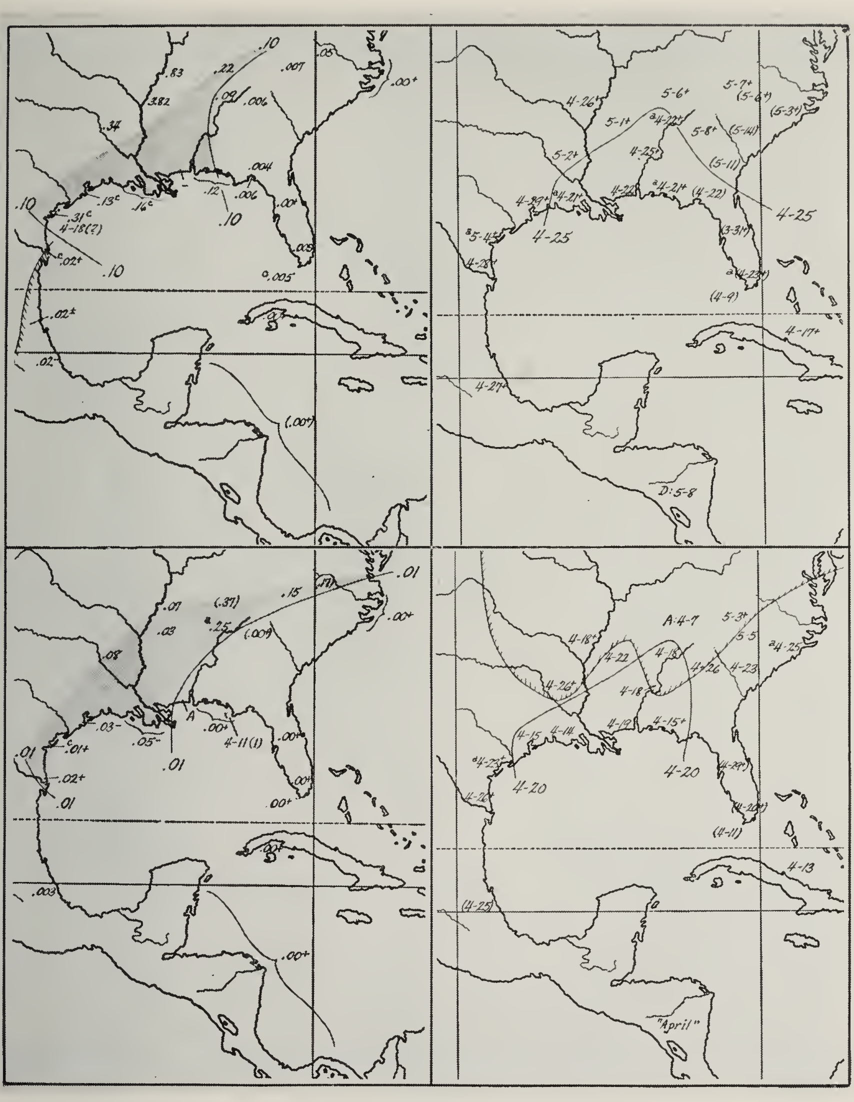


FIG. 39 (upper left) Comparative Abundance and FIG. 40 (upper right) Median Dates for the Tennessee Warbler.

FIG. 41 (lower left) Comparative Abundance and FIG. 42 (lower right) Median Dates for the Cerulean Warbler.

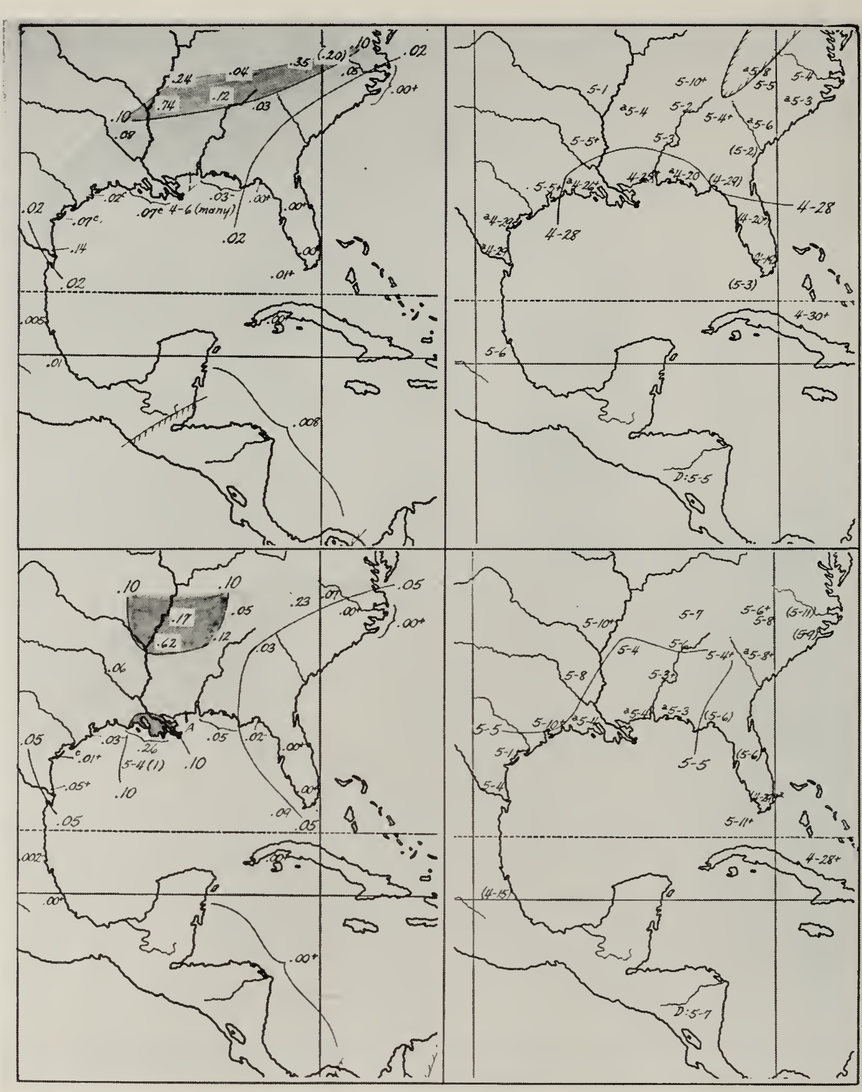


FIG. 43 (upper left) Comparative Abundance and FIG. 44 (upper right) Median Dates for the Chestnut-sided Warbler.

FIG. 45 (lower left) Comparative Abundance and FIG. 46 (lower right) Median Dates for the Bay-breasted Warbler. .

FIG. 47 (upper left) Comparative Abundance and FIG. 48 (upper right) Median Dates of the Black-poll Warbler.

FIG. 49 (lower left) Comparative Abundance and FIG. 50 (lower right) Median Dates for the Kentucky Warbler.

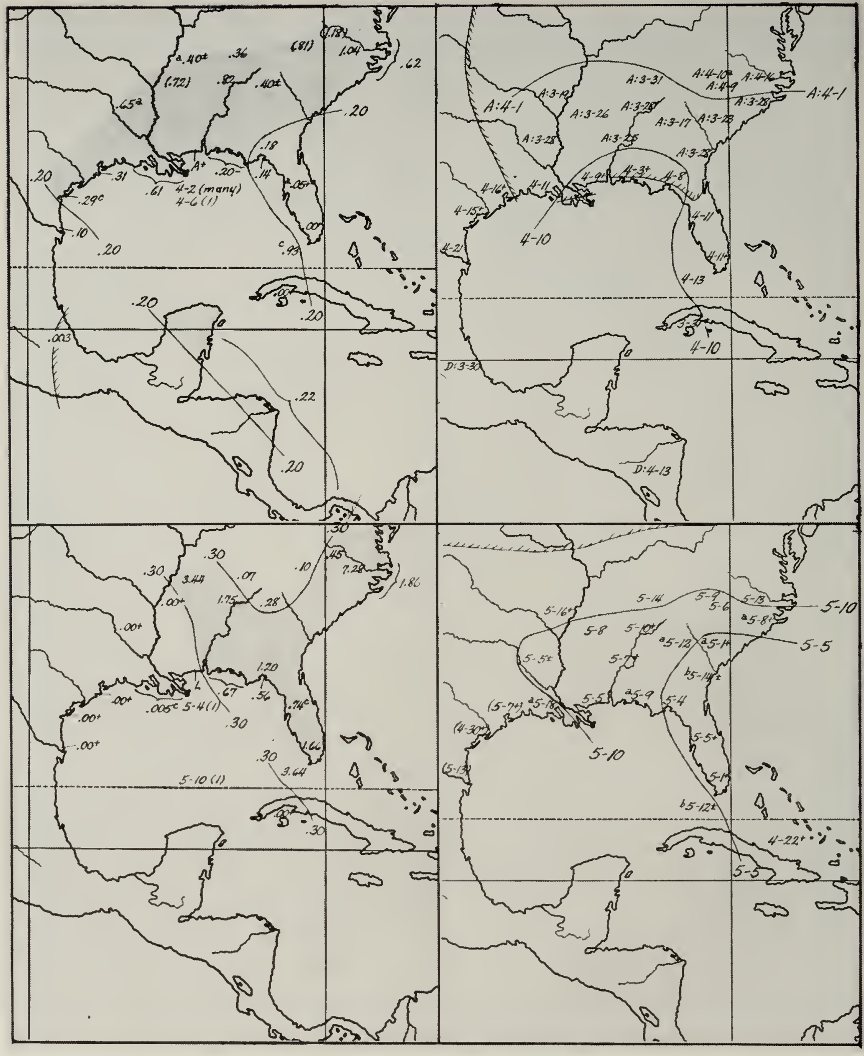


FIG. 51 (upper left) Comparative Abundance and FIG. 52 (upper right) Median Dates for the Hooded Warbler.

FIG. 53 (lower left) Comparative Abundance and FIG. 54 (lower right) Median Dates for the Bobolink.

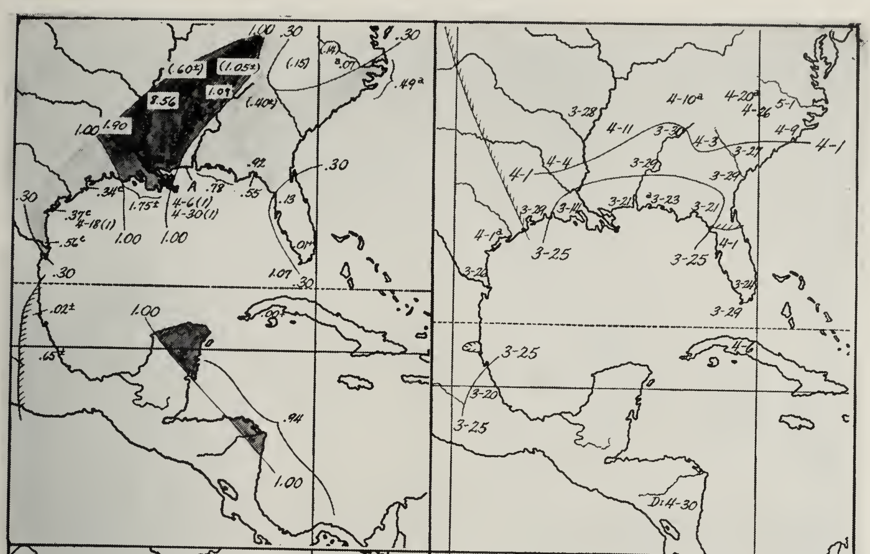


FIG. 55 (upper left) Comparative Abundance and FIG. 56 (upper right) Arrival Dates for the Orchard Oriole.

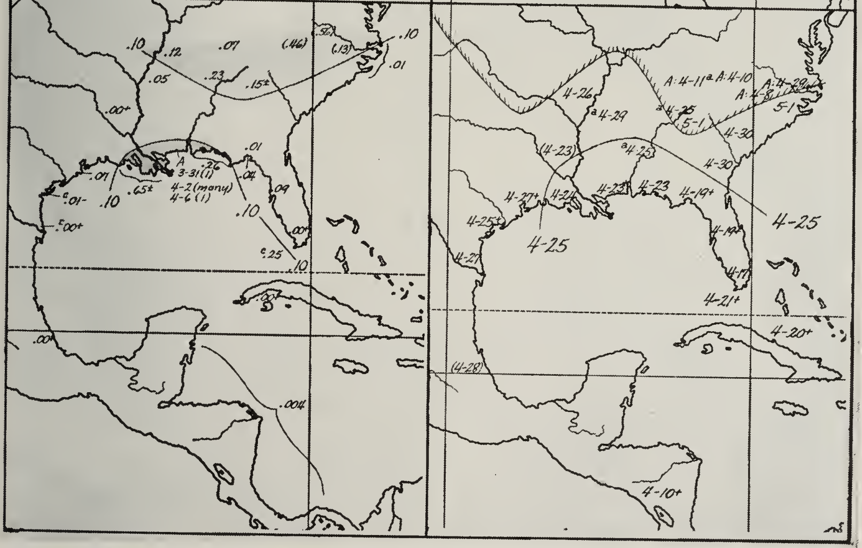


FIG. 57 (lower left) Comparative Abundance and FIG. 58 (lower right) Median Dates for the Scarlet Tanager.

Fig. 59 (upper left) Comparative Abundance and Fig. 60 (upper right) Median Dates for the Rose-breasted Grosbeak.

Fig. 61 (lower left) Comparative Abundance and Fig. 62 (lower right) Arrival Dates for the Dickcissel.

(Lowery and Newman, 1954). The migration of the Black-throated Blue Warbler is much more nearly confined to the Florida Peninsula, very few venturing across the Gulf. Conclusive evidence on the commonly-wintering Myrtle Warbler is difficult to obtain, but its quantitative distribution in spring and records on the Gulf denote trans-Gulf flights with an occasional straggler near the middle of May. The Black-throated Green Warbler may be the only eastern member of its genus to migrate chiefly through eastern Mexico, but a few also cross the Gulf in spring. Cerulean (Figs. 41 and 42) and Blackburnian warblers precipitate on the Texas and Louisiana coasts, only small numbers occurring in eastern Mexico; their median dates are also earlier on the northern Gulf coast. Early arrivals on the northern Gulf and a record 60 miles off the Louisiana coast (Bullis and Lincoln, 1952) signify a trans-Gulf passage for the Yellow-throated Warbler, but it is possible that migrations through Mexico and the Florida Peninsula are equally heavy. The trans-Gulf migration of Chestnut-sided and Bay-breasted warblers brings the largest numbers to that part of the coast lying between southern Texas and extreme western Florida (Figs. 43–46). The spring migration of the Black-poll (Figs. 47 and 48) and Prairie warblers is very similar to that described for the Cape May, except that many more precipitate on the southern Atlantic coast. Trans-Gulf migration for the rare Kirtland's Warbler is geographically most unlikely. With the probable exception of a small per cent of its total population, the Palm Warbler appears not to cross the Gulf in spring. The Oven-bird migrates on a broad front, but perhaps the most important flight crosses the Gulf (some northwestward?) to the stretch of coast from Galveston Bay to Pensacola, Florida. Essentially the same statement applies to the Northern Water-thrush, but the Louisiana Water-thrush converges (appropriately enough) mainly on the Louisiana coast. The northern and western Gulf receives the greatest numbers of Kentucky Warblers in spring, eastern Mexico and the Florida Peninsula apparently having but few (Figs. 49 and 50). The Connecticut Warbler is so rare that a dogmatic statement of its main migration route would be foolhardy, but there is no evidence that it concentrates on any major part of the southeastern United States. Mourning Warblers pass northward mainly along the Mexico-Texas coast and the record of "many" 30 miles off the Louisiana coast on the early date of April 2 (Frazar, 1881) is very surprising, to say the least. The Yellow-throat is a permanent resident along the Gulf coast, and the only definite clue to its migration route is the fact that numbers have been seen on the open Gulf on four occasions. It is possible that its migration on the sides of the Gulf is equal in volume. Most Yellow-breasted Chats move into the eastern United States through Mexico and Texas, but the likelihood that a few make the Gulf transit in spring should not be overlooked. The Hooded Warbler is a striking example of a trans-Gulf migrant, despite the fact that only two offshore records are known (Figs. 51 and 52). Many Wilson's and Canada warblers travel up the Mexico-Texas coast in spring, but there is evidence that some fly directly from Central America to Louisiana. The heaviest movements of American Redstarts are up the Florida Peninsula and across the central and western Gulf, with eight records on the Gulf.

ICTERIDAE. Although the Bobolink has frequently been mentioned as an example of a Florida Peninsula migrant, it was found in this study to occur most frequently on the Dry Tortugas and to be fairly common as far west as the Alabama coast. Taken in conjunction with three records on the Gulf, this leaves little doubt of Gulf-crossing by some individuals (Figs. 53 and 54). Both eastern species of orioles unquestionably follow trans-Gulf routes to a large extent, their center of abundance comprising the coasts of Texas and Louisiana (Figs. 55 and 56).

THRAUPIDAE. Tanagers are classic examples of trans-Gulf migrants. Most of the Scarlet Tanagers cross the coast line of Louisiana, Mississippi, and Alabama (Figs. 57 and 58), but the wider-ranging Summer Tanager is about equally common from northern Florida to Galveston Bay.

FRINGILLIDAE. Rose-breasted Grosbeaks are most numerous on the same parts of the Gulf Coast as Scarlet Tanagers, and the two species usually occur in the same waves (Figs. 59 and 60). Apparently the Blue Grosbeak is chiefly a trans-Gulf migrant, but there is great variation in abundance from one region to the next, and the values in eastern Mexico are not so low as for many other migrants. Available evidence points to a route across the western Gulf for the Indigo and Painted buntings, but in each case their status in eastern Mexico is somewhat uncertain. Dickcissels have not been recorded in eastern Mexico in numbers comparable to those on the Texas coast, and many are believed to take a shorter route from the Yucatan Peninsula to Texas (Figs. 61 and 62). There is little or no evidence for a trans-Gulf migration of the five species of sparrows included in this study (Savannah, Grasshopper, Lark, White-crowned, and Lincoln's), except for one record of the Grasshopper Sparrow on the open Gulf (Brooks, 1922).

COMPARISONS WITH FALL MIGRATION

Although the subject of the coastal hiatus of spring transients has been adequately characterized and analyzed (Lowery, 1945; Williams, 1950), I know of no quantitative data which have been cited in support of this phenomenon. Numerical records of birds seen on field trips in the Tallahassee, Florida, region from September, 1946, through May, 1955, reveal some significant differences between the spring and fall migrations. Data in the fall of 1954 were omitted from the Leon County totals in order to equalize the amounts of time afield in spring (March through May) and fall (July through November), justifying numerical comparisons of the species considered. These figures, presented in Table 4, characteristically show greater contrast inland than on the coast for most species.

GENERAL CONCLUSIONS

Evidence bearing on the migration routes of spring migrants was adduced from direct observation, comparative abundance around the Gulf of Mexico, and the sequence of migration dates. Each line of evidence indicated that both the circum-Gulf and trans-Gulf routes are commonly utilized in spring. Approximately 40 species of summer residents, winter residents, and transients were found more frequently along the northern Gulf coast (exclusive of Texas) than on its eastern and western sides. Many species, however, were much less frequent there in spring than in fall, validating the theory of the coastal hiatus (Lowery, 1945). The larger numbers of species and individuals on the Texas coast are due to the fact that it makes up a part of both the trans-Gulf and circum-Gulf migration routes. It is thought prob-

Table 4

Comparisons of Numbers of Birds seen in the Tallahassee, Florida, Region in Spring and Fall, 1946-55

	Leon County (Inland)		Coastal Counties	
	Spring	Fall	Spring	Fall
Number of parties	5	5	12	10
Total hours in field	388	388	470	481.5
Species:				
Bank Swallow	3	116	7	46
Barn Swallow	56	536	305	1488
Cliff Swallow	—	2	—	5
Catbird[1]	6	67	90	267
Olive-backed Thrush	1	4	15	4
Gray-cheeked Thrush	—	2	7	4
Veery	—	19	1	12
Golden-winged Warbler	—	11	—	5
Blue-winged Warbler	1	4	2	4
Tennessee Warbler	1	73	2	16
Yellow Warbler	1	33	13	88
Magnolia Warbler	—	29	4	48
Black-throated Green Warbler	1	35	4	10
Cerulean Warbler	—	23	—	4
Blackburnian Warbler	—	47	3	21
Chestnut-sided Warbler	—	44	—	27
Bay-breasted Warbler	—	9	6	15
Northern Water-thrush	7	30	6	24
Hooded Warbler[2]	61	268	59	251
American Redstart	6	73	7	142
Scarlet Tanager	4	6	13	4
Rose-breasted Grosbeak	—	8	10	5

[1] A few are present in winter, especially near the coast.
[2] A few are present in summer.

able that most individual land birds tend to follow a direct route from their wintering grounds to their breeding grounds, but may be carried off course by strong winds. Therefore a part of the supposed coastwise migration in Texas and Florida may have begun as a trans-Gulf migration.

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SOME OBSERVATIONS ON SUN-BATHING IN BIRDS

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The effect of the sun on passerines and other terrestrial birds is a subject about which little has been written. Voluntary sun-bathing, accompanied by preening, surely has been observed widely but the details seldom have been recorded for the benefit of those interested in all phases of bird behavior. Therefore, it seems worthwhile to report my observations of sunning behavior which have been gathered over a number of years.

From the end of March, 1954, until August 20, 1954, in Gainesville, Florida, and thereafter at Fayetteville, North Carolina, I have observed and recorded in sun-bathing attitudes, hundreds of individual birds of 33 different species. These records suggest that there are two reasons for the assumption of the characteristic posture:

1. Voluntary, or normal sun-bathing; an attitude assumed by a bird apparently for reasons of health and well-being, accompanied by preening, shaking, scratching and repeated resumption of the sun-bathing posture.
2. Compulsory Sun Position, the same attitude assumed when a bird is suddenly and apparently unexpectedly exposed to direct sunlight, under more or less extreme conditions of humidity and heat. This response may be accentuated by the physiological condition of the bird; and it appears to be unpremeditated and irresistible. Upon recovery the bird usually flies immediately to shade.

Voluntary Sun-bathing in Songbirds

On April 17, 1952, I saw a Brown Thrasher (*Toxostoma rufum*), in full sun, deep in the soft, dry sand of our driveway in Gainesville, Florida. Breathing heavily, with its bill wide open, the bird's head had fallen back as though it were suffering and dying. The body feathers were ruffled and the tail and wings spread into full fans, but as I approached closer the thrasher recovered completely and flew into the brush.

Since witnessing that incident, I have seen birds sun-bathing from Maine to Texas and, although some species differ slightly in their posture, the general pattern is much the same.

It is recognized that many birds expose themselves to the rays of the sun, fluffing out their feathers and leaning to one side, immobile, and then ruffling and preening. The specific good they derive from such behavior is not definitely known. It has been suggested that birds fluff their feathers to remove parasites by exposing them to the sun or to dust. Some authorities, notably Hou (1929, cited by Kendeigh, 1934) believe that there is a connection between the use of the preen gland and the proper effect of irradiation. Dr. Herbert Friedmann wrote me (June, 1954) that he had experimented with the secretion of the preen gland: "The secretion, when rubbed on the feathers and subsequently exposed to sunlight and then inadvertently swallowed by the bird when preening its plumage, is a source of Vitamin D."

It appears, from my observations, that the previous weather conditions often have a great deal to do with sun-bathing. A rainy spell or several dark days, followed by strong sunlight appear to accelerate the need for the sun's rays and will bring many birds out to bask in the sun and to preen. However, Miller (1952) reported sun-bathing in House Finches (*Carpodacus mexicanus*) under conditions of low relative humidity and high summer temperature in California and my records include many incidents of voluntary sun-bathing in hot, dry periods.

In addition, it appears that there is a social quality in sun-bathing; that a single bird in the Voluntary Sun Position attracts the attention of other birds, which join the first and also sun-bathe. These may be of the same or of a different species. Another factor rests in the use of a particular site for repeated sun-bathing, day after day and month after month. In my yard in Florida during 1954 dozens of birds of different species sun-bathed in my pear tree; at present, in Fayetteville, North Carolina, a fallen but still verdant pecan tree is the community sun bath. When sunshine follows a heavy rain, I can see from 10 to 30 birds of six or more species sun-bathing in that single tree.

Young birds are seen sun-bathing more frequently than adults except during the late summer molting season when many adult birds in all stages of molt may be seen preening and sunning.

Sun-bathing patterns of some perching birds are described below:

At 1:20 p.m. on May 7, 1954, a female Cardinal (*Richmondena cardinalis*) was observed in full Sun Position on the ground. Its bill was slightly open, head and body at a 50-degree lean to the right, body feathers fully fluffed; then it leaned even further to the right. The bird changed its position from facing the sun to placing its left side to the sun. Preening briefly, the bird then flew to the pear tree after about five minutes in the sun.

The earliest morning record of voluntary sun-bathing was that of a female Cardinal in heavy molt at 7:30 a.m. on August 4, 1954. With only one full-length feather in its crest and three in its tail, the ragged-looking bird spent fully 15 minutes sun-bathing in the early morning sun. The bird first faced the sun and then turned with its back to the sun, assuming the full Sun Position after each lengthy period of preening during which it appeared to work its bill along every one of its feathers.

August 12, 1954, at 11:50 a.m., a young female White-eyed Towhee (*Pipilo erythrophthalmus*) came to the water pan to bathe fully with House Sparrows (*Passer domesticus*) three or four times. Then it flew to a spot on the ground, in full sun, beside the wax myrtle hedge. In company with six or eight sparrows, already in different stages of sun-bathing, the towhee preened, fluffed its feathers and shook its body for five minutes; then it settled low in a modified sun-bathing position with crown feathers raised, bill open, and body and head leaning to one side but without the body feathers being fully fluffed. The bird alternately preened and resumed the sunning pose. A young Blue Jay (*Cyanocitta cristata*) flew down and settled by the towhee and assumed the sun-bathing position, with crest raised high, body feathers fully fluffed, and wings and tail fanned, leaning to one side with its bill open for 30 seconds, and then flew away. A second young jay dropped down for a brief sun bath with the sparrows and towhee. The sparrows were changing constantly, with new sun-bathers taking the places of those which left.

Of the order Piciformes, I have seen the Flicker (*Colaptes auratus*), the Red-bellied Woodpecker (*Centurus carolinus*) and the Golden-fronted Woodpecker (*C. aurifrons*) of Texas in sun-bathing attitudes. The latter two birds use telephone poles as well as trees in full sun for their sun-bathing perches.

April 25, 1954, at 9.00 a.m., a Red-bellied Woodpecker was making loud "kraaaak" calls from the top of a telephone pole. After three or four calls, it would preen and ruffle its feathers and call again. The bird repeatedly pecked into the top of the post, digging its bill then into its feathers all over its body and wings, back and front. Then it waddled over 12 inches to the top of the cross-bar of the pole where it continued to preen and call and stretch its wings. Next the bird spread itself out into full Sun Position, with crown feathers raised, head cocked to one side, bill open, with the upper eye staring at the sun. Staying thus only briefly, the woodpecker would get up to preen, stretch, call, and change position on the cross-bar, probably half a dozen times. At one change, the bird straddled the cross-bar with its wings hanging down at either side, full fanned, and its tail spread wide and the crown feathers raised.

The Ground Dove (*Columbigallina passerina*) differed from most species in that it never leaned far to one side nor opened its bill, despite the length of its stay in the full sun; and it also was the only bird which blinked its eyes throughout the sunbath.

May 1, 1954, at 11:30 a.m., a Ground Dove sun-bathed at what later proved to be a favorite spot, on a heap of drying magnolia leaves. The bird preened lengthily with its rump feathers raised high while preening the wings. Turning to face different directions after each brief period of preening and sunning, it spread its wings and made a partial fan of its tail and, raising the crown and body feathers, stood immobile but still blinking. The dove's sunbath lasted for 15 minutes.

The month of June, 1955, in Fayetteville, had been extraordinarily cool, rainy and overcast, with only a few hot days and very little sun. On June 25, a day with moderate to fresh breezes and an air temperature of 90° F., I verified the site of a second sun-bathing location, having earlier seen many species flying into this place. The site was a compost heap, primarily composed of decaying elm leaves, in a corner of the yard just below the fallen pecan mentioned earlier, and well secluded by shrubs and high grasses. No birds were sun-bathing on the pecan, probably because of the breezes. Onto this heap, from 1:30 to 3:00 p.m., when the sun was free of the drifting clouds, I watched three Crested Flycatchers (*Myiarchus crinitus*), two Tufted Titmice (*Parus bicolor*), three Blue Jays, Catbirds (*Dumetella carolinensis*), Cardinals and House Sparrows approach via a perch on the pecan tree, then onto the fence, and finally down to the leaf bed. Here they immediately assumed the Voluntary Sun Position, and in each of the birds, the attitude was so exaggerated that I returned to the house for a Taylor candy thermometer, which registered 140° F. when laid on the leaf bed in the full sun.

None of the birds preened at this site but, having exposed themselves to the sun for one to three minutes, they flew to shade with bills still open, panting. I believe that some, if not all, flew down to bathe at the creek after the sun-bath, but heavy brush made it impossible to follow any individual bird with my glasses although the creek is not over 40 feet from the leaf bed.

Figure 1 (inset 6) illustrates a Mockingbird (*Mimus polyglottos*) in an exaggerated sun-bathing pose, with the neck so stretched and twisted that its under side is uppermost. A Brown Thrasher was also recorded in this posture on May 5, 1954, at 3:00 p.m., after a heavy rain when the sunshine was clear and intense. While remaining fully fluffed, with wings and tail fanned, the thrasher raised its head 6 or 8 times, when alarmed, and then leaned again to turn its head over completely and continue its sunbath.

The species which have been observed in Voluntary Sun-bathing Position are listed in Table I. Only three species, the Brown Thrasher, Carolina Wren (*Thryothorus ludovicianus*), and House Sparrow, have been seen taking sand-baths in connection with the sun-bathing.

Certain questions arise with reference to the Voluntary Sun-bathing:

1. How can a bird so expose its eye, and then, on turning the head, expose the other eye to the direct rays of the sun, without damage? Is it possible that the eye does absorb some ultra-violet rays when so directly exposed?
2. Does the voluntary exposure of the bird to full sun stimulate the preen gland to manufacture and/or produce oil for dressing the plumage? When a bird is in sun-bathing position with its back to the sun, the feathers at the rump are raised so high that they fully expose the naked preen gland.
3. Do continuous days without sun deprive a bird of necessary irradiation, especially in the case of young birds just recently out of the nest? Does a need of irradiation by the sun's rays explain the deliberate and voluntary exposure to intense heat, such as indicated by a reading of 140° F. on the compost leaf pile?
4. Do the external parasites to which birds are the hosts increase in numbers in damp, cool weather, making exposure to intense solar radiation more necessary following periods of cloudy weather?

Compulsory Responses to the Sun

In January, 1954, at my home in Gainesville, Florida, I replaced an old bread tin, which had served as a window feeder, with a brown masonite tray measuring 18 by 22 inches. The window faced due south and for about

TABLE 1

SPECIES OBSERVED IN VOLUNTARY SUN-BATHING POSITION

Green Heron (*Butorides virescens*)
Royal Tern (*Thalasseus maximus*)
Mourning Dove (*Zenaidura macroura*)
Ground Dove (*Columbigallina passerina*)
Flicker (*Colaptes auratus*)
Red-bellied Woodpecker (*Centurus carolinus*)
Golden-fronted Woodpecker (*Centurus aurifrons*)
Crested Flycatcher (*Myiarchus crinitus*)
Wood Pewee (*Contopus virens*)
Blue Jay (*Cyanocitta cristata*)
Tufted Titmouse (*Parus bicolor*)
Carolina Wren (*Thryothorus ludovicianus*)
Mockingbird (*Mimus polyglottos*)
Catbird (*Dumetella carolinensis*)
Brown Thrasher (*Toxostoma rufum*)
Robin (*Turdus migratorius*)
Starling (*Sturnus vulgaris*)
Red-eyed Vireo (*Vireo olivaceus*)
Yellow Warbler (*Dendroica petechia*)
Myrtle Warbler (*Dendroica coronata*)
American Redstart (*Setophaga ruticilla*)
House Sparrow (*Passer domesticus*)
Summer Tanager (*Piranga rubra*)
Cardinal (*Richmondena cardinalis*)
Common Goldfinch (*Spinus tristis*)
White-eyed Towhee (*Pipilo erythrophthalmus*)
White-throated Sparrow (*Zonotrichia albicollis*)

four hours during the day this tray was exposed to the sun's rays continuously. Birds had fed at this tray from dawn until dusk each day throughout the winter, as well as at the eight other feeders in the yard, all of which were in full or partial shade.

On March 25, 1954, a Myrtle Warbler (*Dendroica coronata*) alighted on the window feeder. It fluffed out all its head and body feathers, fanned its wings and tail and, leaning its head far to one side, appeared briefly to be in a coma. There was an accidental quality about the assumption of the posture which I had not previously noticed in birds which sun-bathed, since it began and proceeded quickly to its climax even as the bird was reaching for food.

In the next three weeks, a period of exceptionally warm weather, my records showed more sun-bathing incidents than in the preceding three years, all but three taking place on or near the feeding tray. The repetition of incidents, combined with what appeared to be an involuntary compulsion to fall into sun-bathing position (in which the birds appeared often to be in obvious discomfort), suggested that it was the compelling force of the sun which brought on this reaction. Furthermore, this sun-bathing was not observed on the tray earlier than 9:30 a.m., (a Myrtle Warbler), nor later than 1:45 p.m., (an Orange-crowned Warbler, *Vermivora celata*). The intervening hours corresponded with the period during which the window feeder was in direct sunlight.

Early records seemed to indicate that the birds suffered from some form of "heat prostration" because of the immediacy of the reaction to the sun (often within 30 seconds of landing on the tray) as well as the apparent discomfort of the bird. However, continued observation suggests that the Compulsory Sun Position may be a means of regulating the body temperature when the individual is suddenly exposed to the sun. Frequently the bird continues to manipulate a seed in its bill while its feathers are fully fluffed and the bird is leaning far to one side. With some birds, the response alternately is accentuated and subsides many times during the feeding period and before the bird flies to a shady spot; always the bird remains alert to any outside alarm and is able to fly away instantly.

The wild birds recorded in the following pages were under no controls except their own interest in the food always available at the feeding locations.

Several levels of response to the effect of the sun have been distinguished, and are enumerated as follows:

I. The crown feathers are elevated, the wings are dropped so that the tips of the feathers touch the ground, and the tail feathers are spread; then the bird flies away.

II. The crown is elevated, wings dropped, tail feathers spread and the body plumage is fluffed fully before bird leaves.

III. The crown is elevated, wings dropped, tail fanned, body plumage fluffed fully and the bird leans to one side and settles, with bill opened, and eyes open, the upper eye staring at the sun. This response may last from 15 seconds to two minutes or more, depending, in most cases, on outside influences. At no time has any bird become unconscious; all were alert and able to fly away at any alarm.

Position III may be alternated with a return to normal behavior during which the bird preens, scratches and feeds briefly and resumes Level III for as many as six or eight times before flying to shade.

IV. Exaggerated Sun Position—when the bird's wings flopped forward wildly and it gasped, as if for air, and fell flat and widespread on the tray or lawn. This posture was observed most often in young birds, notably in young Jays. Note: In the case of two adult Starlings (*Sturnus vulgaris*), the "lean" was forward, with neck arched and the bill touching the ground, both wings fanned and thrust far forward.

In May, 1954, I put a Taylor candy thermometer, which registers to 300° F., flat on the tray and took the readings recorded in some of the incidents which follow. I recognize the inaccuracy of the readings, which probably include the heat of the sun, air, tray, and reflected heat of the white brick wall, but I include these figures for their possible interest in comparison, and because they seem to indicate that heat, alone, is not the motivating factor. The birds recorded included Cardinals, Blue Jays, Brown Thrashers and Red-bellied Woodpeckers.

Degrees Fahrenheit	Level of Response		
	II	III	IV
105°—109°	3	1	–
110°—114°	3	4	1
115°—119°	13	5	1
120°—124°	3	3	1
125°—129°	–	7	–
130°—134°	15	5	2
135°—139°	7	2	1

A further indication that heat is not the primary factor lies in the realization that air temperatures as low as 55° F. and 60° F. did not preclude a response from some species, all of which are migratory: Myrtle Warbler, Slate-colored Junco (*Junco hyemalis*), White-throated Sparrow (*Zonotrichia albicollis*), and Purple Finch (*Carpodacus purpureus*).

Cloudless, humid days of still air and intense sun resulted in the greatest number of individual responses.

Responses of Permanent Resident Species

On April 12, 1954, at 10:55 a.m., at Gainesville, Florida, a female Cardinal flew to the tray and was visibly affected by the sun's rays as she fed. The crest was raised high, the body feathers fluffed out and the bill opened as the bird breathed heavily. The Cardinal jerked its body as a Myrtle Warbler perched briefly on the tray but remained in Level III. Other Myrtle Warblers, flying toward the tray, swerved away and flew to a nearby shrub. After two minutes, the Cardinal recovered and fed and flew off on the arrival of a male Cardinal.

Both male and female Cardinals, visiting during the sunny hours, were frequently affected in this manner, and before long most of them were confining their trips to the period when the tray was in shade. To those that did visit it in the sun, tray temperatures of 130° F. and above usually brought response II or III, except in the case of a female which was wet from a recent bath and did not respond at all.

On June 18, 1954, at 11:15 a.m., with the tray temperature 112° F., a female Cardinal gave me a further indication that the rays of the sun, rather than heat alone, caused the response. It was a very hot day, with intermittent breezes and clouds. The bird landed on the tray when the sun was behind a cloud and began to feed on sunflower seeds. Suddenly the sun came out, sharp and clear, and the bird went into Level III, still working the seed in its bill. The Cardinal appeared aware of a House Sparrow and a Blue Jay which landed on the tray, but it stayed leaning to one side with its plumage fully fluffed manipulating the seed. A cloud covered the sun and the bird resumed its normal sleekness and moved to the other side of the tray; the sun reappeared and the bird reassumed Level III; another cloud covered

TABLE 2

LEVELS OF RESPONSE OBSERVED IN COMPULSORY SUN-BATHING POSITION

Species	Level			
	I	II	III	IV
Mourning Dove (*Zenaidura macroura*)			x	x
Flicker (*Colaptes auratus*)				x
Red-bellied Woodpecker (*Centurus carolinus*)	x	x		
Blue Jay (*Cyanocitta cristata*)	x	x	x	x
Tufted Titmouse (*Parus bicolor*)		x	x	
Carolina Wren (*Thryothorus ludovicianus*)			x	
Mockingbird (*Mimus polyglottos*)			x	
Catbird (*Dumetella carolinensis*)			x	
Brown Thrasher (*Toxostoma rufum*)		x	x	
Robin (*Turdus migratorius*)			x	x
Starling (*Sturnus vulgaris*)	x		x	x
Orange-crowned Warbler (*Vermivora celata*)		x	x	
Myrtle Warbler (*Dendroica coronata*)	x	x	x	
Ovenbird (*Seiurus aurocapillus*)		x		
House Sparrow (*Passer domesticus*)	x	x	x	x
Bronzed Grackle (*Quiscalus versicolor*)[1]			x	
Cardinal (*Richmondena cardinalis*)	x	x	x	
Purple Finch (*Carpodacus purpureus*)		x		
Common Goldfinch (*Spinus tristis*)			x	
Slate-colored Junco (*Junco hyemalis*)			x	
Chipping Sparrow (*Spizella passerina*)			x	
White-throated Sparrow (*Zonotrichia albicollis*)	x	x	x	

[1] Maine

the sun, and the Cardinal took on its normal appearance and left the tray. Within a minute it was back again, crest erect and body plumage fluffed in the bright sun. A second female Cardinal landed on the tray and both uttered sharp "chick" sounds, as the first bird fluttered its wings, probably in threat, while fully fluffed and leaning, until the second female flew away. The bird continued to manipulate a seed in its bill while in Level III, and flew away when a cloud once again covered the sun, after four full minutes since its first arrival at the tray.

Only one young Cardinal was recorded at the window tray in the sun during the spring and summer of 1954. At the time of its visit the tray temperature was 117° F., and the bird immediately assumed Level III before flying away. It did not return to the tray again during the sunny hours.

A record made on a very hot day in Fayetteville, North Carolina, August 28, 1954, leads me to wonder if the young Cardinals are "taught" the wisdom of avoiding exposure to the sun. At 3:30 p.m., a female and two young flew to the fence and one young bird hopped down to feed at the grain which was on the grass in full sun. The young bird immediately fell into Level III.

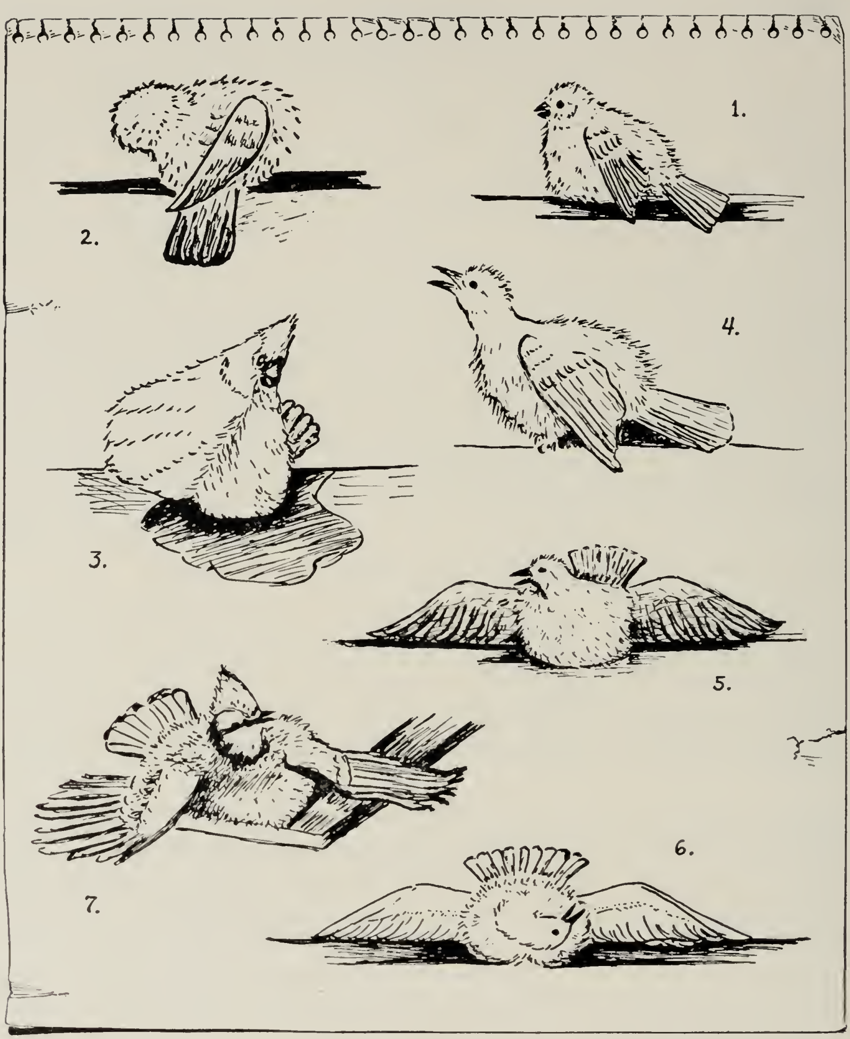

FIG. 1. Sun-bathing postures of some passerine birds sketched by the author. (See text for discussion.) (1) White-throated Sparrow in Level II. (2) Sparrow in Level III, fully fluffed plumage and horizontal lean. (3) Cardinal in Level III. (4) Catbird in Level III. Notice likeness to threat display and courtship display. (5) Mockingbird in Level IV. (6) Mockingbird in Level IV with neck elongated and head turned upside down. (7) Young Blue Jay, in complete collapse on window tray.

A male Cardinal flew in at full speed and, diving down at the young one, chased it up into a tree. Then the male, female and two young birds flew down together and fed in the shade.

Blue Jays began to respond to the sun on the window tray in mid-April, 1954, two weeks later in the season than did the Cardinals, and soon were making their visits so quickly that they often did not land at all, but grabbed a piece of bread while on the wing. One jay, distinctive because of a heavy face molt, was particularly prone to succumb to Level III, although this bird, like the female Cardinal mentioned above, was unaffected when wet from a bath, at a tray temperature of 134° F.

The young Blue Jays did not seem to learn to avoid the tray during the sunny hours, although they were often the most powerfully affected. With wings fanned to the utmost and flapping forward in slow motion, the jays opened their bills and appeared to be both reaching and gasping for air as their body feathers fluffed out and the birds settled flat onto the tray, as though in a state of collapse.

It was not until August 1, 1954, that the Red-bellied Woodpeckers gave any indication of a response to the sun although the males visited the tray daily throughout the summer at all hours. The females had ceased coming to the window in early spring. The response of the young birds was greater than that of the adults. In both, the crown feathers rose first and more fully on the right side, the belly feathers fluffed out, and the right wing was thrown forward flat onto the tray. The birds always left immediately after the wing was thrust forward.

Summer Tanagers (*Piranga rubra*), which are summer residents of the Gainesville area, and Ground Doves, permanent residents, although present on the tray at the same moments as other species mentioned above, appeared never compelled to make any response at all to the sun.

No permanent resident was seen in Compulsory Sun Position in Fayetteville from August 28, 1954, until April 4, 1955, when a female Cardinal assumed Level III at 1:15 p.m., while feeding on the lawn with an air temperature of 67° F.

Responses of Winter Resident Species

The Myrtle Warbler described in the earlier section of this paper was not the last member of the Parulidae to be affected by the sun. By noon of April 12, 1954, I had obtained a fourth record of Myrtle Warblers, including one male in full nuptial plumage, and then they ceased feeding at the tray and fed only at the shaded feeders. All the Myrtle Warblers recorded were affected immediately on landing on the edge of the tray, or as they reached forward for food.

On April 12, 1954, an Orange-crowned Warbler came to the tray twice, at 10:50 a.m. and at 11:55 a.m. On the first visit it fluffed its feathers fully and leaned in Level III immediately, and remained so for a full minute. On the second visit, the bird flew off quickly when its body plumage fluffed and tail fanned, Level II.

Throughout the rest of that day and the next, this warbler fed only in the shade. On April 14, at 1:45 p.m., it came to the window tray. The crown feathers were raised, the tail fanned, body feathers fluffed out; then the bird flew quickly back to a shrub, two feet away. Its perch here, too, was in full sun, and with its bill wide open and all feathers fluffed out, leaning to the left and, apparently unable to recover, the bird dropped and spread its wings and tail widely. The sun went under a cloud and the bird depressed its feathers, preened briefly and flew to the plum tree where it fed at a suet cup in the shade. This warbler and the few remaining Myrtle Warblers did not visit the window tray again before leaving for the north.

Does this failure to continue feeding at a tray which these warblers had visited daily for several months indicate that they "learned" how they would be affected, and did not want to repeat the experience? Kendeigh (1934:336) says, with reference to temperature tolerances of birds in winter that "A heavy coat of feathers and a thick layer of fat, while serving for better protection of birds in the winter against low air temperature, are at the same time detrimental at extremely high air temperatures because they diminish the radiation of excess heat from the general body surface."

On November 18, 1954, White-throated Sparrows were feeding with House Sparrows at the poultry grain on the lawn. At 12:40 p.m., with an air temperature of 72° F., the sun suddenly came out sharply after three days of rains. Some of the sparrows of both species fluffed their feathers and leaned far to one side as the sun came out. The White-throated Sparrows reacted individually in several different ways (Fig. 1). The first response was always the drop of wings, as described in Level I, while the birds continued to feed: then the belly feathers fluffed out very fully, the crown feathers were raised and the birds leaned far over in Level III. Suddenly a bird would scratch its head violently and resume the fluff and lean. In some cases the bird flew to shade on recovery; in some cases it continued feeding while fluffed. Succeeding days of the same air temperature, with no further rain, brought no such response although the birds fed in full sun.

White-throated Sparrows again responded to the sun from the close of February, 1955, until they left in early May, in air temperatures as low as 55° F. Some of them remained fluffed, in Level III, for as long as three minutes. Many individuals would assume Level III and then subside to preen briefly and feed as many as six or eight times before flying to shade.

This repetition of Level III suggests that there may be sufficient dissipation of body heat after each assumption of the sun-bathing position for the bird to feed again briefly before the rays from the sun once again made it respond.

Discussion

The foregoing records appear to give evidence of what may be an involuntary, compulsory response to the sun on the part of many species of birds. Of primary interest is whether sudden excessive heat is the factor which produces the fluffing of body feathers, crest elevation and fanning of wing and tail feathers at the time of exposure to the sun.

Brown and Davies (1949:92–93) report some observations of the Reed-warbler (*Acrocephalus scirpaceus*):

> ". . . In sunny weather a few of the nests built on the fringe of the reeds are exposed, usually for short periods of the day only, to full sunshine. Under these conditions the hen bird will shade the chicks by standing in the nest and half opening her wings so that the cup is completely covered. In really hot weather it soon becomes apparent that the hen herself is being severely affected by the heat. The first indication of this distress is a mild form of "panting" with mandibles slightly open, but after a short while the panting increases and the mandibles are open to an angle of as much as thirty or forty degrees. Should a bird in this state continue to shade the chicks, she will suddenly collapse in a most extraordinary manner, lurching over on one side, sometimes closing her eyes and certainly giving the impression that she is on the point of expiring. She then raises the wing on the free side of her body and extends it vertically above her to its fullest extent, the primary feathers standing out like fingers. She maintains this rigid attitude for several minutes, during which she gradually opens her eyes and virtually stops panting. Quite suddenly she closes the wing and stands up in the nest as if nothing had happened and will then either continue to shade the chicks or go off in search of food. In the hot summer of 1947 this curious piece of behavior, which we then believed to be completely original for the species, was witnessed on four or five occasions and two observers were fortunate enough to get photographs, one of the initial stage of collapse, and the other of the bird with the free wing rigidly extended. Quite clearly the stretching up of the wing has beneficial effect upon the distressed bird and it may well be that this serves to expose the sub-clavian vein to the air, thus resulting in direct cooling of the blood."

The response of these nesting Reed-warblers to the sun appears to parallel my own observations closely. The implications of this apparently compulsory response to the sun's rays prompt questions which can only be answered by scientific study.

Are the feathers fluffed in order to expose as much as possible of the outer skin surfaces to the air, to better combat the excessive body temperature? This would be in direct contradiction to the statements of men who had studied the effects of artificially induced heat in birds. Dawson (1954:115) states that "Birds decrease the effectiveness of their insulation by compressing their feathers. They also expose the thinly feathered sides of the thorax by holding their wings away from the body." Likewise, Wallace (1955:40) states: ". . . in warm weather, the feathers are often depressed or held close to the body to allow some escape of body heat."

The response to high temperatures discussed by these authors holds true of birds in shady locations on extremely hot days, as well as in artificially-controlled cages, but exposure to direct sun appears to evoke an entirely different response that I have called Compulsory Sun Position.

Is this reaction a physiological response generated by the bird's heat-dissipating mechanism? Alternation of Level III with normal composure, described earlier, was a commonplace incident in the case of the White-throated Sparrows on many different days, suggesting that there was sufficient dissipation of body heat after each assumption of the sun-bathing position for the bird to recover and feed until the sun again forced the bird into Level III.

Humidity appears to play a more important part than high air temperatures in the responses that I have recorded. The condition of the individual bird, whether breeding, molting or migrating, appears also to have its effect.

The colors of the birds recorded include almost every shade including iridescent black, a circumstance which would indicate that pigment, or lack of it, was not a determining factor. The only species, feeding when these records were made, which were never seen in Compulsory Sun Position were the Ground Dove, Summer Tanager and Fox Sparrow (*Passerella iliaca*).

The sun plays a vital part in the life-cycle of birds as it does for every living thing. It is hoped that this paper will draw attention to the subject and that observation and study of the effect of the sun on birds will follow.

ACKNOWLEDGMENTS

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302 GREEN STREET, FAYETTEVILLE, NORTH CAROLINA, MARCH 1, 1956

METHODS AND CRITERIA FOR AGING INCUBATED EGGS AND NESTLINGS OF THE MOURNING DOVE

BY HAROLD C. HANSON AND CHARLES W. KOSSACK

RECENT studies of the Mourning Dove (*Zenaidura macroura*) have indicated the need for better information concerning the migration routes and wintering grounds of the different regional populations in the United States and Canada. Recognition of this need (Kossack, 1955) has resulted in a cooperative program of banding of nestling doves by amateur banders and state and federal workers. Extensive banding operations can be carried out most efficiently if it can be determined in advance when the eggs in various nests will hatch and when the young will be of suitable age for banding. It is hoped that the following descriptive data and photographs will be useful to banders in determining incubation stages of eggs and ages of nestlings. For his excellent work in photographing the nestlings we are indebted to William E. Clark, staff photographer, Illinois Natural History Survey, Urbana.

AGING INCUBATED EGGS

Since 1950, the writers have used portable egg candlers (Hanson, 1954*a*) and a series of reference photographs (Fig. 1) for determining incubation stages in Mourning Doves. The person who may not wish to construct an egg candler can candle an egg with some success by cradling it between the thumb and forefinger and holding it over a two-cell flashlight. The egg can then be examined under a dark cloth or viewed through a tube of adequate size.

The principal anatomical structures that can be observed in viewing incubated eggs of the Bob-white Quail (*Colinus virginianus*) and certain ducks by transmitted light have been shown and discussed in some detail in an earlier report (Hanson, 1954*b*). Because of their relatively small size and white, translucent shells, the eggs of Mourning Doves are particularly suitable for candling. Usually greater detail can be seen in candled dove eggs than in those of the above species.

The daily development stages shown in Figure 1 are believed to represent typical stages, although the field investigator may not always be able to see similar details in eggs being candled. The photographs alone may not always suffice at first to permit an investigator to accurately determine the age of each egg examined. In such cases the notes presented on the characteristics of the various stages of development should be helpful, but they will not be needed after experience is gained. Difficulty, however, will generally be ex-

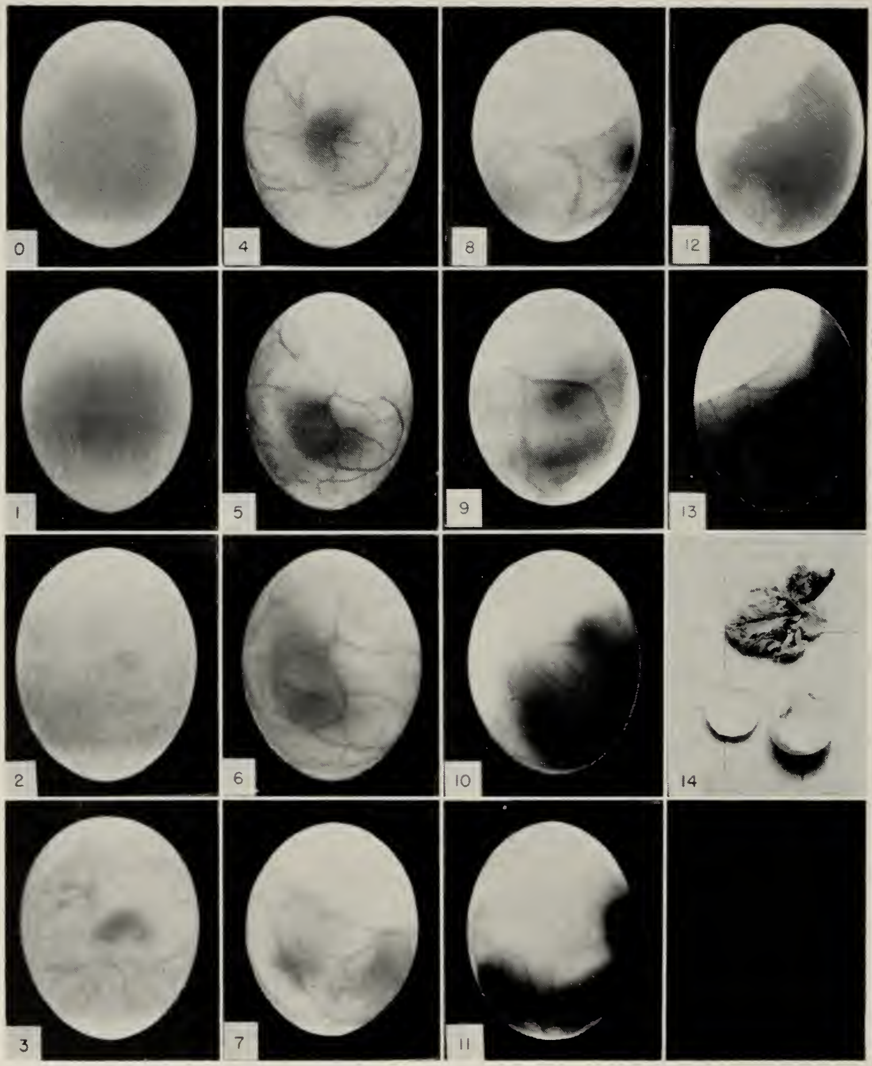

Fig. 1. Incubation stages of Mourning Dove eggs. Days of incubation designated by numerals.

perienced in attempting to make exact age determinations from the seventh through the tenth days of incubation.

There are normally only two eggs in a Mourning Dove clutch and these are usually laid, although not always, a day apart rather than on two successive days. As a result, depending on the incubation habits of the individual pairs, there is normally a difference of about one day in the stages of development of the eggs (as well as the hatching, and growth stages of the nestlings). The two eggs also vary in shape and size. Almost invariably the second egg laid is slightly longer and is less oval in appearance than the egg that was laid first (McClure, 1943; Hanson, 1954*a*). For this reason, should the characters of age not be readily seen in candling, it is important that only one egg be accurately aged. The stage of the second egg relative to the first is a reliable clue as to whether it is a day advanced or behind the first egg in incubation.

INCUBATION STAGES

Fresh egg.—Egg shell is usually clean and egg has a translucent appearance in normal daylight. Viewed in the candler, the yolk area is yellow to light orange in color and its boundaries poorly defined.

First day.—Yolk area is more sharply defined and darker orange in color than in the case of a freshly laid egg. This difference is readily apparent in alternately viewing eggs of these two stages in a complete and normal clutch.

Second day.—Embryo is first seen. It appears as a slightly thickened and slightly flexed reddish line 6 to 7 mm. in length. The beating heart is visible at this stage. Distance between anterior vitelline veins is about 10 mm.; *area vasculosa* or yolk sac as delimited by the *sinus terminalis* is about 19 mm. in diameter.

Third day.—Embryo is much thickened and more flexed. Beating heart is still visible. Vitelline veins are now a complete network. Difference between this and the second day stage may best be estimated by comparison of the two eggs in a normal clutch.

Fourth day.—Embryo is 8 to 9 mm. long and about 3 mm. wide; eye is prominent and easily seen. The *amnion* is about 15 mm. in diameter.

Fifth day.—The embryo is not easily seen at this stage due to the fact that it is moving about within the amnion in which it is suspended well below the surface of the egg shell, and is not sufficiently large and opaque unless it lies immediately under the shell. In the latter case, the head and body are apparent as distinct entities. The flexed embryo is about 16 mm. in diameter, and flexes and sways about. The veins of the *allantois*, which has overridden the *yolk sac*, are conspicuous and relatively heavy.

Sixth day.—Distance across (diameter) flexed embryo is about 16 mm.; body of embryo is about 10 mm. in length. This stage and the succeeding two are best determined by the diameter length of the embryo relative to the width of the shell and by the relative length of the neck. The neck is not readily seen but its length is indicated by the position of the head and body of the embryo (see stages 5 to 8, Fig. 1).

Seventh day.—Flexed embryo is 17 to 18 mm. in length; silhouette of head about 4 mm. Embryo still flexes and sways to some extent, but from sixth day on becomes gradually less active.

Eighth day.—Embryo now lies across the part of the egg distal to the air sac. Movements may be slow or fairly active.

Ninth day.—Embryo is much less active than it was during the eighth day. It is not clearly seen in outline, but often appears as a huddled mass in the central area of the egg.

Tenth day.—Embryo is now curved in a semicircular position, usually against the shell. Head and neck may move some and kicking movements of the feet may be observed.

Eleventh day.—Embryo lies very still, often found stretched out against the shell in the manner shown in Fig. 1, stage 11.

Twelfth day.—Embryo immobilized, fills two-thirds of egg distal to air sac; no detailed structures observable.

Thirteenth day.—The egg is opaque except for the air sac and a small transverse area in which veins can be seen lying immediately above the area occupied by the embryo. Head of embryo later breaks into air sac.

Fourteenth day.—Embryo has hatched, apparently in most cases during the preceding night.

NESTLING GROWTH STAGES

Brief notes on the development of nestling Mourning Doves have been presented by Nice (1922) and McClure (1943). The more detailed records presented here, which are based on study of several hundred nestlings, including both captives and wild birds, permit more exact determination of age. In Figures 2 and 3, photographs showing the day by day development of nestling Mourning Doves are presented. Analysis of these records permitted the construction of an "aging gauge," which is shown in Figure 4.

The aging gauge has four scales; the one indicates the average combined length of body and tail of Mourning Dove nestlings of known age; the two other scales are calibrated in millimeters and inches; and the fourth or lower scale is the range in length for birds of a known age. Length and age data are obtained by placing the nestling on the gauge so that the surface of the breast feathers just comes in contact with the end of the vertical stop. The approximate age of the nestling is indicated by the point of terminus of the body—or tail when present.

With the aid of these photographs, the "aging gauge," and descriptive notes given below, the authors had little trouble in determining the age of nestlings through the seventh or eighth day. After the eighth day the problem was more difficult when photographs alone were used, for some of the characters of age were not apparent in the photographs.

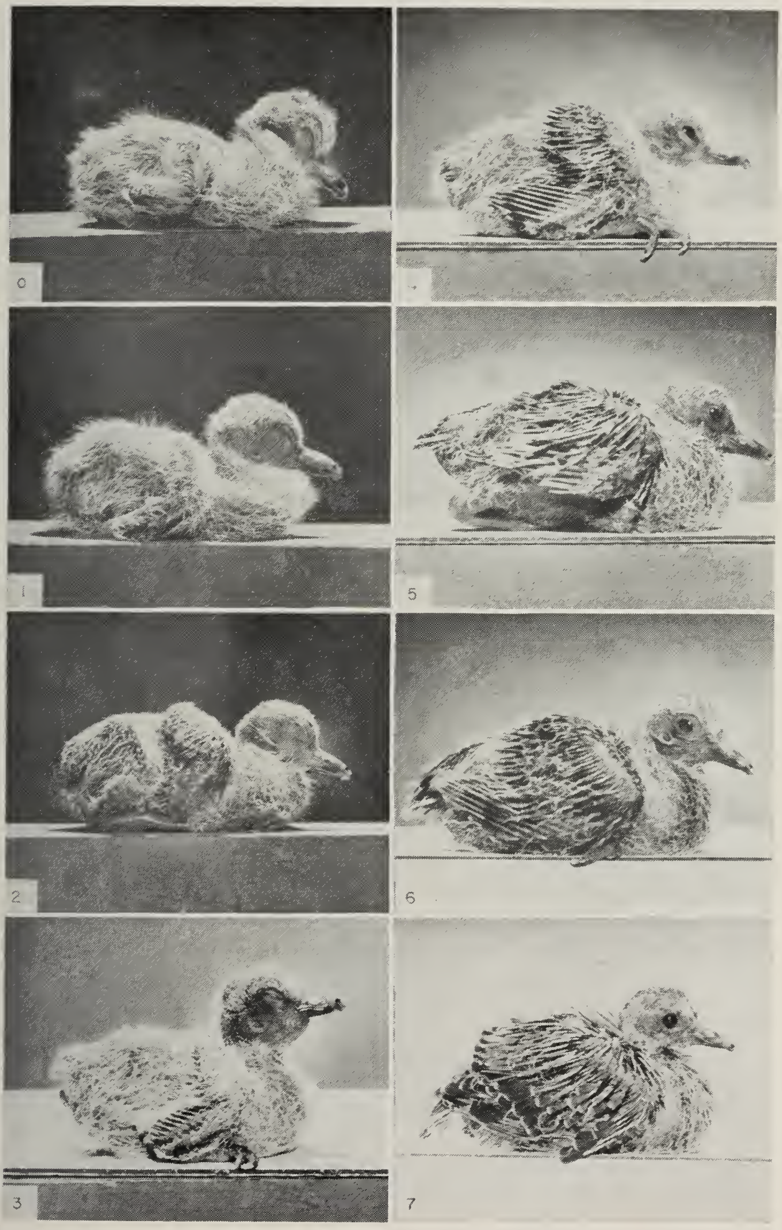

FIG. 2. Growth stages of Mourning Dove nestlings. Age in days designated by numerals.

The tendency in our experience was to overestimate the ages of nestlings nine or more days of age. This factor plus individual variation in size, or stunting, (Fig. 5) emphasizes the need for the combined use of size, plumage and physical characteristics. For example, McClure (1943) noted, as we did (unpublished), that body weight was lower and development was retarded for all nestlings in nests that contained three young as compared with nests that contained two young. Conversely, we have found on several occasions both with wild and captive birds that a single survivor of a clutch may be unusually large and well developed, apparently as a result of an above normal intake of food made possible by lack of competition from a nest mate.

Although it happens infrequently, the younger nestling occasionally grows faster than its nest mate. The writers have measured and marked nest mates when they were two and three days of age. When these nests were revisited and the young were eight and nine days old, the physical development of the younger bird indicated in each case that it was the older. In similar cases in captivity, the younger bird has been observed to be the more aggressive in obtaining food from the parents.

The banding of nestling Mourning Doves at an early age was made possible by the use of "Dalzoflex" elastic adhesive tape (made in England) to hold the bands on the legs (Kossack, 1952). A piece of tape one-half inch wide and sufficiently long to overlap on the band is used. The lower portion of the tape is fastened to the band; the upper portion to the tarsus and to the down feathers on the lower portion of the tibio-tarsus. Half-inch wide plastic adhesive tape has also been used with some success, but it is less desirable than the elastic tape.

In the descriptive notes below, all "lengths" are body length or length of body plus tail (when latter is present) as measured on an aging gauge. Wing measurements are of the straightened and flattened wing, from the bend of the folded wing to its tip. Nestling Mourning Doves have an egg tooth near the tip of both the upper and lower mandibles. For convenience, when both are present, they are referred to as "egg teeth." Reference should be made to Figs. 2 and 3 in reading the descriptions which follow.

Less than one day old (Fig. 2 stage 0).—Length 33 (32 to 35) mm.; not much larger than egg from which it was hatched. Bird has difficulty holding head erect. Eyes closed; egg teeth on upper and lower mandible prominent. Down is cream colored. *Key character.*—Small size.

One day old.—Length 40 (38 to 41) mm. Increased size of wing is principal change in body characteristics. Primary feathers of wing have not appeared. Eyes closed. Both egg teeth present. *Key character.*—Increased size of wing.

Two days old.—Length 49 (45 to 55) mm. Head and body still covered with cream colored down. Skin of wings becoming blue in color. Wing about 19 mm. Primaries just emerging from wing; exposed portion may be 1 to 2 mm. in length. *Key character.*—Emergence of primaries.

Fig. 3. Growth stages of Mourning Dove nestlings. Age in days designated by numerals. Young doves usually leave the nest when about 12 days old.

Three days old.—Length 55 (51 to 66) mm. Body and head still covered with down, but skin is beginning to take on a bluish cast. Wings are dark blue in color. Eyes one-fourth to one-third open. Egg teeth present. Wing about 23 mm. Sheathed primaries 5 (1 to 12) mm. Tail feathers may be just breaking through skin. Tarsus about the width of a no. 3 band (6 mm.) in length. Band will slip readily over foot. (This is the earliest age in which a band may be applied with the aid of tape. Care should be used in applying tape.) *Key character.*—Length of primaries.

Four days old.—Length 67 (60 to 77) mm. Body still down-covered. Eyes one-third to one-half open. Egg teeth present. Sheathed primaries 13 (5 to 20) mm. Sheathed tail feathers 3 to 7 mm. Secondary wing feathers have emerged. (Band will still slip over foot. This is the ideal age to begin applying bands with the use of elastic adhesive tape.)—*Key character.*—Length of primaries and tail feathers.

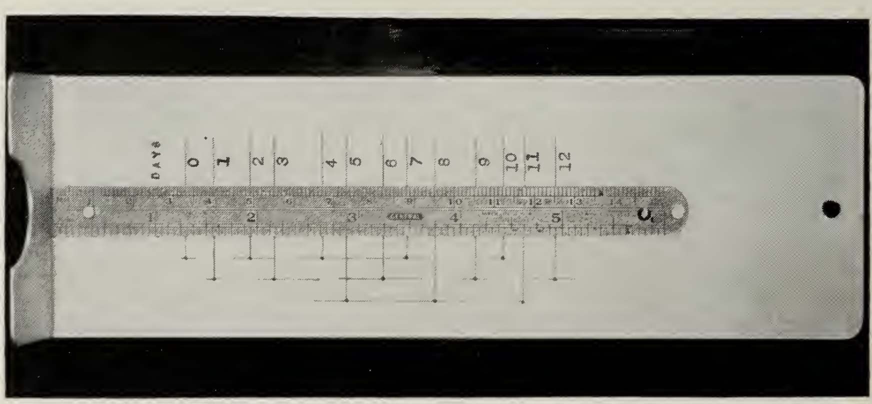

FIG. 4. Gauge for aging nestling Mourning Doves. Average length per day of body, or body plus tail when latter is present, is shown by vertical lines with large numerals. Extremes for these measurements are indicated by the horizontal lines below the center rule.

Five days old.—Length 73 (65 to 83) mm. Eyes are about three-quarters open. Egg teeth are present. Pin feathers (sheathed body feathers) just emerging on upper breast. Scapular feathers sheathed. Sheathed feathers present on spinal tract of back. Wing 47 to 50 mm. Tip of wing folded against the body terminates half way between point of juncture of femur and tail feathers with the body (see Fig. 2, stage 5). Sheathed primaries 24 (18 to 29) mm. Tail 6 (3 to 9) mm. Squabs when taken from nest may crawl about slowly. (At this stage the band will slip over the foot; but tape should be used.) *Key character.*—Wing tip terminates between juncture of femur and tail.

Six days old.—Length 82 (71 to 92) mm. Eyes fully open. Remnants of egg teeth present. Sheathed feathers on crown of head beginning to emerge from skin. A few feathers of spinal tract on lower back begin to emerge from sheaths. Wing about 59 mm. Wing coverts still sheathed. Primaries 82 (71 to 92) mm. Tip of folded wing extends to base of tail feathers (Fig. 2, stage 6). Tips of primaries in some individuals may be just breaking through sheaths. Tail 13 (10 to 17) mm. Young taken from nest now will crawl fast or may take a defensive attitude with wings raised over back. (In banding at this stage, bands should be opened, and then closed on leg and held in place

FIG. 5. Two nestling Mourning Doves, 12 days of age, showing the contrast in size between a nestling of normal development (left) and one whose growth was stunted (right). Respective weights and measurements: normal nestling, 52 grams, wing 100 mm. and tail 41 mm.; stunted nestling, 32 grams, wing 85 mm. and tail 30 mm. The stunted dove was very weak.

by tape.) *Key character.*—Tip of wing extends to base of tail feathers. Tips of primaries begin to emerge from sheaths.

Seven days old.—Length 88 (78 to 94) mm. Egg teeth present but tooth on upper mandible has nearly disappeared. Feathers on crown of head still sheathed. Upper breast feathers and spinal tract feathers partly out of sheaths. Scapular feathers emerging from sheaths. Wing 70 (65 to 73) mm. Primaries 40 (33 to 45) mm. Emerged tips of primaries 8 (3 to 18) mm. Primary wing coverts still in sheaths, but secondary and tertiary coverts becoming free of sheaths. Tail 17 (16 to 21) mm. Nestling will "crawl-run" rapidly. (Band will slip off of leg; use tape.) *Key character.*—Feathering out of tips of primaries and wing coverts.

Eight days old.—Length 95 (85 to 102) mm. Egg tooth occasionally still present on upper bill; always present on lower bill. Feathers of spinal tract free of sheaths to a point about midway up back. Breast feathers just beginning to lose sheaths in appreciable numbers. Wing 76 (73 to 80) mm. Primaries 47 (42 to 49) mm. Primaries free of sheaths 24 (15 to 28) mm. Primary wing coverts breaking free of sheaths. Gaps appear between primaries when wing is spread, since the primaries have not become sufficiently free of the sheaths to present a completely closed wing surface. Tail 26 (23 to 30) mm. (Band will slip off of leg; use tape.) *Key character.*—Appearance of gaps among wing feathers.

Nine days old.—Length 105 (102 to 108) mm. Egg tooth absent from upper mandible, may still be prominent on lower mandible. Small patch of crown feathers free of sheaths. Upper portion of breast now fairly well feathered out. Ventral tract feathers of belly losing sheaths. Wing 83 (78 to 87) mm. Primaries about 54 mm., free of sheaths for over half their length. Primary feathers of wing now present a continuous surface when spread. Tail about 30 mm. Nestling may leave nest if alarmed. (Occasionally it will be necessary to use tape in banding.) *Key character.*—Feathering out of crown and closing of wing surface.

Ten days old.—Length 112 (108 to 115) mm. Feathers of head (capital) and back (spinal) tracts out of sheaths, but feathers of lower back of neck remain sheathed. Auricular feathers becoming free of sheaths. Wing 89 (85 to 94) mm. Tail 37 (31 to 42) mm. (After the ninth day the young are easily frightened and may leave the nest when disturbed.) *Key character.*—It is doubtful whether the age of nestlings can be judged with any certainty beyond the 9th day. Probably the presence of sheathed feathers on the back of the neck along with the wing and tail measurements are the best indicators of this age.

Eleven days old.—Length about 116 mm. Feathers of ventral tract of belly area becoming unsheathed. Wing about 92 mm.; tail 40 mm. *Key character.*—Unsheathing of belly feathers.

Twelve to 14 days old.—Length about 121 mm. Wing about 99 mm. As McClure (1943:388) states, feather development from the twelfth to the fourteenth days "is that of a refinement, with the completion of feather coverage under the wings and belly and with the development of the fine feather bloom." (From the ninth day on the young may leave the nest when disturbed.)

SUMMARY

Methods and criteria for aging incubated eggs and nestlings of the Mourning Dove are described. With the use of a portable egg candler and the aid of photographs of incubated eggs taken by means of transmitted light, incubation stages, except for 7 through 10 days, can usually be determined with accuracy. Descriptive notes are also furnished as an additional aid in determining incubation stages.

Nestling Mourning Doves were aged by comparing them with photographs of nestlings of known age. An aging gauge showing the average and range of combined body and tail length also proved helpful. Descriptive notes that emphasize the "key characters" of age at consecutive days of growth are presented. The use of elastic adhesive tape in banding nestling doves is also described. Studies of captives and doves in the wild revealed that stunting in nestlings sometimes occurs. Also in some cases, the second hatched nestling may outgrow the first hatched nestling because of the former's more aggressive feeding behavior.

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ILLINOIS NATURAL HISTORY SURVEY, URBANA, ILLINOIS, OCTOBER 15, 1956

STATUS OF BREWER'S BLACKBIRD ON THE GRAND PRAIRIE OF EASTERN ARKANSAS

BY JOHNSON A. NEFF AND BROOKE MEANLEY

THE Grand Prairie of eastern Arkansas is described geologically as an upland plain in the Mississippi Valley part of the Gulf Coastal Plain. Comparatively flat, wooded lowlands border the principal drainage streams, but the higher, rather flat uplands are essentially treeless. The area lies mostly in Lonoke, Prairie, and Arkansas counties and is bounded on the west by the Bayou Meto, on the south by the Arkansas River, on the east by the White River, and on the north by Wattensaw Bayou. The name, we are told, was given by early explorers who found here a true prairie where typical prairie grasses grew waist high.

There is little doubt that even in those days of the virgin prairie, Brewer's Blackbirds (*Euphagus cyanocephalus*)—common birds of the more westerly plains—visited the Grand Prairie in winter, but even as late as 1950 there was insufficient information to permit accurate definition of the status of the species in the area. Hollister (1902. *Wilson Bull.*, 9:10–15) reported them at Stuttgart in 1902 and they have been reported by other students intermittently during the intervening years.

Early in 1948 Neff initiated an intensive study of the relationship of blackbirds and other species to the Arkansas rice crop, and in May, 1950, Meanley became resident biologist on the study, with headquarters at Stuttgart. Our task was to study the various species involved and to determine the status of each. During the six years of study much information on the Brewer's Blackbird was assembled.

Few observers on the Grand Prairie recognized the Brewer's Blackbird as a separate species. It was only a blackbird working over the fields, one of the myriad that spends the winter actively scavenging the fallow and stubble fields, or feeding on the plowed or newly-planted oat or lespedeza fields.

In this district, rice is sown in April or May. In earlier years rice was cut with a binder, shocked, allowed to dry in the shock, then threshed; often wet autumn weather delayed threshing till November or December, even occasionally into January. Early in the 1940's, studies were initiated on the artificial drying of rice and by 1948 more than half the state's rice acreage was cut with combine harvesters and dried at the mills. Today fully 95 per cent of the rice acreage is so harvested, and most of the crop is out of the field by mid-October. Binding and shocking remains a fairly common practice only in a few localities.

Oats are planted from September to November, and harvested in June.

Lespedeza is seeded in February or early March and the seed crop is harvested after rice harvest in October or November. A frequent practice is to burn off the stubble and waste straw after combining or before plowing for the next crop.

The Brewer's Blackbird is a common winter resident of the Grand Prairie and of the other open, prairie-like areas found in a number of other eastern Arkansas counties. Fully 10,000 birds wintered within a radius of 25 miles of Stuttgart and there was little or no visible fluctuation in their numbers during Meanley's four winters of observation.

The earliest arrivals come in October (October 6, 1952, October 13, 1951) but true fall migration does not begin before November 1. Flocks that sometimes number 2,000 arrive in the second week of November. In the spring, birds have been recorded in the area as late as April 21 (1951 and 1952); the bulk of them have left the Grand Prairie by late March.

Here, as in its more westerly range, the Brewer's is primarily a bird of the open country. It feeds in plowed fields, fallow land, stubble, and on newly-planted grain fields, and occasionally about cattle feed lots, hog pens, and straw stacks. Essentially ground feeders, these birds were never observed feeding on standing grain, but occasionally fed on shocked rice in the Slovac area (10 miles north of Stuttgart) and on stacks of threshed rice straw.

The feeding locations used most heavily by Brewer's Blackbirds were burned-over stubble fields followed in order by pastures, fall-planted oat fields, plowed fields, rice stubble and miscellaneous sites.

Few Brewer's Blackbirds arrive before rice harvest is completed, and their only attack on the ripe rice crop is upon shocked grain in localized districts. Most of the wintering population has moved northward before any but the earliest rice fields are seeded in the spring, but these birds undoubtedly pick up some of the uncovered seed grain in these early-planted fields.

Most of the Grand Prairie's oat acreage is planted after the arrival of these birds and they pick up only the seed kernels that remain uncovered on the surface of the fields. Damage to oat fields, however, is insignificant. Lespedeza seed does not interest any of the blackbird group and is taken only accidentally; this we have demonstrated by offering lespedeza seed to caged wild-trapped blackbirds which starved to death without taking a weighable amount of the seed.

When the Brewer's Blackbirds arrive in late October some fields of grain sorghum and field corn still are unharvested, but these birds confine their activity entirely to the ground, picking up kernels dropped by Red-winged Blackbirds (*Agelaius phoeniceus*), Brown-headed Cowbirds (*Molothrus ater*) and grackles (*Quiscalus*).

FOOD HABITS

An extensive study was made of the food habits of all blackbird species involved in depredation upon the rice crop. No special effort was made to collect the minor species and at the end of the field work we had a total of 59 stomachs of the Brewer's Blackbird distributed as follows: January, 4; February, 8; March, 7; April, 2; October, 6; November, 26; and December, 6. For this seven-month period, vegetable food items comprised 84.3 per cent of the food, while insects or other animal matter averaged only 14.6 per cent. The value for plant foods is slightly higher than that reported for a five-month winter period by Martin, Zim, and Nelson (1951. "American Wildlife and Plants." p. 174).

Rice, mostly waste grain, comprised 36.5 per cent of the diet in 47 stomachs. Oats, made up 14.6 per cent of the total in 14 stomachs, and field corn and grain sorghum, all waste grain, totalled 22.4 per cent in 31 stomachs.

Seeds of barnyard grass or wild millet (*Echinochloa crus-galli* and *E. colonum*) made up 3.6 per cent in 26 stomachs. Seeds of bristlegrass, paspalum, *Brachiaria*, crabgrass and panic grass were found in 51 stomachs and totalled 4.5 per cent.

Seeds and tubers of nutgrass, spike rush, sedges and other marsh vegetation were found in 13 stomachs but made up less than 1 per cent of the food. Croton seed averaged 1.6 per cent and ragweed seed made up only 0.3 per cent. Miscellaneous seeds included those of dock, smartweed, and some unidentifiable items.

Fragments of grasshoppers and crickets in 18 birds made up 4.7 per cent. Beetles of a number of species were found in 56 birds but in such small quantities that they comprised only 7.9 per cent. In addition to these, weevils of several species (including remains of the rice water weevil, *Lissorhoptrus orysophilus*, a serious rice pest) were found in 16 stomachs and added 0.7 per cent more. The remaining 2.4 per cent animal food was made up of minute quantities of a wide variety of insects including ants, stink bugs, flies and leafhoppers.

The food of the Brewer's Blackbird during its winter sojourn on the Grand Prairie is, therefore, largely made up of waste grain that has little or no value to the farmer. Only a minute quantity of seed oats or rice from newly seeded fields, or of unthreshed grain from shocked rice fields, can be classified as a loss to the farmer. At this season animal food is not abundant, but these birds manage to find a respectable percentage of insects, among them several of the farm crop pests of the Grand Prairie. Few if any of the farmers of the area would deny that this blackbird benefits them during its winter sojourn.

Small numbers of cowbirds, starlings (*Sturnus vulgaris*), redwings or grackles were often noted feeding with larger flocks of Brewer's, but as evening approached these detached themselves and joined the streams of their own species that crossed the evening sky from all directions, all headed for the currently-favored communal roosting thicket. The Brewer's alone remained aloof; only once was a Brewer's Blackbird found roosting in the central roost with the other species.

The Brewer's Blackbird is the last of the wintering blackbird species to go to roost each day—later even than the cowbird. Late in the afternoon an entire flock might be found perched quietly on a rural telephone line alongside a stubble field; later, in the gathering dusk, the observer may be quite sure that the flock of blackbirds winging low over the stubble in wide circles is made up entirely of Brewer's, and that their chosen roosting site is somewhere in the stubble below them, for grain stubble or reasonably high grass is their preferred roosting cover on the Grand Prairie. This species is a little-known but truly interesting part of the immense wintering blackbird population of the Prairie.

U.S. Fish and Wildlife Service, Denver, Colorado, and Alexandria, Louisiana, April 26, 1956

GENERAL NOTES

Notes, chiefly distributional, on some Florida birds.—In September, 1955, my wife and I spent two weeks observing Florida birds, and taking a few specimens for the Carnegie Museum. In trying to determine which of our observations were worth placing on record I have had to depend largely on Sprunt's "Florida Bird Life" (1954). Although aware that this book has certain shortcomings as a guide to the current status of Florida birds (see Robertson, 1955. *Everglades Natural History*, 3:55–57), I have not had access to other recent information. Dr. Henry M. Stevenson was therefore kind enough to help me select records for publication.

Ardea occidentalis. Great White Heron.—"Straggles north to the Tamiami Trail in late fall and even farther at times, but not to be expected anywhere north of Cape Sable, or Ten Thousand Islands, with any regularity" (Sprunt, 1954:23). As we crossed San Carlos Bay on the Sanibel Island ferry on September 11, we observed a Great White Heron standing in the shallow water just off Punta Rassa, Lee County.

Dichromanassa rufescens. Reddish Egret.—"Occurs sporadically on the mainland at least as far as Lake Okeechobee in the interior. . ." (Sprunt, 1954:29). One was seen with three Little Blue Herons (*Florida caerulea*) on September 9 near the St. Johns River west of Melbourne, Brevard County, along route 192.

Falco columbarius. Pigeon Hawk.—Sprunt's dates for this species range from September 19 on. We saw one on September 14 as it flew east along the north shore of Bahia Honda Key.

Grus canadensis. Sandhill Crane.—This species is supposedly very rare as far south as Everglades National Park. We saw two at very close range on route 27 just 10 road miles beyond the Royal Palm Ranger Station, Dade County (on the stretch of road which is *not* actually within Everglades Park) on September 13. We were gratified at the large number of cranes we were able to see along the road during the course of our visit to Florida, but surprised at the few young of the year seen. For example, in a flock of 18 seen 10 miles north of Okeechobee on September 16, only two were young birds lacking the patch of bright red skin on the crown.

Charadrius alexandrinus. Snowy Plover.—Sprunt (1954:158) gives Estero Island as the southernmost definite nesting locality, and gives no indication whatsoever as to whether there is any migratory movement in this species in Florida. On September 12 we saw a single Snowy Plover on Marco Island, Collier County, some 35 miles south of Estero.

Columbigallina passerina. Ground Dove.—Verheyen (1953. *Bull. Inst. Royal des Sci. Nat. de Belgique*, 29, no. 27) has published an extensive list of species of birds whose skulls he examined to determine the extent of cranial ossification in adults. Among the Columbidae he examined skulls of *Turtur chalcospilos*, *Treron australis*, *Columba arquatrix*, and *Streptopelia semitorquata*. Of these, in the first species only was the "pneumatization" of the adult cranium complete. In the crania of the other three, a "window" was present in each frontal bone. This was also true of a male specimen of *Columbigallina passerina* which I collected on September 9 at the bridge over the Kissimmee River west of the city of Okeechobee. The plumage and soft-part colors of this Ground Dove were those of an adult, and its testes were quite large (left, 9 × 3.5 mm.; right 11 × 4.5 mm.). It would appear that *Columbigallina* may be added to the list of bird genera in which a completely ossified double-layered cranium is not attained with maturity.

Crotophaga ani. Smooth-billed Ani.—On September 8 we discovered a single ani in the scrub on North Merritts Island, Brevard County, along route A1A, 2 miles beyond the point at which that road leaves route 402. The bird was collected, and proved to be an adult male with testes measuring 9 × 6 millimeters. It was fat, and had been feeding on insects, mostly grasshoppers. This apparently constitutes a new northernmost locality record for this species, which is purely casual in Florida away from the southern Lake Okeechobee area.

Hirundo rustica. Barn Swallow.—On September 10 we were watching a large flock of Barn Swallows hawking insects over an extensive cane field on the Glades-Hendry county line at route 720. Among them, but impossible to collect, was a beautiful albino. As is so often the case in such abnormally-colored birds, the loss of pigment was differential. Although the upper parts were pure white, the areas of the underparts which are pinkish buff in a normal Barn Swallow were a creamy yellow in this bird.

Vermivora ruficapilla. Nashville Warbler.—On September 14 I was attempting to collect one of a small flock of Prairie Warblers (*Dendroica discolor*) at the west end of Bahia Honda Key. It was a particularly windy day, and I found it difficult to keep track of individual birds as they moved about in a small clump of trees. When I finally did fire, the bird which fell proved to be a Nashville Warbler, a species which I had not realized was present among the Prairie Warbler flock. A trick of the wind had conspired to distribute my shot pattern so that the bird was completely mangled. Being unaware at the time of the extreme rarity of this warbler in Florida, I discarded the specimen. I have since learned from Mrs. Margaret H. Hundley of Key West that there are no previous records of this species from the outer Keys. I have also learned never to discard specimens!—KENNETH C. PARKES, *Carnegie Museum, Pittsburgh 13, Pennsylvania, March 29, 1956.*

Golden Eagle attacks decoy duck.—While concealed in a sand-pit duck blind on November 20, 1955, I watched a mature Golden Eagle (*Aquila chrysaëtos*) display unusual interest in some decoy ducks. It was a clear, cold day on the South Platte River near Sedgwick, Colorado, and my 20 decoys (11 mallards fronted by nine pintails) fringing the far side of a 15-foot channel were strung out for 30 feet upstream from my willow-bordered blind. The eagle, soaring into the light wind, came in low over the river bottom and alighted at the water's edge directly across the stream and about 20 feet from me. After a few minutes of critical inspection, head cocked first to one side and then the other, the big bird gingerly waded toward the decoy mallard drake, only five feet away, that brought up the rear of the spread. This first advance into the shallow water abruptly changed to a much faster and ungainly backward retreat as the eagle got its "pants" wet. A second entry into the water and hurried exit to land failed to discourage this hungry bird, for, with two quick beats of spread wings, it was in the air three feet above the water and, passing slowly over the decoys, it landed close to the lead decoy—a bright black and white male pintail.

Here the first half-hearted wading effort was quickly followed by a bold approach to the rear of that pintail decoy, which was slowly tacking with the current. Now the eagle spread its wings, reared back and thrust its feet forward to strike the decoy's back with distended talons. That first vicious strike was repeated as soon as the decoy righted from its half-submerged roll and the scrape of talons on the hard surface of the decoy could have been clearly heard much farther away than my 40 feet. Now, standing in six inches of water and just downstream from the tacking decoy, the eagle gave a sudden wing flap, reached out and grasped the decoy's head with its right foot, and both eagle and decoy were in the air.

Hurriedly, I raised up in the blind as the eagle took wing but I stood motionless when it dropped the decoy on the shore and alighted nearby. Then, although I was exposed head and shoulders above the blind, the eagle's full attention was on its "prey" for, turning toward me, it walked back to the decoy, now lying on its side, and putting one foot on the "duck," made three sharp pecks at its belly. The noise of the big predator's beak striking the board bottom of that hollow decoy sounded like a slow-motion tattoo of a flicker (*Colaptes*) pounding a house. Finally, apparently convinced that the decoy duck it had "captured" was not edible, the eagle gave up its futile feeding efforts and took to the air, flying leisurely downstream to pass me at eye level and within 10 feet of my face.—CHARLES C. SPERRY, *U.S. Fish and Wildlife Service, Denver, Colorado, April 3, 1956.*

***Telmatodytes palustris plesius* wintering in southwestern Kansas.**—On January 28, 1956, while in Kearny County, Kansas, with four members of a field party from the University of Kansas, I heard an estimated five Long-billed Marsh Wrens (*Telmatodytes palustris*) in a marshy area below the earthen dam of Lake McKinney. Although the water along the perimeter of the marsh was frozen, open areas existed near the center. I collected two specimens, a fat male (K.U. 32991) having minute testes, and a female (K.U. 32992), in which the ovary was four by three millimeters, that had little fat.

The collection at the University of Kansas contains another winter specimen (K.U. 28939), a male, taken one and a half miles north of Fowler, Meade County, Kansas, on December 31, 1948, by Henry Hildebrand. This specimen, previously identified as *T. p. dissaëptus*, and the two birds from Kearny County are assignable to *T. p. plesius* on the basis of the over-all pale coloration, distinctly barred tail coverts, and large size. All three specimens came from the valley of the Arkansas River.

T. p. plesius is known to breed east to central Colorado (A. O. U. check-list of North American birds, 4th ed., 1931:249). Therefore it is not surprising to find it wintering in the valley of the Arkansas River. Many species which breed in the Rocky Mountains occur in that valley in migration or in winter. Western Kansas should be investigated in the breeding season; it would be interesting to know if Long-billed Marsh Wrens breed there and, if they do, to what subspecies they belong.

Tordoff, in his recent check-list of the birds of Kansas (1956. *Univ. Kansas Publ., Mus. Nat. Hist.*, 8 (5):338), lists only *T. p. dissaëptus* as occurring in the state. It is considered an uncommon transient throughout Kansas, known as a breeding bird only from Doniphan County, in the extreme northeastern part of the state. This note records the occurrence, and at least occasional wintering, of *T. p. plesius* in Kansas.—GLEN E. WOOLFENDEN, *Museum of Natural History, University of Kansas, Lawrence, Kansas, March 28, 1956.*

"Frightmolt" in a male Cardinal.—The description of the occurrence recorded here has been stimulated by the recent publication of an extensive paper on frightmolt, "Schreckmauser" (Heinrich Dathe. 1955. *Jour. f. Ornith.* 96:5–14). Dathe defines this process as a partial molt which takes place out of the normal molt period and which is set in motion through fright or fear and without any application of force. He gives a long list of birds in which this event has been recorded, stating that it does not seem to have been found among waterfowl or birds of prey. The rectrices are shed most frequently, and next, the smaller feathers of the breast and the dorsal tracts; the wing feathers are seldom, and the feathers of the head, never affected. For the most part, the feathers seem either to be expelled, so to speak, shot away, or, alternatively, the muscles of the follicle seem to become relaxed so that the quill is set free. Fully formed feathers alone are discarded; regenerating feathers are not lost. Although Dathe ascribes most of his cases to fear, he records an individual cockatoo that "fright-molted" with rage.

My household in Beltsville, Maryland, has for many years scattered feed on the terrace upon which a large glass door opens and which affords a good view from the dining table. Visitors are hence under frequent surveillance. In the late spring or early summer of 1950, a male Cardinal (*Richmondena cardinalis*), flying toward this spot, struck heavily against a casement that had been opened further than usual. The bird fell stunned to the lawn where it was picked up. It had shed the major tail feathers, which lay close by, save the two left lateral-most ones. The Cardinal recovered from his shock and continued as a constant visitor during the entire later season, not replacing the tail plumage. He was easily recognized by the two standing feathers; the absence of the major portion of his flight rudder made little apparent difference to his landings.

The incident discussed above clearly falls into the class discussed by Dathe, and shows also that feather loss is not necessarily a stimulus to regeneration. Probably, however, regeneration would occur at periods closer to the normal molt where, of course, the antecedent activation of the feather papilla is the mover. The entire complex of "frightmolt" is an interesting question which may involve both nervous and humoral participation; the latter is especially suggested in the rage reactions described for the cockatoo.—MARY JUHN, *Jull Hall, University of Maryland, College Park, Maryland, April 25, 1956.*

New bird records for Barbuda, British West Indies.—To my knowledge the last ornithologist to visit Barbuda was Stuart T. Danforth, who spent three days collecting on that island in August, 1933. His activity (1935. *Jour. Agric. Univ. Puerto Rico*, 19 (4):473–482) added seven species to the avifauna known from the island, bringing the total to 54 species. In addition, seven species were listed as doubtfully occurring.

I visited Barbuda from October 29 to November 4, 1955. In spite of the heavy rains which fell at this time, eight species were added to the list recorded from the island, bringing the total to 62 species with seven still carried hypothetically. The additional species are the following:

Coccyzus erythropthalmus. Black-billed Cuckoo.—On November 1, 1955, an immature male was collected about one mile south of Codrington Village. This bird was in the company of Mangrove Cuckoos (*C. minor*) which were fairly common. In a letter to me dated November 21, 1955, Mr. James Bond says: "The former [Black-billed Cuckoo] is an interesting record and it is only the second specimen of the species from the West Indies that I have examined."

Anas crecca carolinensis. Green-winged Teal.—This duck was taken from a flock of 20 small ducks in a rain water pond in the south of the island on October 31.

Porzana carolina. Sora Rail.—I observed one at close range while hunting ducks in a small rain water pond about three miles south of Codrington Village on October 31.

Squatarola squatarola. Black-bellied Plover.—About half a dozen of these plover were observed feeding on the green bordering the lagoon at Codrington Village. They were seen every day during my stay.

Charadrius vociferus. Killdeer.—Two pairs of these birds were observed on several occasions on the green bordering the lagoon at Codrington Village.

Hirundo rustica. Barn Swallow.—A small flock of these swallows could be seen daily coursing over the green at Codrington Village.

Riparia riparia. Bank Swallow.—These little swallows were easily identifiable among the Barn Swallows at Codrington Village.

Progne subis dominicensis. Caribbean Martin.—These birds were reported inhabiting and breeding in the cotton gin building at Codrington Village. They were said to appear yearly. Called "swallows" by the natives. Though this bird was not actually seen, the description given of it and the fact that it nested locally seems to justify its inclusion in this list.

A large hawk, said to visit Barbuda irregularly and reported as very destructive to poultry, is very likely a Duck Hawk. Mr. Danforth lists this bird hypothetically.—G. A. SEAMAN, *Box 472, Christiansted, St. Croix, Virgin Islands, January 9, 1956.*

Status of the Stolid Flycatcher in the American Virgin Islands.—Not until 1943 was the range of the Stolid Flycatcher (*Myiarchus stolidus antillarum*) known to include any of the American Virgin Islands. On June 10 of that year Harry A. Beatty collected a specimen in a ravine near the Bovoni Estate on St. Thomas. At this time he made a call-note count of about 15 birds in the Bovoni ravine area. It was his opinion (1944. *Auk*, 61: 146) that this *Myiarchus* was "faced with extermination through the increasing difficulty of finding holes in trees sufficiently large for their nests as these small islands become more widely denuded of their older forest growth."

In making a wildlife survey of these islands in 1949 the writer located this *Myiarchus* on St. Thomas in the identical area described by Beatty. Nowhere else on St. Thomas has the bird been found by me and until recently it has never been observed on any of the other islands making up the group.

On March 5, 1956, while on the way to Reef Bay, St. John Island, a male *Myiarchus* was collected in a small clearing along the trail which traversed a light, deciduous forest. The taking of this flycatcher on St. John extends its known range through this archipelago nine miles. The bird is now known from Puerto Rico, Vieques, Culebra, St. Thomas and St. John.

Non-migratory and of very sedentary habits, the Stolid Flycatcher remains a seldom seen and rather poorly known bird. Its habitat in the Bovoni ravine, St. Thomas, consists of dense thorn scrub and vines interspersed with a few small, scattered trees clinging precariously to thin soil and rocky hillsides. Since this type of environment is rather common in the Virgin Islands, the fact that this *Myiarchus* confines itself to this one spot on St. Thomas is highly interesting and probably warrants further study.

Some of the heaviest forest left in the Virgin Islands is to be found on St. John. The bird collected there was taken on the outer fringe of this forest where it begins to thin out into scrub. This *Myiarchus* nests in natural cavities in trees or in old woodpecker holes. There would be no woodpecker holes here (since there are no woodpeckers) but inside the nearby heavy forest there might be found suitable conditions for nesting. The habitats where the bird has been found in the Virgin Islands to date are in no way alike, and this fact poses an interesting question as to the exact requirements of this flycatcher.—G. A. SEAMAN, *Box 472, Christiansted, St. Croix, Virgin Islands, April 5, 1956.*

A peculiar type of flight in Cooper's Hawks.—On April 17, 1953, while trapping hawks at the Cedar Grove Ornithological Station in Sheboygan County, Wisconsin, I noticed what seemed to be a very unusual bird which I could not readily identify. Except for its obvious excessive size its method of flight could easily have been mistaken for that of a Nighthawk (*Chordeiles minor*) or more easily for that of a Short-eared Owl

(*Asio flammeus*). In shape and silhouette, however, it was very reminiscent of a Marsh Hawk (*Circus cyaneus*). The bird was a Cooper's Hawk (*Accipiter cooperii*) and in the three years following this event I have seen a repetition of this pecular flight performance at least 17 times.

Since I spend two months during each of the spring and fall seasons at the Station I am in an excellent position to notice such phenomena during the course of our routine observation and banding of migrating hawks. Indeed, all but one of the above observations were of migrating birds at Cedar Grove, whereas the last hawk was seen in Portage County, Wisconsin, by Mr. Alan Hamerstrom, Mr. Lorenz Kramer and myself. This bird also was considered to be a migrant.

All 18 of these observations were made in a total of six days, with the most occurrences on a single day being nine. It is quite likely that in all cases different individuals were involved. Only one of these birds was seen "Nighthawk-flapping," as we have come to call it, in the fall, the other records being in the spring. Seven occurrences were noted in spring 1953, none in 1954, nine in spring 1955, one in fall 1955 and, one in spring 1956. Migrant Cooper's Hawks are normally seen from March 10 to about May 25, but nighthawk-flapping was seen only between April 17 and 21. The sky was clear on five of the six days on which nighthawk-flapping was observed.

Birds flying in this manner usually were seen at somewhat greater heights than those seen in normal migratory flight. In addition, their flight is more erratic. with sudden jogs to one side or the other being quite frequent. Often at this time the hawks fly in long arcs or in large circles, quite in contrast to their normal direct type of flight. Another departure from the normal is the long and narrow appearance of the wing, which acquires a very deep beat much like a butterfly. Ordinarily Cooper's Hawks have quite a rapid stroke but, while nighthawk-flapping, the duration of the wing beat cycle is at least twice as long. Since four of the displaying birds were trapped. resulting in only a minor deviation from our normal trapping percentage, it is doubtful that this behavior is deterrent to our trapping efficiency.

There seems to be no tendency for one sex to indulge in nighthawk-flapping more than the other but, of the nine birds that were aged, only two proved to be first-year birds. Migrant Cooper's Hawks in April, however, are trapped in a ratio of about three adults to one immature.

At least once an adult male and female were seen flying together in this manner, but more often only single birds were seen. All in all with the present evidence it seems doubtful that this is a courtship display but, I am reluctant to speculate on what other purpose it might serve.—Daniel D. Berger, *Cedar Grove Ornithological Station. Cedar Grove, Wisconsin, April 28, 1956.*

Effects of unusual spring weather on Scarlet Tanagers.—The unseasonably cold spring of 1956 in southern New York State pointed up a critical situation in the ecology of the Scarlet Tanager (*Piranga erythromelas*). Consistently cool weather, except for a few days, persisted well into May and culminated with killing frosts on the nights of May 23 and 24 as far south as Yorktown and Thornwood, in Westchester County, where temperatures of 28° F. were recorded in the lowlands. Heavy losses were sustained by florists, nurserymen, orchardists and vegetable gardeners. Weather records reveal that the average dates of the last killing frost are April 20 in southern Westchester and April 30 in northern Westchester County. Similar conditions prevailed in New York City immediately to the south, and in adjacent New Jersey and Connecticut.

The first Scarlet Tanagers normally return to this area from their winter quarters during the first week of May, the males usually preceding the females by a week or so. Presently the trees are well leafed out, and the birds, concealed above the thick foliage, are feeding vigorously on early caterpillars as they go about their nesting. In 1956 the tanagers returned on their normal schedule, but were greeted by conditions far from customary. The foliage was not advanced, nor were large insects abundant. Tent caterpillars appeared, but these are frequently disdained by tanagers. The hatch of other caterpillars was delayed, but the hordes of warblers present at this time appeared to find an ample supply of small insects for food.

By May 15 the tanagers, particularly the males which had been in the vanguard of the flight, were noted with unusual frequency. And, surprisingly, they were seen mostly on or within a few feet of the ground, foraging for whatever might befall. By May 23 the National Audubon Society, the A.S.P.C.A., and the Bronx Zoo were swamped with inquiries from a curious public. Specimens were brought in, information was sought on proper first aid treatment and on the cause of the phenomenon. On May 25, at four locations in the New York Zoological Park, I observed nine male and four female Scarlet Tanagers; all were near the ground, many congregated about trash receptacles where scraps of food were to be found. They obviously were undernourished; their wings often drooped, they flew reluctantly and with difficulty, and sometimes even clung on vertical tree trunks to rest. Several were brought to the Park for treatment, picked up by hand from the ground, though uninjured. Within a few days they responded to a standard insectivorous bird diet. The public was advised to offer them bread crumbs and raisins, which served as an acceptable substitute.

The cold weather abated by May 29 and conditions for the tanagers improved quickly. By June they had resumed their normal stations in the tree tops where, presumably, their proper food was finally available. They were noted feeding on alate ants and on the larvae of noctuid moths. The crisis caused by a slight fluctuation in temperatures was past, but we have no indication of the mortality attributable to starvation, heavy automobile traffic, or terrestrial predators during this period. The entire episode graphically demonstrates how narrow is the threshold which may, when disturbed, radically affect a natural population.—RICHARD H. MANVILLE, *New York Zoological Society, Bronx 60, New York, June 9, 1956.*

Hudsonian Godwit in Colorado.—A male Hudsonian Godwit (*Limosa haemastica*), apparently the first of the species to be collected in Colorado, was secured by the undersigned and his grandson, Jack Murphy, along the shores of Clarkson Reservoir at the Mile High Duck Club, Adams County, on May 26, 1956. It was in company with a Lesser Yellow-legs (*Tringa flavipes*), an Avocet (*Recurvirostra americana*) and a Long-billed Dowitcher (*Limnodromus scolopaceus*). Its actions resembled those of the latter bird, but the godwit was noticeably larger and darker. The white band across the lower back was not evident as the bird fed in the shallows. There is a prior observation for the state (*Colo. Bird Notes*, 2[10]:10) by John and Margaret Douglass, a lone bird which they identified as this species, near Jackson Reservoir in Morgan County on May 22, 1955.—ALFRED M. BAILEY, *Denver Museum of Natural History, Denver, Colorado, June 22, 1956.*

Water moccasin preys on Pied-billed Grebe.—On December 28, 1953, a large water moccasin (*Agkistrodon piscivorus*), was killed in Gulf Hammock, Levy County, Florida. Dissection revealed the presence of an adult Pied-Billed Grebe (*Podilymbus podiceps*) in the alimentary canal.

The omnivorous appetite of this reptile is well known to many who have had the curiosity to examine a number of their partially digested meals, as attested by Allen and Swindell (*Herpetologica*, 1948: 1st suppl.). Although "birds" are not uncommonly listed as prey of this reptile (Ditmars, 1936. "The Reptiles of North America," p. 329, 330; Carr, *Tech. Publ. Univ. Florida, Biol. Ser.*, 3[1]:94) few have cited specific instances as have Adams (1956. *Wilson Bull.*, 68:158) and Carr (1937. *Proc. Fla. Acad. Sci.* 1:86–90) in his delightful essay on the Gulf-Island Cottonmouth.

The unusual size of the species ingested seems worthy of record in this instance.—B. B. Leavitt, *Department of Biology, University of Florida, Gainesville, Florida, July 16, 1956.*

Egg-carrying by the Whip-poor-will.—On June 26, 1956, in Tamworth, New Hampshire, a Whip-poor-will (*Caprimulgus vociferus*) flew from the ground at noon and hovered irregularly back and forth before my face. With tail depressed, the bird's flight was fluttering and moth-like. It alighted parallel to the limb of a fallen tree, approximately four feet above the ground and 10 feet from where I stood. The Whip-poor-will was facing me and holding an egg in full view, beneath its body and against the bark, as my two sons could readily see. Although the bird's feet were not visible, it appeared that the egg was being held with the legs and feet. The Whip-poor-will flew away a minute later, carrying the egg. I now discovered two more eggs lying on dead leaves six or seven feet from where the bird had been perching. One was whole and a chick had just begun to pierce the shell of the second one. The eggs, although shaded, lay adjacent to a bare area exposed to full sunshine, 100 feet from a field, in woods of low growth and slash resulting from hurricane damage.

I returned an hour later. The slash made a quiet approach difficult. The parent bird flew up as before, carrying an egg in the region of its legs and hovering before my face. It again alighted on the limb of the fallen tree, with the egg in full view. Then it flew to a log on the ground, about 25 feet from its nesting site. It perched parallel to the log, with egg pressed against the bark. One downy, brown chick had completely emerged at the nesting place. It made a low "bee-rp" note. I returned again at 2:30 p.m. The Whip-poor-will hovered in hesitating fashion, then perched cross-wise on a limb behind me. It was not carrying an egg. A chick and an egg were at the nesting site. It appeared possible that the bird had lost its third egg when flying away with it at the time of my second visit. The second chick had hatched by the following morning. On June 28, the parent bird fluttered in front of me, then perched cross-wise to a limb with wings drooping and, with throat puffed out, gave a grotesque appearance. It made several low notes; a "chuck," a "qu-irk," and a "qu-irr." The two chicks were a few inches from where they had been located originally.

The above incident appears of interest because of the scarcity of recorded information on how a Whip-poor-will may carry an egg and the fact that three eggs were present. Although I have encountered no adequate descriptions of egg-carrying in related birds, Dr. Herbert Friedmann has furnished the following reference regarding an African coucal (1929. *The Bateleur.*, 1:29). "Mr. C. Giles reports that a coucal (probably *Centropus superciliosus*) at Kampala, Uganda, removed its chicks one by one to a place of safety, when the elephant grass in which its nest was constructed was on fire, by carrying each one in turn between her thighs. Mr. Giles is most emphatic in describing what he observed and is certain that the adult bird did not carry the chicks in her feet."—Lawrence Kilham, *7815 Aberdeen Road, Bethesda 14, Maryland, July 10, 1956.*

Varied Thrush in Texas.—A male Varied Thrush (*Ixoreus naevius*) appeared under the hedge in my yard in El Paso, Texas, on February 12, 1956, and remained as a visitor until March 21, 1956. At first he was very shy and stayed well under cover, but within a day or two he was feeding openly on the mixed grain I had put out for sparrows, pausing now and then to drive away the sparrow nearest to him. Before long he became so tame that he would fly only a short distance when anyone approached. I saw him only once at the bird bath. He seemed to prefer to drink from the end of the hose and I often let it run just for his benefit. Early in March Mr. Dewitt Johnson set up a blind in the yard. Mrs. Johnson spent two mornings in it and obtained a sequence of colored movies. In addition to the colored movies, two different persons obtained recognizable pictures during the early part of the thrush's sojurn so there is absolutely no question as to the correct identification.

This is believed to be the first authenticated record of the Varied Thrush in Texas. However, Mrs. E. W. Miner (1946. "Bird Check-list of Southeast Texas, p. 26) reported sight records at Cove, Texas, on November 4, and 6, 1935. The species is not mentioned by Wolfe (1956. "Check-list of the Birds of Texas").—MARY BELLE KEEFER, *3027 Federal St., El Paso, Texas, August 1, 1956.*

WILSON SOCIETY NEWS

It is with deepest regret that we report the death of Josselyn Van Tyne on January 30, 1957. In addition to his accomplishments as an ornithologist, Dr. Van Tyne will be remembered for his unstinting service to the Wilson Ornithological Society. He served as President, 1935–37, and as Editor of *The Wilson Bulletin*, 1939–48, but he also performed a myriad of tasks in an unobtrusive fashion and his advice was sought invariably in the affairs of the Executive Council. As a memorial to Dr. Van Tyne, the American Ornithologists' Union has established the Van Tyne Research Fund. Contributions may be sent to Dr. Philip S. Humphrey or to Dr. Robert W. Storer, Museum of Zoology, University of Michigan, Ann Arbor.

We learned with regret of the death of Lawrence E. Hicks on January 20. Dr. Hicks served as President of the Wilson Society, 1940-41.

1957 ANNUAL MEETING

Members of the Wilson Ornithological Society are reminded that the annual meeting for 1957 will be held on the University of Minnesota Campus at Duluth, June 13–16. Duluth is situated in the coniferous forest region, and field trips are planned to wilderness areas where species such as Arctic Three-toed Woodpecker, Brown-capped Chickadee and Spruce Grouse may be found. A variety of activities has been planned and the details of these will be presented in an announcement that will be mailed to members shortly. Plan now to attend and to participate in the program.

LOUIS AGASSIZ FUERTES RESEARCH GRANT

Application forms for the 1957 Louis Agassiz Fuertes Research Grant may be obtained from the chairman of the Research Grant Committee of the Wilson Ornithological Society, Dr. Kenneth C. Parkes, Carnegie Museum, Pittsburgh 13, Pa.

A detailed account of the history of the Grant and the criteria by which applications are judged was published in the December, 1955, issue of *The Wilson Bulletin*, pp. 307–308. Briefly, $100 is awarded annually by the Society to aid in the completion of the ornithological research project which, in the judgment of the Committee, seems most likely to make an important contribution to ornithological science. Affiliation with a university is not required; the Committee particularly solicits applications from non-student amateurs.

Deadline for applications for the 1957 Grant will be May 20. The Committee's decision will be announced at the annual meeting at Duluth on June 13, and published in the September issue of *The Wilson Bulletin.*

The University of Oklahoma announces that a grant from the National Science Foundation has provided funds for a number of grants-in-aid to be awarded to competent students and investigators in biology for the 1957 summer session at the University of Oklahoma Biological Station, Lake Texoma. Three types of grants are available: (1) postdoctoral grants of $500; (2) predoctoral grants of $350; (3) $200 grants to superior undergraduates or beginning graduates. The investigations pursued must be suitable for the Biological Station.

Applications for grants-in-aid should be made by April 10, and should be sent to: Carl D. Riggs, Director, University of Oklahoma Biological Station, Norman, Oklahoma.

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ORNITHOLOGICAL LITERATURE

PHEASANTS IN NORTH AMERICA. Edited by Durward L. Allen. The Stackpole Company, Harrisburg, Penn., and the Wildlife Management Institute, Washington, D. C., 1956: 6¼ × 9¼ in., xviii + 490 pp., illus. $7.50.

This book is published as a successor to W. L. McAtee's "The Ring-necked Pheasant and Its Management in North America" (1945). It follows somewhat the plan of the earlier work but, by intent, the authors are different from those of McAtee's book. The book is illustrated by 82 fine plates, 33 figures, and a colored frontispiece reproduced from a painting by Bob Hines, who also contributed the excellent sketches which head each chapter. The bibliography lists 249 references and the book is concluded by a detailed index of subjects and authors.

In Chapter 1, Fred H. Dale clearly summarizes the present knowledge of the life history and biology of the Ring-necked Pheasant in North America. In Chapter 2, J. Burton Lauckhart and John W. McKean present a lucid discussion of the pheasants in the northwestern United States and British Columbia. Chapter 3, by Chester M. Hart, Ben Glading, and Harold T. Harper, deals entirely with California. Lee E. Yeager, Jessop B. Low, and Harry J. Figge discuss the pheasants in the arid southwest in Chapter 4. In Chapter 5, James W. Kimball, Edward L. Kozicky, and Bernard A. Nelson write about the pheasant in the mid-western prairie states. Chapter 6, the longest chapter in the book, on the pheasants in the Great Lakes region, is by Robert A. McCabe, Ralph A. MacMullan, and Eugene H. Dustman. In Chapter 7, Allen W. Stokes presents an account of the pheasant populations on Pelee Island, Ontario. Chapter 8, by Allan T. Studholme and Dirck Benson, covers the pheasant in the northeastern United States. Finally, in Chapter 9, the editor sums up the pheasant management outlook.

The seven chapters which deal with various geographical regions of North America follow the same general form. Each discusses the establishment of this exotic in the region and each includes a description of the present distribution and relative density of the birds. Each chapter also includes an excellent description of the habitat, a discussion of fluctuations in the numbers of the birds, consideration of limiting factors and possible causes for population fluctuations with, occasionally, some general discussion of population dynamics, and, finally, a discussion of management problems.

In the introduction, C. R. Gutermuth states that the book ". . . will provide answers to almost any of the questions of all those interested in this exotic . . ." and that it will be of especial interest to wildlife students, fish and game technicians and administrators, game breeders, and sportsmen. It is not surprising that a book attempting to meet such an ambitious goal and aimed at satisfying such a wide audience should fall somewhat short of the mark. Although the book contains a great deal of information about pheasants, it still leaves many questions unanswered. It also fails to meet the needs of the wide audience for which it was intended, since it is obviously a technical work written *by* technicians *for* technicians. Such concessions as seem to have been made to the sportsman appear only to have decreased the technical value of the book without making it more intelligible to him.

For the technically minded, this book is an important summary of the existing knowledge and present day philosophy of pheasant research and management in North America. For the neophyte, the bibliography is a good general summary of the literature on pheasants through 1953. All who read this book will glean much from the excellent habitat descriptions for the various regions and from the discussions of the distribution and fluctuations of pheasant populations in these habitats. Wildlife biologists, especially, should gain much from the broadened perspective which they will gain from this work and the critically minded readers with a bent for research should be excited by the challenging problems which remain to be solved.

There are a few deficiencies in the book which detract, somewhat, from its usefulness. There is a lack of uniformity in expression of sex ratios and numbers of birds per unit area. The regional distribution maps are interesting diagrams of pheasant distribution but the break-down into birds per 100 acres is largely wasted effort since no indication is given as to the season represented. Information regarding band recoveries is often difficult to interpret since the birds released often are not described, the time of release is frequently not given, and often no information is presented regarding the method of release, the release areas, hunting pressure or method of band recovery. The excellent maps in Chapter 5 showing the east-west changes in pheasant populations during the 1940's are marred by being broken-down into population densities described as being low, medium, high, very high, and excessive. Terms such as these represent a point of view and as such may be meaningful to the authors today but even to them they may not have the same meaning that they did a decade ago or that they will a decade hence.

A few editorial errors occur but they do not detract unduly from the value of this work. These include some inconsistent table headings, some grammatical and typographical errors, an awkward placement of several tables, a paragraph in each of Chapters 6 and 8 which seems to have been misplaced, an error in numbering Figures 19, 20 and 21 in the text and the omission of a cited reference from the bibliography. More important is the fact that no references are cited for some of the information and conclusions presented in this work and, as a result, few but biologists currently engaged in pheasant work will be able to evaluate these for themselves.

The philosophy underlying much of present-day game research and management, as indicated in this book, is important. Throughout this work the underlying concept of population dynamics appears to be an extremely simplified one involving a carrying-capacity which is apparently a definite population level and which appears to be determined by the numbers and distribution of obvious, relatively easily measured environmental things but which seems to be largely unaware of obscure environmental factors and, except in a very superficial manner, of the biology and psychology of the animal being considered. There is often a tendency also to accept as fact certain theories which have been advanced by researchers to explain population phenomena observed on specific areas over relatively short spans of time. Some of these hypotheses, due perhaps to having been advanced by well known biologists or to having been in use for a long time, have acquired the status of ecological principles in wildlife thinking. As a result, conclusions are drawn at times from rather brief studies, particularly if the results of these studies seem to agree with the "principles," while at other times data which seem not to support the "principles" often appear to be overlooked. Thus we discover a statement being made regarding limits on pheasant populations (Chapter 9) which is based on a three-year study but find no mention of further data from the same area which would seem to require modification of any conclusions which might be based on the earlier work.

From this process certain characteristics of pheasant populations for which no research data seem to be available are postulated and management programs are developed. This type of reasoning seems to be the basis for conclusions such as ". . . where only cocks are shot, nearly all topgrade ranges are supporting an excess of hens that cannot be as effective as breeders." (p. 460). Two somewhat similar statements are: "Between incubation time and October, on many ranges it takes about two eggs to make one subadult bird. This means that Nature has overproduced by 100 per cent to allow for a loss of half the crop between May and hunting season." (p. 436) and "Under ordinary conditions we can assume that Nature does a large overstocking job and natural limitations cut the annual production down to a size that will fit a given environmental pattern." (p. 437). No specific data are cited to support these conclusions, though this may be due to an attempt to make the text more readable for the non-technical audience, and they seem to be the basis, in part, for liberalizing the hunting seasons and for shooting hens in some areas where they would crowd a restricted winter habitat and overproduce the following breeding season. Stocking as a management procedure, except for commercial shooting areas, is generally discouraged, as are pheasant sanctuaries. State-wide habitat management programs are the rule at present and annual changes in hunting regulations seem to be regarded as unnecessary since when populations are low hunters stop hunting and take little game and ". . . it appears that getting the available surplus of cocks into the game bag is a much greater problem than preventing hunters from killing too many." (p. 463).

These remarks are intended to be entirely impersonal and are not intended to be critical of the authors or the editor of this book. They are intended to suggest, however, that this book, rather than being a final report which answers almost all questions about pheasants should, in fact, be considered a progress report which faithfully, and in a very excellent, readable manner, summarizes the present-day knowledge and philosophy of pheasant research and management. They are also intended to suggest that, while much progress has been made, there is still a vast *terra incognita* awaiting an enthusiastic, energetic explorer who can approach the problems with a fresh viewpoint. This book should be in the library of everyone interested in wildlife and it becomes, at once, a part of the necessary impedimenta of every game manager and administrator who has pheasant problems and of every technician working on a pheasant project. The editor is to be commended for performing well a big job, the completion of which has produced an extremely valuable contribution to the wildlife field.—ROBERT A. PIERCE

CHECK-LIST OF THE BIRDS OF TEXAS. By Col. L. R. Wolfe. Published by the author at Kerrville, Texas, 1956: 6 1/8 × 9 1/4 in., 89 pp., map. $1.75.

The purpose of this compilation is to provide a list of the species and races of birds reported reliably from Texas and to outline briefly the distribution of each within the state. The author lists only those forms recognized by the Check-list Committee of the American Ornithologists' Union. Details of the circumstances of record are provided for most of the species which have been reported infrequently from the state. However, for others, such as the Rivoli Hummingbird, the pertinent details would have required little more space than that taken by the statement "several specimens have been taken during the summer."

The distributional data in most instances are reported by the system of eight regions defined for administrative purposes by the Texas Ornithological Society; a map of these areas is provided. Even though these "areas" may be considered as having relatively uniform ecologic conditions, the designation of geographic ranges by such a system leads to vagueness. For many species this is a reflection of the lack of precise data on the limits of the range in the state, but I feel that the mention of counties of actual record would have been more effective. In addition to some indefinite distributional references, the author is prone to rely on the probability of occurrence in the assignment of ranges. For example, the Mountain Chickadee is stated to be "Resident in area 4" (trans-Pecos Texas), whereas it has been reported breeding only in the Guadalupe Mountains (in the northern part of the area) and once in winter in the Davis Mountains further to the south. The citation of a definite locality of record followed by a phrase "is to be looked for" in nearby areas, would seem preferable.

In a few cases reliance has been placed upon records which have not been substantiated in recent decades. Bachman's Sparrow is listed as a summer resident in some parts of central Texas that are rather sparsely wooded, apparently on the basis of Lloyd's report (1887. *Auk*, 4:292). I know of no recent specimen records for central Texas. However, the paucity of information concerning the distribution of this and some other species is considerable.

In reviewing a work with the distribution of a group in an area as large and diverse as Texas one tends to seek out the flaws and to pass over the bulk of satisfactory text. Persons interested in the ornithology of Texas owe Col. Wolfe a debt of gratitude for providing a firm basis for future work on the distribution of birds in that state. It is hoped that ornithologists with notebook records or unreported specimens will publish their data or report them to Col. Wolfe so that a revised list with more precise range definitions may be forthcoming.—KEITH L. DIXON.

AN ANNOTATED BIBLIOGRAPHY OF NORTH DAKOTA ORNITHOLOGY. By T. C. Stephens. Published by William Youngworth as Occasional Papers, No. 2, Nebraska Ornithologists Union, Crete, Nebr., 1956: 8½ × 11 in., 2 + 22 pp. multilith. $1.00.

A chronological list of 267 titles, 1858-1947, and brief account of the author. In many of the references the species concerned are noted. References that have been re-checked are indicated and some are noted as "not seen". Through some oversight the years 1932 and 1933 are included in 1931.

It is unkind to criticize such a posthumous and apparently meritorious work but some discrepancies should be noted. Dr. Stephens apparently had not seen Coues' Field Notes of 1873-74 but it is hard to understand how he could have dismissed this important paper with "Uncertain if there are any explicit North Dakota Notes."

The references to Mrs. Bailey's series in the *Condor* include only 3 of the 17. Essential references missing include Bailey's Biological Survey of North Dakota, Swenk and Stevens on Harris' Sparrow, William's list from the Red River Valley, Reid's Birds and Mammals observed by Lewis and Clark, notes in Maximilian's travels, and in Audubon's journals.

Dr. Stephens probably was not aware of a manuscript bibliography to 1928 compiled by Russell Reid, a copy of which was deposited in the library of the North Dakota Agricultural College. This contains 168 entries, arranged alphabetically, and includes many additional titles.—O. A. STEVENS.

This issue of *The Wilson Bulletin* was published on March 30, 1957.

SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (fourth edition) and supplements thereto insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. The Illustrations Committee will prepare drawings, following authors' directions, at a charge of $1 an hour, the money to go into the color-plate fund. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A WORD TO MEMBERS

The Wilson Bulletin is not as large as we want it to be. It will become larger as funds for publication increase. The Society loses money, and the size of the *Bulletin* is cut down accordingly, each time a member fails to pay dues and is put on the 'suspended list.' Postage is used in notifying the publisher of this suspension. More postage is used in notifying the member and urging him to pay his dues. When he does finally pay he must be reinstated on the mailing list and there is a publisher's charge for this service. The Bulletin will become larger if members will make a point of paying their dues promptly.

NOTICE OF CHANGE OF ADDRESS

If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia. He in turn will notify the publisher and editor.

Your 1957 vacation plans should include

THE THIRTY-EIGHTH ANNUAL MEETING

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DULUTH, MINNESOTA

June 13–16

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June 1957

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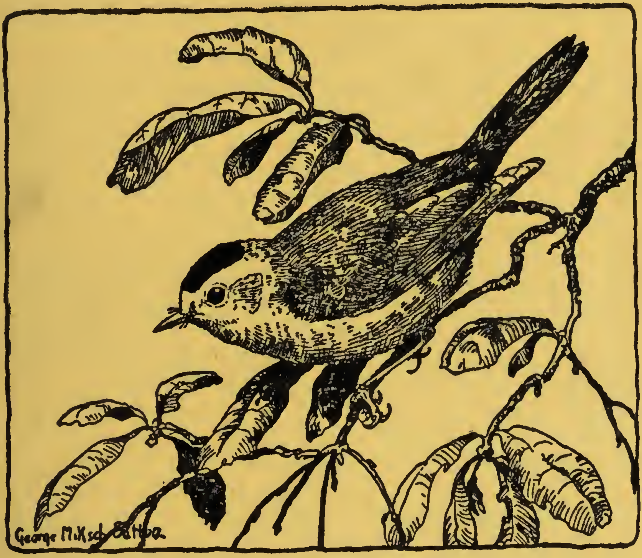

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THE WILSON BULLETIN

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CONTENTS

SINGING QUAIL

(Dactylortyx thoracicus pettingilli)

Male (above), female, and two newly hatched chicks on heavily wooded slope above the Río Sabinas, near Gómez Farías, Tamaulipas, México. From a water-color painting made in the field on April 16, 1941, by George Miksch Sutton.

THE SYSTEMATICS AND BIOLOGY OF THE SINGING QUAIL, *DACTYLORTYX THORACICUS*

BY DWAIN W. WARNER AND BYRON E. HARRELL

INHABITING a number of the complex forest communities of Mexico and northern Central America is a small, stout-bodied, large-footed, short-tailed, crested quail with a melodious voice. It is *Dactylortyx thoracicus,* the Singing, or Long-toed, Quail, about which little has been written, and whose biology and distribution have never been accurately described. It is the only species in the genus.

The Singing Quail is distributed as a forest bird from coastal plain to high mountains, from humid vapor forests to scrub forests that are largely deciduous and subject to extreme drying for part of the year; nevertheless, in many localities its ecological and altitudinal range is markedly limited. Complete discontinuities exist between most of the populations. Some of these discontinuities are of recent origin, whereas others have existed a much longer time; some of the narrowest of these may be among the oldest. Morphologically each isolated population has external characters differing from those of all other populations.

The closest relative of *Dactylortyx* is *Cyrtonyx* (Mearns' or Montezuma Quail), which it resembles somewhat in structure, especially that of the feet and the synsacrum (Miller, 1943). The genera are wholly unlike in coloration and ecological requirements. *Dactylortyx* is a terrestrial bird most characteristic of almost impenetrable forest thickets. In such places its rather somber but beautifully patterned plumage of gray, brown, black and chestnut is combined, by the presence of delicate lines, broad bars, stripes and faint vermiculations, into patterns that are beyond simple description. Only in the colors of the throat, malar region and superciliary line is there some boldness of pattern, but even this coloration blends so well with the forest floor that the bird is almost impossible to see.

These pattern characteristics apply to both sexes and to all plumages. As shown in the frontispiece, adult males have the chin, throat, cheeks and superciliary with some shade of chestnut contrasting with the grayish feathers of the breast, which are marked variably with lighter shaft streaks. In adult females the chin, throat, cheeks and superciliary are shades of gray contrasting with a faintly streaked chestnut breast, the gray usually extending onto the crown. In a few females some of the chestnut and rich brown colors of the male plumage are present on the head, and in a few males the head pattern approaches that of the female. In the juvenal plumage the sexes are not distinguishable with certainty. This plumage is most distinct from that of the adults in the black spotting on the feathers of the breast, sides and flanks; the head and throat pattern is similar to that in adult females. Downy young are rich brown to chestnut dorsally with a buffy superciliary line and a buffy stripe along the side of the rump; the cheeks are rich buff, the underparts mottled gray-buff and the bill red-brown.

Although more than a century has passed since the first specimens of this quail reached the United States and Europe, knowledge of its habits, of its behavior, and even of its plumages and distribution is fragmentary. Only within the last 24 years was the bird discovered in Honduras. The first specimens from Tamaulipas were taken only 15 years ago, those from San Luis Potosí and Quintana Roo even more recently. The accompanying map, Figure 1, illustrates clearly the restricted known range of this species—pin points on a vast area. This paucity of information stems from two major factors: at many points the forests inhabited by this species occur in very narrow belts which lie chainlike along rugged mountain slopes, and have been inaccessible or uninteresting to the collector; the elusive habits of this bird have defeated many who have found it and tried to collect and study it.

This study is based on examination of 181 specimens, field data gathered by both authors, field notes contributed by other biologists and references in the literature.

Acknowledgments

We thank the authorities of the following institutions for the loan of specimens: U.S. National Museum; U.S. Fish and Wildlife Service; American Museum of Natural History; Museum of Comparative Zoology, Harvard; Cornell University; Philadelphia Academy of Natural Sciences; Museum of Zoology, University of Michigan; Chicago Natural History Museum; Museum of Natural History, University of Kansas; Museum of Zoology, Louisiana State University; Museum of Vertebrate Zoology, University of California, Berkeley; University of California, Los Angeles; Laboratory of Zoology, Occidental College; Peabody Museum of Natural History, Yale University; University of Oklahoma, Norman. For special assistance in the preparation of this report we are indebted to the following: Erwin Stresemann, Ernst Mayr, Herbert Friedmann, Pierce Brodkorb, Raymond A. Paynter, Jr., Kenneth C. Parkes, George M. Sutton, Ernest P. Edwards, Alexander Wetmore, John Davis, Robert T. Moore, William Beecher, A. Starker Leopold, Allen Duvall, Eiza Matuda, Faustino Miranda, Archie Carr, John W. Aldrich.

Biology

Geographic Distribution.—The Singing Quail has been found in at least 83 localities in Mexico, Guatemala, El Salvador and Honduras (Fig. 1). We have examined specimens from 56 of these localities.

In eastern Mexico the species is known from southwestern Tamaulipas, eastern San Luis Potosí, northeastern Puebla and along the mountains of Veracruz south to Córdoba. It occurs also in central Campeche, in Yucatán and Quintana Roo, at a single locality on the border of Oaxaca and Chiapas and in several parts of Chiapas. To the northwest a single bird has been taken in Jalisco; and several series have been secured in the Sierra Madre del Sur in Guerrero. In Guatemala *Dactylortyx* is known to occur on at least three volcanoes, in several other cloud forest localities of the Pacific Cordillera, and in the northwestern part of the country. It has been noted and collected at only three localities in El Salvador and at three (possibly four) places in Honduras.

Although in Tamaulipas, San Luis Potosí, parts of Veracruz, Guerrero, the Sierra Madre de Chiapas, and perhaps in Yucatán and Quintana Roo, this quail may range rather continuously over hundreds of square kilometers, in other areas the total range of a population is restricted to a single small area or to several small, closely adjacent areas. Distances between populations in western Mexico exceed several hundred kilometers. On the other hand, two racially distinct populations in Honduras are clearly separated by a barrier about 20 kilometers wide.

Habitat.—The presence of *Dactylortyx* is not defined by mere altitude or life zones or other biotic distributional systems. The areas inhabited by this quail are extremely variable in climate, forest type and size. All the forest habitats have in common the presence of dense undergrowth for cover. Some populations range continuously through two, three or more vegetation types; other populations are restricted sharply to one vegetation zone, such as cloud forest. At the extreme southern end of the range of the species two of the small, isolated populations seem to be existing in suboptimal habitat, probably because the original preferred habitat (cloud forest) has been extirpated as a result of post-Pleistocene increase in temperature and drying and to disturbance by man. Current studies by Harrell on the biogeography of Middle American cloud forests demonstrate that such changes in climate are indicated by a great amount of disjunction of cloud forest fauna and flora and that these disjunctions must have been preceded by much wider distribution of cloud forest in this region of Central America. This condition is reflected in several of the small, isolated populations of this species restricted to mountain tops in Honduras and El Salvador in which random differentiation seems to be present; between these populations clinal relationships are not apparent. Thus, among the important factors affecting morphological differentiation in this species have been the types and extent of the forests and their associated climatic conditions. The following descriptions of the habitats of the different populations, although far from complete, serve as an introduction necessary to a study of the systematics of the species.

In southwestern Tamaulipas this quail occurs from the edge of the coastal plain at the base of the Sierra Madre Oriental at an altitude of approximately 300 feet to about 6,000 feet. The lower forest is a semi-deciduous type of tropical forest on steep slopes and is tall with dense crown in many places. Where there are openings, as along rocky outcrops, thickets of brush occur. At about 2,000 feet the forest begins to change, and at 3,000 feet it has become well developed oak-sweet gum (*Quercus-Liquidambar*) forest which can be considered the cloud forest of this region. In this tall (about 100 feet), dense forest, undergrowth is variable but most of the shrubby plants are not densely leaved. At altitudes between 4,000 and 4,800 feet, the oak-sweet gum is joined in some places by beech (*Fagus*) as an additional dominant; the underbrush here is somewhat more open. Above most of the oak-sweet gum there is a fairly abrupt change to open pine-oak forest. The transition from the beech type is somewhat less abrupt and is marked by narrow necks and patches of both types of forest. The pine-oak here consists of tall but well-spaced trees with underbrush frequently very dense. Occasionally patches of more mesic forest are found in small canyons and around springs, these spots characteristically having in them a few of the trees from the oak-sweet gum forest of lower elevations. The Singing Quail occurs in the mountainside tropical, the oak-sweet gum and beech areas. At higher elevations it is found in some of the mesic spots in pine-oak woods. It was recorded once in a forest of oak and madroño (*Arbutus*). Just above the Río Sabinas at the base of the Sierra Madre, it inhabits steep, thicketed slopes (Sutton and Pettingill, 1942). At elevations 3,000 feet higher, in the oak-sweet gum and beech forest, Harrell (1951 MS) found individuals throughout the forest area but with no special places of marked concentration. Apparently the habitat distribution in San Luis Potosí is similar to that in Tamaulipas.

In Puebla and Veracruz altitudinal limits are between 1,200 and 7,000 feet, approximately. Jalapa and Córdoba are representative of cloud forest elevations and Misantla, Papantla and Hacienda de los Atlixcos are in the Veracruz equivalent of the semi-deciduous tropical forest of Tamaulipas.

In Yucatán the species occurs primarily in the area classified by Leopold (1950) as tropical evergreen forest climax, but there are extensive recent disturbances of the forest which is now a second growth deciduous forest (Paynter, 1955). In Quintana Roo, Paynter (1955:83–84) has found *Dactylortyx* in lowland rainforest.

The single bird known from Jalisco probably came from Milpillas near San Sebastián, about which Goldman (1951:180) wrote as follows: ". . . Both sides of the deep canyon above Milpillas are clothed with a heavy oak forest, in which other trees and many shrubs also occur. The forest is a mixture of tropical and extratropical species, as might be expected from the location near the frost line at about 4,000 feet."

In Guerrero the Singing Quail is found in mountain forest mostly above 6,600 feet. This forest is pine-oak-fir with an abundance of alder (*Alnus*) in wet places and fir (*Abies*) most common at higher elevations where this quail was usually found ". . . in ravines of dense woods with an almost impenetrable undergrowth of shrubs and climbers" (Leopold and Hernandez, 1944; translated from Spanish).

Oak-sweet gum forest occurs above Niltepec, Oaxaca (Miranda and Sharp, 1950) and may be continuous in the mountains to above Santa Efigenia (Oaxaca-Chiapas border). *Dactylortyx* has been reported from the latter locality only.

In Chiapas this quail has been found at a number of localities, including Cerro Brujo where Miranda and Sharp (1950) reported the occurrence of an oak-sweet gum forest. Ernest P. Edwards (personal communication) found it in cloud forest containing sweet gum near El Fenix in the eastern edge of the state (see Edwards and Lea, 1955). Harrell found it in sweet gum forest from Jitotol to north of Rincon Chamula, and south of Ixtapa in a ravine more humid than the surrounding low, deciduous tropical woods. Specific habitats of birds from the Sierra Madre de Chiapas are not known, but many of the upper slopes are covered with a vapor forest similar to that of Honduras. Smaller areas of oak-sweet gum and pine-oak also occur in that region. Several plant communities are probably present near Socoltenango but we do not know in which type the specimens were taken. In the San Cristóbal region E. W. Nelson (MS notes in files of U.S. Fish and Wildlife Service) saw a covey in dense woods at about 9,500 feet at which elevation both pine and fir occur. The specimens collected were reported to have come from ". . . wooded hills to the north of the town [San Cristóbal]." *Dactylortyx* is known from Volcán de Tacaná (3,000 meters), at which altitude the dominant vegetation is fir forest in the more humid pockets (Faustino Miranda, 1952 and personal communication). The Volcán de Tacaná is physiographically a part of the volcanic system of Guatemala.

In Guatemala *Dactylortyx* has been found as low as 5,000 feet in heavy cloud forest (Saunders, 1950) and from 7,000 to 8,500 feet in "typical cloud forest" and in heavy oak and pine forest above Tecpam (Griscom, 1932).

Dickey and van Rossem (1938), writing about this bird in El Salvador, give its distribution as, ". . . oak association of the Arid Upper Tropical Zone on Volcán de San Miguel . . . vertical range . . . 2500 to 4000 feet . . . On Volcán de San Miguel during March, 1926, quail were sometimes flushed from the litter of leaves under the nearly leafless oaks on the southeast slope and were also, although rarely, found in the upper edge of the Lower Tropical Forest . . . On many parts of Mt. Cacaguatique . . . they showed a decided tendency to favor the coffee groves instead of their natural habitat in the oak scrub."

On Mt. Cacaguatique cloud forest is restricted and it is absent on Volcán de San Miguel. There is, however, an abundance of cloud forest on the Volcán de Santa Ana group where this quail was found at a coffee *finca* in cloud forest on Cerro del Aguila at 5,000 feet (Marshall, 1943), and by Harrell in cloud forest on Volcán de Santa Ana at 7,000 feet.

Carr (1950) figures and describes the Hardwood Cloud Forest in Honduras as follows: "The truly primeval vapor forest is similar in superficial appearance to the most luxuriant tropical rainforest, but is almost wholly different in details of composition. On the average it is a mesic woods in which various species of oaks and *aguacates* usually predominate and with an epiphytic flora of often bewildering variety . . . The trees are large—often immense—and usually strongly buttressed . . ." There this forest extends from about 4,000 to 7,000 feet. The Singing Quail has been found in such forest on the San Juancito Mountains and on nearby Cerro Cantoral in Francisco-Morizan. On San Juancito Mountain Harrell heard many songs in second-growth cloud forest; he noted this species also in heavy virgin cloud forest there. A third area in which the species occurs is near Catacamas, Olancho, about which Carr (letter, April 2, 1951) writes as follows: "The 'cloud forest above Catacamas' is probably the vast Agalta forest of which there are several isolated sections. Thus, for zoogeographic purposes the label 'Catacamas' would mean very little. The Olancho cloud forests are generally similar to, but botanically somewhat more varied than those of the Pacific slope (including San Juancito)."

". . . elevations above 5,000 feet are in this section (of Honduras) nearly always covered with cloud forest; and on the northern slopes cloud forest may extend much farther down and may even intergrade with the Caribbean rainforest."

Behavior.—To field biologists who have encountered the Singing Quail in the field usually only two things are evident about the bird—its song and its escape tactics. Even the song has sometimes gone unrecognized, and the escape pattern, so sudden and dramatic, has been only briefly noted.

Dactylortyx is a terrestrial species; it has never been reported perching above the ground. Its large feet and long claws serve a dual purpose: for the scratching in litter and humus by which much of its food is obtained, and as an aid to its escape.

Harrell (1951 MS) observed foraging activities in the oak-sweet gum forest in Tamaulipas. The bird interrupted its picking; then, leaning to one side, it lifted the opposite leg and extended the foot far forward, even beyond the bill. With a single, long and powerful backward thrust, which carried the foot straight out behind the tail, the litter was torn and scattered by the strong claws. From the debris the bird picked edible material.

Little is known about the food habits of this species. Both vegetable and animal matter are taken from the surface as well as in the humus layer. Stomachs have contained plant bulbs, insects, larvae and seeds (Leopold and Hernandez, 1944); euphorbiaceous and leguminous seeds (Cole, 1906); seeds, insects and gravel (Dickey and van Rossem, 1938); beetles, centipedes, crickets and grubs (Harrell, 1951 MS).

The strong feet and legs serve also for escape. Although Singing Quail sometimes squat and remain still until almost stepped on, if pressed closely they run rapidly to cover, often in a zig-zag manner, especially if the terrain is irregular. When flushed, they depart suddenly on whirring wings, banking and turning neatly around rocks and trees. Flight distance depends upon proximity to cover; in our experience cover was always close at hand and the flight distance was about 50 to 75 yards, often less. Locating flushed birds again usually was impossible. By running or lying still they managed to remain undetected. Probably nearly all of the 200 or so specimens in museums were shot on the ground or were trapped.

In contrast to the observations of others, Harrell (1951 MS) found this quail to be rather tame and unwary in the undisturbed oak-sweet gum forest in Tamaulipas. The birds would often be unconcerned if he stood quietly 20 or 30 feet away. On one occasion four fully grown birds were observed feeding at a distance of about 80 feet; at the sound of his voice they stopped and became quiet but shortly resumed their activity.

Dusting pits were noted by A. W. Anthony (in Griscom, 1932) who found rounded depressions in the damp leaves along deep, shaded trails where flocks of these birds had dusted in the "rain forest" of Volcán San Lucas, Guatemala.

Flocks.—From the appearance of the first broods in spring until the beginning of the next breeding season this species is encountered most often in flocks of from four or five to a dozen birds. Composition of these flocks is not accurately known, but all age groups of both sexes are present. Small groups probably are families and the larger flocks may represent several family units. At the approach of the breeding season flocks break up, but even during the nesting period more than two adults may be found within a small area.

Population density.—The only population estimate available is that made by Harrell (1951 MS) during his census studies of the breeding birds of the Rancho del Cielo area in Tamaulipas. In climax oak-sweet gum forest at 3,600 feet there were approximately 3.5 pairs per 100 acres in each of two years.

Although even crude population estimates are impossible for nearly all of the other populations, the calculated total breeding populations of two subspecies are worthy of comment. As determined by calculating the total habitable area from descriptions and maps and applying the figure of 3.5 pairs per 100 acres, the total effective breeding populations of each of the races *salvadoranus* and *taylori* (inhabiting the slopes of Volcán de San Miguel and Mt. Cacaguatique, respectively, in El Salvador) do not exceed 500 pairs. As has been pointed out, several of the isolated southern populations appear to have undergone random differentiation, a phenomenon of some small populations.

Songs and calls.—As pointed out by Sutton and Pettingill (1942), who first gave this bird the name Singing Quail, the loud, rhythmical outburst of song is its truly unforgettable feature. This song has also been described by Gaumer (in Boucard, 1883), by Anthony (in Griscom, 1932), by Marshall (1943), and by Harrell (1951 MS).

The first part of the song is a series of about four loud, penetrating whistles, which increase in frequency and pitch and seem to be an announcement of the start of a song; these whistles often are repeated by other birds. Sometimes an imitation of these notes will initiate singing in nearby birds. The last of these notes is followed immediately by the second part of the song, a series of three to six rapid phrases, each made up of notes of differing pitch, the middle ones higher and more definitely accented. The notes are described as staccato by Marshall (1943), and the phrase rendered as *che-vä-lieu-a* by Gaumer (in Boucard, 1883), as *cua-kaka-wak* by Anthony (in Griscom, 1932), as *pitch-wheeler*! by Sutton and Pettingill (1942), and as *tser-teé-lur* by Harrell (MS). These phrases are followed by a low twittering which is often not audible or may be absent. There is no evidence that the female sings.

Anthony, quoted by Griscom (1932), described perfect duetting between two captive birds kept in separate cages on different sides of a house in Guatemala.

Song is at its height during April and May, decreasing during the latter part of the summer, but some birds are still singing through the fall and into the winter as late as December 26 in Tamaulipas (Harrell, 1951 MS).

The common calls are faint twittering notes which apparently serve as a location call within a family or small group. On one occasion a call was heard from a bird in flight—*bdr—ddr—bdr—ddr* (Harrell, 1951 MS).

Breeding season.—The breeding period is long, extending from February through October or later. There is apparently no latitudinal or altitudinal correlation in date of initiation or in length of the breeding season. Tamaulipan birds begin to nest at about the same time as those in El Salvador.

Dactylortyx in Tamaulipas were in full song on March 12. A breeding male and a female with well-developed brood patch were taken there on April 11 and a female and her brood of newly hatched young on April 16 (Sutton and Pettingill, 1942). These birds must have begun their breeding activities more than a month before, in early March or late February.

In El Salvador Dickey and van Rossem (1938) found birds nearly ready to breed in the latter part of March. On Mt. Cacaguatique in that country

Marshall (1943) collected a female still in postjuvenal molt on January 6. The date of hatching of this bird must have been late September or early October. May-taken juveniles from Omilteme, Guerrero, indicate that the onset of the breeding season at that high-altitude locality is in February.

Paynter (1955), in describing the breeding season for birds inhabiting the deciduous forest of Yucatán, states, ". . . it appears that nesting extends from early May to early August." The onset of breeding may here correspond to the beginning of the rainy season in May following the three driest months of the year.

Most of the juveniles have been taken from May through July. This fact, together with the waning of song in late summer, and taking into account the many months through which adults have been found in postnuptial molt, suggests that not more than a single brood is usually raised per year.

The nest of this quail has never been described. The only description of eggs (presumably of this species) is that of Nehrkorn (1881), who stated that, "yellow clouds are distributed over the otherwise white eggs" (translated) which measured 31 x 25 mm.

Harrell, after close association with this species during several seasons, found it almost impossible to be sure of the number of young in each brood; usually only two to four were seen. Paynter (1955) reported that a female collected on May 7 was incubating five fresh eggs.

Molt.—As is expected in a species which has an extended breeding season, specimens of this quail show feather replacement during most of the year. The postnuptial molt begins in June and continues through at least the rest of the calendar year. During the months of July and August the greater part of the adult population is in molt, however. A male with black testes measuring 10 x 5 and 7 x 4 mm., taken on March 26 in Tamaulipas, has a few partly sheathed feathers on the breast, suggesting either a partial prenuptial molt or the final stages of the postnuptial molt.

Singing Quail in juvenal plumage have been taken as early as May and this plumage still is present as late as January. The last easily identified body feathers of this plumage appear as a collar of spotted feathers on the upper breast immediately below the throat patch.

The subadult plumage, which is worn through the first winter and first breeding season, is not readily recognizable by the two outer primaries and those greater primary coverts which may be retained from the juvenal plumage. We cannot agree with Dickey and van Rossem (1938:154) in their statement that the subadult may be determined by the spotted juvenal upper, greater primary coverts. Markings of any kind on the outer three or four of these coverts in the skins examined are negligible, and, when present, appear in all age groups; thus they constitute no valid criterion for age determination. We have found it difficult or impossible, too, to separate subadults on the basis of the outer pair of primaries. In only a few specimens are the outer primaries *sharply* pointed. Several others may have had these feathers sharply pointed but the feathers now are broken and frayed. On the other hand we have a number of birds still in partial juvenal plumage that have the outer two primaries of each wing more rounded at the tips than are others that we believe to be fully adult.

Since the base of the bills of young birds is light, we have used this character in combination with the narrow outer primaries to determine the subadult age group.

Feather wear is slight and fading is negligible. Some birds have the tips of the primaries slightly worn and broken, apparently through natural wear; others have these feathers frayed and broken, but obviously from post-mortem handling.

Systematics

Before discussing morphological variation within the species, several facts should be emphasized. First, we are dealing with an extremely sedentary, terrestrial bird which lives in a number of forest types of differing amounts of solar radiation, humidity, rainfall and temperature. Second, discontinuities exist between populations throughout the range of the species; some of them are very narrow, whereas others are broad. Gene flow between populations was in some cases cut off long ago; in others the break has occurred more recently. In some parts of the range gene flow occurs today through a major part of the total population. Third, the several separated populations vary tremendously in total numbers of individuals. Some of the long-isolated southern populations probably consist of no more than 400 or 500 pairs, whereas on the Atlantic slope some of the total effective breeding populations must be considered to be in the magnitude of hundreds of thousands of individuals.

Our studies show the presence of 17 subspecies among the known populations of this quail. Nine of these have been described previously, but one is without a valid name. Eight are described as new. One specimen probably represents another race but it is left without a name.

The species has been known to the taxonomist for little more than a century. Gambel described *Ortyx thoracicus* from Veracruz in 1848. Two years later John Gould (1850) published a description with a colored plate of *Odontophorus lineolatus* from a Lichtenstein manuscript name (*Perdix lineolata*) of a male and female in the Berlin Museum, but he gave no locality except "Mexico." In 1893 Ogilvie-Grant described a new genus, *Dactylortyx*, and recognized the priority of Gambel's name *thoracicus*. A revision of the genus by E. W. Nelson appeared in 1898 in which he described *devius* from San

Sebastián, Jalisco, and *chiapensis* from Chiapas and Guatemala, giving them specific rank. After comparing a male from Gineta Mountain, on the border of Oaxaca and Chiapas, with Gould's plate of *lineolatus*, Nelson concluded that this specimen belonged to that race (a subspecies of *thoracicus*) and gave the range of *lineolatus* the restricted locality "Gineta Mountain." Nelson's revision was based on eight specimens. In 1903 Nelson described *sharpei* from Yucatán and Campeche as a subspecies of *thoracicus*. All subsequent authors have recognized that the genus is monotypic. Dickey and van Rossem described *salvadoranus* from Volcán de San Miguel, El Salvador, in 1928. The description of *taylori* from Mt. Cacaguatique, El Salvador, by van Rossem appeared in 1932; and the description of *fuscus* from Honduras by Conover was published in 1937. These names were accepted along with the designated ranges of the subspecies until Friedmann, Griscom and Moore (1950) included in *fuscus* the birds from Guatemala and the Sierra Madre de Chiapas, thereby confusing the actual relationships of the populations in that part of the range of the species. Another subspecies, *paynteri*, was recently described from Quintana Roo by Warner and Harrell (1953).

All measurements are expressed in millimeters. Wing measurements are on the chord; culmen from base. Where measurements of five or more specimens are given, the standard error follows the mean. Weights are in grams.

Within *Dactylortyx thoracicus* the following subspecies may be recognized:

Dactylortyx thoracicus ***pettingilli*** new subspecies

Type: Adult male, No. 13019, collection of George Miksch Sutton; Rancho del Cielo, five miles northwest of Gómez Farías, Tamaulipas, Mexico; altitude 3,300 feet, in mountain cloud forest; March 21, 1949; collected by George M. Sutton; original number 153 in catalogue of Paul S. Martin.

Characters of male.—Compared to a single male of *D. t. thoracicus* (see Ridgway and Friedmann, 1946:382), grayer both above and below, interscapulars and feathers of the upper back with centers plainer gray, margins paler cinnamon-brown and vermiculations less distinct; shaft streaks of scapulars paler buff to nearly white, inner half of outer web much grayer; breast, sides of lower neck and upper abdomen pale buff to nearly pure steel gray (not buff-brown), margins suffused with pale buff, shaft streaks much narrower; sides very different, varying from grayish-buff to pale cinnamon with shaft streaks pale buff-gray and much broader and often edged with dark gray or black nearly to the tip, rest of feather barred with dark wavy bands; lower back, rump and upper tail coverts grayer.

Characters of female.—Compared to *thoracicus*, breast, sides of lower neck and abdomen more vinaceous; sides paler, shaft streaks broader and barring more distinct; upper back and scapulars grayer as in males; lower back and rump grayer; throat whiter, set off sharply from gray sides of neck.

Characters of juvenile.—Of four juvenile females taken in July (16, 19, 28) two are in nearly full juvenal plumage; the other two are about half through the postjuvenal molt. Compared to one juvenile female from Guerrero, buffier, less rufescent below, especially on upper breast; shaft streaks of upper breast broader and whiter; slightly grayer above; rump, upper tail coverts and tail lighter (less brownish). Differs from a male from the Sierra Madre de Chiapas in grayer (less brown) lower back and rump; black spots on breast and sides about half the size of spots on the Chiapas specimen.

The natal plumage has been described and illustrated by Sutton and Pettingill (1942).

Remarks.—Six males and one female from San Luis Potosí are intermediate in coloration between *thoracicus* and Tamaulipas specimens of *pettingilli* but are closer to the latter. A male from Cerro Conejo is darkest; two from Xilitla are palest and closely resemble males from oak-sweet gum forest in Tamaulipas.

Measurements.—Males: Wing (19) 123.0–128.5 (125.72 ± 0.61); culmen (18) 17.0–18.7 (17.87 ± 0.05); tarsus (20) 31.5–34.4 (33.1 ± 0.20). Females: Wing (9) 119.0–126.1 (121.99 ± 0.88); culmen (10) 16.0–18.0 (16.99 ± 0.20); tarsus (10) 29.9–34.0 (32.02 ± 0.40). Weights: TAMAULIPAS: Males 180.0, 180.0, 185.0; females (juvs.) 115.0, 122.5, 125.0, 140.0, 146.0. SAN LUIS POTOSÍ: Males, 203.0, 205.0, 210.9, 218.1, 219.0; female, 206.0.

Range.—Forests (semi-deciduous tropical, oak-sweet gum and beech, and mesic areas in pine-oak; once recorded from oak-madroño) of the Sierra Madre Oriental of southwestern Tamaulipas and southeastern San Luis Potosí from 300 to 7,000 feet.

Localities.—TAMAULIPAS: Gómez Farías region (near Río Sabinas, 2 males, 2 females, 2 natal; Rancho del Cielo, 5 miles N.W., 8 males, 5 females, 4 juv. females; La Joya de Salas; Carabanchel; the Nacimiento of the Río Sabinas); on trail from Ocampo to Tula. SAN LUIS POTOSÍ: Sabinito (1,200 meters), 1 male; Cerro Conejo, 1 male, 1 female; Aquismon region, mts. east of Rancho Moreno, 2 males; Xilitla region, 1 male; Rancho Ustuapan, 1 male; Platanito, 1 male, 1 female; 8 mi. by highway E. of Santa Barbarita (3,900 ft.), 1 male; Xilitla region, Rancho Miramar Grande, juv. unsexed; Xilitla Gorge, 1 male; Cerro Miramar (6,400 ft.), 1 female; 6 mi. W. of Ahuacatlán (6,000 ft.), 1 male, 1 female; on highway 16 mi. E. of Ciudad del Maíz (4,500 ft.).

We name this race for Olin Sewall Pettingill, Jr., who collected the first specimens in Tamaulipas.

Dactylortyx thoracicus thoracicus (Gambel)

Ortyx thoracicus Gambel, *Proc. Acad. Nat. Sci. Philadelphia*, 4, 1848: 77 (Jalapa, Veracruz; type in collection of the Academy of Natural Sciences of Philadelphia).

The one male of this race available for examination is darker than males of *pettingilli* and *sharpei*, and does not approach the latter in width of ventral shaft streaks.

Three females of this race are darker than *pettingilli* and *sharpei*, and are less vinaceous on the breast and sides with less distinct light centers to the feathers than specimens from Chiapas. These three specimens, including the type, are old and seem to be somewhat "foxed," but the differences described are obvious and not the result of post mortem color change.

The fourth female, bearing original no. 159, was collected by Francis Sumichrast in December, 1865. The only other information on the original label is "Rio Seco." Although there are several streams bearing that name in eastern Mexico, Sumichrast collected a number of birds on about that date at or near the river bearing that name which at one point lies only a few miles from Córdoba, Veracruz. Yet this bird differs markedly in color and size from a female from Córdoba and two from Jalapa. It is much darker throughout; the top of the head is blackish; the line above the eye, sides of neck and lower throat are dark gray; the white of the throat is much restricted (the female in this respect resembling *chiapensis* but is even darker); the wings are darker and the rump grayer. These differences suggest that this bird came from a population isolated from the Córdoba and Jalapa populations.

Measurements.—Male (1): Wing 129.0, culmen 16.2. Females: Wing (3) 122.0–130.4

(125.5); culmen (3) 16.6–18.0 (17.4); tarsus (3) 32.1–33.0 (32.5). (Río Seco, female: wing 120.4, tarsus 32.1, culmen 18.0).

Range.—Forests of the Sierra Madre Oriental and evergreen tropical and probably semideciduous tropical forests of adjacent lowlands in northeastern Puebla and central Veracruz. Altitudinal range and forest types are probably essentially similar to those inhabited by *pettingilli.*

Localities.—PUEBLA: Metlaltoyuca, 1 male. VERACRUZ: Papantla; Misantla; Hacienda de los Atlixcos; Jalapa, 2 females; Atoyac; Córdoba, 1 female; Cerro de la Defensa; Río Seco, 1 female.

Dactylortyx thoracicus sharpei Nelson

Dactylortyx thoracicus sharpei Nelson, *Proc. Biol. Soc. Wash.*, 16: 152, 1903 (Apazote, Campeche, Mexico; type in U.S. National Museum, Biological Survey Collection).

The small size in combination with over-all paleness distinguishes this race from all others except *paynteri.* Although similar to *paynteri* in size, males of *sharpei* are browner and the ventral shaft streaks narrower. Females are darker gray than *paynteri* on the forehead, over the eye and on the throat.

Within *sharpei* there is considerable difference between the type and males from Yucatán. The male (type) from Campeche is slightly darker on breast and sides; ventral shaft streaks are very narrow in the type, wider in Yucatán specimens. Yucatán males are closest to *paynteri.*

Measurements.—Males: Wing (5) 118.0–124.0 (121.62 ± 1.03); culmen (5) 18.0–19.5 (18.9 ± 0.25); tarsus (5) 31.0–33.0 (31.72 ± 0.36). Females: Wing (4) 115.0–120.5 (117.4); culmen (5) 17.0–17.4 (17.1 ± 0.07); tarsus (5) 29.0–31.0 (30.0 ± 0.32). Weights: one male, 202.0.

Range.—Tropical evergreen forest climax of lowlands of Campeche, deciduous forests in Yucatán and area of interdigitation of deciduous and evergreen forests in northern Quintana Roo. Altitudinal range probably not more than a few hundred feet.

Localities.—CAMPECHE: Apazote, near Yohaltún, 1 male, 2 females. YUCATÁN: Chichén Itzá, 3 males, 2 females; Xocempich (10 km. N. of Chichén Itzá), 1 male; Peto; Tizimín; "Yucatán," 1 male, 1 female. QUINTANA ROO: Carrillo Puerto (1 female examined by Raymond Paynter).

Dactylortyx thoracicus paynteri Warner and Harrell

Dactylortyx thoracicus paynteri Warner and Harrell, *Revista de la Sociedad Mexicana de Hist. Nat.*, 14:205, 1953 (published 1955) (12 km. W. of Bacalar, Quintana Roo, Mexico; type in Peabody Museum of Natural History, Yale University).

This is the palest of all races in coloration, especially of the breast and bellies of males and of gray areas of the head and throats of females. The ventral shaft streaks are broad and nearly pure white in males; females are light gray over the eye and very pale gray on the throat.

Measurements.—Male (type): Wing 122.5; culmen 18.0; tarsus 35.0. Females: Wing (2) 112.0, 119.5; culmen 16.5, 17.8; tarsus 30.2, 32.5. Weights: females 168.0, 193.6.

Range.—Lowland rainforest of south-central Quintana Roo, Mexico.

Localities.—QUINTANA ROO: 12 km. W. of Bacalar, 1 male; 24 km. N.W. of Xtocomo, 2 females; 46 km. W. of Chetumal; Laguna Chacanbacab.

Dactylortyx thoracicus devius Nelson

Dactylortyx devius Nelson, *Proc. Biol. Soc. Wash.*, 12:65, 68, 1898 (San Sebastián, Jalisco, Mexico; type in U.S. National Museum, Biological Survey Collection).

This race was described from a single male from Jalisco. The type is still the only specimen of this race, since the Guerrero birds, formerly included in *devius*, represent a distinct race. Critical examination of this specimen, which has the wings folded far down the sides so that most of the side feathers and part of the breast are covered, shows that the feathers of the breast have much of the webs light chestnut; the edges and a narrow area bordering the shaft streak grayer than in males from Guerrero; sides rich reddish-brown, becoming lighter on the flanks; shaft streaks so narrow as to be scarcely noticeable. The male of *devius* is the reddest of all males examined. In size and coloration it is closest to males from Guerrero, but, upon critical comparison with the male of *thoracicus* (Puebla), it shows also a close relationship with that bird in the sheen on the wings and in arrangement of the brown pigment in the color pattern. This similarity suggests a possible continuity of distribution across the plateau of Mexico during a time probably not earlier than Pleistocene. *Measurements.* Male (type): Wing 132.0; culmen 18.0; tarsus 33.3.

Range.—The single specimen was collected on March 17, probably in the canyon above Milpillas near San Sebastián at an altitude above 3,850 feet, in heavy oak forest.

Localities.—JALISCO: San Sebastián (Milpillas), 1 male (type).

Dactylortyx thoracicus ***melodus*** new subspecies

Type: Adult male, no. 98134, University of California Museum of Vertebrate Zoology; Omilteme, 30 kilometers west of Chilpancingo, Guerrero, Mexico; altitude 7,200 feet; weight 266.0 grams; November 2, 1944; collected by A. Starker Leopold; original no. 218.

Characters of male.—Differs from *devius* in having breast grayer, outer parts of webs duller, nearer pale buff to almost pure olive-gray in some specimens; shaft streaks of breast much broader (edged with blackish in three specimens); sides and flanks buffy to brownish-olive and shaft streaks much broader and very pale buff. It is distinguished from all other races principally by more brownish-olive breast and sides and buffier belly; it is also larger than all but birds from Guatemala.

Characters of female.—Differs most markedly from all other females by having entire underparts suffused with buff; middle of belly deeper buff, not whitish or pale buff.

Individual variation is well marked among the nine males examined. Two have the shaft streaks of the breast narrow; on five these are very wide. Three with broad shaft streaks have the shaft streak broadly edged (to 2 mm.) with blackish. The breast and sides of two are nearer fuscous; two are nearer light gray-buff; four have light chestnut on the feathers of the breast. Eight specimens of both sexes have much black spotting and chestnut on the mantle; eight others have little or none. Other marks of individual variation are present in both sexes, but the females show less than males.

The juvenal plumage is similar to *pettingilli* in black ventral spotting but differs in being browner above and below.

Measurements.—Males: Wing (9) 132.0–139.0 (135.06 ± 0.91); culmen (10) 18.0–19.0 (18.6 ± 0.13); tarsus (10) 34.0–37.0 (35.91 ± 0.31). Females: Wing (7) 129.0–134.0 (131.14 ± 0.72); culmen (6) 18.0–19.0 (18.5 ± 0.13); tarsus (7) 33.0–35.0 (34.2 ± 0.31). Weights: (Males) 235.0, 266.0.

Range.—Mountain forest of pine-oak-fir from 6,000 to 9,000 feet in the vicinity of Omilteme, Guerrero.

Localities.—GUERRERO: Sierra Madre del Sur; Omilteme, 9 males, 2 juv. males, 7 females, 1 juv. female.

Nelson (1898) restricted the locality of *Dactylortyx thoracicus lineolatus*

(Gould) to Gineta Mountain on the border of Oaxaca and Chiapas on the basis of certain similarities between one male from that mountain and the male illustrated in Gould's plate of the cotypes (male and female) which accompanied the description that gave only "Mexico" for locality (Gould, 1850). We made the same comparison but found fewer similarities between the male in Gould's plate and the two males from Gineta Mountain. At our request Dr. Erwin Stresemann kindly examined the records and the male cotype of *lineolatus* in the Berlin Museum and sent the following information: "The two cotypes of *Odontophorus lineolatus* Lichtenstein MS studied by J. Gould when preparing his monograph of the Odontophorinae (Berlin Mus. male Nr. 11614 and female 11615) were both collected by Ferdinand Deppe about 1829, male at Papantla (Veracruz), female at Misantla (Veracruz). The name *lineolatus* therefore applies to the race *D. thoracicus thoracicus*, leaving the 'Oaxacan Long-toed Quail' without a valid scientific name."

"Deppe's male is still kept in the Berlin Museum; but I cannot trace the female at present." (See also Stresemann, 1954:89).

As a new name for this subspecies we propose:

Dactylortyx thoracicus ***ginetensis*** new name

Type: Adult male, no. 472,630, American Museum of Natural History; Gineta Mountain (near Santa Efigenia), Oaxaca-Chiapas border, Mexico; November, 1880; collected by F. Sumichrast; original no. 137.

Characters of male.—Compared to *melodus*, paler (less brownish) below, shaft streaks of breast and sides broader, belly whiter, less buffy; top of head nearer pure olive-brown, chestnut on scapulars and tertials brighter.

The female is unknown.

Measurements.—Males (2): Wing 132.0, 133.5; culmen 16.2, 17.2; tarsus 32.0, 35.0.

Range.—Forested slopes of Gineta Mountain near Santa Efigenia, Oaxaca, near the border of Chiapas.

Localities.—OAXACA: Gineta Mountain, near Santa Efigenia, 2 males.

Dactylortyx thoracicus chiapensis Nelson

Dactylortyx chiapensis Nelson, *Proc. Biol. Soc. Wash.*, 12:65, 66–68, 1898 (San Cristóbal, Chiapas, Mexico; type in U.S. National Museum, Biological Survey Collection).

The range of this race becomes restricted to the type locality, San Cristóbal, Chiapas. E. W. Nelson (MS notes in files of U.S. Fish and Wildlife Service) wrote, "The three specimens secured were brought in by Indian hunters who killed them in the wooded hills to the north of the town. A small covey of these grouse was flushed in the dense woods at an altitude of about 9,500 feet on the mountain."

The type and one other male examined have the ventral shaft streaks very narrow, the breast, sides and flanks dark gray, near fuscous, with only a faint tinge of brown and buff. The single female examined is duller than females from other Chiapas localities and is paler than females from Guatemala.

Measurements.—Males (2): Wing 123.0, 125.0; culmen 18.0, 18.5; tarsus 35.0, 35.0. Females (1): Wing 127.5, culmen 17.5, tarsus 34.0.

Range.—Mountain forests of the central Chiapas highlands near San Cristóbal.

Localities.—CHIAPAS: Distrito Las Casas: San Cristóbal, 2 males, 1 female.

During March and April of 1952 Harrell heard the Singing Quail at the following additional localities in the central highlands of Chiapas: several places in remnants of sweet gum forest from 3 kilometers north to 11 kilometers south of Pueblo Nuevo Solistahuacán (near Jitotol and Rincon Chamula); in a ravine alongside the Interamerican Highway at the junction of the road to Ixtapa (about 12 kilometers south of Ixtapa and 27 kilometers east of Chiapa de Corzo).

Dactylortyx thoracicus **dolichonyx** new subspecies

Type: Male, University of Michigan Museum of Zoology no. 102.077; March 10, 1939; Cerro Ovando, Dist. Soconusco, Chiapas, Mexico; altitude 2.000 meters; collected by Pierce Brodkorb and Arthur E. Staebler; original no. 14,043 in collection of Pierce Brodkorb.

Characters of male.—Differs from *chiapensis* by having the breast, sides and flanks lighter gray suffused with pale buff or light chestnut; ventral shaft streaks broader; belly whiter; lower back, rump and upper tail coverts brownish-olive, less grayish; throat and line over eye deeper chestnut; wings averaging paler. Compared to *ginetensis*, breast, sides, top and sides of head and throat, lower back and rump darker, less olivaceous; ventral shaft streaks narrower; chestnut on tertials and scapulars reduced in extent by addition of black and gray markings.

Characters of female.—Differs from those of *chiapensis* by having lower breast and belly paler; markings of tertials darker, less reddish; rump and upper tail coverts darker brown; line above eye and sides of head darker gray.

Juvenile male.—Differs most obviously from all other juveniles by the large and very black ventral spots.

Measurements.—Males: Wing (16) 129.0–136.0 (132.19 ± 0.52); culmen (15) 17.0–19.0 (18.06 ± 0.15); tarsus (16) 34.0–36.5 (35.3 ± 0.22). Females: Wing (9) 123.0–130.0 (127.17 ± 0.64); culmen (9) 17.0–18.6 (17.58 ± 0.15); tarsus (9) 32.5–34.1 (33.61 ± 0.22). Weight: (Male) 241.5.

Range.—Forests of the Sierra Madre de Chiapas from about 4,000 to 9,000 feet.

Localities.—CHIAPAS: Dist. Tonala: Catarinas, 1 male. Dist. Soconusco (Municipality of Escuintla): Mount Ovando, 10 males, 4 females; Santa Rosa, 2 males, 1 female; Finca Juarez, 1 male; Pico de Loro (40 mi. N.E. of Escuintla), 2 males; Peña Flor (1700 meters), 4 males; La Hacienda (900–1300 meters) 1 male, 1 natal female; Niquivil, 1 natal female. Dist. Moriscal (Municipality of Siltepec): Siltepec, 1 male; Malpaso, 2 males, 1 female; Honduras, 1 female; Porvenir, (Cerro Malé), 2 juv. males, 1 female; Letrero, 3 females; Barranca Honda, 1 female; La Cascada (900–1300 meters), 1 male, 2 females; La Frailesca (1300–1700 meters), 1 female.

Dactylortyx thoracicus **moorei** new subspecies

Type: Male; collection of Robert T. Moore, Zoological Laboratory, Occidental College no. 27.079 M-X"35; Cerro Brujo, Ocozocoautla, Distrito Tuxtla, Chiapas, Mexico; July 2, 1940; collected by Mario del Toro.

Characters of male.—Breast, sides and flanks grayer and paler than *chiapensis* and *dolichonyx* and with only faint buffy cast; shaft streaks on breast broad and white, wider than in *chiapensis* and averaging broader than in *dolichonyx*; differs from both in being lighter dorsally, especially on edges of inner webs of tertials and on outer webs of scapulars on which the shaft streaks are broader and whiter and adjacent parts of outer webs grayer. Color of crown variable but with a strong tendency toward loss of melanin or to restriction of melanin to centers of webs. In two specimens the crown is nearly entirely rich brown (not deep brown or chestnut), not brown-olive as in *ginetensis*.

Close to *ginetensis* in ventral shaft stripes but grayer (not olive-buff) below; crown browner; less chestnut on tertials. Close to *paynteri* in breast color but belly buffier; size larger.

In males crown color varies from nearly pure rich brown to pale gray-brown. Five have incomplete bars and longitudinal stripes on webs of some crown feathers. One has much white on the throat; all others have a little; but none is rich chestnut on the throat. There is also variation in the width of the ventral shaft streaks and in the amount of buff on breast, sides and belly. One male, apparently adult, shows two characters of the female plumage, considerable white on the throat, and a tinge of vinaceous on a few feathers of the breast.

Characters of female.—Compared to *chiapensis* and *dolichonyx*, paler and less bright both above and below, especially on breast, sides and rump.

Among females variation is most apparent in ventral streaking, breast color and in a tendency toward black spotting on the breast. Four have the shaft streaks of the breast visible, but they are buffy. Another female, apparently adult, from Socoltenango has these streaks broad and nearly white, and has also black spots, some resembling incomplete barring, on many breast feathers. This specimen is of additional interest in that it exhibits a tendency toward male plumage in the presence of gray in many breast feathers and of brown on several feathers of the throat patch. A few black spots are present on the breast feathers of the four other females also.

Measurements.—Males: Wing (11) 123.0–133.0 (127.45 ± 1.03); culmen (11) 17.0–19.0 (18.04 ± 0.16); tarsus (11) 31.1–34.0 (33.23 ± 0.22). Females: Wing (4) 121.0–127.0 (124.5); culmen (5) 17.1–18.5 (17.74 ± 0.24); tarsus (5) 32.0–34.5 (32.7 ± 0.46).

Range.—Known only from mountain forests of Cerro Brujo and near Socoltenango, central Chiapas.

Localities.—CHIAPAS: Distrito Tuxtla: Cerro Brujo, Ocozocoautla, 8 males (1 marked female), 3 females. Distrito Comitán: Socoltenango, 3 males (1 marked female), 2 females.

We name this race for Robert T. Moore.

Dactylortyx thoracicus ***edwardsi*** new subspecies

Type: Adult male, no. 13,020, collection of George Miksch Sutton; El Fenix, 5 miles northwest of Monserrate, Distrito Tuxtla, Chiapas, Mexico; altitude approximately 5,000 feet in high cloud forest undergrowth; August 5, 1952; collected by Ernest P. Edwards; original no. 1473 in catalogue of Ernest P. Edwards.

Characters of male.—Closest to *moorei* but darker on crown; upper back and wings deeper chestnut; lower back and rump darker (more olivaceous); buff on inner edge of tertials darker; medial tertials with black extending to near edge of feather across buffy edge, giving spotted effect to buffy edge; gray on upper breast with less buffy suffusion (near pure gray); ventral shaft streaks wider and longer than in nine of eleven specimens of *moorei.* Darker and less olivaceous than *ginetensis;* darker above and ventral shaft streaks broader than in *dolichonyx.*

The two adult males examined are similar in crown color but the second differs from the type by being browner on upper back, wings, rump, upper tail, breast and sides; both have a few pure white feathers on the throat.

Characters of female.—Close to *moorei* but upper back, wings, rump and upper tail darker, less brown; slightly less vinaceous on breast; sides and flanks grayer, less brown; middle of belly less buffy; paler than *chiapensis* and *dolichonyx.*

One of the females is slightly browner on the lower back and rump than the other.

Both have much light reddish-brown on the lower throat and sides of head and neck, and a little chestnut on the forehead.

Two juveniles are less buffy below than *pettingilli* and *melodus* and the ventral spots are larger and blacker; breast spots smaller than *dolichonyx.*

Measurements.—Males (2): Wing 128.0, 132.0, culmen (1) 17.8, tarsus 34.0, 34.4. Females (2): Wing 122.0, 126.5; culmen (1) 17.0; tarsus 32.0, 32.0.

Range.—Cloud forest, 5,000 feet, near El Fenix, 5 miles northwest of Monserrate, Chiapas.

Localities.—CHIAPAS: Distrito Tuxtla: El Fenix, 2 males, 2 females, 1 juv. male, 1 juv. female.

We name this race for Ernest P. Edwards.

Dactylortyx thoracicus ***calophonus*** new subspecies

Type: Subadult male; Museum of Comparative Zoology, Harvard University, No. 145,696; Quezaltenango, Guatemala, altitude 8,500 feet; November 18, 1919; collected by Austin Paul Smith; original number 19,078.

Characters of male.—Darker than *dolichonyx;* top of head and line above the eye, mantle, back, wings and rump darker rich brown; underparts darker, more brownish; ventral shaft streaks narrower. Two males (Tecpam and Volcán de Fuego) are lighter than the two others examined (Quezaltenango and Tecpam) but have even narrower ventral shaft streaks. Much larger than *fuscus* from which it is further distinguished by lighter crown, line above eye, back, wings and rump; ventral shaft streaks are broader. From *chiapensis* it differs by being larger, browner above and below but with much less chestnut on the wings.

Characters of female.—Compared to *dolichonyx,* darker and duller (less bright) on breast and sides, belly darker; line over the eye and sides of head darker gray; rest of upper parts slightly darker. Differs from *chiapensis* by having the throat much darker gray; breast and belly darker; lower back and rump browner. Differs from *fuscus* (one female) by being paler throughout.

Measurements.—Males: Wing (4) 133.0–137.0 (135.5); culmen (4) 18.0–18.5 (18.1); tarsus (4) 36.0–38.0 (36.7). Females: Wing (3) 126.0–129.0 (127.7); culmen (3) 17.0–17.1 (17.1); tarsus (3) 32.2–35.0 (33.8).

Range.—Mountain forests of the volcanoes of southeastern Chiapas (Volcán de Tacaná) and southern Guatemala, 5,000 to 10,000 feet.

Localities.—CHIAPAS: Volcán de Tacaná (3,000 meters), 1 female. GUATEMALA: Volcán de Santa Maria, 1 female; Quezaltenango, 1 male; Tecpam, 2 males, 1 female; Volcán de Fuego, 1 male; Volcán San Lucas; Dueñas; near Patzun; Finca Helvetia, 12 miles north-northeast of Retalhuleu on the Pacific slope of Volcán de Santa Maria (Saunders, 1950). The species was observed in captivity by A. W. Anthony (Griscom, 1932:108) at Finca Perla located northeast of the Cuchumatanes Mountains near the border of Chiapas; Saunders (1950) reported the occurrence of this quail at Nebaj. It is doubtful that birds from these last two localities belong to this race.

Dactylortyx thoracicus subspecies

A male taken at 5,000 feet in a coffee finca in cloud forest on Cerro del Aguila, Dept. Santa Ana, El Salvador, in coloration is close to one male of *salvadoranus* and two males of *taylori,* but is lighter gray on the breast, sides, belly, wings, back and rump; and by these same characters is markedly different from *calophonus.* Without question it is closest to *salvadoranus* and *taylori,* but is completely isolated from both. The measurements of the specimen are: Wing, 128.2; culmen, 18.4; tarsus, 33.0. Harrell observed this species in cloud forest at 7,000 feet altitude on Volcán de Santa Ana which is closely adjacent to Cerro del Aguila.

Dactylortyx thoracicus salvadoranus Dickey and van Rossem

Dactylortyx thoracicus salvadoranus Dickey and van Rossem, *Proc. Biol. Soc. Washington*, 41:129, 1928 (Volcán de San Miguel, alt. 4,000 feet, Dept. San Miguel, El Salvador; type in Dickey Collection, University of California at Los Angeles).

Males are darker gray, less brown, than *taylori.* The single female is darker and duller than the five females of *taylori* examined; the cheeks are grayer, not brownish; the sides and especially the flanks are darker.

Measurements.—Males (2): Wing 126.0, 128.2; culmen 17.6, 17.9; tarsus 33.6, 33.9. Female (1): Wing 124.0; tarsus 33.2.

Range.—Oak association (2,500–4,000 feet) of Arid Upper Tropical Zone and rarely in upper edge of Lower Tropical Forest on Volcán de San Miguel, Dept. San Miguel, El Salvador.

Localities.—EL SALVADOR: Volcán de San Miguel, 2 males, 1 female.

Dactylortyx thoracicus taylori van Rossem

Dactylortyx thoracicus taylori van Rossem, *Trans. San Diego Soc. Nat. Hist.*, 7:151, 1932 (Mt. Cacaguatique, 3,500 feet, Dept. San Miguel, El Salvador; type in Dickey Collection, University of California at Los Angeles).

This race is closest to *salvadoranus* and the bird from Cerro del Aguila, El Salvador. The five males examined are paler and browner than *salvadoranus*, especially the type and one other taken by van Rossem on the southwest slope. The other three, taken on the north slope by another expedition, are grayer and with ventral shaft streaks broader; one is scarcely distinguishable from the type of *salvadoranus* but is slightly brighter on the wings and rump. Six females (one in postjuvenal molt) are readily distinguishable from *salvadoranus* by their lighter throats and sides of heads which are tinged with reddish brown, by brighter reddish breasts, sides and bellies, and by browner, less fuscous, wings and backs. The females, especially one adult and one juvenile (in molt), have some reddish on the throat feathers and on the sides of the head.

Males of *taylori* are very different from those of *fuscus*, being much paler and browner. Females are paler and brighter than females of *fuscus.*

Measurements.—Males: Wing (5) 125.0–134.0 (129.0 ± 1.5); culmen (5) 18.0–19.1 (18.72 ± 0.21); tarsus (5) 31.8–34.0 (32.8 ± 0.40). Females: Wing (5) 121.0–124.0 (122.36 ±0.59); culmen (5) 17.6–18.2 (17.9 ± 0.11); tarsus (5) 31.5–33.0 (32.4 ± 0.29).

Range.—Oak and coffee association of the Arid Upper Tropical Zone and probably in the limited cloud forest on Mt. Cacaguatique, El Salvador.

Localities.—EL SALVADOR: Mt. Cacaguatique, 5 males, 5 females, 1 juv. female.

Dactylortyx thoracicus fuscus Conover

Dactylortyx thoracicus fuscus Conover, *Proc. Biol. Soc. Washington*, 50:73, 1937 (Alto Cantoral, Tegucigalpa, Honduras; type in H. B. Conover Coll., Chicago Natural History Museum).

This race, here restricted to the Alto Cantoral region of Honduras, is the darkest of all races of this quail. The two males examined are much darker than *calophonus* from Guatemala and are much smaller. The top of the head is nearly black, the ventral shaft streaks scarcely visible on one and very narrow on the other; the wings, back, rump and underparts are deeper fuscous, much less brownish. These differences are even greater when the birds are compared with *taylori* and *salvadoranus.*

The single female of *fuscus* differs from females of *dolichonyx* and *calophonus* by being much darker. It is somewhat similar to the female of *salvadoranus* and a female from Catacamas, Honduras, being intermediate between them in coloration.

Measurements.—Males (2): Wing 129.0, 129.0; culmen 16.5, 16.5; tarsus 35.1, 36.7. Female (1): Wing 125.4, culmen 17.0, tarsus 34.5.

Range.—Cloud forest of the Alto Cantoral district of Tegucigalpa, Honduras.

Localities.—HONDURAS: Department of Tegucigalpa: Cantoral, 1 male; Alto Cantoral, 1 male (type), 1 female.

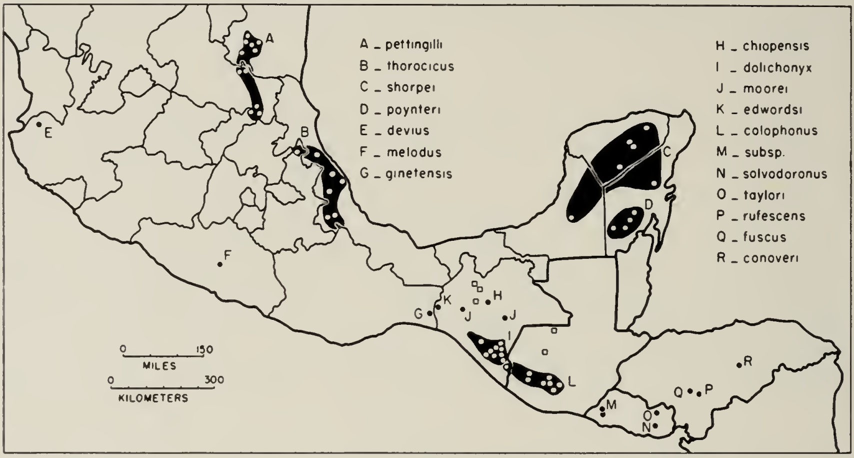

FIG. 1. Map showing the geographic distribution of *Dactylortyx thoracicus.*

Dactylortyx thoracicus ***rufescens*** new subspecies

Type: Subadult female, no. 161,030, Museum of Comparative Zoology, Harvard University; Rancho Quemado (San Juancito Mountains, Dept. Tegucigalpa), Honduras, March 13, 1932; collected by C. F. Underwood.

Characters of female.—Brighter red above and below than all other races; closest to *chiapensis* in breast color but redder, abdomen more buffy, sides of throat and head much paler gray, the feathers washed with reddish-buff in the type; chin and throat whitish, not gray, with a distinct buffy wash on lower throat; mantle redder; lower back, rump, upper wing coverts and secondaries rich golden ochraceous, not grayish buff. Approaches *taylori* most closely in color of throat and sides of head; otherwise it is brighter red throughout. Differs most strikingly from *fuscus* (1 female) and from two females from Catacamas, Honduras, in being much lighter, brighter red, on the mantle, wings, sides of neck, breast and flanks.

The male is unknown.

Remarks.—The distinctive, red coloration of the females of this race was noted even in the field by Harrell who saw clearly and without binoculars this character in a female at a distance of about 15 feet on August 8, 1954, in the cloud forest on San Juancito Mountain.

Measurements.—Females (3): Wing 123.0–129.5 (126.2), culmen (2) 17.5, 18.0; tarsus 31.2–34.3 (32.9).

Range.—Hardwood cloud forest (4,000–7,000 ft.) on the San Juancito Mountains, Department of Tegucigalpa, Honduras.

Localities.—HONDURAS: Department of Tegucigalpa: San Juancito, 2 females; Rancho Quemado, 1 female (type).

Dactylortyx thoracicus ***conoveri*** new subspecies

Type: Adult male, testes "½ enlarged"; H. B. Conover Collection no. 12,666 (Chicago Natural History Museum); Catacamas, Department of Olancho, Honduras; September 29, 1937; collected by C. F. Underwood.

Characters of male.—Three males examined (nos. 12,665–6–7, H. B. Conover Collection; one just completing the postjuvenal molt) resemble *sharpei* and *pettingilli* most closely, but chestnut above the eye and on the throat less bright, some feathers showing much white toward the base; chestnut on crown restricted to edges of a few feathers; breast darker gray, sides darker and finely barred; belly grayish-white, not buffy. From *fuscus*, the geographically nearest race (from which we have males), it differs by being much lighter and grayer, not dark fuscous.

Another male (H. B. Conover Collection no. 12,664) which has almost completed the postjuvenal molt, although bearing the same locality name on the label, is so different from the birds already described that, even taking into account individual variation, it probably came from another locality. The new feathers of the throat and superciliary area are dark chestnut in this bird; it is as dark dorsally as *fuscus*, and is close to that subspecies in ventral coloration, but is browner on the sides. Since the vast Agalta forest above Catacamas is divided into several isolated sections (Archie Carr, *in litt.* 1951), the locality "Catacamas" might refer to more than one population.

Characters of female.—One (no. 12,668, H. B. Conover Collection) is closest to *fuscus* and *salvadoranus* but darker throughout and with more reddish on throat patch than *salvadoranus*; very similar to *fuscus* but slightly darker reddish on breast; top of head blacker.

Another specimen (Conover Collection, no. 12,663; in the last stages of postjuvenal molt) has tawny-chestnut on the throat and in front of the eye. The new plumage resembles quite closely that of the adult, but is darker. This specimen is apparently a female but in the amount of chestnut in the throat patch and above the eye it resembles a male.

Remarks.—All of the Catacamas specimens are placed in the race *conoveri* although we are not certain that the females and the dark males came from the same forest locality as the light gray males; these dark birds may represent another isolated population and may not belong to the race *conoveri*.

We name this race in honor of the late H. B. Conover who suggested (Hellmayr and Conover, 1942:284) that the pale males from Catacamas might not belong to *fuscus*.

Measurements.—Males (3): Wing 124.5–131.0 (127.8) (dark bird 125.0), culmen 18.0–18.9 (18.5) (dark bird 17.1), tarsus 33.3–34.0 (33.5) (dark bird 35.0). Female (1): Wing 131.5, culmen 17.5, tarsus 34.9. Conover no. 12,663, female (?), imm.: Wing 126.0, culmen 17.2, tarsus 36.2.

Range.—Forests (probably cloud forest above), Catacamas, Department of Olancho, Honduras.

Localities.—HONDURAS: Department of Olancho: Catacamas, 4 males, 2 females.

DISCUSSION

The high degree of plasticity observed in the Singing Quail is not unexpected when consideration is given to the wide range of soil, climate and vegetation types and the altitudinal range occupied by this sedentary species, and to the degree of isolation of a number of its populations. Within the species there are demonstrable correlations of size with altitude and of plumage coloration with humidity; but these correlations do not extend to all populations. There are also clines in color. The largest individuals of *Dactylortyx thoracicus* are found in the populations occupying the high mountains of Guerrero (*melodus*), the Sierra Madre de Chiapas (*dolichonyx*) and the Guatemalan volcanic system (*calophonus*). The smallest birds occur near sea level in Campeche, Yucatán and Quintana Roo. While the palest races occur on the Yucatán peninsula, only a part of the population of *sharpei* inhabits the drier deciduous forest near the northern tip; *D. t. paynteri* is found in rainforest. Since the rainforest birds are in contact over a broad area with the populations of the drier parts of the peninsula, their resemblance to *sharpei* in paleness is not surprising. The darkest birds are all from humid mountain forests, the extremes occurring on Cerro Cantoral (Honduras), "Catacamas" (Honduras, females only) and in the Guatemalan volcanic system.

The most obvious cline is in coloration in the races of the Atlantic slope extending from Tamaulipas into Honduras; the gray of the breast and belly of the males is the best example. The races involved are *pettingilli, thoracicus, sharpei, paynteri* and *conoveri*. This group contains the only examples of probably continuous ranges between subspecies; these are between *pettingilli* and *thoracicus* and between *sharpei* and *paynteri*. The olivaceous tinge and broad ventral shaft streaks of males of *melodus* also are found in *ginetensis*, with the broad shaft streaks reappearing in *dolichonyx, edwardsi* and *moorei*. Thus, on the Atlantic slope and lowlands there is a cline which is continuous across the north side of the Isthmus of Tehuantepec, whereas on the Pacific slope, populations are more isolated and clinal relationships are less clearly defined. Here, topography and associated climatic conditions have created stronger barriers to *Dactylortyx*. On the other hand, on the basis of specimens so far examined, clinal relationships are not apparent among the southeasternmost populations, especially between females of the races *fuscus* and *rufescens* and between males of *fuscus* and *conoveri*. This condition was readily noticeable when all of the specimens were laid out in the laboratory in physiographic and geographic order. It is in these closely adjacent but completely isolated and probably small populations that random differentiation appears to have occurred.

The Balsas Basin has likely been a major barrier to the spread of *Dactylortyx*. The single bird from Jalisco (*devius*) bears a closer resemblance to specimens from the Sierra Madre Oriental than it does to *melodus* of Guerrero. This resemblance suggests a past continuity across the Transvolcanic Belt or an area further north rather than one across the Balsas Basin. This is weak evidence but results of current studies of the genera *Philortyx, Callipepla* and *Colinus* add support to this hypothesis. Other peculiarities in the evolution and biogeography of this forest-inhabiting, disjunct species are becoming more clearly interpretable through current studies on the grassland-inhabiting *Colinus* species. In the region under discussion both the geographic and ecological distributions of the two genera are largely complementary; and, although their paleo-climatic histories are identical, their ecologies are different. Even more important is that their evolutionary histories are very different, particularly with respect to time of occurrence of similar events in each. For instance, the development and decline of discontinuities between populations as the result of climatic change have occurred in opposite order in these two genera. Thus, at present there exist the disjunct populations of *Dactylortyx* comparable to the condition which prevailed among *Colinus* populations during cooler and/or moist climates of the past and the concomitant existence of more continuous forest in Mexico and northern Central America. The breakdown of these forest "bridges" to *Dactylortyx* (which act as barriers to *Colinus*) has resulted in increasing isolation of *Dactylortyx* populations; but to *Colinus* this breakdown has meant the re-establishment of contact zones between formerly isolated populations. Some of these populations had undergone major differentiation. The current comparative study of these complementary populations and those of the other Odontophorinae are beginning to prove valuable aids in systematics and biogeography of Middle America.

SUMMARY

The Singing, or Long-toed, Quail inhabits a number of forest types from near sea level to about 10,000 feet in Mexico, Guatemala, El Salvador and Honduras. Many of the populations are disjunct. The habitats occupied are extremely variable in climate, forest type and areal extent. Some dense undergrowth for cover is essential. Some populations occur in two, three or more vegetation types; others are restricted to a single type. These vegetation types include deciduous forest, semi-deciduous tropical forest, tropical evergreen forest, rainforest, oak-sweet gum cloud forest, mesic areas in pine-oak, pine-oak-fir-alder, oak-*aguacate* vapor forest, second growth cloud forest and coffee groves in areas of limited natural forest.

Knowledge of biology and behavior of the Singing Quail is fragmentary. It escapes by short, rapid flights or by running or both. Much of its food of seeds, bulbs and invertebrates is obtained by scratching in the litter and humus.

Flocks of as many as 12 individuals of both sexes and all age groups have been observed. Even during the breeding season more than two adults may be present in a small area. During two breeding seasons approximately 3.5

pairs per 100 acres were found in climax oak-sweet gum forest in Tamaulipas. Estimates based on this figure for the total populations of each of two isolated volcano populations in El Salvador do not exceed 500 pairs.

The breeding season, which extends from February through October or later, is similar for all populations except for indications that in the deciduous forest of Yucatán it may be delayed until May following the three driest months. No nest has been described, but a female was reported to have been incubating five eggs; usually broods have had two to four young. The postnuptial molt begins in June and continues through at least the end of the year; during July and August most of the adult population is in molt. No completely satisfactory criteria were found for separation of first year from older birds.

Song and other vocal notes are described. The song is usually in two parts: a series of about four loud, penetrating whistles followed by three to six rapid phrases of notes of differing pitch.

The taxonomic history of *Dactylortyx thoracicus* is reviewed. Nine races had previously been described but one race without a valid name is given the name *ginetensis*. The following eight new subspecies are described: *pettingilli, melodus, dolichonyx, moorei, edwardsi, calophonus, rufescens* and *conoveri*.

Over a part of the range of the species there are size and color correlations with altitude and climate respectively, the largest birds living at higher altitudes, the smallest near sea level. The darkest birds are cloud forest inhabitants; the palest occur on the Yucatán peninsula in both deciduous forest and rainforest. Color clines are strongest in the largely continuous Atlantic slope populations and are weaker among the Pacific slope and interior Chiapas populations. Clinal relationships are not apparent among some Honduras populations. In some of these small populations random differentiation seems to be present.

The race *devius* from Jalisco exhibits some characters of the Sierra Madre Oriental populations suggesting a former connection with the eastern populations across the Transvolcanic Belt rather than across the Balsas Basin with *melodus*.

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THE BODY TEMPERATURE OF THE AMERICAN KESTREL, *FALCO SPARVERIUS*

BY GEORGE A. BARTHOLOMEW AND TOM J. CADE

Despite the number of falcons which have been trained and kept in captivity, remarkably few quantitative data are available on even the most obvious aspects of their physiology. Aside from the studies on *Falco tinnunculus* reported over half a century ago (Simpson and Galbraith, 1905) and the data compiled by Wetmore (1921), almost nothing has been published on body temperature in members of the order Falconiformes.

The genus *Falco* offers particularly attractive opportunities for the study of comparative physiology. It comprises an extremely homogeneous group morphologically, yet various of its species occur at almost all latitudes and occupy virtually every terrestrial habitat. The species *F. sparverius,* considered in the present study, ranges from the northern limit of trees in North America to Tierra del Fuego at the southern tip of South America, and occurs in a variety of habitats including deserts.

Materials and Methods

The kestrels were captured in noose traps of the "balchatri" type (see Cade, 1955, for a description). Except when being used for experimental purposes they were housed together in a cage measuring 6 × 6 × 6 feet and made of fish net with half-inch bar stretched over a framework of tubular aluminum. The data presented herein were obtained between November, 1954, and September, 1955. Ten adult birds were used. Except for one bird which was killed by an overdose of anesthesia, none died or suffered any apparent injury as a result of the experimental treatment. The captive birds maintained their weight without water on a diet of beef heart and freshly killed mice.

All temperatures were measured to the nearest tenth of a degree centigrade with silver-soldered 30-gauge copper-constantan thermocouples which were connected to a recording potentiometer.

The long term records were obtained from thermocouples implanted in the pectoral muscles. The copper and constantan wires were soldered end to end, ground smooth, and threaded through a surgical needle. The bird to be studied was anesthetized with an intramuscular injection of nembutal. A perforation was made in the skin in the pectoral region and the needle was inserted. The thermocouple was then drawn through and adjusted to lie beneath the pectoral muscle adjacent to the sternum. Leads were attached to the thermocouple and seized to a stitch sewn through a dorsal feather tract. Kinking of the leads, which were led out through the top of the cage, was prevented by sheathing them in vinyl tubing. It was possible to obtain continuous 24-hour records from birds which were rigged in this manner and were free to eat and move about in cages with a volume of about 2 cubic feet.

The short term records of deep body temperature were obtained from thermocouples sheathed with vinyl tubing and inserted through the cloaca into the large intestine to a depth of 3 or 4 cm. and secured in place by clips attached to the rectrices. Skin temperature of the legs was determined from thermocouples attached to the naked tarsometatarsus with adhesive tape. The ambient temperature was monitored with thermocouples and controlled by an insulated chamber equipped with heating and cooling units, a blower, lights controlled by a clock-driven switch, and insulated glass ports for observation.

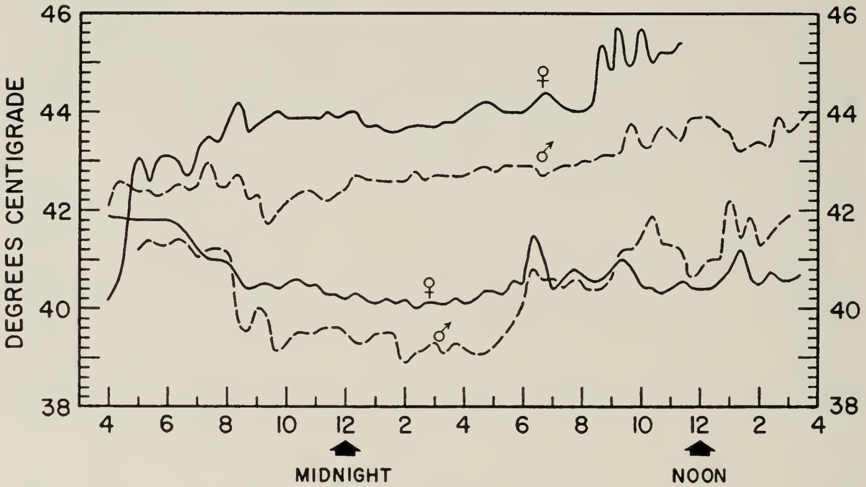

Fig. 1. Continuously recorded body temperatures in *Falco sparverius.* The two lower records are from birds held at an ambient temperature of 20° to 22° C. The two higher records are from birds held at an ambient temperature of 39° to 40° C. Photoperiod for all runs, 6:00 a.m. to 8:00 p.m.

Results

BODY TEMPERATURE IN THE ABSENCE OF STRESS

The deep body temperature of the kestrel, like that of other birds which have been studied, shows considerable lability. Because of the excitement incidental to handling, manually taken cloacal temperatures were apt to be above the resting level. A better approximation of the true resting body temperature was given by continuous records obtained from thermocouples implanted in birds, which had become adjusted to captivity. Two such records are presented in the lower part of Figure 1. There is a diurnal cycle. The body temperature at night averages about one degree lower than during the day, but it is relatively more uniform. The variations in body temperature in the daytime center about 40.5° C. and may rise almost to 42° C. under conditions of moderate excitement, such as produced by sudden illumination, or by eating. During the investigation many hours of continuously recorded temperatures were obtained from birds that we judged to be relatively unstressed. These data agree with the 24-hour records shown in Figure 1 and indicate that in the absence of conspicuous nervousness, environmental stress, or high levels of activity, deep body temperatures lie between 40.2 and 41.4° C. in alert adults of this species.

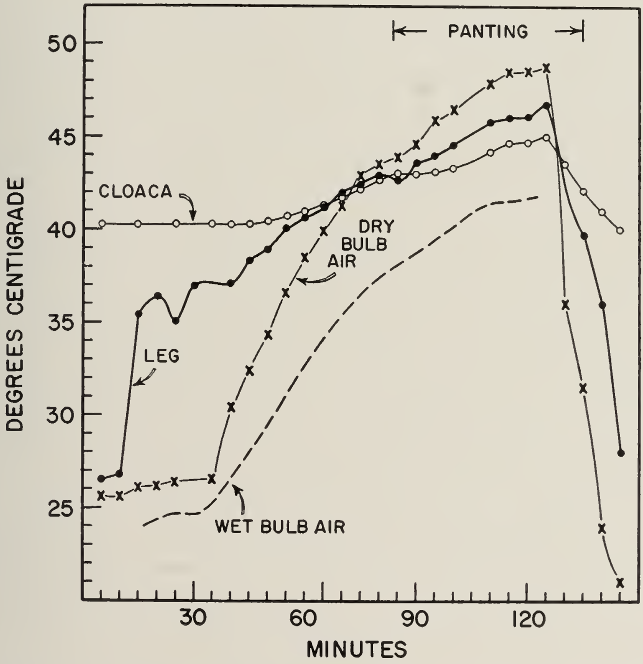

Fig. 2. Response of cloacal and tarsometatarsal temperatures to changing ambient temperature.

BODY TEMPERATURE DURING HEAT STRESS

Short term response to rising air temperatures.—After many unsuccessful attempts, continuous records of leg and cloacal temperatures were obtained from four individuals exposed to a slowly rising and then rapidly decreasing ambient temperature. All four birds showed responses of the sort shown in Figure 2. At ambient temperatures around 25° C. the cloacal temperature was between 40° and 41° and the first measurement of the temperature of the scaly part of the tarsometatarsus was between 25° and 30° C. but this almost immediately rose to 35° or more, presumably as a result of vasodilatation. As the ambient temperature started to rise, the leg temperature immediately increased but the cloacal temperature rose only slightly if at all. As the ambient temperature passed 35°, cloacal temperature began to rise more steeply, and as the ambient temperature continued to increase, cloacal and leg temperatures approximated and paralleled each other. When cloacal temperature reached 42.8° to 43.0° C., panting usually commenced; saliva was clearly visible in the open mouth, and the cere appeared to become somewhat moist. As the cloacal temperature continued to rise the panting became heavier and more rapid, and a powerful, rapid, in-and-out flutter of the tongue was initiated. As the cloacal temperature approached 45° C. the plumage became compressed, the wings drooped, and the eyes bulged.

When the cloacal temperature reached 45° C. the doors of the temperature chamber were opened and ambient temperature was allowed to fall rapidly. With all its mechanisms for heat dissipation activated, the animal's cloacal and leg temperatures fell rapidly and soon returned to the original temperatures prior to the period of stress.

Response to sustained high ambient temperatures.—We were able to obtain from implanted thermocouples two continuous 24-hour records of body temperature in birds maintained at air temperatures of 39° to 40° C., which is as high as any mean daily temperature that kestrels are apt to meet under natural conditions (Fig. 1). In both cases deep body temperature rose (in one instance 2° and in the other 4° C.) above normal and remained at this new high level. The birds panted almost continually, but ate normally. During the hours of darkness, the temperature of both birds approached an equilibrium condition, but as soon as the lights came on it started to rise. In one case, something approaching thermal homeostasis was maintained for some hours, but the bird eventually lost control and a series of oscillations ensued with the body temperature approaching 46° C. at the peaks. To prevent injury the bird was returned to room temperature and in about one-half hour its cloacal temperature had fallen to the customary level. The bird behaved normally thereafter and two days later it was released in good condition. In the second case, as soon as the lights came on, body temperature began to rise. Despite the continuous panting of the bird its increased activity apparently imposed a severe heat load and body temperature rose and oscillated between 43.5° and 44.0° C. until the experiment was terminated.

WATER ECONOMY

The American kestrel can be maintained indefinitely in captivity on a diet of fresh meat without drinking water. None of the birds used in the present study was given water and all either maintained or gained weight during the period of captivity. In the spring of 1954 a pair of kestrels was kept in captivity for two months during which time they mated and laid eggs. Although no water was available even the female, despite the water loss involved in ovulation, gained weight.

Discussion and Summary

Body temperature in *Falco sparverius* shows a clear diurnal pattern related to activity, and conspicuous short-term variations related to excitement and stress. However, the diurnal temperature cycle of *F. sparverius* and also that of *F. tinnunculus* (Simpson and Galbraith, 1905) are of smaller amplitude than those of most birds for which data are available. As in most birds, panting is the principal mechanism of heat dissipation when ambient temperature exceeds body temperature, but the possibility of slight evaporative cooling from the cere, and perhaps the cornea, exists. When ambient temperature is lower than body temperature heat loss is regulated to a considerable degree through vasomotor activity in the unfeathered parts of the tarsometatarsus. When subjected to high ambient temperatures, the kestrel's body temperature rises from the normal resting level of about 40.5° C. and maintains itself at a new level 2° to 4° C. higher.

The observations summarized above assist in understanding the ability of kestrels to occupy desert regions even during the hot weather of summer. Their capacity to exist under conditions of heat and aridity appears to be related in part to their toleration of greatly elevated body temperatures and to the fact that their carnivorous diet minimizes the importance of drinking and thus frees them of dependence on surface water. Their physiological tolerance of desert conditions is of course reinforced by their behavior. In the desert in the summer kestrels confine their hunting to early morning and early evening. They are inactive during the heat of the day and stay in the shade. In the winter they hunt throughout the hours of daylight and occupy exposed perches. Despite the tolerance of kestrels to heat and aridity, the density of their breeding population in deserts is low when compared with levels in cooler and less xeric environments.

That the remarkably extensive geographic range of this species includes deserts as well as virtually every other major terrestrial habitat south of the tree line in the New World is another instance of the success of a eurytopic bird in occupying the desert without special physiological adaptations (Bartholomew and Dawson, 1953; Bartholomew and Cade, 1956).

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NOTES ON FALL PLUMAGES, WEIGHTS, AND FAT CONDITION IN THE RUBY-THROATED HUMMINGBIRD

BY ROBERT A. NORRIS, CLYDE E. CONNELL, AND DAVID W. JOHNSTON

Between September 6 and 24, 1955, a notable concentration of Ruby-throated Hummingbirds (*Archilochus colubris*) was observed in extensive patches of *Crotalaria spectabilis* in the Savannah River Plant area, southwestern Aiken County, South Carolina. In this seasonal or aspect community of leguminous, yellow-flowered herbage, the hummingbirds perched, hovered, drank nectar, gave squeaky callnotes, fought one another, dashed about in various directions, and otherwise made themselves conspicuous. The birds seemed to set up vague territories or defended areas, which brought to mind Pitelka's (1942:200) reference to fall concentrations of hummers in which individuals were mutually hostile and manifested belligerence to the extent that "a sort of vestigial territoriality" was seen. In the *Crotalaria* patches the birds were present not only in the daytime but also at night, as dawn and dusk observations indicated. With such an aggregation of hummingbirds close at hand it seemed almost mandatory that one avail himself of the opportunity for detailed study. Accordingly, some 30 hours were spent netting live birds, collecting others for study of plumages, weights, and fatness, and making incidental observations. In order to round out the study of fat deposition, additional specimens were collected from middle Georgia and northern Florida.

Habitat and Population

Standing two to three feet high, the *Crotalaria* grew thickly in three major patches, each occupying about one acre. There were additional smaller patches and strips, especially along road edges. The total area dominated by the legume was estimated at roughly four acres. Most of the neighboring areas were old fields in which composites (*Heterotheca* and *Haplopappus*) and grasses (*Andropogon* and *Digitaria*) were especially prominent. A wooded strip along a stream was situated about 100 to 200 yards from the areas blanketed with *Crotalaria.* Not infrequently Rubythroats would fly to this wood, and possibly some of them roosted here. It was reckoned that between 100 and 150 hummingbirds were aggregated in the *Crotalaria* patches and their near vicinity. This suggests that there were at least 25 birds per acre, hardly an overestimate for early September. Insofar as could be told, numbers had reached a maximum or a near maximum on September 6, the time of our first visit; the population had dwindled somewhat by September 16, and had fallen off rather suddenly, to only a few individuals, by September 23. The last date on which hummers were seen here (or elsewhere in the region) was September 24; at this time only two or three were noted. Many of the *Crotalaria* flowers were present fully a week after the birds had departed.

During their sojourn, the Rubythroats were the only birds present in the patches, which might be called, in ecologic terms, a "*Crotalaria-Archilochus* Aspect Association." Large bees (Bombidae and/or Xylocopidae) were also conspicuous members of this relatively simple, seasonal community. Although Pitelka (1942:191) and others have described altercations between Rubythroats and bees, none was observed in the *Crotalaria* patches.

NETTING AND ATTEMPTS AT COLOR-MARKING

The first objective was that of catching with Japanese mist nets some of the hummingbirds for color-marking, with a view to elucidating the behavior of individuals and something of the nature of territoriality in this autumnal aggregation. This endeavor was successful only in the sense that the birds could be caught, weighed, sexed, and color-marked; it was unsuccessful in that no repeat records were established. Mist nets placed along swaths cut through the herbs, or where a patch stopped at the edge of a road, were moderately successful in catching fast-moving hummingbirds at various times of day. Many birds slipped through or out of nets, and some were adept at "braking" just short of nets and backing off or otherwise maneuvering away. Too, many of them flew around or, more commonly, over the nets. Occasionally, to the watcher's dismay, one would even perch on the top trammel of a net. In general the hummers were more skillful in avoiding the nets than are many passerine birds. They were not only capable of learning what to avoid but also possessed, to use terms from Bené (1945:15), "an aerial perspective . . ., an unobstructed view of the total configuration, [which] facilitates perception of spatial relations. . . ." With two to four nets set up, each 30 to 40 feet long, it was found that about one Rubythroat per hour could be ensnared and handled—a slow rate by some standards but one that might prove satisfactory to one making special studies of individuals or small populations of hummingbirds.

Each bird caught was slipped into a vial, its head protruding, and a cap of aluminum foil with a perforation just large enough to slip over the hummer's head was secured to the open end of the vial with a rubber band. A bird thus immobilized could be weighed and color-marked. Ten birds so handled (including five of either sex) were marked by means of small celluloid color bands suspended from the throat. The band was attached with thread and Duco cement to small elastic loops, and the elastic was stretched by an improvised expander and slipped over the diminutive head. On some birds an extra bit of cement was used to make the elastic adhere to certain of the neck feathers. The desired effect, as the bird might be viewed from some yards away, was that of a bright ornament (red, blue, yellow, or a combination) bulging or hanging from the throat region. In spite of the dubious outcome of this particular marking attempt, it would seem that the above-sketched method or some modification of it might prove effective for hummingbirds with respect to seasonal or short-term marking.

SPECIMEN COLLECTIONS

Specimens for laboratory study collected with .22 caliber shot cartridges lost little blood, and they were weighed within a few minutes of the time of collection. With some specimens, nectar flowed out of the throat and mouth onto the balance pan; it was clear that nectar, perhaps more than small insects, was an important source of nutriment. Two specimens were prepared as study skins; others were preserved as flattened, dried parts (bill, tongue, throat feathers, spread wings, and rectrices). The rest of the specimens, including seven from the *Crotalaria,* four from middle Georgia, and one from the Gulf Coast of western Florida, were given to Connell for analysis of fat content.

SECONDARY SEX CHARACTERS

Size and plumage coloration.—An investigator marking and releasing Rubythroats in the postbreeding period will naturally wish to rely on external characters for recognition of males and females. As is generally known, adult male Ruby-throated Hummingbirds may be identified at any season by their dark, metallic red throats and their relatively-narrow, unspotted rectrices. Since females of this species, and apparently of the entire genus *Archilochus* (Bent, 1940:358), are larger than males (cf. Ridgway, 1911:629), one could identify females vs. immature males by recording dimensions of wing, tail, bill, etc. However, such measurements are neither the most rapid nor, it would seem, the most reliable way of determining sex in this species. Nor can throat coloration be used in all instances, for although some immature males have one or more red throat feathers this is not always the case. Furthermore, while Ridgway's (*loc. cit.*) statement that the young female is "similar to the young male, but throat without dusky streaks," does indicate a tendency, it does not provide adequate means for identifying young hummers as to sex. More specifically, the short streaks or spots on the throat, grayish to dusky in the young male, are usually paler, more blurry, in the young female, but this sex difference is subtle and may almost overlap, so that the observer, unless he has studied carefully the throat markings in series of immature Rubythroats, will probably err in his judgment of some individuals.

Tail spots.—According to the series at hand, the fourth rectrix (from the outside) of females shows at least a trace of white at the tip. By contrast young males, which otherwise display white tail-spots similar to those of females, show no trace of white on this rectrix.

The sixth primary.—In the present study the shape of the sixth primary (or the fifth counting from the outermost, or tenth, primary), a feather that seems not to have been used by previous workers, proved the most reliable single character for determining sex irrespective of age. It is true that Ridgway, in his characterization of the genus *Archilochus,* says that the "six innermost primaries [are] abruptly narrower than the rest, with the edge of [the] inner web forming a more or less prominent angle subterminally." Now among these six narrow primaries, the outermost, or sixth, is conspicuously narrower than those (the seventh through the tenth) lying distal to it; this holds not only for adult males but also for immature ones. In males the tip of this primary is more pointed and more abruptly angulated than in females. Also its outer web tapers so as to become extremely narrow along the distal half of the feather. Subterminally, the width of this outer web is approximately 1 mm. in females, whereas it is 0.3 mm. or less in males (a difference readily seen at a glance).

AGE CHARACTERS

The distinctiveness of the adult male has already been mentioned. Adult females are not so easily singled out, and they might be confused with young females in the postbreeding or premigration season. Ridgway (1911:629), although helpful, does not make a direct comparison of females of the two age classes. In our series only one adult female (taken in mid-September) was available for plumage comparison. This specimen resembled most of the young hummers in that extensive molt was apparent over head, breast, and belly regions. The old bird, but not the young, also was molting the upper tail coverts, which were mere pinfeathers. Although the Rubythroat is said to have a complete molt in spring (*fide* Bent, 1940:358), we find no mention of its molting extensively in September. As is consonant with Ridgway's implication (*loc. cit.*), the throat and belly regions of the adult were whiter than in young females, and also the adult's flanks were more grayish, lacking the decidedly buffy tinge of the immatures. The remiges, and especially the rectrices at their tips, were more worn in the older female Rubythroat, and the remiges had a rather more brownish cast than did those of immature birds.

SEX RATIOS AND AGE RATIOS

Birds trapped or taken from the *Crotalaria* population showed an even sex ratio, 16 males to 16 females. Of this series of 32, only two (a male and a female) were adults, the rest being birds of the year. From this sample, which was obtained randomly or strictly on the basis of availability, we may say tentatively that adults made up only about 7 per cent of the aggregation. Since three or four adult males were noticed in the group, this would tend to support the estimate that this gathering comprised 100 or more individuals.

Body Weight and Weight Loss

Body weight.—In the Savannah River Plant area, a triple-beam balance taken into the field enabled prompt weighing, inside a car, of birds netted or shot for study purposes. The times at which birds were obtained varied, so that very little bias results from daily fluctuations in weight. The data on body weight, or total weight, of Ruby-throated Hummingbirds, as well as on heart weight relative to body weight and on fat content, are summarized in Table 1 (see Figure 1, also, for total weight). In both sexes body weight tends to fluctuate until mid-September, whereupon it increases. Just as females have larger measurements than males, so they tend to weigh more, the mean values (weighted) derived from Table 1 being 3.84 grams for females and 3.51 grams for males. A comparable difference holds for samples from both earlier and later parts of the aestivo-autumnal period. Weights of males taken on September 23 and November 4 are about 36 per cent greater than those handled from September 6 to 9; similarly, those of females taken on September 23 are some 45 per cent greater than those obtained on September 6 to 9. As may be judged from weight data in the literature and from the fact that the hummingbirds taken in earlier September already were moderately fat, the per cent increase in weight from mid- or early summer to late September would seem even more drastic, probably of the order of 50 to 70 per cent.

Weight and moisture loss.—A test of weight loss after death was made for seven specimens. Taken between 7:20 and 9:35 a.m., these were weighed almost immediately after death, then kept in small aluminum-foil cones placed inside protective paper cones, and finally weighed again after periods of 3.5 to 5 hours (the day was very hot and the cones were kept in a shady place). Weight loss in the hummingbirds in this period, which averaged more than four hours, ranged from 0.26 to 1.87 per cent, averaging 1.09 per cent. Whether paper cones alone would have checked desiccation as satisfactorily as this remains to be determined. It is our feeling that metal-foil cones provide an adequate safeguard against desiccation and consequent weight loss in small birds collected in hot weather. Such a safeguard is recommended if such specimens are to be carried for several hours before they are weighed.

As to the netted birds, it was noted that considerable moisture formed inside the vials in which Rubythroats were kept for several minutes. Inserted dry, the birds would come out damp. Dr. Eugene Odum expressed interest in this fact, commenting that "birds are not supposed to sweat." One of the

Table 1

Body Weight, Heart Ratio, and Fat Content in Ruby-throated Hummingbirds in Late Summer and Fall

Date[1]	Total Body Weights: Collected and Color-Marked Birds			Heart Ratio[2]	Fat Content: Collected Birds			
	No.	Mean	Extremes		No.	Gross Ratings[3]	Per Cent Fat of Wet Weight	Per Cent Fat of Dry Weight
Males								
July 15 (G)	1	3.4	—	—	1	—	15.1	45.88
Sept. 6, 7	2	3.51	3.10, 3.92	2.04	1	(3.0)	—	—
Sept. 8	5	3.41	3.05–3.85	2.05	5	(3.0)	—	—
Sept. 9	4	3.32	2.94–3.82	1.83	1	(3.0)	—	—
Sept. 12	2	3.06	2.83, 3.36	2.26	2	(2.5)	—	—
Sept. 16	2	3.56	3.32, 3.81	1.98	2	(3.5)	18.8, 28.6	47.82, 61.05
Sept. 23	1	4.99	—	1.50	1	(5.0)	44.3	75.64
Nov. 4 (F)	1	4.20	—	—	1	—	40.6	74.08
Females								
June 11 (G)	1	3.2	—	—	1	—	11.1	33.02
Aug. 2, 11 (G)	2	3.55	3.2, 3.9	2.43	1	—	14.0	45.41
Sept. 6, 7	3	3.75	3.44–3.97	—	–	—	—	—
Sept. 8	3	3.34	3.21–3.37	1.80	2	(3.0)	—	—
Sept. 9	3	3.61	3.54–3.96	1.60	2	(3.5)	—	—
Sept. 12	3	4.03	3.64–4.34	1.58	3	(3.7)	—	—
Sept. 15 (G)	1	3.5	—	—	1	—	16.3	42.35
Sept. 16	2	4.21	4.18, 4.24	1.66	2	(4.0)	28.2, 32.6	60.13, 64.72
Sept. 23	2	5.16	4.73, 5.65	1.16	2	(5.0)	41.2, 45.9	75.37, 77.89

[1] "G" in parentheses refers to specimens taken by Johnston in the Macon, Georgia, region; "F," to a specimen taken by H. L. Stoddard in 1954 in western Florida. Four specimens (female, June 11; male, Sept. 8; female, Sept. 15; female, Sept. 16) were adults; the others were immatures.

[2] Heart weight expressed as a percentage of body weight, as determined for 12 males and 11 females.

[3] Crude estimates, thus—1 = slightly fat, 2 = somewhat fat, 3 = moderately fat, 4 = very fat, and 5 = extremely fat; these estimates were made before the fat content was determined.

writers (Norris), having seen that nectar was an important food item, wondered whether some or most of the moisture was excreted via the cloaca and anus. It might be added that when the living hummingbirds were handled, the surrounding temperatures were usually warm to very hot. In this observation of moisture loss by closely confined hummers we might have the germ of an interesting physiological problem.

HEART RATIO

Hearts from a number of specimens were excised for weighing. First, stumps of vessels were trimmed off, blood was washed from the auricles, and the surfaces of the hearts were gently blotted. Weights were recorded to the nearest five-thousandths gram on the same balance as used for body weights. It is apparent in Table 1 that the "heart ratio," or heart weight/body weight ratio, decreases as total body weight increases. Thus the high ratio characteristic of relatively lean Rubythroats, which seems to be 2 per cent or more even in females (cf. Hartman, 1954:468; also the August 11 specimen, Table 1), becomes increasingly obscured as the birds wax heavier and fatter with the passage of September. As Odum and Perkinson (1951:219, 229) point out for a passerine species, the heart's fat deposits, unlike those of other parts of the body, show little seasonal variation. Hence, a decrease in the heart-ratio value with increased general fat deposition, which is especially well illustrated by the data on female hummingbirds (Table 1), was actually to be expected. For this reason very fat birds are not useful in ascertaining heart ratios for comparative purposes.

Actual heart weights, in grams, were as follows: 12 males, .071 ± .0012 (.065–.080); 11 females, .063 ± .0016 (.055–.075). Coefficients of variability were 5.6 for males, 8.3 for females. This difference, in which the male has the larger heart, is statistically significant ($t = 4.1$; $P<.01$); it could be accentuated if expressed in terms of heart ratios for birds with little or no fat. Even the ratios for the more or less fat specimens (Table 1), while of limited value for interspecific or higher-category comparisons, provide good indications of sex differences in heart size. Thus, while the heart ratio of the fattest male was reduced to 1.50 per cent, those of the two fattest females, collected at the same time as the male, were both reduced to approximately 1.16 per cent.

Fat Content of Specimens

In making fat extractions of certain of the specimens, Connell based his procedure on that outlined by Odum and Perkinson (1951:217, 218). As is evident in Table 1, both the gross estimates or ratings of fatness and the exact percentage values for extracted fat show increases in mid- and late September. Clearly the total-weight increases are due largely to increased deposits of fat. Although quite limited, the data from adult hummingbirds suggest that there are no appreciable differences in fatness with reference to age class. Immatures, which made up over 90 per cent of the aggregation in the *Crotalaria* patches, were among the fattest and heaviest of the collected birds, and they probably are typical of the species as a whole. Incidentally, the young female weighing 5.65 grams, of which 45.9 per cent was fat, is very likely the heaviest and fattest Rubythroat on record! As may be calculated from figures in the column on wet weights, the last hummingbirds shot, on September 23 and November 4, were carrying from 1.7 to 2.6 grams of fat (averaging about 2.1 grams), a considerably heavier load than was estimated by Pearson (1950:151). As has been pointed out by Odum and Connell (1956), if Pearson's data, including figures on flight speed and rate of energy expenditure, are employed, 2.1 grams of fat should enable Ruby-throated Hummingbirds to fly about 800 miles—hence across the Gulf of Mexico.

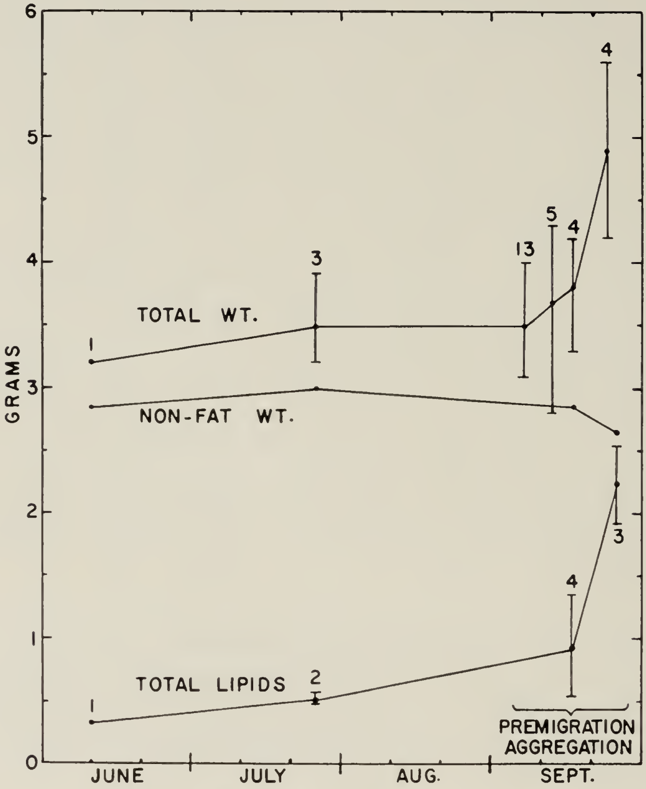

FIG. 1. Changes in weight and fat deposition in Ruby-throated Hummingbirds in late summer and fall. Numerals above vertical bars indicate number of specimens for each sample.

SUMMARY

In early September, 1955, an estimated 100 to 150 Ruby-throated Hummingbirds foraged, waged battle, and roosted in about four acres of *Crotalaria* in the Savannah River Plant area, Aiken County, South Carolina. Much of their food was nectar taken from the *Crotalaria* flowers. The birds' numbers declined after mid-September, and the last individuals were seen on September 24. Ten hummingbirds caught in mist nets were color-marked, but there were no repeat records. Both the shape of the sixth primary and the throat coloration provided criteria for distinguishing in the hand males and females among immatures. An adult female lacked the ventral buffiness characteristic of young females. The sexes were present in about the same numbers, but adults (male and female) seemed to comprise only about 7 per cent of the aggregation. Body weights for summer- and (especially) fall-collected hummingbirds (including some from Georgia and Florida) averaged about 3.8 grams for females and about 3.5 grams for males. Weights increased markedly after mid-September, as did fat content. Heart ratios, in contrast, decreased with increase in body weight and fatness; heart weight *per se* was relatively constant and was significantly greater in males than in females. Fat content, expressed as per cent of wet weight, ranged from about 11 to 15 per cent in June to about 41 to 46 per cent in heavy, premigratory individuals. The heaviest birds, each carrying about two grams of fat, were thought to have sufficient fuel to travel nonstop some 800 miles.

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SOME AVIAN FLYWAYS OF WESTERN AMERICA

BY LOYE MILLER

MUCH has been written concerning the pathways followed by birds that pass back and forth in seasonal migration but, in North America, these items pertain largely to the eastern and mid-western sections. Many of the routes followed are hypothetical, being drawn with the ruler laid down on the map and connecting the breeding area with wintering area or point of release with point of recapture, too little being known as to the specific route followed. Furthermore, even those excellent accounts that report the bird in actual transit deal with migrants flying at low elevations and where topography of land surface enters as a determining factor and the element of guidance receives the major emphasis.

In the western United States some local flylines seemingly are determined by contrasting elevation and the correlated conserving of energy on the part of the bird. Relatively low basins are isolated by high and abrupt mountain masses through which water gaps and faulting lines form the main pathways of communication. These mountain passes may constitute pathways of seasonal migration or of slower diffusion through a succession of years. The factors of guidance or of upwelling air currents may participate but they appear to be of minor significance.

Many years of field work on my part in California and Arizona have resulted in some rather distinct impressions supported by definite data. These impressions, used in oral presentation before classes in ornithology, I have been urged to present in some more permanent medium.

The Role of Fault Lines

One striking character in the physiography of California is the multitude of its fault lines. The San Andreas, Garlock, Elsinore, and Sierra Madre faults—to mention but a few, have I am confident had an influence upon bird movement (Fig. 1). My many camps along one or another of these lines have given me the feeling that they constitute fly-lines for birds that are even more definite than some of the sky-ways of human aviators and sometimes for comparable reasons.

The San Andreas Fault.—This great fault begins with the extended trough of the Gulf of California, in Mexico. Here in late March of 1938, I watched the California Gulls (*Larus californicus*) organizing their bands to set forth on the northwestward drift to the breeding grounds in the basin country of California and Nevada.

Farther along this fault the Coachella Valley, leading into San Gorgonio Pass, offers a pathway ranging from below sea level at Indio to approximately

2,000 feet at Banning, whereas the mountains on either side of the pass rise to 10,800 and 11,400 feet. Many observations have been made along this segment of the fault. Birds actually watched in transit are recorded as follows—

March 15, 1913.—A mixed flock of Vaux Swifts (*Chaetura vauxi*), Violet-green (*Tachycineta*), Cliff (*Petrochelidon*), Tree (*Iridoprocne*) and Barn (*Hirundo*) swallows moving slowly to the northwest.

April 18, 1916.—A flock of the same species moving similarly. In addition there was one Belted Kingfisher (*Megaceryle alcyon*) by himself.

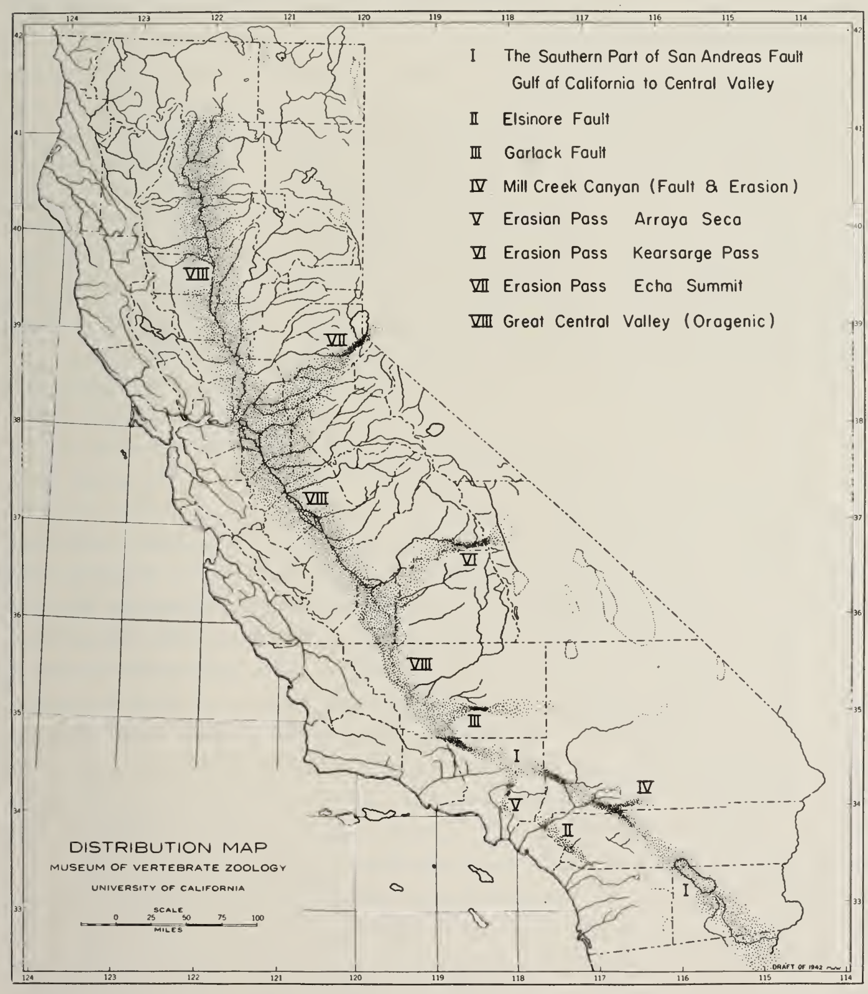

Fig. 1. Outline map locating routes in California that are mentioned in the text. Density of stippling suggests concentration of migrants through narrow parts of passes. Prepared by Gene Christman.

April 2, 1920.—Barn, Violet-green and Tree swallows in flocks. Not in flocks were Scott's Oriole (*Icterus parisorum*), Tolmie Warbler (*Oporornis tolmiei*), Yellow-throat (*Geothlypis trichas*) and Black-crowned Night Heron (*Nycticorax*).

March 26, 1921.—Violet-green Swallows in flock.

March 30, 1921.—A dozen *Phainopepla nitens* in a fairly close flock moving out through the pass.

April 8, 1922.—An Osprey (*Pandion haliaetus*) beating out the pass against the wind just above the desert shrubs. A large flock of Swainson's Hawks (*Buteo swainsoni*) tarried to feed on sphynx moth larvae at a point below sea level. On one spring trip a flock of White-fronted Geese (*Anser albifrons*) worked northward through the pass near Whitewater Ranch. They were flying less than 15 feet above the creosote bushes and tacking back and forth against a strong headwind.

April 9, 1922.—Large numbers of Lewis Woodpeckers (*Asyndesmus lewis*) at the northwestern end of the pass below Beaumont.

Further items are merely repetitious and need not be included.

From San Gorgonio Pass the fault leads northwest through Cajon Pass and Swarthout Canyon to Antelope Valley, which is occupied by desert vegetation of Joshua tree, creosote bush, various cacti and sagebrush. Here during the spring migrations, I have observed steadily moving flocks of sandpipers and White Pelicans (*Pelecanus erythrorhynchos*) close above the Joshua tree forest and a single Bonaparte Gull (*Larus philadelphia*) in high plumage that seemed to be catching a meal of grasshoppers *en route.*

Near old Fort Tejon the San Andreas Fault breaks across the southern end of the great Interior Valley of California, the Sacramento-San Joaquin basin that runs for the major part of the length of the state at an elevation of less than 2,000 feet and migrant birds have no further need of the great fault as a flyway to the northward.

The local subsidary fault of Mill Creek Canyon lies parallel with San Gorgonio Pass but at a higher elevation. It is separated by a relatively low notch from the Whitewater River on the desert side and debauches into the San Bernardino Valley to the westward where it connects with Cajon Pass of the major San Andreas Fault. On August 24, 1913, just before sunset, I saw a flock of Phainopeplas flying through this canyon in close formation like a flock of blackbirds. They are not found in this canyon ordinarily but these individuals were seemingly moving from the San Bernardino area to their wintering grounds in the Colorado Desert, perhaps as far south as Sonora. Abundant mistletoe berries furnish a winter food supply for a large population of this species in the Colorado Desert basin.

The Elsinore Fault.—In the early history of California as a state the Butterfield Stage Company played an important part in connecting coastal southern California with the eastern United States. Part of the stage route through the mountain and desert barrier to the eastward followed the Elsinore Fault that opens into the valley of the Santa Ana River near the present city of Corona. Along this fault near the site of the former stage station of Temescal

I found on April 9 of 1907, numbers of Lewis Woodpeckers in northward movement and in August of 1908 large flocks of White Pelicans.

The ephemeral Lake Elsinore and Lee Lake occupy this depression. In certain rainfall cycles, the White Pelicans are abundant on Lake Elsinore. The Santa Ana Mountains rise very abruptly to an elevation of 5,600 feet along the west side of the fault. The pelicans seemingly preferred not to scale this high wall.

The Garlock Fault.—This transverse fault extends for many miles across the southern end of the Sierran block to cut through the mountains east of Bakersfield via Tehachapi Pass and connect the Mojave Desert with the great Central Valley. Through this pass two great railway systems send all their eastbound traffic from the San Joaquin Valley. The Garlock joins the San Andreas Fault in the vicinity of old Fort Tejon. Along its course there may have diffused the several species of desert plants and animals that are found in the southern end of the San Joaquin Valley.

Only once have I been fortunate enough to observe it as a "fly-line" in active use. On one of my spring trips to Berkeley, I stood on the observation platform of a Southern Pacific train near Mojave Station and watched a flock of gray geese flying low over the desert scrub, overtake our laboring train and pass on through the notch cut through the Tehachapi Mountains by the Garlock Fault.

The Role of Erosion Passes

A fascinating aspect of biologic study in southern Arizona is the mixture of northern and southern faunas that one encounters there. This blending takes place, to be sure, across a man-made political boundary not visible to the wild creature. Nevertheless there are certain pathways that are recognizable. Two of these have been especially evident in my field studies. One of them is the valley of the Santa Cruz River. From the region of Nogales it runs northward to join the Gila River beyond Tucson and thence into the great Colorado basin. The Beardless Flycatcher (*Camptostoma imberbe*), Ferruginous Pigmy Owl (*Glaucidium brasilianum*), and Boat-tailed Grackle (*Cassidix mexicanus*), to mention but a few, come northward along this path into Arizona.

In early April of 1894, I saw a flock of about a dozen Black-headed Grosbeaks (*Pheucticus melanocephalus*) migrating along this fly line. They were all males, they were in a compact flock and moved steadily northward over the desert vegetation just out of old Tucson.

About 15 miles west of Nogales the Pajarito Mountains are cut through by the narrow gorge of Sycamore Canyon that is occupied by a stream flowing south into the Magdalena drainage of Sonora. By way of this canyon we have received from Mexico a number of plant species, a small minnow, a frog, and a tree snake. On June 30, 1945, all at once the canyon was enlivened with the calls of many Yellow-billed Cuckoos. They were not there during the two previous days and by July 2 they were heard no more. On June 30, also, two strange raptors were observed passing through the gorge close to our camp. My camp mate, A. J. van Rossem, and I saw them but neither could name them. We were quite in agreement, however, that they were strangers to the North American fauna. They disappeared slowly down the gorge and have remained an enigma ever since.

The San Gabriel Mountains of California make up the east-west barrier that separates the coastal plain of the Los Angeles area from the Mojave Basin to the northward. The deepest erosion notch through this range is cut by the Arroyo Seco that descends into the busy metropolitan area near where the little Mexican pueblo of Nuestra Senora La Reina de Los Angeles was first established in the early days of Spanish colonization.

For 25 years my home was on the west bank of this waterway that I soon learned was likewise a flyway. A high gear automobile road now takes advantage of this gateway through the wall but the birds must have used it for a geologic period. Time and again we have stood on our overlook balcony and watched the flocks of White Pelicans ploughing the air up the Arroyo Seco only a few hundred feet above the housetops. About the last of March I would begin to expect them and have even made bold at times to predict (with success) that, within the week, some of us would see the White Pelicans passing northward up the canyon headed for the Great Basin. One spring I happened to be on the slopes of Mt. Wilson when a flock came in. They had not gained quite enough altitude to take them safely through the notch, so they had to circle in an up current. I actually looked down upon the backs of these great birds, some of them measuring upwards of eight feet in wing spread. They looked most incongruous against the pine trees of the mountain sides.

Much of the eastern border of California is separated from the Great Basin area by the high, abrupt wall of the Sierra Nevada. In this area altitude must certainly influence the course of migration, since much of the range lies at 12,000 feet or more, and gateways at lower levels offer a distinct advantage to heavy bodied birds during extended flights.

One such gateway lies at the head of the American River near which I camped for two summers. Here again the White Pelicans were observed on June 15, 1919, passing between the interior valley of California and their breeding grounds at Pyramid Lake in the Great Basin country. They flew so low over the pine tops that the rush of their wings was like escaping steam.

Another summer we were camped at Bull Frog Lake on the west side of Kearsarge Pass in the southern part of the Sierra. On August 23, 1928, I stumbled up to the pass in the half light of dawn to watch the sun come up out of the desert to the eastward. I was soon diverted, however, to bird-watching and spent nearly four hours beside the survey marker that registered 11,823 feet. Peaks rose abruptly another thousand or more feet on either side, the divide was almost knife-edge sharp and devoid of vegetation, yet birds were moving through. Chipping Sparrows (*Spizella passerina*), Audubon's Warblers (*Dendroica audubonii*) and a small greenish warbler passed through from the west. One Red-tailed Hawk (*Buteo jamaicensis*) went through but the most impressive was a flock of White-fronted Geese (*Anser albifrons*). Just as the sun came up a dozen of these geese came wedging their way in from the northeast headed for their wintering grounds among the grain fields of the great Central Valley. They cleared the pass by what seemed only a few inches—almost scraping their checkered breasts on the sharp rocks but a few dozen yards from me. They had probably been flying all night and they were conserving every ounce of fuel. Their steady wing beats carried them through the notch and out over the lower parts of the canyon where the sun had not yet risen. I saw them disappear into the blue shadow whence they could plane down to a resting ground in the marshy country about Buena Vista or Tulare lakes. I wondered how many generations of their ancestors had followed that same trail through the notch of Kearsarge Pass.

True it is that many observations have been made that record birds migrating at fairly high altitudes and quite independent of surface topography. Here they may gain ultimately by advantageous air currents or meteorologic "fronts." On the other hand, I am inclined to believe that, all other factors being equal, the bird will fly at a moderate altitude if no barrier confronts him, and that mountain passes here in the West have determined some very definite fly lines.

Summary

Actual observations of moving birds through mountain passes in California and Arizona are put on record. These passes are discussed under two heads—fault lines and erosion gaps. It is postulated that altitude is an important factor in the bird's metabolic economy during migration. Hence it may determine the migration route.

Museum of Vertebrate Zoology, Berkeley, California, July 27, 1956

FOOTEDNESS IN DOMESTIC PIGEONS

BY HARVEY I. FISHER

In studies of the landing forces of Domestic Pigeons (*Columba livia*) it was noted (Fisher, 1956*a*, 1956*b*) that the birds did not always land simultaneously on both feet. The apparatus used made it possible to determine which foot was of primary importance in landing.

In some landings both feet are uniformly extended forward and down to meet the platform; this is designated as landing on both feet. At other times and in other pigeons the right or left foot is extended farther forward and bears the main brunt of landing; the opposite leg and foot are moved laterally and apparently serve as a balancing brace at the time of contact with the perch. Any laterally directed push exerted by either leg is indicated as a lateral force on the recording drum of the machine. A right-footed landing is one in which the left leg and foot are the brace and the right foot touches down first to stop the bird. Left-footed landings are characterized by a balancing function of the right foot, while the left takes the force.

Correlation of slow-motion pictures, of observation at the moment of landing, and of the record of forces measured by the apparatus enabled me to establish "patterns of footedness" for each pigeon.

The general methods of handling the birds were as described earlier (1956*a*). In the present experiments the birds usually were landed at least 100 times in a 3-hour period at weekly intervals. Duration of experimentation with each bird can be found in Table 1. Birds nos. 54–104 were used in 1954–1955, the others (106–110) in 1956. Because many of these data were gathered from experiments designed for other purposes, only fragmentary information was available on several birds. On some dates, data on footedness were taken only part of the time. However, the data analyzed included 7259 landings by 11 different pigeons.

From the curves representing forces exerted by the feet it is possible to derive two kinds of information on footedness—footedness at the time of initial contact with the platform and footedness based on greatest lateral force exerted during landing. Both these analyses were made and the results did not greatly differ. The foot used as a brace on the initial contact with the platform was usually the one that exerted the greatest force later in the process of landing. For example, in Table 1 it may be noted that, on an initial contact basis, bird no. 102 landed 56 per cent of the time on the right, 37 per cent on the left, and 7 per cent on both; comparable data, on a greatest lateral force basis, are 50 per cent right, 34 per cent left, and 16 per cent both. Further, it appeared that initial choice was a better indication of innate behavior than was greatest force, which might depend on other variables, such as imperfect balance after landing, for example. Therefore, all data in this paper were derived on the basis of the initial contact.

RESULTS

Data in Table 1 indicate that, if all the landings for each bird are considered, seven of 11 pigeons were right-footed most of the time, three were left-footed, and one (no. 108) showed no significant preference for either foot. (No. 57 is a special case to be discussed later; it is here considered to be right-footed.) In each instance the preference was significant (at least 3 to 1, except for pigeons 102 and 107); in no. 102, with only 244 observed landings, the difference may or may not be significant, but the difference between 35 per cent and 53 per cent for pigeon 107, which was observed on more than 1300 landings, was significant.

TABLE 1

SUMMARY OF FOOTEDNESS IN ELEVEN PIGEONS

Pigeon number	Total landings	Duration of experiment (weeks)	Foot landed on (per cent)		
			Right	Left	Both
54	338	6	27.2	66.0*	6.8
55	218	6	63.8*	22.9	13.3
57 (first weeks)	477	7	70.2*	23.5	6.3
57 (last weeks)	496	8	13.3	82.5*	4.2
101	276	5	65.6*	24.6	9.8
102	244	7	56.1*	36.9	7.0
104	40	1	12.5	47.5*	40.0
106	61	1	91.8*	3.3	4.9
107	1312	16	35.1	52.6*	12.3
108	1443	16	44.4	43.2	12.4
109	1302	12	92.5*	2.6	4.9
110	1052	14	93.3*	5.2	1.4

* Indicates predominant use.

It is of interest that three birds (nos. 106, 109, 110) were right-footed more than 90 per cent of the time. The other extreme is of course no. 108 which was nearly "ambidextrous."

Simultaneous and equal use of both feet usually occurred less than 15 per cent of the time (Table 1, Figs. 1 and 2); bird no. 104 showed 40 per cent of the landings on both feet, but this was seemingly a phenomenon associated with the small number of landings.

Figure 1 illustrates the day-to-day variation in footedness as exhibited by pigeon no. 107. Such working graphs were constructed for each bird. Figure 1 represents a situation similar to that found in pigeons 54, 55, 101, 102, and 108. Several interesting facts are evident, and they are generally true for all the pigeons just listed. On the first day's trials the birds showed less preference than was usual in later trials. The only pattern visible was that for several weeks (April 19–May 1, for example) a bird would be left-footed, then be right-footed for one to three or four weeks, and finally again be left-footed or right-footed, as the case might be. Footedness in these pigeons might thus be considered partly as a pattern set up each day by some event during the first trials of that day or perhaps by something in the latter landings of the previous period of experimentation. However, it is evident in Figure 1 that no. 107 was essentially left-footed for the first eight weeks and then *gradually* became predominantly right-footed.

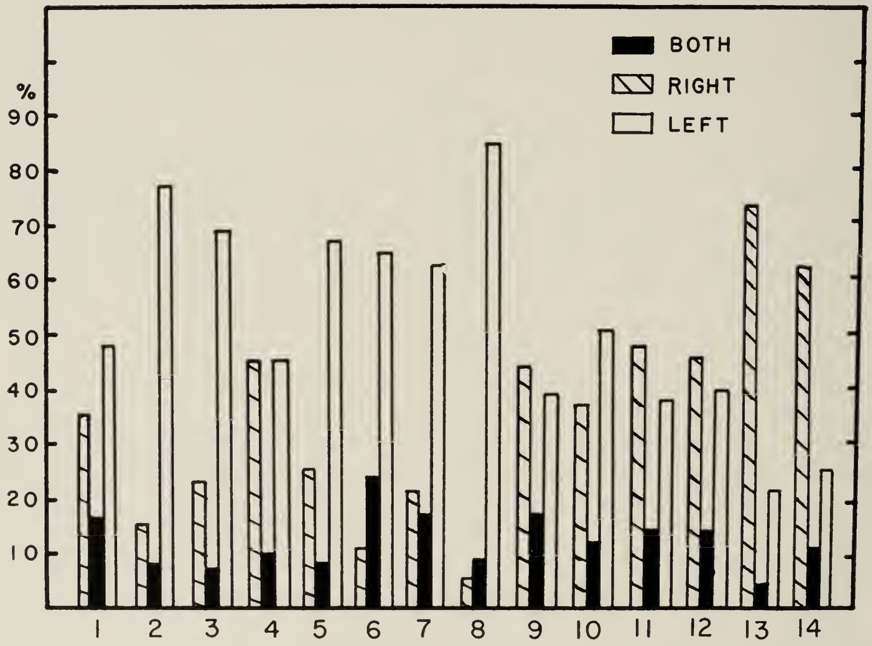

Fig. 1. Choice of foot during 14 successive, weekly sets of 100 experimental landings by pigeon number 107.

In an attempt to discover the causes of change in footedness, the data for each bird were set up in successive groups of 20 landings on each date. Information in Tables 2 and 3 is selected from the much more extensive working tables for these birds. Study of these working tables revealed that the pigeons demonstrated less preference for either foot during the early trials on any one day than was generally the case for subsequent trials on that day. Note the data in Table 1 on pigeon no. 104. Further, in Table 2 compare landings 1 to 20 with the average of any other set of 20. Bird no. 108 (Table 3) did not show this pattern, but remember that, considering all dates and trials, it was the one bird that showed more or less uniform use of either foot. It is of passing interest that the landings from 40 to 80 in no. 108 were significantly right-footed, based on the averages of all trials, not just those shown in the table.

Rapid, perhaps day-to-day, changes from left to right or vice versa might be foreshadowed by changes in choice evident the preceding day of trials.

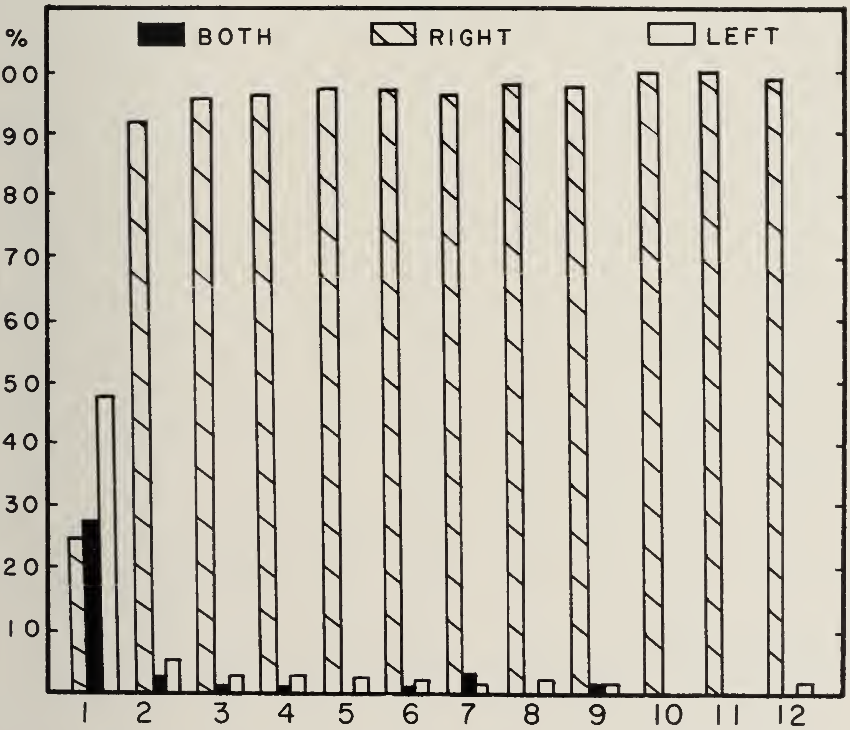

Fig. 2. Choice of foot during 12 successive weekly sets of 100 experimental landings by pigeon number 109.

This did not seem to be true, however. There was no tendency, for example, for a right-footed bird to be more left-footed in the later trials of the day preceding its change to the left-footed condition.

Figure 2 illustrates successive experiments with a bird that was unquestionably right-footed. Birds 109 and 110 were extremes of this type.

Pigeon no. 57 represented a particularly interesting example of an apparent

TABLE 2

FOOTEDNESS IN PIGEON NO. 107 ON SELECTED DATES

		Trials				
Date	Foot	1–20	21–40	41–60	61–80	81–100
April 19	right	lost	6	6	9	8
	both		0	4	4	5
	left		14	10	7	7
April 24		1	5	4	3	none
		2	3	0	2	
		17	12	16	15	
May 22		9	4	7	4	1
		2	3	1	2	0
		9	13	12	14	19
May 29		3	2	4	1	1
		7	4	4	4	5
		10	14	12	15	14
June 19		10	7	10	8	10
		5	1	6	2	4
		5	12	4	10	6
June 26		7	10	9	7	3
		4	2	2	3	1
		9	8	9	10	16
July 3		17	4	6	8	13
		1	4	4	5	1
		2	12	10	7	6
July 24		10	13	18	15	18
		1	1	0	1	0
		9	6	2	4	2
All 14 days of trials—percent	right	41.9	34.6	36.2	29.7	33.9
	both	16.2	11.6	10.8	13.3	9.4
	left	41.9	53.8	53.1	57.0	56.7

change in footedness. This bird was one of six used in extensive experiments in 1954–1955 (Fisher, 1956*a*). Some time after the culmination of the initial experiments, all the birds exhibited typical symptoms of Vitamin B deficiency and their condition was later diagnosed as such. The pigeons had been held indoors for nearly a year, and fed a diet of cracked corn, cracked wheat, and sorghum grain. However, for three months prior to the appearance of the symptoms the diet was primarily cracked wheat which was stored in a heated building; the vitamins were largely lost under these conditions.

TABLE 3
FOOTEDNESS IN PIGEON NO. 108 ON SELECTED DATES

Date	Foot	Trials				
		1–20	21–40	41–60	61–80	81–100
April 19	right	10	8	3	2	none
	both	2	2	6	0	
	left	8	10	11	9	
April 24		6	5	3	2	4
		2	4	6	6	2
		12	11	11	12	14
May 1		11	17	17	18	14
		0	0	3	1	1
		9	3	0	1	5
July 3		2	1	4	2	1
		2	2	2	0	1
		16	17	14	18	18
July 10		4	2	4	2	0
		6	2	4	5	3
		10	16	12	13	12
July 24		10	16	19	20	18
		3	3	1	0	1
		7	1	0	0	1
All 14 days of trials—percent	right	43.2	41.4	49.4	47.8	43.0
	both	10.4	13.9	12.8	12.0	12.1
	left	46.4	44.6	37.7	40.2	44.9

Treatment of the birds with concentrated vitamins apparently resulted in complete recovery.

No. 57 which had been a right-footed bird prior to the deficiency (Table 4) became decidedly left-footed and remained so until its death from other causes some six months later. It is significant that the change took place within a two-week period. At autopsy there was observed a macroscopic lesion of the central portion of the central lateral part of the right cerebral hemisphere. Whether the damage was induced by the deficiency and whether the lesion caused the change in footedness could not be determined; the evidence was circumstantial.

This pigeon showed the typical less-defined choice of foot in the initial 20 to 40 trials each day. As a right-footed bird the initial trials each day were about 54 per cent right and 39 per cent left; by the end of the first 100 landings each day it landed 90 per cent on the right foot and 5 per cent on the

TABLE 4

FOOTEDNESS IN PIGEON NO. 57, IN PERCENTAGES

Date	Foot	Trials 1–20	21–40	41–60	61–80	81–100	Average
Dec. 3–30	right	54.3	59.2	88.8	82.5	89.5	70.2
	both	7.1	9.2	2.5	5.0	5.3	6.3
	left	38.6	31.7	8.8	12.5	5.3	23.5
Jan. 8–Feb. 9	right	25.4	8.3	9.2	8.1	9.9	13.3
	both	3.0	4.2	7.3	1.6	4.2	4.2
	left	71.6	87.5	83.5	90.3	85.9	82.5

left. As a left-footed bird, it averaged 72 per cent left and 25 per cent right in the first 20 trials each day, and by the finish of the day's trials it averaged 86 per cent left and 10 per cent right.

It should be noted here that the birds were worked in pairs in so far as was possible; that is, nos. 54 and 55, 101 and 102, 107 and 108, and 109 and 110 were flown and landed on the same days. The fact that the two birds in a pair did not always show the same preference indicated the probability that external factors were not the deciding factors on any one day. Further evidence for this probability is in Tables 2 and 3. Compare, for example, the percentage for the two birds on July 3.

SUMMARY

Observations and mechanical recordings were made of 7259 experimental landings by 11 domestic pigeons. During the five to 16 weeks of experimentation with each bird it was noted that seven pigeons used the right foot predominantly, three the left foot, and one bird showed no particular preference for either. Three birds used the right foot more than 90 per cent of the time. No individual showed such a significant choice of the left foot; no. 57 used the left foot 83 per cent of the time but only under abnormal conditions. One might say, therefore, that the right-footed condition was usual and that the left-footed pigeons were not as strongly left-footed as the right-footed birds were right-footed.

To my knowledge, predominant use of right or left limbs has not been demonstrated previously in any animal except man.

The pattern in pigeons does not, however, seem to be of the same kind as in human beings. In pigeons, although they may show an average preference for one foot over a long period of time, choice of foot seems in part to be a matter of daily preference. In general, there was less choice shown on the first

day a pigeon was landed and on the first 20 to 40 landings each day. Analysis of records preceding day-to-day changes in footedness did not reveal any gradual change in choice of foot. There may, however, be a gradual change over a period of several weeks.

It may be that there was a determining stimulus in the way the birds were handled, but all birds were treated in exactly the same manner and pairs of birds landed on the same days exhibited different patterns. If there was an external stimulus provided by the experimental situation, it did not affect all pigeons in the same way.

ACKNOWLEDGMENTS

A number of persons helped me in the rather tedious process of training and flying the pigeons. The Graduate College at Southern Illinois University provided financial assistance. My thanks go to all who aided me.

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DEPARTMENT OF ZOOLOGY, SOUTHERN ILLINOIS UNIVERSITY, CARBONDALE, ILLINOIS, FEBRUARY 4, 1957

Saw-whet Owl (*Aegolius acadicus*)
with meadow vole (*Microtus*). Photographed on the Weber River, Weber County, Utah, in April, 1948, by R. J. Erwin and Richard D. Porter.

GENERAL NOTES

Lark Sparrow oiling its tarsi.—Elder's (1954. *Wilson Bull.*, 66:6–31) study of functions of uropygial glands of birds and his review of the literature prompt me to report a related activity of the captive male Lark Sparrow (*Chondestes grammacus*) whose behavior I have been studying for over a year. This bird was brought me by Jean Graber, who found it on a sidewalk in Norman, Oklahoma, apparently unattended by either of its parents, on June 10, 1955. We judged from the amount of natal down still clinging to feathers of back and crown, the quarter-inch length of exposed rectrices, and the way the bird sat upon its heels that it was about 10 days old. The sparrow was and has been vigorous, healthy, free of obvious ectoparasites, and apparently normal in every way. It will not dust-bathe but does take one water bath each second, third or fourth day. Tarsi and toes of the bird are sleek, smooth, rather glossy and of a pale flesh-pink color. Its pale horn-colored bill is smooth but not noticeably glossy.

Although it was in November, 1955, that the Lark Sparrow was first definitely known to oil its tarsi, I had noted, almost from the time it first began to bathe, that after the bath it made movements of the head toward the tarsi. But I had not given this much notice, believing the bird merely was trying to wipe water from its face. Close attention, however, soon showed that the bird was in fact oiling its tarsi. I now have watched this operation dozens of times at a distance of about 10 inches—the bird is completely trusting and strongly imprinted on me.

Typically, its behavior after the bath is as follows:

From the kitchen counter, where it bathes in a pie plate, the bird flies to the top of its hardware cloth cage and shakes itself vigorously. Then it begins to hop about, occasionally holding one wing or the other slightly out to the side with wrist somewhat lifted. It repeatedly wipes its face and the area of the eyes upon the cage top; also the bill alone sometimes is wiped there. During this short interval of hopping, shaking itself, and fluttering the wings, it will bring its widely spread tail around on one side, with rump feathers lifted, and begin to make incipient motions of the bill toward the oil gland. These preliminary movements are usually repeated on the other side before the bird at last puts it bill and face under the rump feathers. I can see the bill touch the skin there but cannot see actual touching of the uropygial nipple, though I feel certain this is happening.

After briefly touching the gland, the Lark Sparrow deliberately places one foot firmly forward on the cage top and rather quickly runs its opened bill down upon the front of that tarsus, from bend of heel to the toes. It pulls itself upright, places the other foot forward, and treats this other tarsus in like manner. Only *after* both tarsi have been oiled does the bird begin to preen, usually starting by pulling at mid-breast feathers and then stripping remiges of either wing. Preening and drying actions, continuing until the bird is dry, sometimes require 35 minutes. Once preening has started, the bird neither utilizes the oil gland nor employs the bill upon its tarsi. There are, nevertheless, one or two variations that may occur after the bath and prior to preening.

For one thing, after taking oil, the bird sometimes will oil, in the described manner, each tarsus as many as four times, on some occasions taking a second or third supply of oil to do so. For another, it will, additionally, treat its toes; but this is done on an average of about one time out of four.

Attention given the toes is curious. Movements are extremely rapid and hard to observe clearly. For a time I passed this off as scratching. Then I began to see that the bird was not scratching its face. The foot was brought directly upward to meet the down-reaching head as it was being lowered; rarely was it brought forward over the wing as in normal scratching of head and face. Treatment of toes, when it occurs at all, takes place invariably after the tarsi have been oiled. With head bent down upon the lifted foot, the bird rapidly plays the bill over its toes. The act seems to involve more or less circular movements of both bill and foot, in lateral planes. Feathers proximal to the bill seem to be touched also by the toes. It is a question whether the bird is oiling its bill or its toes. Perhaps it is doing both.

An interesting feature of the entire oiling procedure is that treatment of legs and feet is never seen except immediately after the bath, and is always preceded by the taking of oil from the gland. The bird seems not to take oil during preening unassociated with bathing. I have never seen it preen directly after touching the gland. Sometimes the Lark Sparrow will bathe twice, with a period of a minute or two between. At such times, touching of the gland and oiling of legs and feet are done immediately following the first bathing but not after the second bath. However brief its bath sometimes may be, the bird never fails to oil its legs subsequently.

I have seen no published reports of this behavior, and none of several ornithologists with whom I have discussed the matter had knowledge of it. Yet, Mrs. Aven Nelson, Colorado Springs, Colorado, and formerly a member of the botany faculty at the University of Oklahoma, writes me that she has observed this same activity in a pet House Sparrow (*Passer domesticus*) belonging to her sister in Long Beach, California.

Elder (*op. cit.*) found that ducks with ablated oil glands developed, in addition to plumage abnormalities, dryness and cracking of skin on feet and legs. The bills of these birds became dry and peeled. He showed that the uropygial secretion is necessary in ducks for normal condition of bill but he did not say whether this also holds for normal condition of feet and legs. He offered no explanation for the fact that his experimental birds regained normal conditions of bills, feet and legs during their third summer.

The question of relating tarsal preening in the Lark Sparrow with the probable shedding of its tarsal scutes arises. Robert W. Storer (MS. 1952. The problem of the molt of the tarsal scutes of birds.), pointing out the paucity of information concerning molt of tarsal scales, states that ". . . it would appear that the scales of the feet of birds are molted at least once a year and that this may be under the influence of the annual endocrine cycles. This, however, remains to be proved experimentally."

There seems to be no description of such molt for *Chondestes grammacus*, and I have not been aware of it in this present individual. The bird's manner and frequency of anointing its tarsi have remained the same throughout the seasons and during plumage molt.

Behavior of the captive Lark Sparrow suggests that a primary purpose of the oil gland, at least in some non-aquatic species, may be other than providing oil for the plumage. Perhaps Eugene Law's paper (1929. *Condor*, 31:148–156), showing absence of oil in feathers of certain birds, should not be summarily dismissed (Elder, 1954:11) after all.—Lovie M. Whitaker, *1204 West Brooks Street, Norman, Oklahoma, July 1, 1956.*

Feeding behavior of Red-tailed Hawks.—An uninjured immature Red-tailed Hawk (*Buteo jamaicensis*) was captured by hunters near Dearborn, Michigan, in December, 1948. The bird was placed in a cage two and one-half feet wide, six feet long and five feet high, with a broom handle providing a perch. When I banded the hawk on December 19, 1948, it weighed 793 grams. Periodically, dead mice and live English Sparrows (*Passer domesticus*) were introduced into the cage. The hawk captured the sparrows expertly. It would hold a sparrow under its talons, on the ground, for a minute or more.

Then, taking the sparrow in its beak, it would walk to the part of the cage farthest from the observer, lower its head and raise and spread its wings so as to completely hide its head and body from the observer. It would then pull out some remiges and proceed to eat the sparrow. If the observer moved so as to obtain a front view of the hawk, it would turn quickly, always keeping its back toward the observer and keeping the prey well hidden. When the bird was liberated on February 6, 1949, it weighed 892 grams.

An opportunity to observe the feeding behavior of a wild nestling Red-tailed Hawk was provided in the spring of 1956. One young was hatched in a nest within range of my window. At 1:10 p.m., June 20, the two-months-old young pounced upon the prey brought to the nest by its parent, but did not start eating immediately. The adult flew from the nest and for a few seconds the young one merely pecked at the food. Then, following violent back and forth movements of the head, it regurgitated two pellets within a few seconds. It then fell to eating ravenously. Suddenly it raised and spread its wings just as the captive hawk had done. In a few seconds, it folded its wings. After 10 minutes, it stopped eating and jumped to a small branch beside the nest (not for the first time). On June 21, it left the nest tree (for the first time), but on June 23, at 5:05 p.m., it returned to the nest and began to feed on prey brought there by one of the adult hawks. A Flicker (*Colaptes auratus*) flew over the nest tree, calling. Instantly, the young hawk raised and spread its wings, while continuing to eat, as it had done on June 20. After the Flicker had gone, the hawk folded its wings again. Perhaps this behavior serves to hide the prey from possible competitors.—ALICE D. MILLER, *1150 Brewer Road, Leonard, Michigan, August 21, 1956.*

Specimens of three birds uncommon in New Jersey.—A collection of birds recently made by me in New Jersey contains specimens which supplement the recent list of the birds of that state (David Fables, Jr., 1955. "Annotated list of New Jersey birds." Urner Ornithological Club, xi + 95 pp.). This collection of 108 skins and 94 skeletons is deposited in the University of Kansas Museum of Natural History, with which I was connected at the time.

Podiceps caspicus californicus. Eared Grebe.—I secured a male (K.U. 32994) with testes that measured 4 x 4 mm., weighing 256 gm., on February 16, 1955, at Wreck Pond, Spring Lake, Monmouth County. Fables (*op. cit.*:15) lists "two, or possibly three, sight records" through September 1, 1954. Several Eared Grebes have been observed in winter since this date by members of the Urner Ornithological Club (personal communication), but I believe my specimen is the first to be taken in the state. Comparison with the series at the American Museum of Natural History indicates the specimen is *P. c. californicus.*

Branta canadensis leucopareia. Canada Goose.—On December 21, 1954, I discovered a small, white-cheeked goose accompanying a flock of some 30 Coots (*Fulica americana*) and semi-feral Mallards (*Anas platyrhynchos*) on a fresh-water pond in Point Pleasant, Ocean County. The specimen was obtained the next day. The bird (K.U. 33003), which I identified as *B. c. leucopareia* on the basis of size and dark coloration, was a female (ovary 25 x 6 mm.) weighing eight pounds and was very fat. The brown rectrices indicate the specimen is a bird-of-the-year. The measurements are as follows: wing (chord), 407 mm.; tail, 133 mm.; exposed culmen, 45 mm.; tarsus, 77 mm.; middle toe without claw, 65 mm. There seems little possibility that this goose had escaped from captivity. Fables (*op. cit.*:20) lists several records of birds believed to be of this subspecies, but apparently no specimen had been critically examined.

Sterna fuscata fuscata. Sooty Tern. On August 13, 1955, shortly after hurricane

"Connie" had passed New Jersey to the west, I saw eight adult-plumaged Sooty Terns and one Bridled Tern (*Sterna anaethetus*) flying over Barnegat Bay near Lavallette, Ocean County. The birds were making little headway against the strong southerly winds and some of them rested several times on an island approximately 60 yards from me; thus I had time to study and compare the two species. With the aid of H. Lyman Sindle, I reached this island and secured a female Sooty Tern (K.U. 33036), which had an ovary that measured 11 x 5 mm. The bird weighed 150.1 gm. and had two small grasshoppers in its throat, and the remains of others in its stomach. Fables (*op. cit.*:40) lists four records of the Sooty Tern from New Jersey: one sight record, two decomposed birds, and a specimen which was in a private collection (Huber, 1917. *Auk*, 34:206). Therefore it seems my specimen may be one of the few that has been preserved for future examination. The Bridled Tern has been recorded once from New Jersey (Fables, *loc. cit.*). This record is of a dead bird found at Island Beach, Ocean County, on February 24, 1951, by E. and Q. Kramer. Concerning this specimen, which is number 167592 in the collection of the Academy of Natural Sciences of Philadelphia, James Bond (letter, Oct. 15, 1956) wrote, "It is in immature plumage, and in such bad condition that I have no doubt it had been lying on the beach for many days. Indeed, it may have drifted in from far out to sea!" My sight record is the first time the species has been recorded alive in the state.—GLEN E. WOOLFENDEN, *Department of Biology, University of Florida, Gainesville, Florida, September 22, 1956.*

Ring-billed Gull steals food from Coot.—During March, 1956, at the Crab Orchard National Wildlife Refuge in Cambria, Williamson County, Illinois, I saw Ring-billed Gulls (*Larus delawarensis*) stealing food from Coots (*Fulica americana*) on four different days. The pattern of their actions was essentially the same on each day.

On March 5, as I was watching Redwings (*Agelaius phoeniceus*) settle into their roosting area, I caught a glimpse of two gulls hovering over a Coot on the shore close to the edge of the water. The Coot made jabs at the gulls with its bill, but the gulls managed to keep out of reach. Then the Coot apparently was lured away from a morsel of food it had been guarding, for suddenly one of the gulls swooped in, picked up something, and made off with it. The second gull flew off in a wide circle. About 15 minutes later I saw another Coot eating something as it rested on the water about two feet from shore. A gull swooped toward this Coot which dropped its food and darted aside, thus leaving an easily obtained bit of food for the gull. The latter picked it up while on the wing, carried it about 150 yards, and settled on the water to eat it.

In neither instance could I determine the nature of the food with certainty. However, on one occasion it appeared as a stringy, dark-colored material, something like a pondweed might look. On another occasion the food looked white, compact, resembling a small dead fish.

On another day, just as a Coot surfaced after its dive, a gull dived at the Coot. The Coot immediately submerged again, apparently to escape attack. In this instance no food was involved in the attack.

I wrote to Mr. Gordon Gullion to find out whether this relationship between gull and Coot was a common one. He replied that, "To my knowledge there are no other records of gulls taking food away from Coots, however, the robbing of Coots by Baldpate, scaup and Canvasbacks has been recorded and I believe is of fairly common occurrence." He also pointed out to me that Bent (1926. *U.S. Nat. Mus. Bull.* no. 135:366) records Coots taking food from Canvasbacks and Redheads.—L. M. BARTLETT, *Department of Zoology, University of Massachusetts, Amherst, Massachusetts, November 27, 1956.*

Yellow-headed Blackbird nesting in Michigan.—On July 1, 1955, Robert R. Rafferty of the Michigan Department of Conservation found several Yellow-headed Blackbirds on the Presque Isle River in Gogebic County, Michigan. The locality was about two and one quarter miles southwest of the town of Marenisco (T46N, R43W, Sections 31 and 32) and less than six miles from the Wisconsin line. As a result of his discovery, we visited this identical area late in the afternoon on June 20, 1956, and soon found two male Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*). After watching one male for some time we realized that he had three mates while the second male had two. We were unable to locate a nest that evening so collected a male for the University of Michigan Museum of Zoology. This male weighed 97.3 grams and his testes measured 10 x 8 and 12 x 8 mm. The next morning Walkinshaw again went to the area and soon found two nests of the species. Both of these nests were located in cattails (*Typha latifolia*) along the northwest river bank and about 50 feet from the channel. The two nests were 15 feet apart and apparently belonged to one male and his two mates. Each nest contained three eggs and they were, respectively, 16 and 17 inches above the water. They were better made than Red-winged Blackbird (*Agelaius*) nests; well woven onto the cattail stalks, they were constructed of cattails and *Carex*. The first found nest with three eggs was collected for the University of Michigan Museum of Zoology.

The area where the nests were found was an extensive marsh consisting mainly of cattails, rushes (*Scirpus validus*), *Juncus*, and Bur-reed (*Sparganium eurycarpum*). Two young lads living along the river said they had seen the Yellow-headed Blackbirds prior to our visit but that they had never seen them before 1955. They had fished the river for a number of years.—LAWRENCE H. WALKINSHAW, *1703 Wolverine-Federal Tower, Battle Creek, Michigan*, WILLIAM A. DYER, *Union City, Michigan*, W. POWELL COTTRILLE AND BETTY DARLING COTTRILLE, *6075 Browns Lake Road, Jackson, Michigan, September 26, 1956.*

Nesting of the Bahaman Yellowthroat.—Since nothing has been recorded concerning the nidification of the Bahaman Yellowthroat (*Geothlypis rostrata*), the following account of a nest of the Eleuthera race (*G. r. coryi*) should be of interest. This was found on June 18, 1956, by Herbert Sands, one of my students, who showed it to me on the following day. The nest was situated about two feet above the ground in a six-inch cavity of a broken-off stub of a living custard apple tree (*Anona* sp.) in a temporarily "dry" mangrove swamp. On June 19 the nest, which was composed of leaves with a soft lining of grass, contained two partly-fledged young that were being fed by both parents.—F. M. COLLETT, *Tarpum Bay, Eleuthera, Bahamas, October 1, 1956.*

Mourning Dove nestlings infested with larvae of *Philornis*.—Two nestling Mourning Doves (*Zenaidura macroura*), heavily infested subcutaneously with fly larvae, were found at Baton Rouge, Louisiana, on July 17, 1956. The maggots, which were scattered over all body surfaces, including the abdomen and underside of the wings, measured about one-half inch long and three-sixteenths inch in diameter. Since they were imbedded just below the epidermis with an external opening about one-eighth inch in diameter, they were very conspicuous. The maggots were in an advanced stage of development and could be forced from their host easily by slight pressure applied at the base of each parasite. Seventeen specimens were removed from one dove and 26 from the other.

Several larvae were taken to Dr. J. H. Roberts, Entomologist, Zoology Department, Louisiana State University. Under Dr. Roberts' care, they pupated the day following removal from the doves and emerged as adults 10 days after pupation. Adult flies were sent to C. W. Sabrosky, Entomology Research Branch, U.S. Dept. Agric., Beltsville, Maryland, who identified them as members of the rare and unusual subtropical and tropical genus *Philornis* of the family Muscidae. Since Sabrosky suspected that a new species was represented, no specific name was given.

At the time of discovery, one dove was eight days and the other nine days old. Although infested with the maggots, the young doves remained in a healthy condition, acted normal and appeared to suffer little or no discomfort. Both young were successfully fledged on July 25. Although 120 dove nests were checked the same season within one-fourth mile of the parasitized doves, no other infestations were observed.—Leslie L. Glasgow and Robert Henson, *School of Forestry, Louisiana State University, Baton Rouge, Louisiana, November 14, 1956.*

"Bunching" reaction of Cedar Waxwings to attacks by a Cooper's Hawk.—On November 19, 1955, while driving west on Route no. 9 about one mile south of Southboro, Massachusetts, I saw a flock of approximately 25 Cedar Waxwings (*Bombycilla cedrorum*) being closely pursued by a Cooper's Hawk (*Accipiter cooperii*). I stopped my car and watched the birds for about 10 minutes; during this time the hawk made five separate passes at the waxwings. Each pass was made in the same manner and from the same quarter: the hawk, flying about 25 to 50 yards to the rear and slightly above the waxwings would suddenly increase its flight speed, attempt to seize one of the waxwings at the rear of the flock, then veer off and resume its position to the rear. Each time it was noted that the hawk would not begin a pass until the waxwing flock had been strung out. The reaction of the waxwings was immediate and very striking: as the hawk made its final approach, the waxwings would suddenly "bunch together," forming a very dense flock, and at the same time they would veer in unison to one side. The flock remained dense until the hawk had veered off, then it would loosen up. The evasive movements of the waxwings brought them back to my position, and when the hawk made his last pass it occurred directly over my head. I could see the hawk increase its speed, extend one foot, lunge, miss, then veer off as the waxwings bunched and veered away. When I left the scene, the hawk had evidently given up the chase, since it and the waxwings were headed in opposite directions. The behavior of the waxwings was very similar to that of the European Starling (*Sturnus vulgaris*) as described by Tinbergen (1951, "The Study of Instinct"). Putnam (1949. *Wilson Bull.*, 61:174) described the compactness of a flock of Cedar Waxwigs which flew away after the seizure of one of the flock by a Sharp-shinned Hawk (*Accipiter striatus*), but Dr. Putnam informed me by letter that the waxwings were perched in a tree at the time of the attack.—Andrew J. Meyerriecks, *Biological Laboratories, Harvard University, Cambridge 38, Massachusetts, October 2, 1956.*

Louisiana Heron breeds in New York City.—On April 19, 1955, while observing the roosting behavior of herons on Rulers Bar Hassock, Jamaica Bay, Long Island, New York, a single Louisiana Heron (*Hydranassa tricolor*) was seen to roost with four other heron and egret species in the reeds and low trees bordering Cross Bay Boulevard. The other species were the American Egret (*Casmerodius albus*), Snowy Egret (*Leucophoyx thula*), Black-crowned Night Heron (*Nycticorax nycticorax*), and Green Heron (*Butorides virescens*). One Louisiana Heron, presumably the same bird, used the same roosting site for the next five nights (April 20–24). On the evening of April 25, two Louisiana Herons roosted at this site, but none was seen at this site after that date. On May

13, 1955, four Louisiana Herons were observed flying over a similar site about one-half mile to the north, so I decided to search for a possible nest. During the morning of May 14, I flushed an adult Louisiana Heron from a nest containing one egg, bluish-green in color. The nest, composed of birch and bayberry twigs, was placed in a poplar birch (*Betula populifolia*) about 10 feet from the ground. The nest site was located one and one-quarter miles south of the North Channel Bridge. On the following morning, a Louisiana Heron was flushed from the same nest, which now contained two eggs. A third egg was discovered in the nest on the afternoon of May 17. I returned to the nest on the afternoon of May 18, and I found the remains of the three eggs in and below the nest. A pair of Fish Crows (*Corvus ossifragus*) nested within 100 yards of the Louisiana Herons, and possibly the crows had destroyed the eggs. Although the actual destruction of the Louisiana Heron eggs was not witnessed, I later saw Fish Crows remove eggs from the nests of Black-crowned Night Herons and Green Herons which nested nearby. Other heron and egret species which nested in the same area were the Yellow-crowned Night Heron (*Nyctanassa violacea*), and the American and Snowy Egrets. Louisiana Herons were observed in and around this area throughout the remainder of the breeding season (May, June, and July, 1955), but following the destruction of the Louisiana Herons' eggs mentioned above, I could find no evidence of any further nesting attempts on their part.

Louisiana Herons have been breeding in southern New Jersey since 1948 (Wright, 1948. *Audubon Field Notes*, 2:200), but this is the first breeding record for New York, a northward range extension of over 100 miles. I had expected Little Blue Herons (*Florida caerulea*), which have been breeding in southern New Jersey since 1935 (Stone, 1937. "Bird Studies at Old Cape May," 1:131), to be recorded as breeding birds in New York long before Louisiana Herons; hence, the above breeding record is somewhat surprising. It is impossible, of course, to state whether or not the Louisiana Herons which bred on Rulers Bar Hassock were derived from the Stone Harbor, New Jersey, colony or from one further south.—ANDREW J. MEYERRIECKS, *Biological Laboratories, Harvard University, Cambridge 38, Massachusetts, October 2, 1956.*

Observations on three albino American Robins.—Albinism in the American Robin (*Turdus migratorius*) has been noted by many field observers. Cases of both complete and partial albinism have been reported for nearly a century in scientific journals. (For some early records see the *Amer. Nat.*, 2, 1868: 161, 490, 492; 3, 1869: 279; 6, 1872: 173; 12, 1878: 474.) Scattered records will be found in all of the ornithological journals. However, very few details have been published on continuous observations of such birds. Recent observations of the writer in Portage County, Ohio, are reported here.

In the spring of 1953 a nearly all-white female nested at Edinburg at the residence of Floyd Hickman. It was first noticed by the Hickmans at the end of April. The only plumage coloration was a normally colored orange breast; all other feathers were white. She was mated to a normally colored male and they built a nest in the crotch of a large tree seven feet from the ground. Two eggs were laid after May 10. This nest was soon abandoned, probably because it was flooded during a heavy rain. A new nest was begun on May 16 in the crown of another tree nearby and completed two days later. Three nestlings were raised here, all of which were normally colored. The female performed the incubation and brooding while the male remained on guard. The last date on which the albino was observed was July 27. She did not return in subsequent years.

In the summer of 1954 a white robin was reported on South Walnut Street in Ravenna where it was feeding on sweet cherries over a period of a week (July 9–15). This was not seen by the writer. The following September an albino robin, possibly the same one, was observed by residents on North Prospect Street only a few blocks away from the previous location. It remained for about two weeks. In April of 1955 a female albino robin was again found at the same place and was possibly a return of the same individual. This bird was all white except for several small brown patches on the wings and back. The eyes were normally colored. She was mated to a normal male and the juveniles were likewise fully pigmented. The female, as before, did all of the incubating and brooding. She was last seen in late July, and has not returned to date.

On September 19, 1955, a robin that was all-white except for a brown feather on the left wing and a brownish streak in the middle of the tail was found on Chestnut Street in Kent by Randy Hill, a small school boy living in the neighborhood. This albino was observed until October 2.

Attempts to capture (for banding) the three albino robins reported here were not successful. None was found in 1956 in those places mentioned above. Albino birds probably have a short life span. An exception was a partial albino observed in Cleveland from 1863–65 inclusive (Garlick, 1868. *Amer. Nat.*, 2:492).

The only completely albino robin seen by the writer was a juvenile bird which he banded on July 13, 1948, in Akron, Ohio, and reported in detail (1949. *Bird-Banding*, 20: 187). It was never located again, although two white robins were reported from the same neighborhood in the summer of 1949. Two of the three cases mentioned in this note were symmetrical in their coloration pattern. Very often albinistic patterns of robins are asymmetrical (Dexter, 1947. *Auk*, 64:460–461).—Ralph W. Dexter, *Department of Biology, Kent State University, Kent, Ohio, December 3, 1956.*

Sanderlings eat fishermen's bait minnows.—The Sanderling's (*Crocethia alba*) habit of picking up and eating tiny fish from the edge of the beach, where they have been washed up, is well known, as is the fearlessness of man shown by single birds or small parties of this species. A third condition, man making small fish available, would complete a set of circumstances suitable for a social feeding relationship between bird and man. This third condition exists on a concrete pier at the south end of Lake Michigan, in Michigan City, Indiana. There many people fish for perch, and the favorite bait is a tiny minnow brought alive in buckets. Frequently there are numbers of dead bait minnows lying on the pier, thrown, dropped or spilled there by the fishermen.

For some years I have been aware that during the autumn migration small numbers of Sanderlings often were to be found on this pier, and often in close proximity to the humans. However, only in October, 1956, did I realize that sometimes Sanderlings sought out the fishermen, waited near them, and ate bait-minnows when available.

On one occasion I saw a Sanderling within four feet of an isolated pair of fishermen, pick up and eat a minnow from the pier. I stopped to watch and one of the fishermen, noting my interest, reached into his bait bucket for a live minnow which he tossed three feet toward the watching bird. The Sanderling at once ran, picked up the fish, and, after mouthing it for a moment, swallowed it.

On another occasion three Sanderlings were standing a few yards on one side of a solitary fisherman, while two dozen or so tiny minnows were lying dead on the pier on his other side, apparently thrown there by a fisherman who had left. With some hesitation one Sanderling, within reach of the man, edged between him and the water, though it could easily have circled him at a greater distance, found the minnows and ate five in quick succession. The other birds then joined the first but, perhaps replete, only pecked at the minnows. However, one bird finally picked up a minnow and ran with it. A second bird at once gave chase, the first one dropped the minnow and the second picked it up and swallowed it. This competition for a bit of food took place even though many other apparently equally desirable minnows were lying on the pier, illustrating how one bird's feeding activities may stimulate another's.

Apparently it is a regular practice and apparently well known locally for Sanderlings to be "hangers-on" of perch fishermen of Michigan City pier for the sake of the bait minnows that may be thrown them or left available. Presumably this habit is of recent development, for the country has been settled only about 100 years. With the larger gulls (*Larus*), belonging to a family closely related to that of the sandpipers, the habit of waiting on man for fish or fish scraps is conspicuous. With sandpipers, which eat such small items of food, one would not expect a suitable opportunity to exist often. However, it does arise occasionally, as the above account shows, and then the Sanderlings illustrated how quick birds can be to take advantage of small new factors in their environment.—A. L. Rand, *Chicago Natural History Museum, Chicago 5, Illinois, December 4, 1956.*

Anting by two tanagers in Brazil.—It seems that the performance of anting by birds has not yet been reported from South America; during many years of bird study in Brazil I saw anting only twice, both cases in tanagers:

Tangara cyanicollis melanogaster Cherrie and Reichenberger.—On September 19, 1953, at Serra do Cachimbo, between Tapajós and Xingú river, State of Pará, a single bird high up in a forest tree picked up something on the branch on which it stood, and then rubbed the bill against its feathers, mostly under the wings and under the tail. Doing this, it spread its flight feathers and sometimes cocked the tail upwards in a manner very strange for a tanager. The distance was too far to see what the bird had picked up and I could not watch the unusual attitude more in detail. Knowing "anting" well from the literature, I had no doubt however, that it was the very performance J. Huxley recently designated as "one of the outstanding puzzles of ornithology." After some time I tried to shoot the bird in order to learn something about the presence of ants or some acid smell, which perhaps might have induced the mysterious behavior—but the bird managed to escape.

Tangara cyanoventris (Vieillot).—On February 1, 1955, at Mury, near Nova Friburgo, Serra do Mar, State of Rio de Janeiro, a flock of the tanagers were perched in a tree near the weekend-house where I lived. Some of the birds examined the branches in a striking manner; having found the substance for which they were looking eagerly and which was not plentiful there, they picked it up and ran their bills along the underside of the half-spread wing. Doing this, one bird raised and pivoted its wing and tucked its tail on the same side so roughly that the tailfeathers touched the branch and bent themselves. The movements were carried out very rapidly; therefore I realized the facts only after several repetitions by some of the birds. The distance did not permit me to see what the birds were looking for and what they took into their bills. I could not see if ants were really concerned. On the stump of the tree I collected some ants (*Camponotus rufipes, Iridomyrmex humilis, Brachymyrmex admotus, Procryptocerus* sp. and *Myrmelachista* sp.) crawling upwards or downwards the tree—but I cannot say if one of these insects reached the canopy where the tanagers stayed and if the birds used the ants performing the curious behavior observed.

Such records made at a distance can supply little in the discussion of the difficult problem of anting and I have no suggestion to make as to the biological function of this strange instinctive activity. But the fact that these observations were made in the wild seems to rectify the publication—while most of the statements on this behavior are realized in studying tame birds. The principal facts shown by the two Brazilian tanagers are: (1) the desirous seeking of the stimulants, which suggests that the birds were deliberately anting in order to indulge the process (*T. cyanoventris*) and (2) the ecstasy shown by the anting bird (*T. cyanicollis*). In *T. cyanicollis* it was interesting, too, that the bird cocked the tail over the back, while it is generally stated that anting birds bring the tail forwards, as I also saw in *T. cyanoventris.*—HELMUT SICK, *Fundação Brasil Central, Av. Nilo Peçanha 23 III, Rio de Janeiro, D.F. Brazil, September 7, 1956.*

ORNITHOLOGICAL LITERATURE

THE FLAMINGOS: THEIR LIFE HISTORY AND SURVIVAL. By Robert Porter Allen. National Audubon Society Research Report No. 5, 1956: 7⅞ x 10½ in., xv + 285 pp., 16 pls., and 49 figs. Paper-bound, $3.95.

This fifth in the Research Report series, the third by Robert Porter Allen, makes another important contribution to ornithological knowledge and to the cause of wildlife conservation. Although his study was principally of the survival problems of the West Indian Flamingo (*Phoenicopterus ruber*), the author has nevertheless incorporated into it a thoroughgoing survey of the flamingo populations of the world: of the biology, history, and present status of all six modern representatives of the family. These birds, in most situations, present singularly difficult problems to the field student; and Allen's studies of *P. ruber* involved 24 trips outside the United States, over a period of some three years. A wealth of original behavior data is presented. Fully as important, however, in the text as a whole, are the extensive comparisons with other major studies (notably those of Frank Chapman in America; Gallet, Lomont, and Yeates in Europe; and Salim Ali in Asia), and the very detailed analyses of the literature in general.

Such breadth of treatment inevitably involved a huge problem of selection and of organization, which in my opinion was only partially resolved. To compare one species of flamingo with another at some points, and to lump them all as a sort of single composite population at others, while understandable, leads to some confusion of interpretation. One reading the work consecutively will find an apparent repetitiousness, as when historical accounts of breeding colonies are discussed in part as "Distribution and Migration" and in part under different headings of "The Breeding Cycle." Thoroughness can easily lapse into redundancy: certain of the statistical discussions have been carried farther than the resulting conclusions would seem to justify; elsewhere, quotations from the literature seem to have been multiplied beyond the point of necessity—and I noted instances of the same passage appearing, largely verbatim, in two separate sections. But notwithstanding these weaknesses, of which the total result has been merely to render an otherwise fascinating and very readable account a little less so by virtue of its very bulk, the book has a great deal to offer. It begins by tracing the fossil record of the group, then building up a picture of original distributions and movements from the time of our earliest written references. A detailed study of flamingo habitats follows, with analyses of the small organisms available as food in the mud and slime of these most inhospitable situations, and of the feeding operations of the birds themselves. The steps of the breeding cycle are treated in order. Excellent descriptions of the pre-pairing and pairing displays, and of the incubation and care of the young, are enhanced by photographs and by text figures prepared from field sketches. Of special interest is the tracing of "The Dampier Myth," concerning the alleged straddling posture of the incubating flamingo on the nest mound, and of the steps in its eventual refutation. Vast flamingo flocks remain in Asia and in Africa, and large numbers in South America. Yet, with the West Indian Flamingo reduced to a quarter of its former abundance (though now approximately holding its own), threats existing to colonies in other parts of the world, and the present status of the little *Phoenicoparrus jamesi* of the high Andes quite unknown, the long-range conservation picture appears a gloomy one. The present study afforded Allen unique opportunity for censusing the *Phoenicopterus ruber* population, and for studying it in the light of present-day conditions. While admitting in realistic fashion the human problems involved, he notes increasing support in many quarters for such conservation groups as the Society for the Protection of the Flamingo in the Bahamas.

Despite the extreme sensitivity of these birds to any form of disturbance while breeding, he holds out distinct hope for the success of present and future protective measures.

The format of the book is attractive, the print good, typographical errors very few, the color plates in the copy at hand only fair. The bibliography, of an estimated 700 titles, attests the labor that went into the preparation of the report, and is in itself a major contribution; the index is surprisingly complete, with references even to important literature citations by author. "The Flamingos" will be enjoyed by many; it will do a great deal to disseminate knowledge of one of our most beautiful birds, and to stimulate the efforts being made on its behalf. Except for tropical storms, man, through one agency or another, has been almost the only threat to flamingo survival; common-sense measures, put into effect while there is yet time, can certainly preserve the bird for the enjoyment of future generations.—William A. Lunk.

A Half Century of Change in Bird Populations of the Lower Chippewa River, Wisconsin. Irven O. Buss and Helmer Mattison. Milwaukee Public Museum Publications in Ornithology No. 1, 1955: 7 x 10¼ in., 319 pp., 26 illus. Paper-bound, $5.00.

The large number of local reports on bird distribution, migration, population changes, and related subjects points to the wide interest that exists in this field today. All these published reports aid in extending this interest in birds and the resultant concern over the preservation of our wildlife in the face of skyrocketing human populations and rapid exploitation of our natural areas. We welcome the present book's contribution toward the attaining of this goal.

This is another somewhat expansive resumé of the birds of an area slightly more than one county (Dunn) in extent in western Wisconsin approximately 75 miles east of Minneapolis and St. Paul, Minnesota. The foreword is by Wallace Grange. An introduction is followed by a very brief discussion of "Life Zones and Faunal Areas." Four pages are devoted to a description of the area including the changes that have occurred because of man's occupancy. "Objectives," "Time, Location, and Presentation of Records," and "Acknowledgments" follow. The major part of the work (pp. 21–277) is devoted to the "Annotated List of the Birds of the Lower Chippewa Area," together with notes on 20 species of probable occurrence. An appendix comprises nine pages of "Supplemental Records of Waterfowl Hunting and Birds Nesting at Elk Lake." Included is a table of recent Wisconsin and Dunn County waterfowl-kill data from the files of the Wisconsin Conservation Department. A list of "Scientific Names for Common Names of Plants Used in Text" is given. Then follow 10 pages of measurements and weights of nearly 500 individual birds of 169 species. References to 79 articles in the literature, and a 13-page index complete the book.

This book is presented mainly as a comparison of 12 years (1939–51) of field observations by the authors, together with those of credited co-workers (evaluated by the authors), and the observations of J. N. Clark combined with data from 800 specimens collected by him. Mr. Clark's field work was done in and around Meridean, Wisconsin, between 1886 and 1901.

Although this aim is carried out in the text, one is somewhat disappointed to find that in only a few instances are Mr. Clark's notes of sufficient value to enable the authors to make significant comparisons with the abundance of the species concerned. For this reason, some may feel that the book's title places too great emphasis on this feature of the work and that the book perhaps should have been presented simply as the "Birds of the Lower Chippewa River, Wisconsin" with notes on population changes in the last 70 years.

Most workers concerned with the tremendous bulk of recent ornithological literature would doubtless agree that the core of pertinent information in this book could be presented in a pamphlet of only a fraction the size of this tome. For instance, the listing of whole pages of individual observations made at separately identified observation points within the county seems quite unnecessary. As basic data for specific studies these might be valuable, but, aside from a few local observers, very few persons would ever make use of these voluminous records. Further economies could be made where individual observations for a species are discussed in the text and then repeated in the "Resumé of Records." In waterfowl sections graphs summarize the migration movements over the 12-year period of the authors' observations. This would suffice without the records being repeated in printed form. Again condensation seems advisable with the measurements and weights in the appendix. Such data may be valuable basic research material but in published form they should be summarized in support of some general statements, not printed in full.

The treatment of the problem of subspecies could well have been eliminated, since it further expands the text and adds little or nothing of value. In cases where no specimens were collected, such statements are made as "The Lower Chippewa birds should be assigned to ...." Obviously, the A.O.U. Check-list was consulted and the trinomial given for the race or races attributed to western Wisconsin. In many cases very limited numbers of specimens were available for study, but similar general statements lead one to assume that critical examination of these was not the basis for the statements. Since this definitely is not a taxonomic study, the authors should have followed the present widespread practice of using only binomials in field reports. In two instances genera (*Seiurus* and *Acanthis*) are treated in a confused and decidedly unorthodox manner.

Regarding the accuracy of the facts presented, there appears to be little reason to question most of the records. However, one's faith in the critical evaluation of reports by the authors is severly shaken when on page 265 one finds a paragraph reporting details of a nesting (!) of Harris's (incorrectly referred to as Harris) Sparrow near Colfax, Wisconsin, without as much as an author's comment on the remarkable nature of the record. The facts are that no Harris's Sparrow nestings have ever been authenticated within the United States and all recognized books refer to this bird as nesting only near the tree line in Canada.

It is indeed unfortunate that so much destructive criticism must be directed at the first of an institution's new series of publications in ornithology; but, it is hoped that such criticism will stimulate the authors and publisher to spend more time in self-criticism and condensation.

With all the book's faults, it does present a large amount of distributional data on the birds of Dunn County and gives a good general picture of the recent changes that have occurred as a result of man's use of the area.—W. J. Breckenridge.

This issue of *The Wilson Bulletin* was published on July 2, 1957.

SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (fourth edition) and supplements thereto insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. The Illustrations Committee will prepare drawings, following authors' directions, at a charge of $1 an hour, the money to go into the colorplate fund. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

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The Wilson Bulletin

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General Notes

Female Orchard Oriole (*Icterus spurius*) engaged in anting. Photographed by Arthur A. Allen, at Norman, Oklahoma, on January 14, 1955.

A RÉSUMÉ OF ANTING, WITH PARTICULAR REFERENCE TO A CAPTIVE ORCHARD ORIOLE

BY LOVIE M. WHITAKER

SINCE Audubon (1831:7) wrote of Wild Turkeys (*Meleagris gallopavo*) rolling in "deserted" ants' nests (Allen, 1946), and Gosse (1847:225) reported Tinkling Grackles (*Quiscalus niger*) in nature anointing themselves with lime fruits (Chisholm, 1944), an extensive literature on the anting activities of birds has slowly evolved. The complete bibliography of anting probably would approximate 250 items, yet the purpose of the behavior remains unexplained.

Anting may be defined as the application of foreign substances to the plumage and possibly to the skin. These substances may be applied with the bill, or the bird may "bathe" or posture among thronging ants which invest its plumage.

Among numerous explanations for the use of ants are these: (1) the bird wipes off ant acid, preparatory to eating the ant; (2) ants prey upon, and their acids repel, ectoparasites; (3) ant acids have tonic or medicinal effects on the skin of birds; (4) odor of ants attracts birds, much as dogs are drawn to ordure or cats to catnip; (5) ants intoxicate the bird or give it unique pleasurable effects; (6) ant substances on the plumage, irradiated by sunlight, produce vitamin D, which the bird ingests during preening; (7) the bird enjoys the movement of insects in its plumage; (8) ant substances prevent over-drying of feather oils or give a proper surface film condition to the feathers. For discussions of these possibilities, see Chisholm (1944, 1948: 163–175), Adlersparre (1936), IJzendoorn (1952*a*), Eichler (1936*a*), Kleinschmidt (in Stresemann, 1935*b*), Lane (1951:163–177), Kelso (1946, 1949, 1950*a*, 1950*b*, 1955:37–39), Brackbill (1948), Géroudet (1948), Groskin (1950), and McAtee (1938).

At least 24 kinds of ants and more than 40 substitute materials have been used by anting birds. These materials include fruits, foliages, raw onion, burning matches or tobacco, gum of grass-tree (*Xanthorrhoea preissii*), millipedes (Diplopoda), various beetles ("weevils"; tenebrionid beetles of the genus *Blaps*), grasshoppers (*Anacridium aegyptium*), earwigs (*Forficula*), bugs (*Rhynchota* sp., *Rhaphigaster nebulosa*), wasps, hair tonic, prepared mustard, vinegar, hot chocolate, and moth balls (Ivor, 1941; Laskey, 1948; Parks, 1945; Robinson, 1945; Thomas, 1946; Groff and Brackbill, 1946; Baskett, 1899:243; Burton, 1955*a*, 1955*b*, 1955*c*; Chisholm, 1944, 1948:163–175; Sedgwick, 1947; Poulsen, 1955, 1956; Sedgwick, 1946; Adlersparre, 1936; Osmaston, 1909, 1936; Callegari, 1955; Govan, 1954; Freitag, 1935; Butler, 1910; McAtee, 1938; Fluck, 1948; Scheidler, in Stresemann, 1936; Nice, 1952, 1955*a*; Hill, 1946; and others).

A compilation of records shows that at least 148 species of birds, 65 of them New World forms, are reported to introduce ants, or their so-called substitutes, into or on the plumage. Included is the Wild Turkey, so far known only for dusting in defunct ant nests (Allen, *op. cit.*, citing Audubon; McAtee, 1947, citing Sharp). Not included are several other species, to be mentioned later, that are known to use smoke but not ants or other substitutes.

Among the 148 anting birds listed in Table 3, the first 16 are non-passerines. The Horned Owl and all but one species of the Phasianidae listed dusted in activated ant beds or were seen to have live ants in their plumage. The Scaled Quail (*Callipepla*), the parrots, the Wryneck (*Jynx torquilla*) and the Green Woodpecker (*Picus viridis*) applied ants or a substitute with the bill.

The belief that anting is restricted to passerines has been rather general, and reports of anting among other groups of birds sometimes have been questioned or discounted altogether. Inquiries and search of the literature, however, reveal a notable amount of little known or entirely new data on a number of species, including non-passerines. Evidence for picids now is substantial, as will be seen; and we can reasonably expect further records for other species whose status as performers of anting still may seem suspect to some investigators.

During my visit to Chiapas, Mexico, in July, 1956, Miguel Alvarez del Toro, Instituto Zoológico del Estado, Tuxtla Gutierrez, furnished me with data on five Mexican species he had seen anting in nature. One of these, the Golden-fronted Woodpecker (*Centurus aurifrons*), used a small species of paper-making wasp common in that region. Specimens of the wasp, received from Dr. Alvarez in March, 1957, have been identified by K. V. Krombein, Smithsonian Institution, as *Polybia occidentalis* (Oliv.), a very gentle social species in which only the females have a sting. Wasp venom in general is supposed to contain formic acid.

Still another record for a picid comes from Fred M. Packard, Washington, D. C., who advises me that he has seen anting in the Flicker (*Colaptes auratus*) in New Jersey (letter, July 18, 1955).

Those who hold that non-passerine birds never are anting when they dig into, and dust themselves with, ant-nest earth containing large numbers of agitated, aggressive ants, may not accept Mowat's (1957) interpretation as "ant bathing" for his tame Horned Owl's habit of "tearing an anthill apart and then fluffing the mixture of dust and angry ants through his feathers." Mowat (letter, April 29, 1957) states that the owl regularly engaged in the activity on hot summer days, using the nests of unidentified, small, red lawn ants. "He appeared to brood over these nests, after stirring them up with his talons, and would sit for as much as half an hour without apparent movement. . . . He showed no signs of ecstasy, or stimulation. In fact, he usually appeared to be asleep."

Through the courtesy of Edwin Way Teale (1953; letter, February 6, 1955), I have the statement of Stanley Dashuta of Newark, New Jersey, who many times has seen Ring-necked Pheasants scratch down ant hills. This observer noticed hundreds of ants swarming over the birds and saw many injured ants on the ground afterward.

Robert W. Darrow (Bump *et al.*, 1947:272; letter, November 18, 1955) found that Ruffed Grouse used both deserted and active ant nests, but in most cases dusted in unoccupied nests or those with small populations. Nevertheless, it is by no means certain that this bird, or other birds, dusts in ant beds *only* because these offer a ready supply of loose, light soil. There is some evidence that a bird may be sensitive to special properties in the dusting soil and that anting and dusting may be more closely allied than was suggested by Chisholm (1948:163–175).

Howard Campbell (1954) has shown how Scaled Quail (*Callipepla squamata*), and possibly also Gambel's Quail (*Lophortyx gambelii*), in four New Mexico counties, where dusting opportunities would seem to be optimal, were strongly attracted by places where old motor oil had been spilled. A substantial number of 46 such experimental oiled dust baths were found to have had heavy and continuous use. In a suitable dusting area, the birds chose the oily spots, and they worked even in an area of extremely coarse gravel which had been oiled. Mr. Campbell wrote me that the birds seemed to use the centers of these oiled areas rather than the edges.

At my request, he made temperature readings on treated and untreated dusting areas, using a standard Taylor fisheries thermometer with the half-inch bulb barely buried in the earth. A larger series of readings is needed, but his preliminary investigation shows that temperatures of oiled soils can be as much as 4° F. higher than those taken in adjacent areas.

Gibson (1954) described a White-winged Chough (*Corcorax melanorhamphus*) in Australia that did not dust normally, but instead puts beakfuls of dust into its body plumage and under the wings. The action so strongly suggested anting that Gibson, upon determining no insects were present, had the soil tested for formic acid, with negative result.

It has been argued, largely on the basis of Walter's (1943) work, that birds probably have little or no olfactory sense and that galliform birds, especially, would tend to be insensitive to ant odors. But Hamrum (1953) stated the literature on olfaction and gustation in birds is contradictory and confusing. His own experiments show that both odor and taste probably influence food choice in the Bob-white (*Colinus virginianus*). Thorpe (1956:306) cautioned against dogmatism regarding sense of smell, pointing out that birds "show a considerable range of development of the olfactory lobes" and that only a few forms have been studied critically.

Until more is known about the purpose and effect in birds that apply ants with the bill, the assumption that anting is not to be found in the galliform or certain other groups of non-passerines (Goodwin, 1955*b*; Poulsen, 1956; IJzendoorn, 1952*a*) seems unwarranted. At this stage of investigation, it seems premature, even a little illogical, to say that a pheasant or a grouse, exposing its body to a host of disturbed ants on an ant nest, is not anting but only dust-bathing; while, at the same time, accepting as bonafide anting the behavior of certain corvids, to be mentioned later, that neither apply ants with the bill nor make dust-bathing motions but which stand or sit among ants with special attitudes of wings and tail while allowing ants to invest their plumage.

Closer study of Common Starlings (*Sturnus vulgaris*) and House Sparrows (*Passer domesticus*) should help resolve the question of anting in game birds. Starlings are known to work themselves deeply into the ant nest by use of the feet, bill and wings, and to apply ants deliberately under their wings (Floericke, 1911, and in Stresemann, 1935*b*; Baggaley, 1946). Davis (1945) noted a House Sparrow on an ant hill, dusting itself among the ants; and, in a letter to me, he emphasized that the bird also was using its bill to apply ants under the plumage in typical anting manner.

Cases combining dusting and applying ants with the bill, such as those cited above, are interesting also as possible transitions between "passive" anting (standing, sitting, sprawling among ants, but usually not applying with bill; see Fig. 5) and "active" anting (anointing only by use of bill). This distinction is made by Rothschild and Clay (1952:126–128).

It is unfortunate that the word *anting* is so deeply imbedded in the literature, since it does not have universal definition and is not always descriptive of the behavior. Thus we find McAtee (1938, and in Chamberlain, 1954) excluding the use of substitutes in defining anting; Goodwin (1955*b*) and Poulsen (1956) dismissing records of game birds using activated ant nests—a behavior which McAtee accepts; and Ivor (1951, 1956) excluding such passive anting as that seen in Common Crow (*Corvus brachyrhynchos*). Despite these exclusions, it now appears that the term ought to include all anointings, whether active or passive, with ants or substitutes. Certainly this was the connotation given the term by Stresemann (1935*b*) in coining it.

Although anting is a major ornithological problem that no one has adequately explained, it has received relatively little experimental study. A new theory, offered by Holger Poulsen (1955), who experimented with 34 anting species in the Copenhagen Zoo, states that anting is caused by the ants' spraying of acid on the bird's head. The bird then rubs its head under wing or tail in an effort to remove the irritating acid. Poulsen, observing only active anting, and apparently questioning the many descriptions of passive anting, concluded that feeding was the basic incentive, and the anting actions incidental corollaries to it, as the bird tried to cleanse its head of ant acid or tripped about to avoid being sprayed. He considered tripping and falling, as well as reports of birds lying down among ants, all to be results of the bird's vigorous cleansing and evasive movements. Some investigators, however, found that this theory did not explain anting as they observed it (Nice, 1955*b*; Goodwin, 1955*a*, 1955*b*; Simmons, 1955; Ivor, 1956).

Since then, Poulsen (1956) continued experiments (involving 85 species in all, of which 56 species anted) and discovered that certain species would indeed deliberately expose their plumage to ant spray. But he still is of the opinion that, with few exceptions, anting is unintentional behavior connected with feeding, and that only such exceptional species (more or less passively anting birds, as defined here) seek ants in order to be sprayed, rather than to eat ants. While he does not use the terms, Poulsen makes it clear that he believes active anting to be a response to external stimulus and that passive anting evidently is motivated internally, depending upon the bird's being "in anting mood." He has no definite solution to the problem, and offers these explanations tentatively. In a letter (February 7, 1956) he stated that he regarded anting as a complicated behavior, with more than one biological significance.

In view of the many poorly understood, even puzzling, aspects of anting, it seemed that an intensive examination of the behavior in the individual bird, with various species of ants, might be at once interesting and worthwhile.

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these pictures, some of which are reproduced here. Other photographs, showing anting in two European species, are used by the kind permission of Dr. Hans Löhrl, Ludwigsburg, Germany.

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Anting in a Captive Orchard Oriole

On September 18, 1952, I discovered my hand-raised, three-month-old, female Orchard Oriole (*Icterus spurius*) anting in a file of ants which had invaded a screened porch. Systematic observations on the bird began on March 23, 1953. In the following 31 months I made 80 experiments on as many days, using various ant species found in my yard. Excepting two experiments in which the ant *Tapinoma sessile* was used in September and October, 1955, at East Lansing, Michigan, all observations were made in Norman, Oklahoma, with indigenous ants.

Four other hand-raised individuals—Black-billed Magpie (*Pica pica hudsonia*), Loggerhead Shrike (*Lanius ludovicianus*), House Sparrow, Painted Bunting (*Passerina ciris*)—did not ant, and only the Magpie and Painted Bunting would eat ants. These birds were tested at intervals during periods of two months or longer, the Magpie for over a year, while the Painted Bunting was the constant companion of the Orchard Oriole during the latter's anting experiences. Kuroda (1947) noted anting-like behavior in a captive Bull-headed Shrike (*Lanius bucephalus*); but there seems to be no report of anting in Painted Buntings, and I find but three for the House Sparrow (Table 3). It is strange that there should be no New World record for this race of Magpie, since the species is a well-known "anter" elsewhere (Table 3). In this connection, it is interesting to recall that Brooks (1931) suggested specific rank for *Pica p. hudsonia*.

For present purposes I shall apply the term *acceptable* to those ant species the Orchard Oriole used for anointing (Table 1), and *unacceptable* to those it rejected (Table 2), whether or not the species was eaten.

I found workers of three ant species, *Dorymyrmex pyramicus, Iridomyrmex pruinosus analis* and *Tapinoma sessile* were acceptable and also were eaten. Workers in these species are monomorphic. All are small (2 to 3 mm. in body length), non-stinging ants which feed on honey-dew and insects. Instead of spraying acid secretions when disturbed, these species exude from the anal glands fluid droplets having the scent of rancid butter. This odor, presumably due to butyric acid, is especially strong when the ants are crushed. Evidently these species, all belonging to the subfamily Dolichoderinae, do not produce formic acid. O'Rourke (1950) stated that "so far as is known, the Formicinae [*i. e., Lasius, Formica, Camponotus,* etc.; see Table 1] alone among ants secrete formic acid." For pertinent details on the ant species mentioned above and in the next paragraph, see also Wheeler (1910:29, 42–43, 45, 361), Creighton (1950:110–111, 162, 171, 210, 340, 346–348, 350–352), Cole (1940), Smith (1924, 1928), Dennis (1938).

The very small ants, *Pheidole bicarinata buccalis* and *P. b. longula,* and the small *Crematogaster (Acrocoelia) laeviuscula,* as well as the large *Pogonomyrmex barbatus,* were all unacceptable to the oriole, although both of the *Pheidole* sometimes were eaten. All the rejected ant species belong to the subfamily Myrmicinae. Workers of these species possess a sting. The sting in *Pogonomyrmex barbatus* is extremely painful to man; but that of *Pheidole* is too weak to penetrate human skin, as, in my experience, was true also of the *Crematogaster.* This particular *Crematogaster* feeds on honey-dew, dead insects and animal tissue; but ants of the genera *Pheidole* and *Pogonomyrmex* are largely spermophagous, though some *Pheidole* take insects and honey-dew, and *Pogonomyrmex* will eat insect food. None of the rejected species sprays or exudes repugnatorial liquids.

Neither the Orchard Oriole nor any of the ant species it accepted seems to appear in anting literature, with the exception only of *Tapinoma sessile,* noted by Van Tyne (1943), and *Tapinoma* sp., by Ivor (1943; and in Nice, 1945). I find no mention of butyric acid or of the fact that a non-stinging, non-spraying ant species will induce anting. Thus far not enough attention has been given the various defense mechanisms among ant species used for anting; and even when the ant has been identified, its particular means of defense often has not been stated. Some writers seem to assume, quite erroneously, that all ant species used by birds have the ability to spray or that they all produce formic acid in quantity. Groskin (1950) believed that variations in birds' anting movements might be due to differences among ant species in aggressiveness and, he implies, in the composition of defense fluids. To this I would add difference in amount of the repugnatorial substance and in the method of ejaculation, *i. e.,* whether sprayed or exuded, for reasons that will be clarified later.

TABLE 1

A PHYLOGENETIC LIST OF ANT SPECIES USED BY BIRDS FOR ANTING

Ant nomenclature found in literature on anting is revised to conform to current usage. Insets under specific names indicate synonyms. This informal taxonomic synonymy follows Creighton, "Ants of N. Amer.," 1950, except for extra-limital species. Asterisk denotes species used by Orchard Oriole.

Subfamily and Species	Source
MYRMICINAE (Possess functional sting; otherwise do not eject repungatorial substances)	
Monomorium pharaonis (Linnaeus)	(Den.) Poulsen, 1955, 1956; only by experienced Blue Jay
DOLICHODERINAE (Sting vestigial; exude repugnatorial liquid from anal glands)	
Iridomyrmex detectus (F. Smith)	(Austrl.) Bourke, 1941*b*; Galloway, 1948
**Iridomyrmex pruinosus analis* (André)	(U. S.) Whitaker, this study
**Dorymyrmex pyramicus* (Roger)	(U. S.) Whitaker, this study
**Tapinoma sessile* (Say)	(U. S.) Van Tyne, 1943; Whitaker, this study
FORMICINAE (Sting vestigial; spray repugnatorial liquid from special formic acid gland; anal glands absent)	
Oecophylla smaragdina (Fabricius)	(India) Pillai, 1941; Ali, 1936, quoting H. Abdulali
Camponotus pennsylvanicus (DeGeer)	(Can.) Ivor, 1943 (U. S.) Teale, 1953:168, of "carpenter ant"
Camponotus (*Myrmophyma*) *innexus* Forel	(Austrl.) Wheeler, 1951
Camponotus (*Myrmobrachys*) *senex textor* Forel	(Costa Rica) Skutch, 1948
Camponotus (*Myrmepomis*) *consobrinus* (Erichson)	(Austrl.) Chisholm, 1944; Wheeler, 1951
Lasius alienus americanus Emery	(U. S.) Dater, 1953
Lasius niger var. *americanus*	(U. S.) McAtee, 1944
Lasius niger (Linnaeus)	(Eng.) Carpenter, 1945; Longhurst, 1949 (Switz.) Wackernagel, 1951 (Den.) Poulsen, 1955, 1956
Lasius niger neoniger Emery	
Lasius niger var. *neoniger* (Emery)	(U. S.) Groskin, 1950
Lasius niger var. *neoniger*	(U. S.) Brackbill, 1948
Lasius niger	(Can.) Ivor, 1943 (U. S.) Nice, 1945
Lasius (*Dendrolasius*) *fuliginosus* (Latreille)	(Ger.) Löhrl, 1952
Lasius (*Chthonolasius*) *mixtus* (Nyl.)	
Acanthomyops mixtus Nyl.	(Eng.) Hobby, 1946

TABLE 1 (Continued)

Lasius (Chthonolasius) umbratus aphidicola (Walsh)	
Lasius umbratus mixtus aphidicola	(U. S.) Brackbill, 1948
Acanthomyops claviger (Roger)	
Lasius (Acanthomyops) claviger (Roger)	(U. S.) Groskin, 1943, 1950
Lasius claviger	(U. S.) Davis, 1944
Acanthomyops interjectus (Mayr)	
Lasius interjectus Mayr	(U. S.) McAtee, 1938, quoting Kalmbach
Acanthomyops murphyi (Forel)	
Lasius (Acanthomyops) murphyi	(U. S.) Brackbill, 1948
Formica rufa Linnaeus	(Ger.) McAtee, 1938, citing Heine, 1929
	(Eng.) Goodwin, 1951, 1952*a*, 1953*a*
	(Switz.) Wackernagel, 1951
	(Den.) Poulsen, 1955, 1956
	(Neth.) IJzendoorn, 1952*a*, citing Abma, 1951
Formica obscuripes Forel	
Formica rufa obscuripes Forel	(U. S.) Weber, 1935
Formica rufa	(U. S.) Nice and Ter Pelkwyk, 1940
Formica exsectoides Forel	
Formica exsectoides exsectoides (Linn.)	(U. S.) Staebler, 1942
Formica fusca Linnaeus	(U. S.) McAtee (*in* Chamberlain, 1954), "probably"; Teale, 1953: 159, 199
Formica fusca subsericea (Say)	(U. S.) Brown, 1953; Groskin, 1949, 1950; Nero, 1951; Brackbill, 1948; Hebard, 1949
Formica fusca var. *subaenescens*	(U. S.) Nichols, 1943, "probably *subaenescens*"
Formica fusca s. sp. *subaenescens* Emery	(U. S.) Buell, 1945
Formica (Raptiformica) sanguinea Latreille	(Can.) Ivor, 1943, 1956
Formica (Raptiformica) subintegra Emery	
Formica sanguinea subintegra (Emery)	(U. S.) Groskin, 1950

Total species represented: 24.

METHODS

In summer experiments, I dug up entire ant colonies (earth, ants, pupae, larvae, eggs) and placed the material in a tray on the porch where the Orchard Oriole was free. Sometimes I confined the bird in a large, bottomless cage and placed the cage over the tray, or over an ant nest in the yard. Winter experiments were managed similarly indoors, with ants taken from captive colonies or, occasionally, from the yard. Spraying ants, unavailable locally, were never offered.

Each experiment, except as otherwise noted, was made with a single colony. When more than one ant species was used in the experiment, all material of one species was removed before another species was offered. Duration of experiments varied from a few minutes to three hours, depending upon the bird's interest and the number of ant species offered.

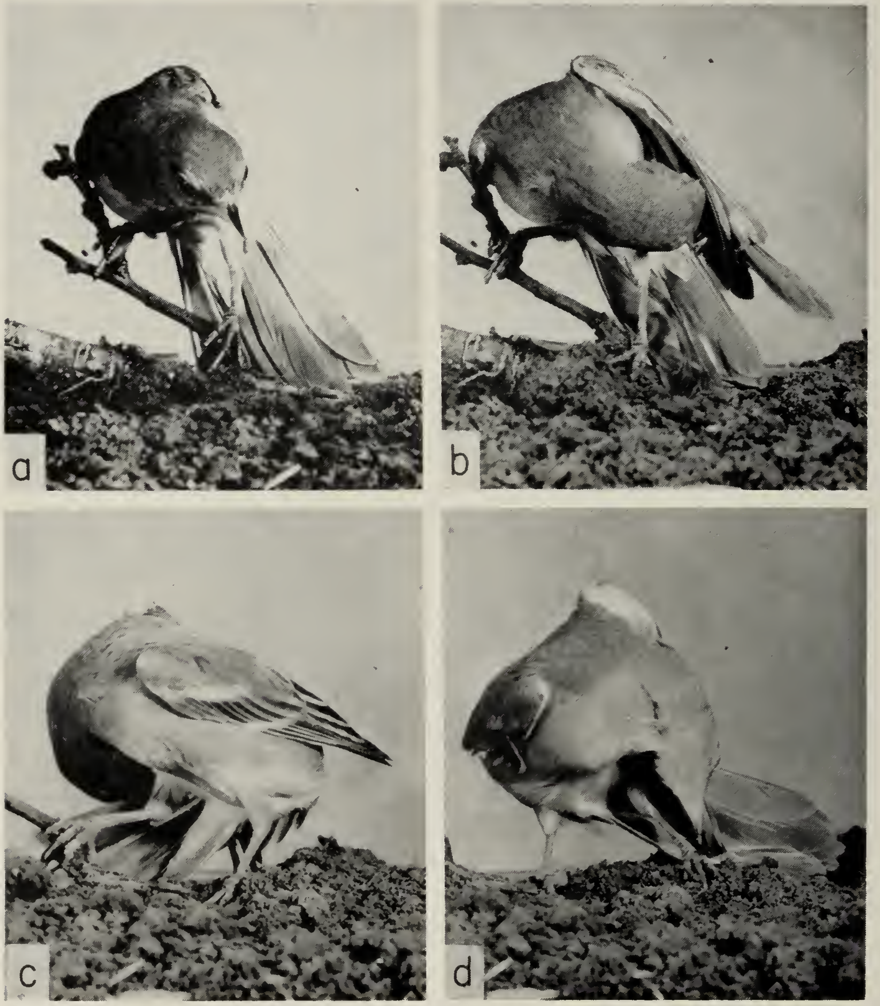

FIG. 1. ((a) Orchard Oriole exposes undertail coverts in preparation for anting. Note ant in bill, and split web of an inner rectrix, caused by anting activity. (b) Bird apparently applies ant to both rectrices and remiges, shown interlocked. (c) Application to bases of outer rectrices. Note wing tip resting upon ground behind tail. (d) With tail pressed against folded wing, bird treats wing tip and possibly the ventral surface of tail. Note displaced (right) greater wing covert.

In three instances, two species of ants, readily distinguishable at sight, were mixed deliberately. In 1954 most summer observations were made with ants that daily invaded the porch in force, attracted by bird food. These invaders invariably appeared to be all of one species, and samples from them, taken July 30, were identified by Dr. Gregg as *Dorymyrmex pyramicus.*

The Orchard Oriole is trusting and permitted closest scrutiny, often performing 10 inches from my face. It never has been sick or injured. Examination with hand lens and brushing out its plumage disclosed no parasites. Since the first prenuptial molt, this female oriole has been in excellent condition, with bright plumage of normal texture and color. All subsequent molts have been autumnal. The bird's somewhat small size may be due to metabolic disturbances as a fledgling on a partly artificial diet.

Plumage Areas Anointed

Although observers do not agree, and reference to application to virtually every accessible plumage tract can be found in the literature, the wings and tail are almost always mentioned (see Adlersparre, 1936; Allsop, 1949; Brackbill, 1948; Chisholm, 1944; Fletcher, 1937; Goodwin, 1953*a*; Groskin, 1943, 1950; Heinroth, 1911*a*; Ivor, 1941, 1943, 1951, 1956; Nice, 1952; Osmaston, 1909, 1936; Reynolds, 1946; Tebbutt, 1946; Van Tyne, 1943; Wheeler, 1951, and others).

Ivor (1946, 1951, 1956) modified his earlier descriptions of applications to ventral surface of primaries by stating that ants are applied to the distal one-third of the primaries, rather than along their entire length; that apparently the undertail coverts sometimes are treated; and that the ventral surface of the tail is treated, although rarely. Poulsen (1955, 1956), however, said that his birds, excepting the Common Grackle (*Quiscalus quiscula*), applied ants only to the quill feathers.

My oriole regularly anointed the ventral surfaces of the outer few primaries, mostly near the tips. In doing this, the spread tail was brought sideward and forward; and the wing on that side was either folded or only slightly spread, with wrist lifted so that the wing tip was held *near* the basal section of the tail, or *against* the ventral surfaces of the rectrices (see Frontispiece). Application of ants caused wing tips to become frayed and their *dorsal* surfaces roughened by displacement of the barbs from beneath.

The ventral surface of the tail also was treated regularly, particularly the basal one-third (Fig. 1*c*). But it was the undertail coverts that seemed to be a main target. Here the deep, vigorous applications at times caused some of these yellow feathers to become so displaced as to stand up conspicuously above the olive-toned *upper* tail coverts!

Sometimes the bird treated its belly, and very occasionally the anterior crural feathers briefly. (For anting of the legs, see Brackbill, 1948; Hein-

TABLE 2

ANT SPECIES REJECTED BY ORCHARD ORIOLE FOR ANTING

Subfamily MYRMICINAE (Possess functional sting; otherwise do not eject repugnatorial substances)

- *Pogonomyrmex barbatus* (F. Smith)
- **Pheidole bicarinata buccalis* Wheeler
- **Pheidole bicarinata longula* Emery
- **Crematogaster* (*Acrocoelia*) *laeviuscula* Mayr

* Sting does not penetrate human skin.

roth, 1911*a*; Nice and Ter Pelkwyk, 1940; Snyder, 1941; Tebbutt, 1946; Troschütz, in Stresemann, 1935*b*.) The flanks and sides seemed to be touched only indirectly as the bird reached toward the wing tips and tail. The feathers of the sides and flanks became disarranged, but I could never detect direct, exclusive application to them. IJzendoorn (1952*a*), noting untidy, ruffled breast and abdomen of a Common Starling anting in the wild at high intensity, suspected the disarray indicated poor condition. The activity itself caused somewhat the same appearance at times in my oriole.

In the rare instances when the oriole applied ant larvae and pupae, it usually ate them afterward. Sometimes a larva or pupa was used when the bird applied the ant which carried it. On some days the bird ate directly eggs, larvae and pupae, yet often these were ignored. Burton (1955*a*) observed anointing with ant cocoons, the bird being a tame Rook (*Corvus frugilegus*), which probably "at some time picked up an ant carrying a cocoon and now associates the two."

On a number of days I examined the oriole immediately after anting. I found ant odor on all these areas mentioned, but no odor on other plumage parts. The odor was always strongest on the undertail coverts and adjoining portions of rectrices. For example, on February 24, 1955, I tested the bird after it had anted at high intensity for 18 minutes with freshly dug ants and I found odor on tips of the primaries, on undertail coverts, basal two-thirds of the tail, and on sides and flanks. The feathers of the fronts of the tibiae were faintly scented. Odor was strongest on the undertail coverts. Save sides and flanks, I had clearly seen the bird treat all these areas. I could detect no odor on other plumage areas and none on the wings, except on the distal one and one-half inches of the primaries. These were, be it remembered, non-spraying ants. Neither on this occasion nor on any other have I seen the bird apply ants to dorsal surfaces of wings, tail or body.

I find but three references to odorous plumage, all relating to birds that used spraying ants. Wackernagel (1951) said his tame Carrion Crow (*Corvus corone*) became so scented with *Formica rufa* that it was still odorous next day. The scent of *Lasius fuliginosus* on tame European Jays (*Garrulus glandarius*) was evident at a meter's distance (Löhrl, 1952, 1956). Mr.

John A. Johnson (letter, Sept. 17, 1954), in Michigan, informs me that his tame, free-flying Common Crow, which has sought unidentified ants of its own volition during nine summers, subsequently reeks with odor to the degree that his own hands become scented from handling the bird. From his description, I judge this bird used spraying ant species. All spraying ants belong to the subfamily Formicinae (Table 1).

Posturing, Tripping and Falling

The awkward posturing and strange acrobatics of the oriole were similar to those described for many small species. Always there was some deflection of the tail, even during low intensity anting. Usually the tail was brought sharply around to one side of the feet, or between them, so that the tip pointed forward and the dorsal surface lay largely on the floor. Often the bird stood on the tail with one or both feet, or briefly sat on it. It habitually tripped on its tail, at times falling sideward or backward. Sometimes it turned complete *forward* rolls. Ivor, Poulsen, Van Tyne, Groskin (1950), Adlersparre, Osmaston (1909), Nichols (1943), the Shackletons, Nice (1943), Löhrl (1956), and others have observed falling or tumbling in anting birds.

The higher its anting intensity, the more the oriole tripped and tumbled. I have seen it stand with the tail turned out to one side while it looked for the next ant; but usually it kept these odd positions only momentarily, and after tripping or falling, would right itself in a flash. All imbalance occurred in conjunction with interference of the tail with feet. Never did this bird lie down, press its breast to floor, sprawl with spread wings, or behave in any way that suggested passive anting.

Likewise, the oriole never permitted ants to crawl upon it, and would quickly pick off those that got on its toes, often flipping away others that came too close. There was no evidence that the bird ever deliberately deposited ants in or on the plumage. Three times only did I see single ants sticking to its plumage, on a rectrix. Examinations in the hand revealed no ants on the bird. However, the projected transparencies show that ants sometimes were rubbed off on the feathers. In one picture two ants may be distinguished on the ventral surface of rectrices, in another an ant is seen on the ventral surface of a primary. These ants appear to be flexed; one of them plainly is wedged between barbs.

The literature indicates that only a few small birds, such as Redwing (*Turdus musicus*), Song Thrush (*T. philomelos*), European Blackbird (*T. merula*), American Robin (*T. migratorius*), Catbird (*Dumetella carolinensis*), Common Starling, and Indigo Bunting (*Passerina cyanea*), sometimes allow ants to crawl upon them in numbers (Bates, 1937; Callegari, 1955; Floericke, 1911, and in Stresemann, 1935*b*; Groskin, 1950; Govan, 1954; Shackleton and Shackleton, 1947; Poulsen, 1956).

MANNER OF APPLYING ANTS

Observers often mention a stroking or preening action of the bill as ants are applied (Adlersparre; Goodwin, 1955*b*; Brackbill, 1948; Buell, 1945; Van Tyne, 1943; Ivor, 1943, 1956; Laskey, 1949; Wheeler, 1951, and others). This was not the case with the captive Orchard Oriole. It always applied ants in quick dabbings, rather than strokings. Moreover, there was also a peculiar motion of the head. As the bird, ant in bill, reached toward the area to be anointed, it moved its head from side to side, so rapidly that the effect was almost that of shuddering. While reaching for the plumage and during each dabbing, thrusting application, the bird vibrated its head in this manner. When performing in a clinging position on the cage wall, the oriole sometimes caught its bill in the hardware cloth as it tried to reach its tail, and the bill rattled loudly and rapidly between the wires. This action on quill feathers produced a rustling sound. Invariably ants were applied thus; but during low intensity anting, vibration and dabbing were likely to be shorter in duration and noticeably slower.

Though these head movements have not been described precisely heretofore, they probably occur in many birds. Adlersparre said only that two Orange Bishops (*Euplectes franciscana*) shook their heads so energetically they sometimes lost the ant from their bills. Poulsen (1956) stated that his birds would "rub the bill among the wing-feathers downward towards the tip with quivering movements of the head"; and he mentioned that they sometimes would shake their heads "more or less vigorously." Both of these writers seem to attribute this behavior to ant spray, a factor not present in the case of the oriole. In response to my query, Ivor (letter, February 16, 1955) wrote that he noticed, on that day, both the dabbing applications and vibrating head for the first time, in the case of a Baltimore Oriole (*Icterus galbula*); and, further, that he believes that, in working with groups of anting birds, he had previously overlooked these motions. Bourke (1941*b*) told of Rufous Whistlers (*Pachycephala rufiventris*) that took ants to bushes and there shook their heads from side to side a few times, then dropped the ants and preened. Head shaking preceding ant applications has been reported in Indian Mynahs (*Acridotheres tristis*), according to Chisholm (1944); and the Cockatoo observed by Glauert behaved similarly with an ant and again when tobacco juice got in its mouth.

Among numerous responses Ivor received, following his recent paper (1956), was one from Henry Petersilie in New York, suggesting that birds may fall over in "ecstasy" because of disturbance in the semicircular canals of the inner ear. The idea has merit. Granted a disturbance to balance mechanism, from head shaking or other cause, this alone would not seem enough to have caused the oriole's loss of footing; for the bird was not seen to trip or fall except when the tail was brought into contact with feet and legs. But there remains the possibility that loss of balance through interference of the tail was augmented by some such condition.

Treatment of Ants

The captive Orchard Oriole seemed to roll these small ants excessively. Usually each one was worked in the bill, and apparently crushed, regardless of its ultimate disposition. Supplies of acceptable dead ants were treated in like manner. I could not tell how severely the bird damaged an ant before applying it; but ants that it had rolled and cast aside unused were so injured they could not crawl. Those flung away after application were either dead or severely injured. Examination of 14 such "used" ants under binocular microscope showed 13 with damaged gaster, several with tissues extruded. Some of them also had the pedicel, head or thorax injured and nearly all had lost appendages.

The bird habitually made several applications, each consisting of many tremulous dabs, with a single ant. Between applications, it would hesitate and roll the ant further. It seemed to me this was done in order to renew or increase the ant's effectiveness.

A number of records show squeezing or crushing of the ants (Troschütz, in Stresemann, 1935*b*; Ali, 1936; Nice and Ter Pelkwyk, 1940; Galloway, 1948; Poulsen, 1955, 1956; Teale, 1953:168) or that dead and injured ants were left on the anting grounds. Ivor (letters, February 1 and 14, 1955) and Teale (*loc. cit.*) each have noticed that workers of the large spraying ant (*Camponotus pennsylvanicus*) sometimes seem not to be crushed before being applied. Teale, Groskin (1950) and others have suggested that spraying ants may give off acid merely by being held in the plumage. Perhaps a bird's treatment of the ant may depend more upon the ant's spraying ability than upon its size. *Formica rufa* and its allies can eject a fine spray for a distance of 20 to 50 cm. (Wheeler, 1910:42–43). It should be recalled that my oriole used only non-spraying ants, and that crushing increased their odor. I found, however, in at least one of these species (*Dorymyrmex pyramicus*), that only the gaster seemed to produce odor. When the gaster was removed, crushing of the head, thorax and other parts did not seem to change or increase the ant's odor.

The Anting Locale

Birds have been observed anting in trees, on roofs or feeding tables—wherever ants happened to be found. Sometimes they carry ants from ground to a tree or bush to apply them, whereas a captive bird may take them to its perch.

Usually my bird anted on the floor. Sometimes it performed on a perch, either bringing up ants or using those that crawled within reach. But it also had a habit of anting while clinging to the cage wall. It might fly to the wall with an ant and cling there to apply it, or hitch its way down the wall, snatch and apply an ant without touching the floor. At times the bird anted while clinging upside down on the wall—a position especially favorable for observing anointment of belly or undertail coverts. Skutch (1948) saw a Black Seed-eater (*Sporophila aurita*), anting in a bush, make one application while hanging upside down from a twig!

ATTACKS BY ANTS

Surprisingly few accounts show that anting birds are attacked by the ants or that they fear them, although some kinds used are formidable biters. Aside from Poulsen's Blue Jays (*Cyanocitta cristata*), which used a small species (*Monomorium pharaonis*), it appears that birds use only those ants incapable of stinging (Tables 1 and 2). Furthermore, Poulsen (1955, 1956) thought the Blue Jays' responses were due to conditioning. His birds in general rarely were cautions or hesitant in taking up ants; and, when bitten, would shake their legs, jump or pick off the ant and fling it away.

Groskin (1950) saw a Song Sparrow (*Melospiza melodia*) suddenly jump and dance around before resuming anting; Ivor (1943) said "numerous times it was evident an ant had bitten a bird"; Bourke (1941*b*) commented on the hastiness with which Rufous Whistlers removed ants gripping their feet; Wackernagel's Carrion Crow at times "showed severe fright reactions and jumped into the air, probably when bitten"; and Löhrl (1952, 1956) described similar behavior for this crow. Goodwin (1952*a*) noted fear and hesitation in Lanceolated Jay (*Garrulus lanceolatus*) and Beechey's Jay (*Cissolopha beecheii*) but not in some other species which apparently used the same ant species. These jays would first take ants to perches to apply them before anting on the ground near the ants.

My oriole approached the unacceptable *Pogonomyrmex barbatus* readily, yet carefully; but it showed no fear of other ants, except, as will be seen, with an acceptable species foraging *en masse*. True, throughout the period of study, the bird performed at times on wall or perch; but it seemed to fly up with an ant in quite the same way it carried off a grasshopper to be eaten. Moreover, with supplies of dead ants the bird behaved this way. Although it would pick up unacceptable ants, even eat certain species of them, I never saw it carry an unacceptable species from the floor.

On June 30, 1954, I discovered a file of ants reaching from the porch door to a screened section occupied by the Magpie. The ants came in force almost daily until September 30, and during this period I put the oriole with them at least once a week. As previously mentioned, probably all of these ants were *Dorymyrmex pyramicus*.

On July 8, after eight successive days of anting with these invaders, the oriole began performing mostly on perch or wall. In the following three weeks, it showed increasing reluctance to perform on the floor. On July 12, 16, and 24, *all* anting took place above the floor. Yet, on July 31 and August 1, the bird anted only on the floor. This erratic behavior strongly suggested fear of attack. Probably the bird had been bitten at one of the times when it had been allowed to remain with ants after the observation period. Later, on August 3, I witnessed an attack that was to affect its performance for quite some time.

As I watched the oriole ant, it suddenly jumped straight upward and then began to probe between a middle and outer toe. Almost at once it flew to a perch and began probing gently at the spot. For several minutes it remained there quietly, looking somewhat subdued, now and then peering down at its toes. Presently it began performing with ants taken from the wall; but not again that day did it go to the floor, except once to snatch an ant and fly with it to a perch. During the following two weeks I tried the oriole with invading ants on seven days. Each day the bird anted, but only above the floor, although on each of two days it did perform a single anting on the floor.

Gathering and Applying Wads of Ants

Sometimes the oriole gathered a ball of ants in the bill tip and held it for a while before eating the wad, applying it, or flinging it away. Once, when anting interest was very low, the bird held a wad of ants for almost two minutes while sitting still on a perch. One or several wads were gathered on 14 days, including experiments with dead ants. I once counted 18 ants taken up in rapid succession. Some wads were larger. The ants, clinging to one another like filings to a magnet, were so injured they did not separate after being cast away. When a wad was applied, parts of it dropped off and the bird seemed to eat the remainder. Of unacceptable ants, only the *Pheidole* were gathered, and then eaten.

Not very many anting species have been reported to gather ants. The Blue Jay, observed by Buell (1945), evidently applied small masses of ants. Gough (1947) watched Song Thrushes apply one or two ants at a time but not the large numbers which some of the birds collected. Ringleben (in Stresemann, 1935*b*) did not make clear whether his Carrion Crow made use of the wad of ants before throwing it aside. Scheidler (in Stresemann, 1936) and Ivor (1956) mentioned captive Common Starlings filling their bills with ants and then rubbing them on the plumage. Gengler's (1925) captive Common Starlings and Funke's (1912; and in Stresemann, 1935*b*) tame Magpie used several ants at a time. Simmons refers to this behavior in these last two species, as do Goodwin (1955*a*; 1955*b*) and Löhrl (1956) to the Starling. Poulsen (1956) said that the Blue Jay and Common Starling often retained ants after applying them and that, by the process of applying and then retaining ants, these birds collected as many as 20 ants before discarding or swallowing the mass. On one occasion he saw this in the American Robin.

REACTION TO ANT-NEST EARTH

A strange activity of the Orchard Oriole concerned not the ants themselves but their nests. On seven days, winter and summer, the bird ate particular bits of nest earth, taking soil only from one or two minute spots in the tray. It always seemed to examine the dirt very closely before finding a spot to its liking. At times I could see what appeared to be grains of earth on its long tongue. Once, after several daily anting sessions, the bird was surfeited and would not ant—yet it ate a little of the nest earth. On two days, with the unacceptable *Pheidole bicarinata buccalis* and *Pogonomyrmex barbatus*, it ate nest earth. Ants, eggs, larvae, pupae were not involved in these feedings, though the bird may have been finding infinitesimal pellets of food residue ejected from the ants' infrabuccal pockets or, conceivably, minute myrmecophilus arthropods (Wheeler, 1910:32, 378–397).

On February 24, 1955, I tested the bird with earth (free of ants) from a nest in the formicarium. The oriole ate certain bits of the earth; yet when I replaced this with garden dirt, the bird hunted over the tray but did not once touch bill to the soil. Next I gave it still another sample of formicarium earth. Again the bird ate soil particles. Twenty minutes later it anted at high intensity with ants fresh from the yard, but it ate no dirt.

I have seen no record of such feeding. Gravel was always available to the bird; and powdery soil, which it spurned for dust-bathing, it never ate. It is a guess that the oriole ate only soil particles impregnated with ant exudations, possibly soil that had lined brood chambers. Wheeler (1910:395) stated that galleries of populous ant colonies becomes "greasy from the attrition of the constantly passing ants." Ivor (letter, May 10, 1956) suggested that the oriole may have found some kind of beneficial mold in the nest earth.

FREQUENCY OF ANTING EPISODES

Little is known concerning frequency of anting in the individual bird. Groskin (1950) observed a banded Song Sparrow, probably two individuals, anting on five days during one month, often "several times a day"; and Mayr (1948) saw a Song Sparrow ant almost daily in July in a certain stand of dock (*Rumex*) frequented by ants. Three Indigo Buntings in the wild used ants on four consecutive days (Shackleton and Shackleton, 1947). John A. Johnson (letter, September 17, 1954) advised me that his tame Common Crow ants perhaps once a month or whenever the weather is warm and dry. Goodwin (1951) found his six European Jays would not ant "two or three days running" and that a week or more seemed necessary between sessions for "keen" performance. Ivor (1951:177) believed his birds would ant only occasionally if ants were kept in the aviary.

On the other hand, Poulsen (1956) stated: "Many birds eating and anting with ants did so every day—sometimes several times daily—for more than a month." But he found that some of the species which applied ants but also allowed ants to invade their plumage (*Turdus philomelos* and *T. musicus*) did not respond again until three days later, while an American Robin, having refused to ant for three consecutive days, anted on the fourth day.

Study of individual differences in amount of anting is long overdue. Why, among captive Magpies (*Pica pica*), should one bird ant and the others never ant? Why did Goodwin's (1955*b*) Lanceolated Jays ant at their first opportunity, in 1951, and thereafter refuse? Why did some of Ivor's (letter, November 25, 1955) anting birds, among them individuals that had anted for years, either refuse or ant only sparingly during repeated tests in spring, summer and fall of 1955?

These and most references to frequency of anting or to absence of anting in experimental birds are unsatisfactory in that there are no precise statements on the quantities of ants supplied, and often the ants have not been identified. Poulsen (1956) gave his birds "a shovelful of earth containing several ants." Sometimes my oriole ate many ants before beginning to apply them. Thus, a bird given a limited daily supply might be expected to show a different frequency of anting from that occurring when its supply is abundant enough to permit daily surfeit. I believe that the amount of insect food in the diet of a captive bird also may affect anting responses, and that a captive starved for fresh insects may eat all of a limited supply of ants without performing any anting.

In this connection, I should emphasize that whenever the oriole had access to invading ants (see Methods) these were in almost limitless supply and continued to invade long after the bird had lost all interest in them. Also, in a majority of the other experiments more ants were offered than the bird could use.

I found anting frequency was high in my oriole, at least in summer. In 1954, between June 30 and September 19, the bird was put with invading ants on 41 days. Of these 41 days when there was opportunity to ant with the same species of ants in their natural state, the bird performed on 34 days. On three other days there was circumstantial evidence of anting; for, on these days, I did not remain to watch the bird, yet later I found scores of dead ants on the floor. On only four days did the bird refuse to ant.

In July alone, during 24 contact days with these ants, the oriole anted on 19, gave circumstantial evidence on three others (the three days mentioned above), and refused to ant on only two days. Also, on three of the 19 days (July 5, 8, 9) the bird was placed with the ants both morning and afternoon, and it anted each time.

The longest period of successive daily performance by the oriole was 10 days (June 30 to July 9); the next longest was seven days (July 31 to August 6). Both sequences occurred with invading ants.

For the entire 31-month study period (March 23, 1953, to October 6, 1955), negative response was even lower. Out of 77 contact days (not including the three days of circumstantial anting), the oriole's response was positive on 67 days and negative on 10 days. Analysis of the 10 refusals shows that the bird refused because of apparent surfeit on only four days. On the other six days rejection was due either to the presence of strangers (one day, with acceptable ants available) or to the fact that only an unacceptable ant species had been offered (five days).

Duration of Anting Episodes

Anting birds frequently perform from a few minutes to one-half hour. Two Scarlet Tanagers (*Piranga olivacea*) anted, with short interruptions, for more than one hour (Groskin, 1943); three American Robins anted in turn for over 45 minutes (Nichols, 1943); and a Common Grackle used green fruits of *Magnolia acuminata* for over an hour (Parks, 1945). In the case of three Cardinals (*Cardinalis cardinalis*) observed by Kurata (Snyder, 1941) to ant for about two and one-half hours, it is not clear whether the birds were under continuous observation or that this constituted a single episode.

My oriole commonly anted for 25 minutes; that is, from the time it began to apply ants until the time it quit or the ants were removed. Frequently it performed for 45 minutes and was still anting when I ended the experiment. On May 22, 1954, the bird anted for 19 minutes with dead ants, and soon thereafter, for 30 minutes with live ants. Again, on April 3, 1954, during one hour and 55 minutes, when the bird was given three separate and varying supplies of ants, it performed for 3, 13 and 20 minutes, in that order. Winter sessions at times were equally long. On January 14, 1955, the oriole anted intermittently for about 90 minutes while Dr. A. A. Allen was taking pictures. Two weeks later it anted for 45 minutes, when there had been no unusual distractions.

As a rule anting continued quite steadily, with brief intervals now and then when the bird might search for ants, rest, or engage in unrelated activities. When anting at top intensity, the bird applied ants, one after the other, as fast as it could snatch and use them. But after a few minutes of such rapid action, it would stop anting and stand still for a while, as if exhausted, before resuming. I was impressed by the bird's strenuous, apparently compulsive, exertion. During warm weather, in strong sunshine, it sometimes stood and panted, but its non-anting companion, the Painted Bunting, did not react in this manner. After long, vigorous sessions, the oriole would feed and then sit quietly for as long as 45 minutes, sometimes sleeping. Ringleben (in Stresemann, 1935*b*), who stated that his Carrion Crow obviously was

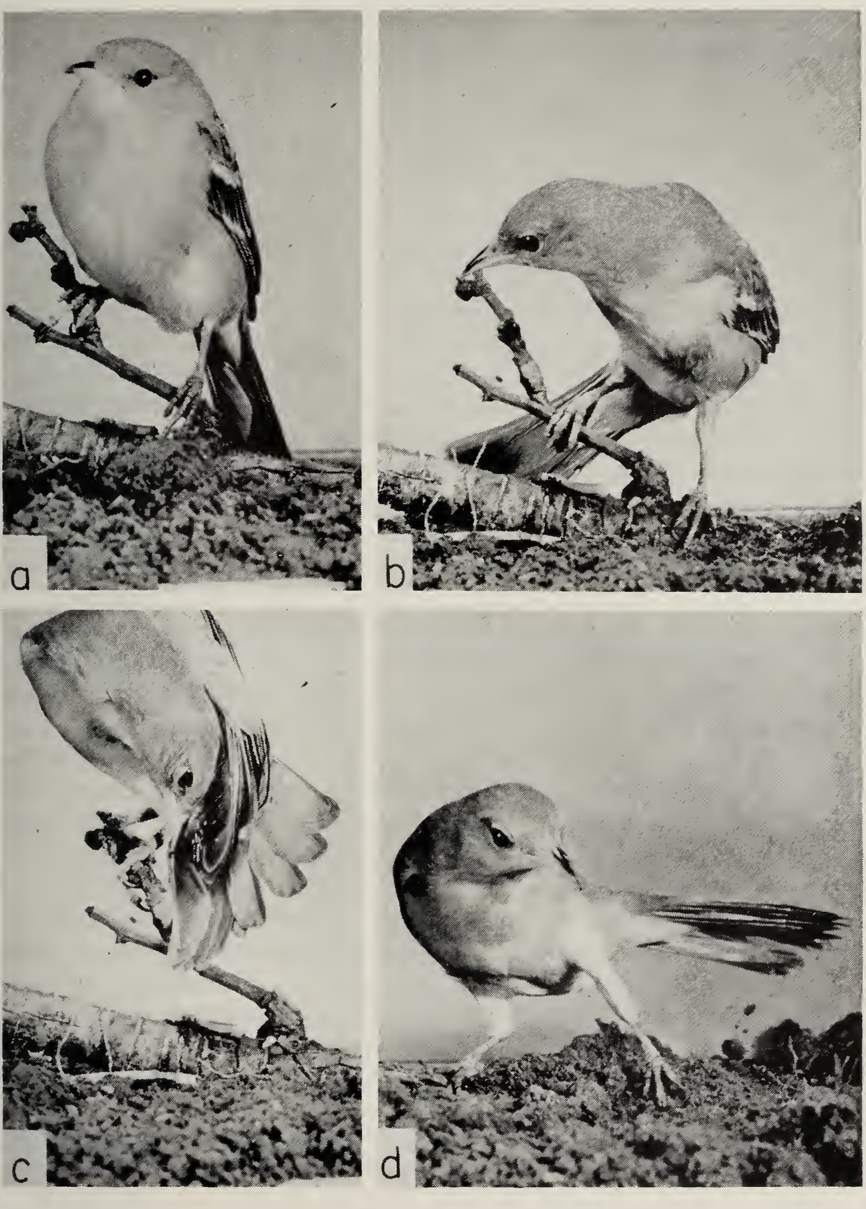

Fig. 2. (a) Orchard Oriole, resting after anting, reveals displaced plumage of belly and side. (b) With one ant wedged in the left outer rectrix (showing below inner toe), bird reaches for another ant. (c) Oriole, ant in bill, almost doubles body in reaching toward juxtaposed wing and tail. Note open eyes. (d) Bird resumes normal pose after applying ant, still held in bill. Note lumps of earth thrown upward by motion of tail.

tired after anting for about 25 minutes, appears to be the only other observer who has noted fatigue.

Selectivity in the Anting Bird

Goodwin (1951:621–623) said of captive European Jays, regularly anting with, but never actually applying, *Formica rufa*: "Attempts to induce anting with small numbers of other species of ants have failed, possibly because they were not offered in sufficient quantity." But he does not name the ant species. I found that the oriole would respond to few ants or to one ant. Adlersparre (1936), Nice (1943, 1955*a*), Nice and Ter Pelkwyk (1940), all had the same experience with actively anting birds of several species. Thus it seems that release of anting response in birds that apply ants is not dependent upon the quantity of ants. Certainly my bird consistently rejected abundant but unacceptable ant species, including harmless ones which it often ate. But I believe the quantity of ants can affect intensity of the performance. Anting in the oriole began at low intensity, as a rule, soon built to a peak, and continued in long plateau before gradually subsiding.

I never saw my bird use a substitute. Daily it fed on apple and orange, both of which are known substitutes (Hampe, in Stresemann, 1935*b*; Chisholm, 1944; Laskey, 1948; Nice, 1952). Hampe (*loc. cit.*) and Poulsen (1955) both reported that vinegar induced anting. But when I once put vinegar solution in the oriole's honey-water vial, the bird seemed puzzled. Three times it plunged the bill into the liquid, backing off as if in surprise and shaking its head. This bird also avoided burning cigarettes and fled their smoke. Fifteen wiggling, inch-long larval centipedes (Chilopoda) excited the bird but it would not approach them. After I had crushed the heads of several, the oriole took one but soon tossed it away.

Certain species, even individual birds, have used ants *and* one or more substitutes (Adlersparre, 1936; Poulsen, 1955, 1956; Burton, 1955*a*, 1955*b*; Nice, 1955*a*; Nice and Ter Pelkwyk, 1940; Scheidler, in Stresemann, 1936; Alvarez del Toro, MS). Dr. Alvarez found the Streak-backed Oriole (*Icterus pustulatus*) in nature using a species of small wasp, as well as two species of ants. Burton's astonishing Rook used ants, both burning and hot (but extinguished) cigarettes and matches, and small live embers, besides performing the same movements of anting whenever it could get within reach of smoke. This Rook, according to its former owner, reacted similarly to steam from an electric kettle, even knocking off the lid at times in order to reach the steam. A number of times it performed in front of an electric heater, apparently stimulated by the heat. But Burton's European Jay, though responding to snubbed but still warm cigarettes or blown-out but smoking matches, refused to use the unidentified ants, cold tobacco and the several other common substitutes offered it.

Dr. P. H. Fluck (1948), whose tame Blue Jay used various bitter, sour fruit juices and hair tonic, informed me (letter, March 24, 1956) that he has a second such bird that anoints *only* with the hair tonic.

Poulsen (1956) noticed that anting in the Magpie-Robin (*Copsychus saularis*), Shama Thrush (*C. malabaricus*), Peking Robin (*Leiothrix lutea*), and Common Starling was more pronounced with *Formica rufa* than with *Lasius niger.* He pointed out that this last ant is smaller, weaker in its bite, and produces less spray. His Western White-Eyes (*Zosterops palpebrosa*) and Blue Sugarbirds (*Dacnis cayana*), on the contrary, were much more likely to perform with this smaller ant and were cautious with the larger species and rarely used it. In his opinion, all of this appeared to indicate that bird species differ in their sensitivity to the bite and spray of ants. One might mention that this also was a case of the smaller birds showing preference for the smaller of two spraying ant species.

My exploratory experiments with selectivity in the oriole yielded some interesting results. Whenever I offered either of the *Pheidole* forms, the bird usually ate them sporadically but never applied any of them. Yet immediately thereafter, it would ant at length with *Dorymyrmex pyramicus.* At the very first experience with *Pogonomyrmex barbatus,* the oriole seemed to sense its harmfulness. Always the bird handled this species gingerly, taking up the ant with a pick-flick motion that sent it tossing. When repeated treatment had stunned the ant sufficiently, the bird would pinch it slowly a few times before discarding it. On one occasion pinching either brought out a distasteful flavor, or the bird was stung; because suddenly the bird flung the ant aside and began working its tongue, shaking its head and repeatedly wiping the bill on the window sill where it had been standing. Never did the oriole eat or apply this species, although immediately afterward it would do so with acceptable ant species.

The ant *Crematogaster laeviuscula* was completely ignored. Indeed the only time I saw the bird touch an ant of this species was when I offered them from the hand and then they were thrown away at once. In the summer of 1955, this species, not *Dorymyrmex pyramicus* as in the previous summer, invaded the porch almost daily from mid-July to mid-August. The oriole was put with these ants a number of times; but, as far as I could determine, this species was rejected, both initially and repeatedly, without as much as an incipient peck. Since the bird seemed to enjoy killing the aggressive *Pogonomyrmex,* whose sting and bite both presented threats, it seems unlikely that the weak sting of *Crematogaster* was the deterrent. In any case, neither of these two ants is particularly odorous, even when crushed.

In addition to the four above-mentioned ants, the oriole also rejected a color variety of an otherwise acceptable species. This happened with *Dorymyrmex pyramicus,* an ant that occurred in my yard in two color varieties, one blackish, the other pale amber. On June 21, 1954, I offered a nest of the amber-colored ants. The oriole looked them over casually but would not touch them, or the larvae and pupae, during 15 minutes. It did, however, once eat a bit of the nest-earth. I then added a nest (no larvae or pupae) of the readily distinguishable dark-colored ants. As I poured out these ants, the oriole was instantly alert, crouching and leaning out on its perch, as if in interested recognition. As soon as my hands were out of the way, it began to ant. But not once, during about 20 minutes of anting, did I see the bird take up a light-colored ant. Each time it chose a dark ant from the mixed colonies. (Specimens from both colonies, taken at the time, were identified by Dr. Gregg.) Three days later I brought in from the original nest site the remnant population of light-colored ants. Again, the bird refused to touch them. Regrettably, I did not test flavor and odor in these ants, and I never again found this pale variety.

Was rejection due to color? Or might the pale ants have been callows and thus less strong in odor and related qualities? According to Wheeler (1910: 534), the young worker ant first develops its own individual odor during the period when the integument is hardening and taking on adult coloration. Fielde (1905) has shown that a worker ant's individual odor intensifies or changes with age "to such a degree that they may be said to attain a new odor every two or three months" and that hostility between colonies of the same species and variety may be caused by a difference in odor "coincident with difference in the age of the colonies." Morley (1941–1942) said that Fielde's work seems to show that ant odor is not fully developed until some time after callow stage and the ant is fully adult. Not recognizing at the time that age of ants might be of possible significance in anting, I did not preserve the pale specimens, once they had been identified.

A thorough study of selectivity needs to be made. No one knows precisely how or why birds make their choices of ant species or substitutes, or whether conditioning on a particular anting material actually occurs. Various non-anting responses of birds, some of them known anting species, to wasps (Hindwood, 1955; Goodwin, 1952*b*; Chisholm, 1952; Moreau, 1942; Rankin, 1950; Powne *et al.*, 1951), together with other cases of definite anting with wasps (Alvarez del Toro, MS; Freitag, 1935; Butler, 1910), suggest that birds may be similarly sensitive to differences in wasp species, in some of which *both* sexes are stingless. Butler (*op. cit.*) said, of *Garrulax* sp., only that "the wasp is seized and its tail rubbed backwards and forwards between the tail-feathers of the bird, either in order to break the sting or exhaust its venom before it is eaten."

REACTION TO DEAD ANTS

Both stunned carpenter ants (*Camponotus* sp.) and dormant ones have been applied by various small birds (Nice, 1943:81; Ivor, 1943, 1956). Of dead "wood ants" (apparently some of them killed in test tubes in boiling water), Adlersparre said only that these ants caused his birds to perform as if with living ones.

On April 3, 1954, I placed 40 *Dorymyrmex pyramicus* on a metal tray, passed it momentarily over low heat to kill the ants, and offered it to the oriole. The bird came at once and ate two ants. Its manner was casual and, during 10 minutes, it applied but four ants, two of which were afterward eaten, and ate 10 others directly. The dabbing and vibrating movements of the bill were very much slower than usual. There was no tripping, and *only* the wing tips were treated. The actual anting span was about three minutes.

I then offered approximately one-half of the nest from which these ants had been taken, together with its living workers and larvae, but no pupae. Now the oriole anted for 13 minutes, using all ants that did not crawl out of reach. Anting intensity was high. Many ants were eaten, with and without application. Forty minutes later, I replenished the tray with the remaining portion of the nest. This time the bird anted at top intensity for 20 minutes, after which I removed the ants. It rolled, fell down and tripped; but it ate few ants and incapacitated ones littered the floor. The usual plumage areas were anointed; and I noted three applications to the crural tracts.

Substantially this same experiment was repeated seven weeks later, on May 22, when I offered first 50 heat-killed ants (probably the *Dorymyrmex*), and then their nest containing live ants and pupae. On this day response to heat-killed ants was somewhat more pronounced. The bird performed intermittently with dead ants for 19 minutes, but with a marked lack of eagerness. Again movements were slow, yet at least 13 applications were made to basal section of the tail (*once* to undertail coverts alone) and eight to wing tips. Eight dead ants were eaten before anting began. Most ants applied were afterward eaten, but I noted nine others were eaten directly. Again, live ants induced intense anting until they were removed after 30 minutes.

A third such experiment next day, with *Iridomyrmex pruinosus analis*, brought a different result. When 150 heat-killed specimens, together with eggs but no larvae or pupae, were offered, the bird refused to perform during 17 minutes. In the first 11 minutes the oriole expressed some interest and ate nine ants; then it hunted over the tray and floor as if seeking live ants, now and then probing at the dead ones without picking up any.

Ten minutes later, I tried the bird with 150 live ants from the same colony, placing them on the bare tray, along with a few eggs. Instantly the oriole was attentive. It ate three ants and then began to perform as usual but at moderate intensity, until only a few dead or maimed ants remained. Twenty-four minutes later I gave the bird the nest of this same colony with the remainder of its population, including eggs, larvae and pupae. The oriole ate four ants, then anted at moderate intensity for 15 minutes.

On November 1, 1954, the oriole applied and ate the few dead, wet ants (probably the *Dorymyrmex*) offered it. These ants had drowned in a formicarium moat. Next day I offered on a saucer about one-half teaspoonful of drowned ants which had been dried at room temperature. There was quick interest, but the bird, unfamiliar with the saucer, seemed afraid. Twice it climbed down the cage wall until it could reach an ant, then applied the ant while clinging upside down. Thereafter the oriole anted readily on saucer and floor for 12 minutes. The usual areas were anointed, including the undertail coverts. When all ants had been "used," the bird hunted for more and applied discarded ants, some of which had been applied previously. Anting intensity was high. I counted 55 ants applied, some of which were afterward eaten, and a number eaten without previous application.

Frozen ants (probably the *Dorymyrmex*) from several colonies, collected in early November, 1954, and stored in a tight but not air-tight container, were also used by the oriole many times that winter through January 18, 1955. I had drowned, rinsed and drained the ants before freezing them. Whether few were offered or many dozens, the bird always performed. Given small numbers, the oriole usually ate each one, about half of them being first applied, and often it hunted for more. It used frozen ants with somewhat less enthusiasm than it exhibited with live ones, yet the usual plumage tracts were treated and action and interest usually were keen.

Then, on January 31, 1955, the bird ate 16 of approximately 100 frozen ants but it refused to ant during 13 minutes. Five minutes later it gave an average performance with live ants from the formicarium. By this time the frozen ants, stored over two months, had lost much of their odor and flavor, a significant change to be described later. Furthermore, frozen ants thereafter were eaten but never again applied, although the bird continued to perform with living ants.

Reactions to Subtle Variations in the Acceptable Ant

Each ant species accepted by the Oriole has only a simple worker caste; and sexual forms never were offered the bird. Nevertheless, during anting sessions, many ants were rolled and flung aside without being applied. Occasionally the bird would then toss its head and wipe its bill as if the ant had been mildly disagreeable. But in the next moment, another ant of the same species and colony would be rolled and applied, while a third one might be rolled and dropped. Frequently the bird returned to such discarded ants, even wads of ants, picked them up, rolled and discarded them again, still without applying them.

It was Margaret Nice who stimulated me to taste ants. I crushed between the teeth and tasted many ants from the supplies given the oriole, testing every species offered.

I found all of the acceptable species, fresh from the yard, usually were sweet at first and then they produced a mildly burning sensation on the tongue. Strangely, individuals of a colony varied—a few of them, although sweet, did *not* burn. I found also that odor among these ants varied. Usually they were strong-smelling when crushed between thumb and finger, but some individuals gave off little or no odor. Larvae and pupae were faintly sweet, but did not burn the tongue; nor did these have the butyric acid odor so characteristic of adult workers. (According to medical science, strongly irritating substances, such as mustard or formic acid, applied to the skin, can produce measurable amounts of heat, due to dilation of the capillaries. Therefore, I shall use the term *thermogenic* in referring to *any* kind of burning or warming quality in anting materials.)

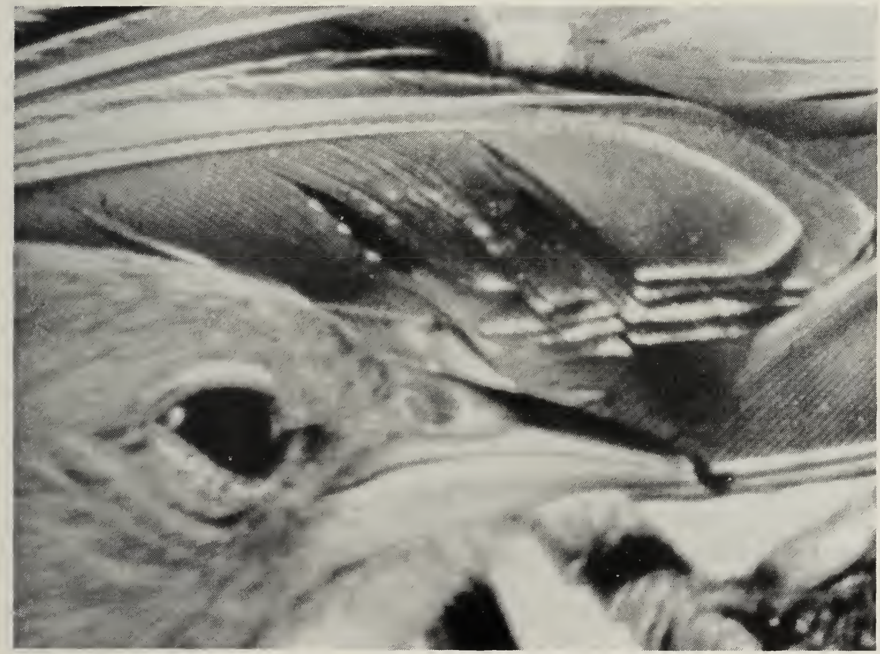

FIG. 3. Greatly enlarged section of Fig. 2*c*, showing effects of vigorous anting in Orchard Oriole. Note (a) rents in four outer primaries caused by bill; (b) ant-nest earth (showing as white specks in photo) on bill just to left of ant, and adhering to edges of punctures in webbing; (c) unworn condition of plumage beyond disrupted area.

In addition, the burning sensation produced by these freshly dug ants seemed to vary with the season, and more of them were likely to have high thermogenic value during summer than in winter. For instance, on February 24, 1955, when the oriole used freshly dug ants at high intensity, most of the ants I tasted burned moderately, although certain others burned strongly or not at all. But later, on May 24, when the bird anted at top intensity, the ants were very strong in thermogenic property, so much so that a single ant was enough to burn the whole tip of my tongue, and only an occasional one did not burn. Furthermore, when I collected some of these ants, as the bird applied and cast them aside, I found most of them burned strongly, although others burned faintly or not at all.

Some of these discarded ants had been applied only once, and briefly. I suspected the bird was applying sparingly those ants which had little or no thermogenic property. I then collected and tasted, immediately after they were discarded, two additional ants which, I carefully noted, had been applied several times. Each of them burned my tongue excessively. O'Rourke (1950) discussed the variation in formic acid content of venom in several ant species. He mentions that Stumper (1922*b*) showed that temperature affected the rate of secretion in *Formica rufa* and that Stumper's results gave a Q^{10} of 2.16—that is, a rise of 10° C. increased the rate of secretion 2.16 times, or roughly doubled it.

Deterioration in the qualities of frozen ants was noted (p. 220) after several weeks of storage. On November 22, 1954, I could detect no change in ants stored since November 4; but by January 31, 1955, when the oriole refused frozen ants for the first time, I found them to be very much less sweet and odorous and to have *no* burning quality whatever. The changes probably had developed earlier, because, when the bird was given a small quantity of them on January 18, 1955, it ate all of them but applied only three. Of even more significance, it treated only the wing tips, once possibly touching the edge of the undertail coverts in doing so, and the right crural tract—this last a plumage area not usually anointed.

I did not test the thermogenic property of heat-killed ants at the time of those experiments. However, it seems probable that the heat had been sufficient to lessen or destroy that property, thereby causing either poor anting response with slow action or outright rejection, as already described. Later, on October 20, 1955, when I did test the effects of heat, applied in the same way, on *Tapinoma sessile*, I found the thermogenic value was very much affected. Of 12 live *Tapinoma*, nine burned the tongue mildly to strongly, and three produced no burn whatever; whereas, of 12 heat-killed specimens from the same colony, nine gave no burn, while three burned slightly.

Unacceptable ant species differed markedly from acceptable ones in these respects. Neither the *Crematogaster*, the *Pogonomyrmex*, nor either of the *Pheidole* forms had appreciable odor, even when crushed. These species were all rather tasteless, not at all sweet, and they did *not* burn.

These variables within the ant colony seemed to explain why the oriole would eat one ant, apply the next, and fling a third away unused. I could not be sure, of course, whether the bird's reaction to a given individual was determined by that ant's sweetness, odor, heating quality, or by factors yet unknown. Evidence that the thermogenic property stimulated anting in the Orchard Oriole may be summarized thus:

1. All ant species accepted produce a burning sensation to the human tongue.
2. The four unacceptable ant forms were found to lack thermogenic property.
3. Larvae and pupae of acceptable species, lacking heating property, were rarely applied.
4. Ants of acceptable species, when subjected to heat that tended to destroy the thermogenic property, brought either very low or negative anting response.
5. Ants of acceptable species, when frozen, remained acceptable until prolonged storage had destroyed their thermogenic quality; once this change occurred, frozen ants were no longer accepted.

Since the general level of thermogenic property in the ant population appears to be lower in winter, it may very well be that the oriole's tendency toward somewhat milder anting response in winter was due to the condition of the ants themselves at that season. Ivor (1943) found the interest in anting pronouncedly lower among his birds in winter.

My fragmentary explorations into the properties of ants that appear to induce anting show the need for full study along this line, if we are to have thorough understanding of anting behavior. The oriole's selectivity also demonstrates that the behavior of birds in the presence of ants cannot be evaluated without determination of the ant species and variability within the colony. This is illustrated further by the instance of birds (several known anting species) congregating to feed on unidentified winged ants but not performing anting actions (Worth, 1938). In this connection it is significant that anting has not been recorded among birds following the purblind, noisome army ants (*Eciton*) of vestigial sting (Schneirla, 1956; Skutch, 1954: 24; Johnson, 1954; Sutton, 1951); and that Elliott (1950), describing relations of birds with red driver-ants, "probably . . . *Dorylus* (*anomma*) *nigricans*," did not mention anting.

Since birds are known to ant with beetles and bugs, anyone looking for evidence of anting among birds attending swarm-raids of army ants should bear in mind the possible role of the routed insects as anting materials. My Slate-colored Solitaire (*Myadestes unicolor*), for example, anoints itself with certain thermogenic beetles but not with some other beetles lacking that value, and thus far has rejected all ant species offered it.

RELATION OF FEEDING TO ANTING

As I watched the oriole perform day after day, it became clear to me that this bird was not primarily interested in ants as food. For one thing, I soon noted that usually more ants were discarded, with or without application, than were eaten; and in some sessions few, if any, ants seemed to be eaten. For instance, on June 30, 1954, during 30 minutes of top intensity anting, the bird ate relatively few ants and I noted very few discarded without use. Yet afterward I counted 88 damaged ants on the floor before giving up the effort to make a full count. These, or most of them, were ants that had been applied. When ants were offered daily, the bird's anting interest tended to decline; and on some of those days, I did not see it eat any ants, although it continued to ant, however mildly.

On the other hand, when the bird's interest rose, following days of low intensity anting, I noted no corresponding increase in its intake of ants. On one such day the bird anted eagerly; but I could be certain of seeing it eat only three or four ants. Yet, while anting was in progress, I counted 56 incapacitated ants on the floor. Notes, made during periods when the bird was given ants on many successive days, contain several remarks that the bird's anting appetite was better sustained than its eating appetite.

No amount of anting seemed to allay the bird's hunger. When the oriole had access to its regular food, it sometimes ate during the anting session, and at times drank honey-water. After protracted anting sessions it commonly fed voraciously. When ants (probably *Dorymyrmex pyramicus*) sometimes were gathered with small grasshoppers in the collecting net, the oriole would apply them before turning its attention to the grasshoppers, which it relished.

Many anting records do not show whether birds were eating ants. Most of those that do note consumption of ants concern birds that performed active anting. Ivor (1941; 1943) said that his birds ate a majority of the ants they used. Poulsen (1955) stated that each ant was eaten, but that "the birds did not always make the anting movements before eating the ant"; and he later (1956) listed 19 species that were seen anting and sometimes discarding the ants. Goodwin (1952*a*; 1955*b*) said that some birds discard all worker ants after using them, and he described three species that habitually went through the motions of active anting without even picking up the ants. He (1955*a*) considered anting to be a "very distinct behaviour pattern, unconnected with feeding."

Curiously, Wackernagel's Carrion Crow, which apparently did not eat ants during the anting sessions. in one instance came back the next day to the anting ground and ate the dead ones that remained. Huth (1951) saw a Chaffinch (*Fringilla coelebs*) apply and then discard the ants. Stegmann (letter, April 10, 1956) observed that a Brown Dipper (*Cinclus pallasi*) in the Tien Shan Mountains, Siberia, in July, 1949, discarded the large brown ants. "Holding an ant in its bill, the bird would pass it over the feathers of the wings and of the sides of the body below the wings. This was performed with three ants, one after the other. The ants after being used were not eaten but dropped anywhere." Chisholm (1944) saw no evidence of eating among a group of Common Starlings anting in the wild. He and others comment upon the numbers of incapacitated ants left on the anting grounds (see Brackbill, 1948; Thomas, 1941; Pillai, 1941; Wheeler, 1951).

It appears that birds performing passive anting usually do not eat ants during the act. This was true of at least five of the eight Common Crows and of the two Northwestern Crows (*Corvus caurinus*) for which I have been able to find records (Frazar, 1876; Weber, 1935, and letter, May 5, 1954; Ivor, 1951; John A. Johnson, letter, September 17, 1954; Frank L. Beebe, letter, March 15, 1954; and G. Douglas Morris, letter, November 25, 1956). Excepting one, these birds were all tame, most of them free-flying individuals. The exception was the "gray-white" albinistic Common Crow which Morris (*loc. cit.*) saw anting beside a trail where many large black ants were crawling around a piece of rotten wood.

FIG. 4. European Jay (*Garrulus glandarius*) in special passive anting posture. This species allows ants to invade plumage; it does not apply them, yet will make motions of picking up and applying ants to wings. Photographed by Dr. Hans Löhrl, Ludwigsburg, Germany.

An investigation of the side effects of anting and ant consumption by birds would seem worthwhile. I have no explanation for the fact that my Orchard Oriole occasionally held a wad of ants in its bill for quite some time, but the behavior reminds one of the somewhat similar human use of ants as smelling salts (Butler, 1897; Löhrl, 1956). The ant *Oecophylla smaragdina,* used for anting, has been a regular food item among certain peoples in India, who, it is said, use it "against fatigue and the sun's heat" (E. H. A., 1889; Long, 1901). According to Dunglison (1846:334), *Formica* sp. "were formerly extolled as aphrodisiacs" and the chrysalides "are said to be diuretic and carminative. . . ." Gorsuch (1934) mentioned a quail that tried to save her nest from unidentified invading ants by eating ants "as fast as they approached until she died, possibly from formic acid poisoning."

Preening and Bathing Following Anting

The relationship of preening and bathing to anting remains obscure. The present meager literature on this aspect of anting suggests that preening and/or bathing after anting may prove to be pronounced only in birds that allow ants to crawl over them and in those birds that apply vegetable substitutes with the bill.

Simmons (1955), apparently making no distinction between types of anting, has generalized: "Normal preening and bathing are almost invariable sequels to anting." He sees in this the implication that anting functions in some way as a "superior preening method." However, Ivor (1943, and letter, April 7, 1956) has found both preening and bathing rare in his many species anting actively with ants. Wackernagel, Löhrl (1956) and Goodwin (1947; 1951) reported bathing following anting in certain species that permitted ants in their plumage.

Govan (1954) noted that her Rose-breasted Grosbeak (*Pheucticus ludovicianus*) bathed twice not very long after having anted in a skillet of sliced onions. And she described unusual bathing by a free-living Catbird that allowed ants to stream over its plumage during active anting. The bird indulged in five brief, successive periods of anting, between each of which it flew to a bath, where it crouched and turned about in the water, stroking its primaries with the bill and shedding ants into the water.

Wright (1909:340) observed a case of apparent anting soon *after* the bath, in a Blue-winged Warbler (*Vermivora pinus*) that dusted in a "black ant hill." (See Dater, 1953, for details on anting in this species.) The report on three Cardinals anting for about two and one-half hours and appearing wet at the end of that time seems to imply that the wetness was due to the ants (Snyder, 1941). The Shackletons (1947) described two anting Indigo Buntings whose tails and wings appeared wet, "as if drenched with liquid"; but they made no deductions. Perhaps these, too, were cases of birds anting after bathing, since there is nothing in these reports precluding the possibility. Here a note by Staebler (1942) seems significant. He and George M. Sutton, noticing the wet, disarranged plumage of an American Robin using *Formica exsectoides,* believed the bird was wet from bath or the heavy dew.

My Orchard Oriole, normally enjoying one or more baths a day, usually had access to the bath during or immediately after anting; but its post-anting baths were so irregular I did not keep full records. I did, however, make notes on 18 days when bath water was available. On seven days the bird bathed at once after anting, in one case first dozing about two minutes with head in scapulars. Excepting one day, these were sessions with live ants, and anting intensities were of top (two days), high (four days), low (one day) levels. The exceptional session was with drowned, air-dried ants, and anting intensity was high.

On five days the oriole waited from three to 15 minutes before bathing, once not bathing until it saw another bird do so. These performances, all with live ants, varied from top (three days), through high (one day), to moderate (one day) intensity.

On still another day, with live ants at high intensity, the oriole waited 30 minutes before bathing. On the remaining five days, the bird did not bathe during the ensuing hour, and once it sunned and preened at length instead. With one exception, these sessions were all with live ants and intensities were high (two days), moderate (two days), low (one day). Here the exception was with frozen ants, used at moderate intensity.

After my oriole's long and extremely exciting first experience with ants, it flew to a perch, fluttered and shook out its plumage, preened thoroughly, and then bathed. But I never again noted this exact procedure. In general, it seemed to me that bathing in this bird was too erratic to be attributed solely to the effect of ant substances on its plumage.

Although most anting records do not mention it, preening often has been reported in association with anting (Robien, in Stresemann, 1935*b*; Brackbill, 1948; Groff and Brackbill, 1946; Hill, 1946; Moltoni, 1948, and others). Yet, it must be pointed out, many of these instances involved use of substitutes or the invasion of the plumage by ants. Dr. Fluck wrote me that his Blue Jays, using substitutes, preened after anting, as was true of John A. Johnson's (MS) Common Crow following passive anting.

Aside from the preening that followed post-anting baths, preening in the oriole was highly irregular, both in occurrence and degree. Sometimes the bird preened not long after anting, often not at all or only much later. Occasionally it shook itself briefly, scratched its head or preened a little during breaks in protracted anting sessions. The bird did not concentrate attention on the plumage parts anointed and, except when preening was brief, it dressed the plumage as it normally would. It seemed to me that heat, fatigue and plumage displacement were certainly as important as the localized ant-ointment in motivating both bathing and preening in the oriole. I observed that handling of the bird, which caused exertion and roughened plumage, almost invariably induced preening, and oftimes rather prompt bathing. Andrew (1956), studying toilet behavior of buntings (*Emberiza* spp.), stated: "Disarrangement of the body feathers often seems to provoke preening."

It appears that observers are overlooking the mechanical effects of anting. Close observation of my oriole showed that sustained anting resulted in disheveled plumage. Tripping and standing upon the tail often caused damage to rectrices. The dabbing action of the vibrating bill regularly roughened, and often split, webs at tips of the primaries. Damage to webbing, while not always conspicuous, was readily discernible. Figure 1*a* shows split web of a rectrix. Figure 3 reveals penetrations in the layered webs of the four folded outer primaries, and particles of ant-nest earth, transferred by the bill, adhering to margins of these openings in the web. Contour feathers never treated during anting sometimes were disarranged by the bird's falling and tumbling, as seen in Figure 2*a*. Extreme displacement of a greater wing-covert is shown in Figure 1*d*. The bird was photographed when in perfect plumage, following fall molt. Several published photographs of anting birds show split webs or the abrasive action of quill feathers pressing against the ground (Corby, 1950; Ivor, 1956; Löhrl, 1956; Poulsen, 1956). Yet these occurrences, as results of anting, have not been commented upon.

Expression of the Eyes During Anting

These non-spraying ants seemed to have had no effect whatever on the oriole's eyes. I found no unusual blinking, spreading of nictitating membrane, or peculiar stare in the oriole during anting, such as some observers report. The eyes seemed to close at the instant the ant was touched to the plumage, just as they close for deep preening. Photographs, taken a fraction of the second before (or after?) application and while the ant is almost but not quite touching the plumage, show the eyes open (Fig. 2*c*). Photographs taken when the ant was in contact with the plumage show that the eyes are closed or covered by the membrane (Fig. 1*b* and Frontispiece). Corby's (1950) photographs show two birds with eyes closed; one of them, with the ant held some distance from the plumage, suggests the ants were a spraying species.

I wonder whether the Mistle Thrush (*Turdus viscivorus*), opening and closing its eyelids (*palpebre*) while ants crawled in its plumage (Moltoni, 1948), and the Baltimore Oriole, photographed in anting posture with nictitating membrane filming the eyes (Ivor, 1956:113), may have been reacting to ant spray in their eyes, rather than expressing enjoyment or apparent rapture, as the observers interpreted. The ant (*Oecophylla smaragdina*), used by birds for anting, is said to cause smarting in the eyes of jungle people who crush masses of these insects for food (E. H. A., 1889).

When Goodwin's (1951) European Jays got acid of *Formica rufa* in their eyes, they would close them instantly and hop away, to stand a moment as if pained. Various small birds, using *Formica sanguinea, Lasius niger* or *Camponotus pennsylvanicus* (all spraying species) partly closed their eyes just before application; but a tame Common Crow, while sitting among ants, "closed her eyes and remained quiet for minutes at a time" (Ivor, 1951). A tame Carrion Crow, applying and sitting among *Lasius niger* and *Formica rufa,* frequently drew the membrane over its eyes (Wackernagel, 1951). Löhrl (1956) said that Carrion Crows "often close their eyes with pleasure when they are lying in an ant hill." But Lühmann (1951) believed his four Carrion Crows closed their eyes to avoid ant spray. Poulsen's (1955, 1956) birds, of various species, applying these last two ant species, sometimes winked the nictitating membrane or closed their eyes, as was the case when they were sprayed about the head experimentally with certain acid solutions that induced anting movements. Sometimes they shook their heads or rubbed their eyes against their shoulders.

Simmons reported that his Peking Robins (*Leiothrix lutea*) shook their heads rapidly and leaped away when ant acid got into their eyes; and that in the Magpie (*Pica pica*) the membrane flicked across the eyes during anting as a protection against acid. But Govan stated that her Rose-breasted Grosbeak had a "trance-like stare" while using weevils found in oatmeal; and that another such bird, applying sliced onions, held the eyes "wide and expressionless," although afterward its eyes were misty and "almost shut."

Attitudes During Anting

Forcefulness of the anting impulse and the apparent satisfaction derived from the act, whether active or passive, with ants or substitutes, are mentioned by numerous writers. The bird's attitude has been variously described as demonstrating enjoyment, excitement, purposefulness, or even apparent ecstasy and intoxication. An element of compulsion seems evident in the many cases where anting birds have ignored threat or refused to be distracted (Davis, 1944; Ivor, 1941, 1956; Groskin, 1950; Bourke, 1941*b*; Lewington, 1944; and others).

The strength of the anting drive also is seen in "displacement" anting and "anticipatory" anting (Armstrong, 1947:120; Goodwin, 1952*a*; Burton, 1955*b*, 1955*c*; Simmons, 1955; Poulsen, 1955, 1956; Laskey, 1949). According to Moynihan's (1955) definition, some of these anting acts may have been "redirection" activities.

In its first few encounters with ants, my oriole was tense and excited. During its initial contact, the bird erected its crown feathers, pulled up its body with feathers appressed, and held its tail high, as it stood among the swarming ants or ran rapidly about on the floor, snatching and applying them. Later on, there was an eager, deliberate tenacity in the bird's manner and

Table 3

A List of Bird Species Reported to Ant

Nomenclature is revised to conform with current usage. Arrangement of Passerine families and subfamilies follows Mayr and Greenway (1956). The list includes species using ants or substitutes, but not those using smoke alone. No attempt has been made to evaluate published records.

Species	Source
PHASIANIDAE	
Capercaillie (*Tetrao urogallus*)	Reymond, 1948
Black Grouse (*Lyrurus tetrix*)	Reymond, 1948
Ruffed Grouse (*Bonasa umbellus*)	Bump, *et al.*, 1947:272
Scaled Quail (*Callipepla squamata*)	Thomas, 1957
Chukar (*Alectoris graeca*)	Reymond, 1948
Domestic Fowl (*Gallus gallus*)	Chisholm, 1944
Ring-necked Pheasant (*Phasianus colchicus*)	Teale, 1953:269; MS, quoting Dashuta
MELEAGRIDIDAE	
Wild Turkey (*Meleagris gallopavo*)	Audubon, 1831:7; 1842:48; Sharp, 1914:65; McAtee, 1947, citing Sharp; Allen, 1946, citing Audubon
PSITTACIDAE	
Unidentified parrot	Lewington, 1944; Chisholm, 1944
Cockatoo (*Kakatoe sanguinea* × *roseicapilla*)	Glauert, 1947
Turquoise Parakeet (*Neophema pulchella*)	Chisholm, 1948:163–175
STRIGIDAE	
Horned Owl (*Bubo virginianus*)	Mowat, 1957
PICIDAE	
Wryneck (*Jynx torquilla*)	Stone, 1954
Flicker (*Colaptes auratus*)	F. M. Packard, MS
Green Woodpecker (*Picus viridis*)	Allsop, 1949; Stanford, 1949
Golden-fronted Woodpecker (*Centurus aurifrons*)	Alvarez del Toro, MS
DENDROCOLAPTIDAE	
Barred Woodhewer (*Dendrocolaptes certhia*)	Skutch, 1948
TYRANNIDAE	
Ochre-bellied Flycatcher (*Pipromorpha oleaginea*)	Skutch, 1948
MOTACILLIDAE	
Tree Pipit (*Anthus trivialis*)	Poulsen, 1956
IRENIDAE	
Golden-fronted Leafbird (*Chloropsis aurifrons*)	Poulsen, 1956
Jerdon's Chloropsis (*Chloropsis jerdoni*)	Ali, 1936
Chloropsis sp.	Ringleben, *in* Stresemann, 1935*b*
LANIIDAE	
Bull-headed Shrike (*Lanius bucephalus*)	Kuroda, 1947, (of related behavior with meat)
BOMBYCILLIDAE	
Cedar Waxwing (*Bombycilla cedrorum*)	Ivor, 1941, 1943, 1956
CINCLIDAE	
European Dipper (*Cinclus cinclus*)	Creutz, 1952
Brown Dipper (*Cinclus pallasi*)	B. Stegmann, MS
Cinclus sp.	Heinroth, 1911*a*; Heinroth and Heinroth, 1924-1932:32; Braun, 1924; *in* Gengler, 1925
MIMIDAE	
Common Mockingbird (*Mimus polyglottos*)	C. Hagar, MS; Levon Lee, MS
Common Catbird (*Dumetella carolinensis*)	Ivor, 1941, 1943, 1956; Thomas, 1946; Brackbill, 1948; Groskin, 1950; Brown, 1953; Govan, 1954

TABLE 3 (Continued)

MUSCICAPIDAE	
TURDINAE	
Magpie-Robin (*Copsychus saularis*)	Poulsen, 1956
Shama Thrush (*Copsychus malabaricus*)	Poulsen, 1956
Slate-colored Solitaire (*Myadestes unicolor*)	Whitaker, this study
Veery (*Catharus fuscescens*)	Ivor, 1941, 1943
Gray-cheeked Thrush (*Catharus minimus*)	Ivor, *in* Lane, 1951:177
Olive-backed Thrush (*Catharus ustulatus*)	Ivor, *in* Lane, 1951:177
Hermit Thrush (*Catharus guttatus*)	Ivor, 1941, 1943
Wood Thrush (*Hylocichla mustelina*)	Ivor, 1941, 1943; Groskin, 1949, 1950; Corby, 1950, and *in* Huxley, 1954
Ring Ouzel (*Turdus torquatus*)	Reymond, 1948
European Blackbird (*Turdus merula*)	Carpenter, 1945; Chisholm, 1944; 1948:163–175; Williams, 1947; Ivor, *in* Lane, 1951:175; Home, 1954; Tenison, 1954; Callegari, 1955
Redwing (*Turdus musicus*)	Troschütz, 1931, *in* Stresemann, 1935*b*; Ringleben, *in* Stresemann, 1935*b*; Poulsen, 1956
Song Thrush (*Turdus philomelos*) (formerly *T. ericetorum*)	Bates, 1937; Chisholm, 1944; Gough, 1947; Wells, 1951; Fitter and Richardson, 1951; Kent, 1952; Poulsen, 1956
Mistle Thrush (*Turdus viscivorus*)	Abma, 1951; Moltoni, 1948
Clay-colored Robin (*Turdus grayi*)	Alvarez del Toro, MS
American Robin (*Turdus migratorius*)	Ivor, 1941, 1943, 1951, 1956; Staebler, 1942; Nichols, 1943; Van Tyne, 1943; Davis, 1944; Lawrence, 1945; Brackbill, 1948; Groskin, 1950; Corby, 1950, and *in* Huxley, 1954; Teale, 1953:158; Poulsen, 1956
TIMALIINAE	
Yellow-billed Scimitar-Babbler (*Pomatorhinus schisticeps*)	Poulsen, 1956
Rusty-cheeked Scimitar-Babbler (*Pomatorhinus erythrogenys*)	Poulsen, 1956
White-throated Laughing-Thrush (*Garrulax albogularis*)	Callegari, 1955
White-crested Laughing-Thrush (*Garrulax leucolophus*)	Poulsen, 1956
Black-throated Laughing-Thrush (*Garrulax chinensis*)	Callegari, 1955; Poulsen, 1956
Gray-sided Laughing-Thrush (*Garrulax caerulatus*)	Osmaston, 1909, 1936
Rufous-necked Laughing-Thrush (*Garrulax ruficollis*)	Poulsen, 1956
Red-headed Laughing-Thrush (*Garrulax erythrocephalus*)	Osmaston, 1909, 1936
Garrulax sp.	Kleinschmidt, *in* Stresemann, 1935*b*; Butler, 1910
Silver-eared Leiothrix (*Leiothrix argentauris*)	Poulsen, 1956; Goodwin, 1955*b*; Callegari, 1955
Peking Robin (*Leiothrix lutea*)	Troschütz, 1931, *in* Stresemann, 1935*b*; Adlersparre, 1936; Steiniger, 1937; Ivor, 1941, 1943, *in* Lane, 1951:175; Simmons, 1955;

TABLE 3 (Continued)

	Poulsen, 1956; Goodwin, 1955*b*; Callegari, 1955
Leiothrix sp.	Kleinschmidt, *in* Stresemann, 1935*b*; Lorenz, *in* Stresemann, 1936
Black-headed Sibia (*Heterophasia capistrata*)	Troschütz, *in* Stresemann, 1935*b*; Poulsen, 1956
Blue-winged Siva (*Minla cyanouroptera*)	Poulsen, 1956
Yuhina (*Yuhina nigrimentum*)	Osmaston, 1909, 1936
Yuhina sp.	Poulsen, 1956
PARADOXORNITHINAE	
Black-throated Paradoxornis (*Paradoxornis gularis*)	Poulsen, 1956
SYLVIINAE	
Golden-crowned Kinglet (*Regulus satrapa*)	Davis, 1939
MUSCICAPINAE	
White-bellied Cyornis (*Cyornis tickelliae*)	Poulsen, 1956
Rufous-bellied Niltava (*Niltava sundara*)	Poulsen, 1956
PACHYCEPHALINAE	
Rufous Whistler (*Pachycephala rufiventris*)	Bourke, 1941*a*, 1941*b*
Little Shrike-Thrush (*Colluricincla parvula*)	Sedgwick, 1946
ZOSTEROPIDAE	
Western White-Eye (*Zosterops palpebrosa*)	Poulsen, 1956
MELIPHAGIDAE	
Yellow-eared Honeyeater (*Meliphaga lewini*)	Bourke. 1941*a*
EMBERIZIDAE	
EMBERIZINAE	
Brazilian Cardinal (*Paroaria capitata*)	Poulsen, 1956
Black Seedeater (*Sporophila aurita*)	Skutch, 1948, 1954
Red-eyed Towhee (*Pipilo erythrophthalmus*)	Van Tyne, 1943; McAtee, 1944; Corby, 1950
Brown Towhee (*Pipilo fuscus*)	Paroni. 1954. (of an attempt)
Slate-colored Junco (*Junco hyemalis*)	Ivor, 1941. 1943; Bagg. 1952
Harris Sparrow (*Zonotrichia querula*)	Ivor, 1943
White-crowned Sparrow (*Zonotrichia leucophrys*)	Ivor, 1941, 1943: Paroni, 1954
White-throated Sparrow (*Zonotrichia albicollis*)	Ivor. 1941. 1943; Teale, MS
Fox Sparrow (*Passerella iliaca*)	Ivor, 1941. 1943
Song Sparrow (*Melospiza melodia*)	Nice and Ter Pelkwyk. 1940; Ivor. 1941, 1943; Nice, 1943; Mayr, 1948; Groskin. 1950
CARDINALINAE	
Common Cardinal (*Cardinalis cardinalis*)	Edwards, 1932; Ivor, 1941, 1943. 1956; Snyder, 1941; Sprunt and Chamberlain, 1949:510–511; Chamberlain, 1954, quoting McAtee
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	Ivor, 1941, 1943, 1956; Govan, 1954
Black-headed Grosbeak (*Pheucticus melanocephalus*)	Ivor, 1943
(*Pheucticus melanocephalus* × *P. ludovicianus*)	Ivor, MS
Buff-throated Saltator (*Saltator maximus*)	Skutch. 1948. 1954
Indigo Bunting (*Passerina cyanea*)	Ivor, 1941. 1943; Shackleton and Shackleton. 1947; Poulsen, 1956
Lazuli Bunting (*Passerina amoena*)	Poulsen. 1956

TABLE 3 (Continued)

Orange-breasted Bunting (*Passerina leclancherii*)	Poulsen, 1956
TANAGRINAE	
Superb Tanager (*Calospiza fastuosa*)	Poulsen, 1956
Blue-breasted Tanager (*Calospiza cyanoventris*)	Sick, 1957
Blue-necked Tanager (*Calospiza cyanicollis*)	Sick, 1957
Scarlet Tanager (*Piranga olivacea*)	Groskin, 1943, 1950
Summer Tanager (*Piranga rubra*)	Thomas, 1941
Red-throated Ant-Tanager (*Habia gutturalis*)	Alvarez del Toro, MS
COEREBINAE	
Blue Sugarbird (*Dacnis cayana*)	Poulsen, 1956
PARULIDAE	
Blue-winged Warbler (*Vermivora pinus*)	Wright, 1909; Dater, 1953
ICTERIDAE	
Brown-headed Cowbird (*Molothrus ater*)	Nice, 1945; Hebard, 1949
Boat-tailed Grackle (*Cassidix mexicanus*)	W. W. Worthington, MS
Common Grackle (*Quiscalus quiscula*) (includes *Q. q. stonei*, *Q. q. aeneus*, *Q. versicolor*)	Ivor, 1941, 1956; Parks, 1945; Robinson, 1945; Groff and Brackbill, 1946; Hill, 1946; Brackbill, 1948; Laskey, 1948; Nice, 1952; Teale, 1953:158, 170; Poulsen, 1956
Tinkling Grackle (*Quiscalus niger*)	Gosse, 1847:225
Baltimore Oriole (*Icterus galbula*)	Ivor, 1941, 1943, 1956
Orchard Oriole (*Icterus spurius*)	Whitaker, this study; Ivor, MS
Troupial (*Icterus jamacaii*)	Poulsen, 1956
Icterus sp.	Goodwin, 1953; Simmons, 1955
Black-throated Oriole (*Icterus gularis*)	Alvarez del Toro, MS
Streak-backed Oriole (*Icterus pustulatus*)	Alvarez del Toro, MS
Red-winged Blackbird (*Agelaius phoeniceus*)	Nero, 1951; Teale, 1953:158; Poulsen, 1956
Common Meadowlark (*Sturnella magna*)	Ivor, MS
Bobolink (*Dolichonyx oryzivorus*)	Ivor, 1943; Nice, 1943
FRINGILLIDAE	
FRINGILLINAE	
Hawfinch (*Coccothraustes coccothraustes*)	Poulsen, 1956
Chaffinch (*Fringilla coelebs*)	Longhurst, 1949; Goodwin, 1951, 1955*b*; Huth, 1951; Poulsen, 1956
Brambling (*Fringilla montifringilla*)	Poulsen, 1956
CARDUELINAE	
Evening Grosbeak (*Hesperiphona vespertina*)	Ivor, 1941, 1956
ESTRILDIDAE	
Red-browed Waxbill (*Estrilda temporalis*)	Givens, 1945, (of smoke-bathing and attempted use of ants)
PLOCEIDAE	
Bubalornis (*Bubalornis albirostris*)	Poulsen, 1956
House Sparrow (*Passer domesticus*)	Davis, 1945; Wheeler, 1951; Common, 1956
Chestnut Weaver (*Ploceus rubiginosus*)	Poulsen, 1956
Yellow-shouldered Widow-Bird (*Coliuspasser macrocercus*)	Poulsen, 1956
Whydah (*Coliuspasser ardens*)	Poulsen, 1956
Long-tailed Widow-Bird (*Diatropura progne*)	Poulsen, 1956
Jackson's Widow-Bird (*Drepanoplectes jacksoni*)	Poulsen, 1956
Bengalese Finch (*Munia striata*), domestic form	Ivor, MS

TABLE 3 (Continued)

Taha Bishop (*Euplectes taha*)	Adlersparre, 1936
Orange Bishop (*Euplectes franciscana*)	Adlersparre, 1936; Poulsen, 1956
Fire-crowned Bishop (*Euplectes hordeaceus*)	Poulsen, 1956
STURNIDAE	
Long-tailed Glossy Starling (*Lamprotornis caudatus*)	Poulsen, 1956
Glossy Starling (*Lamprotornis chalybaeus*)	Poulsen, 1956
Superb Starling (*Spreo superbus*)	Poulsen, 1956
Rose-coloured Starling (*Sturnus roseus*)	Poulsen, 1956
Common Starling (*Sturnus vulgaris*)	OLD WORLD: Hoyningen-Huene, 1869; Heinroth, 1911*a*; Floericke, 1911; Gengler, 1925; Hampe, *in* Stresemann, 1935*b*; Moncrieff, 1935; Scheidler, *in* Stresemann, 1936; Chisholm, 1944, 1948; Gregory, 1946; Baggaley, 1946; Tebbutt, 1946; Hobby, 1946; Armstrong, 1947: 120; Prideaux, 1947, (of using smoke); Williams, 1947, 1948; White, 1948, (of using smoke); Abma, 1951; Wheeler, 1951; Fitter and Richardson, 1951; Goodwin, 1951, 1955*a*, 1955*b*; IJzendoorn, 1952*a*, 1952*b*; Moltoni, 1952, quoting Binelli; Simmons, 1955; Poulsen, 1955, 1956 NEW WORLD: McAtee, 1938, quoting Kalmbach; Pearson, 1938; Brackbill, 1948; Ivor, *in* Lane, 1951:175; 1956; Teale, 1953:158, 159, 199
Pied Starling (*Sturnus contra*)	Poulsen, 1956
Indian Mynah (*Acridotheres tristis*)	Chisholm, 1935*a*, 1944, 1948:163–175; Pillai, 1941; Wheeler, 1951
Chinese Jungle Mynah (*Acridotheres cristatellus*)	Poulsen, 1956
Indian Jungle Mynah (*Acridotheres fuscus*)	Poulsen, 1956
Bank Mynah (*Acridotheres ginginianus*)	Poulsen, 1956
Indian Grackle (*Gracula religiosa*)	Poulsen, 1956
DICRURIDAE	
Drongo *Dicrurus* sp.	Fletcher, 1937
GRALLINIDAE	
Magpie-Lark (*Grallina cyanoleuca*)	Chisholm, 1944; Galloway, 1948
Apostle-Bird (*Struthidea cinerea*)	Chisholm, 1944, 1948:163–175
CRACTICIDAE	
Australian Magpie (*Gymnorhina dorsalis*)	Sedgwick, 1947
PARADISAEIDAE	
Green Catbird (*Ailuroedus crassirostris*)	Poulsen, 1956
Satin Bowerbird (*Ptilonorhynchus violaceus*)	Chisholm, 1944
CORVIDAE	
European Jay (*Garrulus glandarius*)	Robien, *in* Stresemann, 1935*b*; Hampe, *in* Stresemann, 1935*b*; Goodwin, 1947, 1951, 1952*a*, 1953*a*, 1953*b*, 1955*b*; Löhrl, 1952, 1956; Simmons, 1955; Burton, 1955*c*; Poulsen, 1955, 1956
Lanceolated Jay (*Garrulus lanceolatus*)	Goodwin, 1952*a*, 1953*a*, 1953*b*, 1955*b*

TABLE 3 (Continued)

Lidth Jay (*Garrulus lidthi*)	Kuroda, 1947, (of related behavior with acorn: compare with Goodwin, 1952*a*)
Blue Jay (*Cyanocitta cristata*)	Baskett, 1899:243; Ellicott, 1908; Ivor, 1941, 1943, 1946, 1956; Lane, 1943; Buell, 1945; Fluck, 1948 and MS; Laskey, 1949; Corby, 1950; Davis, 1950; Miller, 1952; Anon., 1952; Teale, 1953:158, 168; Nice, 1955*a*; Poulsen, 1955, 1956
Beechey's Jay (*Cissolopha beecheii*)	Goodwin, 1952*a*, 1953*a*
Green Magpie (*Kitta chinensis*)	Goodwin, 1953*a*, 1955*b*; Poulsen, 1956
Red-billed Blue Magpie (*Kitta erythrorhyncha*)	Goodwin, 1952*a*, 1953*a*, 1955*b*; Poulsen, 1956
Azure-winged Magpie (*Cyanopica cyanus*)	Nonomiya, 1935; Goodwin, 1953*a*, 1955*b*
Magpie (*Pica pica*)	Heinroth, 1911*a*; Funke, 1912; Chisholm, 1940, 1944; Reynolds, 1946; Schierer, 1952; Goodwin, 1953*a*, 1955*b*; Simmons, 1955
Tree-Pie (*Crypsirina bayleyi*)	Osmaston, 1909, 1936
Rook (*Corvus frugilegus*)	Prideaux, 1947, (of using smoke); McMeeking, 1949, (of using smoke); Chappell, 1949; Goodwin, 1953*a*, 1955*b*; Burton, 1955*a*, 1955*b*
Common Crow (*Corvus brachyrhynchos*)	Frazar, 1876; Weber, 1935; Ivor, *in* Lane, 1951:175–177
Northwestern Crow (*Corvus caurinus*)	F. L. Beebe, MS
Carrion Crow (*Corvus corone*) (Hooded Crow, *C. corone cornix*, included)	Heine, 1929; Laven, 1931; Ringleben, *in* Stresemann, 1935*b*; Scherping, *in* Stresemann, 1936; Condry, 1947; Coombs, 1947; Wells, 1950; Lühmann, 1951; Wackernagel, 1951; Goodwin, 1953*a*, 1955*b*; Löhrl, 1956
Raven (*Corvus corax*)	Jacobsen, 1911

little or no excitement. Distractions sufficient to prevent or interrupt sunning, bathing or feeding rarely kept the oriole from anting. On a few occasions it called *chak*, but never sang during anting sessions.

SEASONAL FLUCTUATIONS IN ANTING RESPONSE

The Orchard Oriole performed in every month of the year. In the warmer months (March to August), when opportunities were most frequent, anting intensity ranged from top level to very low. In the periods from September to February it ranged from high to very low. Experiments did not test seasonal differences adequately, because of variation in conditions and species of ants offered. However, it is noteworthy that even live ants did not induce top intensity anting in September through February but did so from March through July. On the other hand, the oriole anted at high intensity in September and in November through February. As noted earlier, seasonal changes among the ants themselves appeared to affect intensity of anting response.

As would be expected, a breakdown of American and Canadian records of anting in the wild shows by far the greatest occurrence during May through October, with the highest incidence in August. I find no reports for December to March save in captive birds, except the North Carolina record of a Golden-crowned Kinglet (*Regulus satrapa*), using unknown anting objects in a tree in January (Davis, 1939). Captives appear to ant throughout the year. But Ivor, in Canada, seems to be the only observer who has given close attention to this feature. His birds, representing about 32 American and two or three exotic species, exhibited but little interest in ants except from late April through July.

It seems possible that winter anting may take place in the warmer parts of the United States, where ants are active above ground on sunny days. Observers in these regions should watch for the behavior. But, as Herbert L. Stoddard, Thomasville, Georgia, suggests to me, care should be taken that feeding on weed seed in the nests of harvester ants is not mistaken for anting.

There are relatively few records of anting from southern United States for any season, and only one conclusive record (Levon Lee, letter, May 13, 1956) from the area between western Texas and Oakland, California, as far as I have been able to discover. This lacuna in the Southwest, first noted by Kelso (1949), probably is more apparent than real, since several species breeding there are now known to ant (see Table 3). Because anting sometimes is inconspicuous (Nice, 1945), or resembles preening (Simmons, 1955, Poulsen, 1956), it no doubt often goes unrecognized. Jean Graber has called my attention to an unquestionable case of anting by a Cardinal reported as food-gathering (Edwards, 1932).

Considering how very little we know about anting, it might prove helpful if operators of banding stations would place ant colonies in the traps. Confined by water barrier, the captive colony requires little care and could be a means of obtaining valuable information, particularly as to general health and parasitism among birds anting in the natural state. Obviously ants chosen for this purpose must be of a known acceptable species.

Some workers dismiss all observations on captive birds, apparently because of such factors as inactivity, disease or unnatural diet. Others have been equally reluctant to accept reports of anting among free birds of groups long believed to be non-anting species, such as the Psittacidae or Picidae, simply because captives did not ant. These positions become untenable when we consider the many species, first known to ant in captivity, that are now known to ant in the same way in the wild, and *vice versa*. It may indeed be true that the captive bird is more prone to ant than is its counterpart in nature—lack of normal energy outlets alone might make the difference. But it remains to be demonstrated that captivity *per se* either causes or suppresses anting, or modifies characteristic anting patterns.

Anting in captive birds free of obvious ectoparasites has been reported by Poulsen, Adlersparre, Heinroth (1911*a*), Ivor (letter, May 5, 1954), Scheidler (in Stresemann, 1936), and others. Parks (1945) found no parasites on the Common Grackle he trapped immediately after anting. Beebe, Weber, and J. A. Johnson advised me that their several crows had no obvious ectoparasites, and Beebe adds that his birds had been dusted with a rotenone preparation prior to anting. Frazar's (1876) two Common Crows and the two or three Australian cases involving domestic fowl and free Starlings (*Sturnus vulgaris*), cited by Chisholm (1944), may be almost the only reports of anting in obviously infested birds. It is indeed interesting to see that an Old World oriole (*Oriolus melanocephala*), infested with mites, did not ant, although it ate the ants (Poulsen, 1956).

The plain fact of the matter is that we know almost nothing of the physical condition of anting birds. No one seems to have made skin scrapings or any close examination for minute ectoparasites. Endoparasites as a cause of anting have received scant attention. I have been unable to find a single instance of dissection study on an anting bird, yet at least two ants, one of them *Pheidole* sp., are known to be intermediate hosts for two types of cysticercoids in chickens (Jones and Horsfall, 1935; Eichler, 1936*b*). Since endoparasites may, through lack of intermediary hosts, be lost in the captive bird, they should be considered in connection with the onset of negative anting response sometimes seen in captives.

Discussion: The Anting Objective

Study of the anting pattern of the Orchard Oriole revealed that during intense anting, more often than not, the bird was dabbing ants in the region of the vent. The undertail coverts and very bases of the rectrices certainly were treated, if not the vent itself. As results of the bird's vigorous applications, I found that ant scent was strongest in this region and that the undertail coverts at times became mingled with uppertail coverts.

Tallies of applications indicated preferential treatment in that area also; however, these counts necessarily were incomplete because of the bird's rapid action and occasional obstruction of my view. One of many tallies showed 46 applications to basal half or less of tail, including 15 to the undertail coverts alone; and 22 applications to distal one-third or less of primaries, including a number wherein the basal part of the tail shared in the treatment, as will be explained.

Even when the wing tip was treated, it often seemed that the oriole really was aiming at the undertail region, and that the wing interfered. Almost invariably, as the bird began to reach back with the ant, it simultaneously tucked the posteror body down and under, until crissum at times touched the heels, and rectrices were brought forward on one side of, or between, the feet. In this latter posture, the bird sometimes would anoint the lower belly and the undertail coverts between its heels. Regardless of the area treated, the bird usually reached around on one side, bringing the tail around on that same side. In doing this, the wing on that side would be folded high upon the body, with remiges out of the way behind the tail (Fig. 1*a*). Or again, the folded wing might be held lower, along side and flank, so that wing tip lay against the ventral surface of the tail, as the tail was tucked under and pressed forward. This pressure of tail upon wing was strong (Frontispiece; Figs. 1*d* and 2*c*), and often caused rectrices to interlock with remiges (Fig. 1*b*). Though he does not discuss it, one of Löhrl's (1956) photographs of an anting Carrion Crow demonstrates a similar interlocking of wing and tail in a passively anting species. In much the same manner, some passively anting birds at times will apply ants with the bill, as his bird is shown doing.

During the oriole's treatment of the wing tip, when tail was pressing against it, basal parts of rectrices (including undertail coverts) at times received some of the anointment, thus increasing the proportion of applications affecting the undertail region. This situation is seen in the Frontispiece. The lacerated webs shown in Figure 3, together with the extreme displacement of undertail coverts, already described, indicate that the oriole's bill sometimes penetrated deeply into the plumage. All of this strongly suggests that, when anting in this tail-to-wing posture, the bird sometimes thrust the ant through the wing tip and onto the under surface of the tail. Certainly, at such times, I regularly noticed that the dabbing applications of the vibrating bill involved both the wing tip and the adjacent areas of the tail, including the undertail coverts. In several photographs of actively anting birds (Corby, 1950; and in Huxley, 1954; Poulsen, 1956; Ivor, 1956) this same juxtaposition (and wing-tail anointment?) is illustrated though unemphasized. However, Poulsen (*op. cit.*) did state that it "often looks as if" the tail is treated and that in some cases among starlings, weavers and babblers, he has seen the bill movements "proceed to the tail, which is held close to the wing."

This is not to say that the oriole never anointed the wing tip when the wing was slightly spread and held just clear of the body and tail. It did so regularly; but instead of holding the opened wing out to the side as some birds do, the position of the wing was like that assumed for stripping the outer primaries during preening. Furthermore, this posture was seen less often than either of the other two anting positions just described, and at such times the applications themselves often were atypical. That is, the dabbing action of the bill often was so slow or so brief as to give me the impression that the bird was anting "absent-mindedly"—or possibly confusing anting with preening. Frequently, when anting in this position, the bird would dab the ant about on the wing tip a time or two and then stop, as if confused.

Aberrant anting action was seen again in the oriole's occasional treatment of the crural tracts. Instead of dabbing forcefully, as it did in anointing other areas, the bird *always* would play the ant about on these feathers very lightly, briefly and, it seemed to me, ineffectually and sometimes accidentally. Ivor (1943) has described somewhat similar action in young Wood Thrushes (*Hylocichla mustelina*) that sometimes anted at breast, abdomen and flanks, without actually touching those parts; and Brackbill (1948) noted an American Robin that twice seemed to dab at, but not actually touch, its breast during anting. Poulsen (1956) mentioned that an Indigo Bunting, while applying ants, intermittently made incipient movements of picking up and applying an ant.

These unusual motions, as well as the oriole's sometimes odd wing treatment, might well betoken uncompleted anting acts, occurring when the individual ant used happened to have an inadequate amount of stimulant. Conclusive evidence might be obtained through controlled experiments with spraying ants which previously have been forced to substantial ejection of their defense fluid and then washed. It seems quite possible that such depleted ants could produce significant differences in a bird's anting actions. Poulsen (1956:281) noticed that "birds anted much less with ants [spraying species] which had been kept in a sack for some days and therefore were less active." (Might the rate of venom secretion in the glands of these apparently unfed captive ants have been lower?) My experience with the Orchard Oriole leads me to believe that more precise experimentation with heat-killed ants might show correlation between the level of thermogenic property in the ant and the plumage area treated. I suspected the oriole of using the more strongly stimulating ants on the undertail coverts and bases of rectrices.

It must not be supposed from the foregoing discussion that the oriole treated only the proximal half of the tail. Frequent anointment of the distal portion was extended at times to the very tips of rectrices. Commonly, however, an application to the distal part of the tail *began* as an application to undertail coverts or bases of outer rectrices, the bird merely continuing to reach and dab farther along the tail before stopping and straightening up.

The thermogenic property of ant species accepted by the oriole presumably is due to an irritant in the secretions of their anal glands. Ants of the subfamily Dolichoderinae, which includes all of the acceptable ant species studied here, are known to smear their defensive secretions on enemy ants with frequently fatal effect (Wheeler, 1910:45). It seems, however, that myrmecologists have not determined the irritating constituent in those ant species my bird used. The unpleasantly odorous butyric acid, which these ants are believed to produce in quantity, is non-caustic. A free acid in butter, it has been noted also in meat juice, perspiration and excrementa. It would be helpful to know whether all insects used for anting produce burning sensations. Ants producing formic acid in quantity no doubt do burn, since this is a strong caustic. Many birds have used ants of this type. It appears, therefore, that a sensation of heat is a probable factor in most anting situations, as Burton (1955*c*) surmised.

In speculating on causes of anting, it would be well to keep in mind these points: (a) the fact that a bird sometimes will persist despite interruptions and threat situations, or even continue anting to a state of obvious fatigue; (b) that in captives, at least, the amount of anting varies among species and among individuals of a species; (c) that sudden, unexplained, even apparently permanent abstinence has been seen in captives; (d) that not all captives of a species will ant; (e) that apparently not all, or even most, individuals of a species ant in nature, at least not with any regularity; (f) that active and passive anting are not necessarily mutually exclusive—some passively anting species exhibit elements of active anting, and *vice versa;* but among birds under 10 inches in length, passive anting elements seem to be unusual.

Gross ectoparasites as a cause of the oriole's pronounced anting of the undertail region would have to be ruled out. There was no evidence whatever of such parasitism. But it is possible that itch mites (Acarina) might have been present in skin of the vent and its environs, especially mites in the pockets at feather insertions. Tapeworms (Cestoda) or roundworms (Nematoda) emerging from the vent, or flukes (Trematoda), sometimes known to encyst beneath skin in that region, might possibly cause itching. (For discussion of parasites see Rothschild *et al.*, 1952:39–242; Peters, 1930, 1933, 1936; Boyd, 1951; Eichler, 1936*b*.) Aside from attention given this area during anting, I saw nothing in the oriole's behavior suggestive of irritation. It did not pick, preen unduly or rub its posterior. Yet it did thrust ants among the bases of rectrices and, when treating the outermost few of them, was seen to apply ants at the feather insertions. (Also, if parasites were the sole cause of the bird's anting, then these must have been host-specific ones, for the oriole's companion, the Painted Bunting, has never anted.) There are many records of repeated applications to undertail coverts, "base" or "root" of tail; and in some other cases such treatment seems implied (Bates, 1937; Goodwin, 1953*a*; Groskin, 1950; Nice and Ter Pelkwyk, 1940; Osmaston, 1909, 1936; Thomas, 1946; Staebler, 1942; Snyder, 1941; Brackbill, 1948; Davis, 1950; Home, 1954; Tebbutt, 1946, and others.)

The pleasure principle, on the other hand, seems a more likely basis for theorizing on the oriole's behavior. If, as it appears, the bird's mouth parts are sensitive to thermogenic properties in ants, it seems reasonable to suppose the vent, and perhaps the skin of the undertail region, would be similarly sensitive. Indeed, Simmons suggests that the area of the vent must be a most sensitive spot. Ant secretions might cause a peculiarly pleasurable sensation of warmth, possibly with an element of the masturbatory in it. Autoeroticism is known in domestic parakeets, and, according to Armstrong (1947:160), also in parrots, ruffs, avocets, sage grouse and penguins. One wonders whether the posture of Carrion Crow on its perch, after having anted on the ground, could be a result of heat, fatigue, mild sexual stimulation, or some combination. Goodwin (1953*a*; 1955*b*, figure) showed the bird in relaxed attitude, head tilted downward, tail drooped, and both wings hanging in front of, and well below, the perch.

Fig. 5. Carrion Crow (*Corvus corone*) in ordinary passive anting posture typical of certain larger corvids. Note spread tail, somewhat pulled toward left wing, and lifted contour plumage. Photographed by Dr. Hans Löhrl, Ludwigsburg, Germany.

Might there be sexual significance in those instances of both free and captive birds bringing the vent into close proximity to ants, either by direct application in that region or by holding the vent near the ground? Several of the American Robins, performing active anting, sometimes crouched, rotated or rubbed the body or breast upon the ground, or sat as if holding vent to ground (Nichols, 1943; Van Tyne, 1943; Brackbill, 1948). Ivor (letter, November 3, 1954) informs me that two of 12 Robins regularly crouched but that the others never took that position when anting. Certain of Poulsen's thrushes (*Turdus migratorius*, *T. musicus* and *T. philomelos*), while applying ants, sometimes assumed passive anting posture. He writes that they "suddenly fluffed their feathers and spread both tail-feathers and wing-feathers, making 1–3 strokes with a single ant, which was then discarded. All the while they were sitting on the ground and allowing the ants to crawl on them without removing them. . . ." Lawrence (1945) cited a rather similar case for *migratorius.* Comparable photographs showing American Robins in partial crouch with this double-wing-spread appear in Ivor (1956) and Poulsen (1956). (Might these variations evident in *migratorius* be related to sex difference?)

Posture that would seem to expose the area of the vent to ants also has been described for some other species. Poulsen, as well as Brackbill, noted Common Grackles that repeatedly sat on the ground, with tails stretched out behind, while applying ants. A captive Rook flopped down on the anting area and raised its tail while the ventral body was flat on the ground; and a captive Carrion Crow pressed its tail against the earth while sprawling on the anting area (Goodwin, 1953*a*). Both of these last birds, though using passive anting posture, at times applied ants with the bill. Wackernagel's Carrion Crow applied ants but also lay flat on its belly with wings spread. While lying down, it several times struck here and there with its fanned tail. Once it sat, as if brooding, and rubbed the "anal area" on the ground. Sometimes it interruped anting to go to the turf and, with widely spread tail, drag its plumage through the grass. Simmons states that in the Magpie the ant sometimes quite definitely is "rubbed in the area of the vent" and he suspects this is true of many smaller birds whose quick motions are hard to observe in detail. Osmaston's (1936) birds, three or four species, using bugs (*Rhynchota*), rubbed them only "near the anus."

The foregoing descriptions relate to individuals that performed more or less active anting. As for those that stand, squat or lie and make few or no applications with the bill, the skin of the ventral body, including the vent, would seem especially vulnerable to ants and ant spray, particularly when the contour plumage is fluffed, as often seems the case during passive anting. And here we should bear in mind that ant spray may carry eight inches or more.

Captive European Jays showed "apparent attempts to bring the ventral areas in contact with ants by dragging them along on the ground" (Goodwin, 1951). These birds customarily brought forward or depressed the tail, spread *both* wings forward with convulsive, shuddering spasms, and constantly ran the bill down the wing quills without actually applying ants or even picking up ants. The insects swarmed up their legs and into their plumage. Goodwin's (1955*b*) sketches of some characteristic anting postures show this species in upright. almost penguin-like attitude, with undertail coverts (and vent?) apparently touching the ground, tail flat on the ground behind, and the posterior edges of the opened wings just brushing the ground. Like posture in this jay is shown here (Fig. 4) and in other photographs (Löhrl, 1956; Burton, 1955*c*) and descriptions (Goodwin, 1947; 1952*a*; Poulsen, 1956; Robien, *in* Stresemann, 1935*b*). Incidentally, Burton (*loc. cit.*) demonstrated its occurrence in response to substitute materials.

Scherping (in Stresemann, 1936) observed that a tame young Carrion Crow lying with spread wings on an ant heap never did apply the ants. Condry's tame young bird of this species behaved in much the same way but drooped the head in a "swooning" position until beak touched the ground, and sometimes it put ants *on* its back with the bill. Chisholm (1944) referred to a Magpie-Lark (*Grallina cyanoleuca*) that sprawled on the ant mound as if incapacitated. A young captive Hooded Crow lay with half-spread wings, flapped them as if bathing, but did not apply the ants (Coombs, 1947); and a tame Mistle Thrush pressed itself against the ground, wings spread, while ants crawled on its body (Moltoni, 1948).

Lühmann's Carrion Crows ruffled their plumage, lowered their breasts onto the ant nests, and made bathing motions. Lest this appear to have been mere dust-bathing, it should be added that Lühmann remarks that he was never able to see even an attempt at anting whenever few ants were present at the nest surface. Beebe's Northwestern Crows sprawled, almost as if dead, while ants crawled upon them, except that the head was held up to one side, exposing apteria at the back and shoulders.

As Löhrl and Condry state of the Carrion Crow, John A. Johnson's (letter, September 17, 1954) Common Crow permitted ants to cover it from neck to tail. When picked up from the ant bed before surfeit, the bird would return to the ants at once. It would stand until the insects began crawling up its legs, then would lie down on one side, with fluffed plumage and lifted wing, or again, on its breast with both wings slightly spread. Sometimes it "spread feathers at base of the tail" with its beak, apparently "to let ants reach the skin" but it was never seen to apply ants with the bill.

The above cases of passive anting are not altogether different from the behavior of certain mammals with ants. Bagg (1952) watched a gray squirrel (*Sciurus carolinensis*) roll and tumble on unidentified ants, and occasionally crawl on its belly across the nest. Swanson (1956) described a "timber squirrel" that rubbed its belly and head against a spot on the trunk of a maple tree where ants were feeding on the sap. And Chisholm (1948:163–175) mentioned the case of a domestic cat's (*Felis domesticus*) ecstatic contortions on a rubbish heap where ant-debris from a collector's can had been emptied. It may be significant that a fox and a squirrel evidently did not behave in any unusual way while eating termites (Stewart, 1888), and that anting with termites, which apparently do not liberate defense fluids, appears to be unknown in birds.

From cases reviewed here—and others could be cited—it seems clear that, as a result of either active or passive anting, a bird can receive ant substance upon the skin of the undertail region in proximity to the vent and probably on the vent. I believe further study may show a main focus for stimulation in many, if not all, anting birds to be the undertail region, probably the vent, hence the peculiar positions of the tail which sometimes cause tripping or falling.

In analyzing the literature pertaining to active anting, one is struck by the comparative rarity of instances involving application to dorsal body areas, or even dorsal surfaces of the quill feathers—these latter being favorite targets *ventrally*, according to most observers. Furthermore, such records usually indicate that the dorsal applications were few or that, in the main, the bird was anointing ventral areas of the wings, tail or body. Also, one notes that rump and upper tail coverts are mentioned more often than the other dorsal parts. One citation of application to the back in a young Dipper (*Cinclus* sp.) seems due to error in translation and should read belly (*Bauch*) instead (McAtee, 1938, citing Heinroth, 1911*a*). Anointment of the anterior body appears to be rare, except in grackles, and almost invariably is accompanied by treatment of wings and tail. It is noteworthy that three species of grackles (Icteridae), which are prone to anoint various parts of the body, wings and tail, usually have used one or more of eight substitute materials. Indeed, with these birds, the use of ants would seem to be the exception rather than the rule (see citations in Table 3). The observations of W. W. Worthington (letter, November 24, 1956) on two species of grackles in nature relate to use of limes and lemons on the wings, tail, breast, neck and scapulars, and are thus similar to the reports of several other persons. Poulsen (1956), ignoring passive and active anting as the two basic types of the behavior, recognized five types of anting, to one of which he assigned only his three Common Grackles (*Quiscalus quiscula*), on the basis of their applying ants to the breast, scapulars, rump and upper tail coverts, in addition to the wings.

It is significant also that generally those birds (seldom under 10 inches) which permit massive invasion of the plumage by ants seem not to apply ants with the bill, or seem to do so rather casually or sparingly. Since a good many of the commonly used spraying ants are capable of ejecting their spray with considerable force, may not these birds obtain the desired stimulation (of the ventral body skin) with no effort on their part other than that of standing, squatting or lying with spread wings and sometimes raised contour plumage? (Compare descriptions and the illustrations of Goodwin, 1952*a*, 1955*b*; Coombs, 1947; Condry, 1947; Lühmann, 1951; Wackernagle, 1951, with those of Brackbill, 1948; Groskin, 1950; Ivor, 1941, 1943, 1956.)

In a number of cases, birds behaving this way were known to settle down among the ants only after ants had crawled up their legs (and stimulated body skin?). Wackernagel's bird went to spraying ants and stalked back and forth (increasing the quantity of ant spray?) before settling down among the insects or applying them with the bill. Robien's (*in* Stresemann, 1935*b*) European Jays trod upon ants as if to increase the spray; Condry's Carrion Crow, when ants crawled up its legs to the feathers, sat down among them like a brooding hen.

I have described the oriole's way of treating the distal portion of the tail in a follow-through of applications first made directly to undertail coverts and basal portions of rectrices. Could this extended dabbing, out along the ventral side of the tail, possibly be reflexive action, due to ant substances warming the skin of the undertail region? Might such stimulation cause some of the special movements of wings and tail reported in certain species?

The idea of special movements being reflex consequences of thermogenic agents on the skin may sound far-fetched unless we recall that some of these actions evidently occur *after* ants have been applied or ant spray, presumably, has reached the skin.

Goodwin (1947, 1952*a*, 1953*a*) clearly showed European Jays standing among spraying ant species and assuming their double-wing-spread posture only after ants had swarmed up their legs, in one case after they had reached the ventral body plumage. He and Poulsen both found that this species, the Green Magpie (*Kitta chinensis*), and the Red-billed Blue Magpie (*K. erythrorhyncha*) would advance both opened wings, accompanied by convulsive shudderings. Each of these species let ants swarm into the plumage; none actually applied ants, although they went through the motions of doing so. Poulsen's Blue Sugarbird (*Dacnis cayana*) took like posture. He (1956:274) wrote "This species picks up an ant [spraying species] in its bill, and very rapidly it rises in an almost vertical position with spread tail and moves both wings forward so that they touch each other while quivering, and the head is moved downwards among the tips of the wings." The ant was eaten or discarded afterward. Pillai (1941) noticed Indian Mynahs spreading and quivering the tail during active anting in the midst of a colony of *Oecophylla smaragdina*, a spraying ant species. Tebbutt and Stone each mentioned shaking of wings or tail in anting birds, and other instances are cited elsewhere in this paper. Sick (1957) noticed that a free-living Blue-necked Tanager (*Calospiza cyanicollis*) sometimes cocked its tail *upward* during active anting. Some of these acts bear remarkable resemblance to certain movements of sexually-motivated birds, as discussed by Armstrong (1947), Hinde (1955; 1956), Moynihan (1955) and others.

Another parallel sometimes is seen between the postures of sun-bathing and those of anting, particularly passive anting. Beebe's (MS) Northwestern Crows sprawled on ant nests with their heads "generally held off to one side to expose the fold of naked skin between the feathers of the back and scapulars. . . . The nearest similar behaviour I have observed is that caused by sudden exposure to sun when a bird has been in shade for some time." Condry (1947) and Goodwin (1953*a*) described much this same posture in anting Carrion Crows. The behavior of Burton's (1955*a*) Rook, already mentioned, when exposing itself to electric heat and to steam, may have been analogous to sun-bathing. Other sun-bathing attitudes suggestive of anting postures can be found in Hauser (1957), Rollin (1948), and Gibb (1947).

Hauser (*op. cit.*) showed that free birds, sunning themselves on a brown masonite feeding tray or on a leafy compost heap, were exposed to surface temperatures as high as 140° F. She said that heat alone did not seem to be the primary factor. Yet her "Compulsory Sun Position," as distinct from "Voluntary" sunning, deserves critical study in the light of birds' anting responses to thermogenic materials. Certain of her descriptions and sketches showing intense, involuntary sun-bathing posture seem very much like some of the attitudes described for anting, in situations where, apparently, the only heat involved was in the anting material itself. (Compare, for example, Hauser's sketch of sunning Mockingbird, *Mimus polyglottos*, with Goodwin's [1955*b*] sketch of anting Rook.)

Another point that may prove of considerable importance to better understanding of anting is that passive anting appears to be extremely rare, if it occurs at all, with non-spraying ants. Except for Galloway's (1948) brief statement that a Magpie-Lark which he saw picking up and squeezing *Iridomyrmex detectus* "did not mind the ants crawling about its feathers," all cases I have seen of *identified* ants invading a bird's plumage have concerned spraying species. Unfortunately, Galloway did not describe the Magpie-Lark's posture, or state whether it was applying ants or only feeding on them. Both Goodwin (1951) and Lühmann mentioned negative response in passively anting birds when few ants were present. This seems quite different from actively anting birds which, in a number of instances, have been known to respond to one or few ants; and it suggests that a considerable amount of spray may be required for passively anting birds to assume anting posture. It would be instructive to learn whether the passively anting Common Crow, for instance, would respond at all to non-spraying ants.

In considering the premise that anting birds, at least in some cases, are trying to get thermogenic materials on the ventral body skin, we should not neglect smoke as an anting substance. IJzendoorn, Chisholm (1948:163–175), and others, have discussed smoke in connection with anting. It has been suggested that smoke may be satisfying for its warmth or the thermogenic effects of acids contained in it. Doubtless this is true also of many other substitute materials, such as beetles, earwigs, millipedes, wasps, prepared mustard, and some of the other vegetable materials. The use of hair tonic, previously mentioned, is of unusual interest, for Dr. Fluck wrote me that the lotion contained, in addition to bay rum and alcohol, tincture of cantharides. Cantharides are dried beetles (usually *Cantharis vesicatoria, C. vittata,* or *Mylabris cichorii*), which have the vesicant constituent cantharidin, as well as uric, formic and acetic acids. Of pungent, acrid taste and penetrating, aromatic odor, these insects are used in medicine as a counterirritant, blistering agent, diuretic and aphrodisiac (Youngken, 1948:920; Mansfield, 1937:463).

Some species, even individual birds, seem to perform with smoke exactly as they do with ants and certain substitutes. I have already mentioned how various burning or smoking materials were applied by a Rook and a European Jay. Burton's descriptions and the photographs of these two individuals follow closely Goodwin's descriptions and sketches of these same species when using ants (Burton, 1955*a*, 1955*b*, 1955*c*; Goodwin, 1952*a*, 1955*b*). Although it also used ants, Burton's Rook consistently gave strong, typical anting responses to smoke of any kind. A captive Blue Jay, a species with pronounced anting proclivities, applied burning cigarettes (Miller, 1952), and another such individual held them in the bill, apparently in order to get smoke under its wing (Anon., 1952).

A most unusual account of birds using smoke concerns the small flock of Red-browed Waxbills (*Estrilda temporalis*) at Kairi, on Atherton Tableland, North Queensland, which Givens (1945) observed on several days in June. The birds, as many as a dozen at once, would stand on a smoldering log, in the curling wisps of smoke coming up through cracks in the bark, and there perform anting movements "quite distinct from those commonly seen when birds bathe in dust or water". Each bird would stand upright, with tail as "support" and wings drooping a little forward and downward, and begin sweeping the head forward and down under the wings, meanwhile vigorously shuffling its wings and body feathers and "often toppling backward from the violence of its efforts." Givens, watching from a distance of about six feet, saw no insects on the log, nor could he find any afterward. But he does say that on one occasion "when a piece of bark was torn away from a nearby stump," revealing an ant nest, one of the birds "tried to ant itself there, but soon abandoned the attempt in favour of the smoke." Sometimes a bird, unable to find space in the smoke, performed a few feet away, much as a bird may water-bathe *in vacuo*.

Elsdon (1948) described Linnets (*Carduelis cannabina*), Meadow Pipits (*Anthus pratensis*) and Pied Wagtails (*Motacilla alba*) that for several days in August and September persistently flew into thick smoke from a huge oil-tank fire, at times flying as low as about 50 yards above the flames. Sometimes birds would alight exhausted near the observers, only to fly back into the smoke when they apparently had recovered. Jackdaws (*Corvus *monedula*) repeatedly have hovered briefly in chimney smoke (Ridley, 1948), while Common Starlings and Rooks have perched in such smoke and ruffled their feathers (Prideaux, 1947; McMeeking, 1949). One of the Rooks performed "contortions" in the smoke.

These records of free birds frequenting smoke do not indicate that the smoke was flushing out insects and thus attracting the birds, as may be the case during grassland fires. Although some of the incidents occurred during winter in England, others of them occurred there in June, August and September, when birds may not have been trying to escape cold. Among winter records, when the insect factor would seem improbable, are some that mention preening and posturing in the smoke.

Excepting the Linnets, Meadow Pipits, Pied Wagtails, Jackdaws and possibly the Red-browed Waxbills, all birds mentioned thus far here in connection with smoke have been species known also to use ants or the more conventional substitutes. It is interesting to see that Poulsen (1956) found anting in the Tree Pipit (*Anthus trivialis*).

The other smoke-bathing records that I have seen relate to species not known to ant: Herring Gull, *Larus argentatus* (White, 1948; Stevens, 1948); Black-headed Gull, *L. ridibundus* (Stevens, 1948; Stafford, 1954); Little Owl, *Athene noctua* (Tubbs, 1953); Swift, *Apus apus* (Adler, 1954); Welcome Swallow, *Hirundo neoxena* (Barker, 1939); and House Martin, *Delichon urbica* (Pritchard, 1950).

I find no records of "smoke-bathing" as such in the Western Hemisphere; however, Dr. Arthur A. Allen tells me that he once had a tame Common Crow that liked to get into smoke from an incinerator, and there is the instance of Bluebirds (*Sialia sialis*) and Cedar Waxwings (*Bombycilla cedrorum*), which last species is known to ant, warming themselves on a chimney-top in sub-zero weather (Parker and Parker, 1950).

Chisholm (1948:163–175), reviewing the problems of anting, commented: " 'Smoke-bathing' may in fact be complementary to water-bathing, sun-bathing and dust-bathing, and all four may well be allied to 'anting' with acids."

SUMMARY

Intensive study of anting behavior in a captive Orchard Oriole (free of obvious ectoparasites) with worker ants of several species during a 31-month period showed the bird's basic anting pattern was similar to that described for most small species, but new or different in several aspects.

To summarize present knowledge and for purpose of comparison, an analysis was made of all available anting records, including some unpublished materials.

The compiled list of 148 species of anting birds includes 65 New World forms. Types of anting, theories concerning its significance, and the possible

relationship of anting to dust-bathing and sun-bathing are reviewed. Two basic types of this behavior are recognized: *active* anting (anointing by use of the bill) and *passive* anting (anointing by allowing ants to invade the plumage).

Offered seven non-spraying ant forms, the Orchard Oriole exhibited consistent selectivity in choice of species for anting. Differences in odor, flavor and defensive mechanisms of acceptable and unacceptable ant species are described, the most important being that all acceptable ants (three species) were found to produce a burning sensation on the human tongue, whereas the four unacceptable ant forms did not. This effect cannot be ascribed to the non-caustic butyric acid believed to be produced by all ant species the oriole accepted. The thermogenic agent in these ants has not been determined.

It appears that all ant species used by birds for anting may have thermogenic properties. Most species used are producers of formic acid, and may be presumed to be similarly stimulating. Since many substitute materials used for anting are also of this nature, "heat" seems to be the common factor in most, if not all, anting situations.

A synopsis of the known and *identified* ants used by birds for anting indicates that birds in general are selective. With one exception (probably a conditioned response), birds seem to have used only species that either spray or exude repugnatorial fluids. The ability of spraying ants, at least *Formica rufa* and its allies, to eject a fine mist to a distance of 20 to 50 cm. is an important factor in anting that may not have been generally recognized.

The Orchard Oriole applied ants by dabbing, not stroking. At the same time it rapidly vibrated its head. Regularly the bird anointed ventral surfaces of wing tips and of the base of the tail, and also the undertail coverts. Sides and flanks were touched only indirectly as the bird reached its vibrating head around toward wing or tail. Occasionally feathers of the belly and tibiae were anointed. Undertail coverts and bases of the rectrices received the most attention. Following the performance of anting with non-spraying ants, the bird was found to have ant odor on all these areas but not on other plumage tracts. The bird apparently crushed the ants before applying them. Crushing was found to increase the odor and thermogenic effect to the human tongue.

Tripping and tumbling occurred regularly, resulting from interference of the tail, which was brought forward beneath the body during anting. Often the bird performed while clinging to the cage wall, at times anting in an upside-down position.

Sometimes the oriole gathered and held in the bill a large wad of ants before applying, discarding or eating it. Occasionally it selected and ate certain bits of ant-nest earth, possibly soil impregnated with ant exudations. Ordinary earth was not eaten.

Positive anting response was high in this bird. Of 80 contact days, it performed on at least 67. Negative response due to surfeit was rare. The longest period of successive daily performance was 10 days. Anting sessions, often lasting 45 minutes, became shorter as ants were offered daily. Physical stress of high intensity anting caused noticeable fatigue.

Drowned, frozen, or heat-killed ants elicited pronounced anting reaction, except when the treatment caused loss of thermogenic property (i.e., through heat-kill or long-term freezing).

The oriole distinguished variations among living worker ants of the colony, applying some individuals repeatedly, others only once, and discarding some without use. Taste-testing showed marked thermogenic variation among worker ants of a colony. Apparently the bird used most assiduously those individuals having strong heating value. This property of the ant seemed less pronounced in winter than in summer, and may be a cause of the bird's somewhat milder anting response in winter. The bird was not interested in ants primarily as food.

Preening and bathing following anting were erratic and seemed caused as much by physical exertion and displaced plumage as by the possible effect of ant-ointment on the feathers.

These non-spraying ants caused no unusual blinking or spreading of nictitating membrane, frequently reported in birds using spraying ants.

Records of anting in birds obviously infested with ectoparasites appear to be extremely rare. Endoparasites as a factor in anting should be investigated. No report of an autopsy of an anting bird could be found, or even of microscopic examination for smaller ectoparasites. Literature examined failed to indicate that captivity either causes or suppresses anting or modifies significantly the specific anting patterns.

The cause of anting in the Orchard Oriole was not determined. The bird's preferential treatment of the undertail region, and possibly the vent itself at times, was indicated by direct observation, by extreme displacement of undertail coverts, and by the fact that ant odor was strongest here. Close study showed this region received additional treatment when wing tips were anointed, due to juxtaposition of the wing tip with the tail.

Although there was no evidence of gross ectoparasitism in the oriole, it is possible that ant substances relieved itching caused by minute ectoparasites or cysts of endoparasites, certain species of which are known to occur in skin of the undertail region of birds. Also, the bird appeared to derive sensual pleasure, possibly including sexual stimulation, from the thermogenic effect of the ants. The concept of sexual stimulation might throw light on several peculiar features sometimes seen in anting behavior, such as pressing and rubbing of vent upon the anting ground, drooping-wings posture following anting, convulsive shuddering and quivering in conjunction with a double-wing-spread stance, quivering or shaking of wings and tail, individual differences in the amount and in the occurrence of anting among captives of a species, and the apparent irregularity with which birds seem to ant in nature.

Several facts, derived from study of the literature and considerable reading in the field of myrmecology, may bear upon the problem. First, it is physically possible for ant substances to touch a bird's ventral posterior skin (including the vent) during either active or passive anting, due to ability of a bird to reach this area with its bill (shown in many anting descriptions and commonly seen in preening), and to the spraying force of ants. Secondly, passive anting with non-spraying ant species appears to be almost unknown; and, unlike active anting, it often entails raising of the contour plumage. Thirdly, while anointment of plumage and skin must become general when a bird permits spraying ants to invade its feathers in numbers, species (excepting grackles) that practice active anting apparently seldom or never apply ants to the anterior part of the body, the dorsal body or even to dorsal surfaces of quill feathers.

Certain apparently aberrant anting motions, seen in the Orchard Oriole or reported in literature (incipient or desultory applications, anointment of unusual feather tracts), may possibly be due to inadequate amount of stimulant in the individual ant or in the substitute material used. The oriole's reactions to frozen and to heat-killed ants (stimulant reduced or destroyed) suggest correlation between the amount or degree of the thermogenic agent and the plumage area treated. This topic needs further investigation.

In recognizing "heat" as the common anting factor, smoke must be given consideration as an anting substance. Smoke-bathing appears virtually unknown in the Western Hemisphere. Instances of species, even individuals, performing alike with ants, smoke, and burning or heated materials, all seem cases in point.

This study demonstrates the importance of entomology to any solution of the anting problem. In common with others, it contributes little toward understanding why certain species of birds will ant while others apparently do not, but it does show that new species are continually being added to the list of anting birds. The fact that a species has not been reported does not necessarily mean that it does not ant. Likewise, it is risky to conclude that the anting response is absent in a species merely because individuals have refused to ant.

Many questons raised here cannot be answered short of controlled experiments on a large scale. Perhaps this résumé will provide an impetus for thoroughgoing experimentation, particularly with Common Crows (passive anting) and Blue Jays or Common Starlings (active anting), inasmuch as anting incidence seems to be unusually high among these species.

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1204 WEST BROOKS STREET, NORMAN, OKLAHOMA, MAY 31, 1957

NESTING POPULATIONS OF RED-TAILED HAWKS AND HORNED OWLS IN CENTRAL NEW YORK STATE[1]

BY DONALD C. HAGAR, JR.

FROM the fall of 1948 through the spring of 1952 the writer made observations on raptor populations of southeastern Madison County in New York State. The original intention was to locate the nests and band the young. Efforts were confined therefore to the late winter and spring months, although observations also were made in fall and early winter. The field notes for the four-year period form the basis of this paper. Jack T. Moyer assisted in field work during the first two seasons, while we became acquainted with the country and learned the habits of the birds. However, the data obtained during 1951 and 1952 were more extensive.

Early in the study it was found that the Red-tailed Hawk (*Buteo jamaicensis*) and Horned Owl (*Bubo virginianus*) were the dominant large raptors of the area, occurring much more commonly than other large species, such as the Red-shouldered Hawk (*Buteo lineatus*), Broad-winged Hawk (*Buteo platypterus*), Barred Owl (*Strix varia*) and Cooper's Hawk (*Accipiter cooperii*). Accordingly, our attention was directed largely to the first two species. Data for the Red-tailed Hawk are based on 38 nest sites, 24 pairs with active nests, and 21 broods. The estimated density of their population in the spring of 1952 on the designated study area was 26 pairs (Fig. 1). For the owl there were 14 nest sites, 18 nesting pairs, 16 broods, and their population was estimated to be about 11 pairs in the spring of 1952 (Table 1).

Observations and banding returns indicated that the Red-tailed Hawks were migratory. None was observed after December 5 or before February 10 during the four-year period. Seven hawks banded as young were recovered in winter, all far to the southwest of central New York. This study substantiated those of other workers that the Horned Owl is non-migratory in this part of its range (Bent, 1938). Two of 21 owls banded as nestlings were recovered within a year of their fledging, 20 and 5½ miles from their respective nest sites. In general, Horned Owls seemed more numerous in winter than at other times of year.

Prey or prey-remains found in many nests indicated that during the nesting season the owls killed many cottontail rabbits (*Sylvilagus floridanus*), whereas the hawks fed extensively on young woodchucks (*Marmota monax*). However, a great variety of prey species was found in the nests of both raptors.

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[1] A contribution from the Massachusetts Cooperative Wildlife Research Unit, supported by the U.S. Fish and Wildlife Service, the University of Massachusetts, the Massachusetts Division of Fisheries and Game and the Wildlife Management Institute. Present address: Department of Zoology, University of California, Davis, California.

DESCRIPTION OF THE AREA

The search for nests extended over an area 52 square miles in extent (Fig. 1), comprising most of the town of Hamilton and portions of the towns of Madison, Eaton and Lebanon. This part of New York is on the northern edge of the Appalachian Plateau. Drainage is to the south via numerous small streams and rivers which are a part of the Susquehanna system. The ridges, arranged in long, parallel north-south chains, average 1,500 to 1,600 feet in elevation, and rise 300 to 500 feet above the main valley floors.

Land in the area is nearly equally divided between woodland and farmland. The latter is largely in crops in the main valleys though there are a few rather extensive wooded swamps there also. Agricultural land on the uplands is in pasture, well interspersed with woodlots. Ineffective fencing sometimes allows cattle free access to the latter. The preferred habitat for nesting raptors seemed to be in or along the borders of the mature upland woodlots.

TABLE 1
PAIRS WITH EGGS AND YOUNG UNDER OBSERVATION, 1949–1952

Season	Red-tailed Hawk	Horned Owl
1949	2	2
1950	4	2
1951	7	6
1952	11	8
TOTALS	24	18

Sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), and white ash (*Fraxinus americana*) in that order of importance are the dominant trees of the mature upland forests. A few large hemlocks (*Tsuga canadensis*), often scattered among these hardwoods, are of importance as roost trees, especially for Horned Owls. Occasionally there are pure stands of mature hemlock but they usually occur in ravines and never cover extensive areas. Other less important although common trees include basswood (*Tilia americana*), black cherry (*Prunus serotina*), yellow birch (*Betula lutea*), and elm (*Ulmus americana*).

Wooded swamps in the lowland are largely of dense stands of arborvitae (*Thuja occidentalis*), white pine (*Pinus strobus*), and hemlock. Horned Owls were often heard or observed in this association, whereas it seemed that Red-tailed Hawks favored the uplands exclusively.

METHODS

The nesting sites of raptors were located by searching through woodlots for bulky nests during the late fall, winter, or early spring when the trees were leafless. The locations of these nests were plotted on Army Map Service maps (scale 1:25,000) which, incidentally, show all of the wooded areas conveniently outlined in green. When these nests were revisited during the breeding season they often were occupied. When not, a short search in the immediate vicinity, usually the same woodlot, frequently revealed a new nest. Some pairs of Horned Owls were located by listening for their calls during late February. The nests of a few pairs of Red-tailed Hawks were found after the birds had been observed courting over their nesting woods or by watching them come and go on their hunting forays or while carrying nest-building material.

TABLE 2

OCCUPANCY OF EIGHT NESTS USED MORE THAN ONCE

Nest Number	Tree Species	1949	1950	1951	1952	Total years in use
1	Beech	Hawk			Hawk	2
2	Sugar maple			Hawk	Hawk	2
3	Beech			Hawk	Owl	2
4	Beech		Hawk		Owl	2
5	Beech			Owl	Owl	2
6	Beech	Owl	Owl			2
7	Beech		Hawk	Owl	Hawk	3
8	Beech	Owl	Owl		Owl	3

NEST SITES AND BREEDING SEASONS

Horned Owl.—The hooting of the Horned Owl was heard occasionally on still evenings and early mornings during the fall and winter, but it became most regular during late January and the first two or three weeks in February. Most birds apparently appropriated nests and began incubating eggs by the last week in February or the first week in March. One was incubating as early as February 15. The eggs hatched about the end of March and the nestlings usually were fledged before the end of April. One nest was occupied until the end of May, but it is believed that this is exceptional.

Red-tailed Hawk.—The hawks were observed building new nests or repairing old ones as early as February 19, but rarely laid eggs before the last week in March. Hatching probably occurred during the last week in April or the first week in May, although no detailed observations of nests were made until young were present. The nestlings generally left during the last few days of May and the first 10 days in June. This breeding schedule appeared to be similar to that obtaining in southeastern Massachusetts (Bent, 1937).

Both species of raptors exhibited a tendency to re-occupy the same territory, in some cases even the same nest, in consecutive years. Fourteen of 19 nests of the hawk under observation for more than one year were used in one season only, whereas five were occupied another season (or seasons) either by the hawks or by the owls. Seven of 13 owl nests were occupied for one season only, while six were occupied in more than one year by either species.

TABLE 3

HISTORY OF OCCUPANCY OF THE ELEVEN WOODLOTS USED MORE THAN ONCE

Woodlot	Approx. acreage	1949	1950	1951	1952	Total years in use
1	60	?[1]	?	Hawk	Hawk	2
2	20	?	?	Hawk	Hawk	2
3	15	?	?	Hawk	Owl	2
4	90	?	?	Hawk	Hawk & Owl[2]	2
5	160	?	?	Owl	Hawk & Owl[2]	2
6	60	?	—	Owl	Owl	2
7	25	Hawk	Hawk	Hawk	—	3
8	70	—	Hawk	Hawk	Hawk	3
9	175	?	Hawk	Owl	Owl	3
10	120	Hawk & Owl	Hawk & Owl	Hawk	Owl	4
11	40	Owl	Owl	Owl	Hawk & Owl[2]	4

[1] Query indicates that woodlot was not searched thoroughly.
[2] Both pairs raised young.

A record of eight nests that were used more than once (Table 2) shows that reoccupancy of a previous year's nest by individuals of the same species occurred three times by the hawks and four times by the owls. The two alternated in their use of one nest and exchanged two others. The owls appeared to be quite dependent upon the hawks for providing them with nests. In five known cases owls appropriated nests built by hawks, and eight other nests used by owls were thought. because of their position and construction, to have been built by hawks originally. Owls usually appropriated hawk nests of a previous season but twice they occupied new hawk nests the same season that they were built. In southeastern Massachusetts 11 of 13 Horned Owl nests were old nests of the Red-tailed Hawk (Bent, 1938). Crows (*Corvus brachyrhynchos*), Gray Squirrels (*Sciurus carolinensis*), and Raccoons (*Procyon lotor*) also used old hawk nests.

The tendency toward use of the same woodlots in different years appeared more general than that toward re-use of individual nests. Successive use of certain woodlots by both hawks and owls is shown in Table 3.

In general, this rather small sample indicates that both species use the same woodlot year after year and that owls tend to use a previous year's nest more than the hawks.

The owls seemed to prefer the larger woodlots, most of their nests being in tracts of more than 20 acres. The smallest lot used was 15 acres. Red-tailed Hawks were less dependent on the large woodlots, 13 (about one-third) of their nests being in tracts of 20 acres or less. Three of these were in quite isolated trees standing in open pasture as far as 50 yards from the nearest woods. The largest woodlot used by both species was 175 acres in extent, the biggest on the study area.

TABLE 4

CROWN VEGETATION IN THE VICINITY OF NEST SITES

Forest composition	NESTS	
	Horned Owl	Red-tailed Hawk
1. Mature, deciduous: beech and/or sugar maple predominating; scattered hemlock	10	10
2. Mature, deciduous: beech and/or sugar maple; no hemlock	2	18
3. Virtually pure stands of sub-mature sugar maple; no hemlock	1	5
4. Other		
a. Like no. 1 but scattered Norway spruce in place of hemlock	1	—
b. Lone trees in open pasture or recently cut-over land	—	5
Total Nests	14	38

Horned Owls showed their preference for dense woods in another way. Over half their nests were near the center of woodlots while fewer than 40 per cent of the hawk nests were in this position. The immediate vegetation about the nests of both species seemed to fall into three quite distinct categories (Table 4). Most pairs of both hawks and owls preferred the mature deciduous forest, and a scattering of hemlocks seemed quite necessary for the owls. Crown closure of trees about all the nest sites of the owl was nearly complete. For actual nest trees the hawk used four species: beech, 17 nests; sugar maple, 16 nests; American elm, three nests; and yellow birch, two nests. The owl occupied 10 nests in beech trees and one nest each in sugar maple, red oak (*Quercus borealis*), black cherry and an introduced Norway spruce (*Picea abies*).

POPULATION DENSITY

In the spring of 1952 each woodlot on the study area that appeared to be reasonably suitable for habitation by raptors was searched. Nest site locations and other observations were plotted on maps to determine centers of greatest activity for every pair. The term "territory" is avoided in this discussion because there was little evidence that territorial boundaries were well defined. Results of the census indicated that the combined population of hawks and owls averaged one pair per 1.4 square miles.

Horned Owl Density.—Eleven pairs of Horned Owls were located on the study area in the spring of 1952. Occupied nests of eight of these pairs were found; each successfully raised young. Additional pairs could have been overlooked through failure to cover the lowland swamps. It is doubted that suitable lowland habitat was extensive enough to have supported more than four additional pairs. There was a suggestion that these areas were inhabited by single birds, as evidenced by the nature of their hooting. With a minimum population of 11 pairs the density for the study area (52 square miles) would have been about one pair per 4.4 square miles.

Baumgartner (1939), from studies of this species near Lawrence, Kansas, and Ithaca, New York, states that on optimum range, populations seem to average from one to three pairs per square mile but usually are much lighter. In the region about Ithaca, where cover and topography are similar to that about Hamilton, he believed that in 1934 and 1935 the birds did not average more than one pair to three or four square miles during the spring.

Red-tailed Hawk Density.—The population on the study area probably was about 26 pairs during the spring of 1952. Occupied nests at the beginning of the egg-laying period numbered 17, but only 10 of these pairs successfully raised young. Centers of activity for the other nine pairs were more obscure. In three instances a pair may have been counted twice. Since the hawks tended to avoid the lowlands, and since all upland areas were searched very thoroughly, it seems unlikely that any were overlooked. The minimum number of pairs was therefore estimated to be 23, and the resulting population density approximately one pair per 2.2 square miles.

In Madera County, California, Fitch *et al.* (1946) found the population density of Red-tailed Hawks was one pair to half a square mile (320 acres). Differences in habitat and food supply may have been responsible for this greater density.

LOCAL DISTRIBUTION OF PAIRS

The map (Fig. 1) shows the distribution of pairs of both Horned Owls (circles) and Red-tailed Hawks (triangles) during the spring of 1952. Each symbol represents the center of activity of a single pair. Solid circles or triangles indicate occupied nests, and open circles or triangles, places where

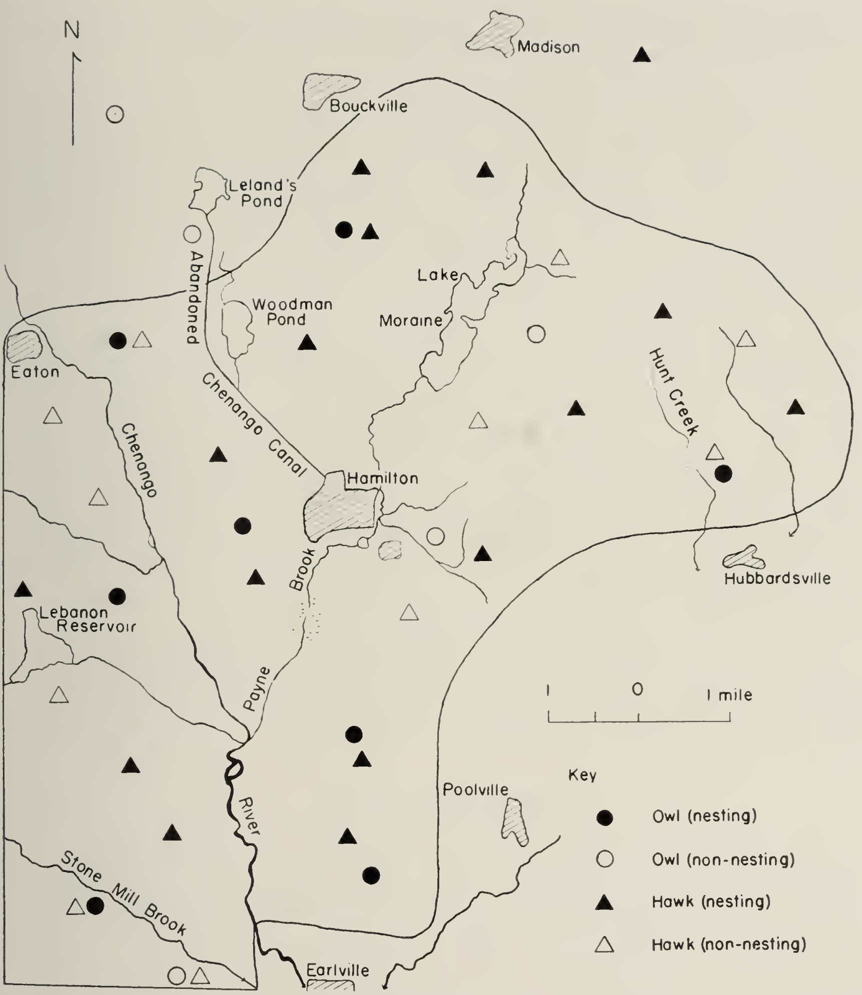

FIG. 1. Distribution of pairs of Horned Owls and Red-tailed Hawks in the spring of 1952.

pairs were observed, usually with unoccupied nests. There is a fairly even distribution of both species, with slightly greater concentration of owls in the western and southern portions where woodlots are more extensive.

Hawks and owls often nested, or attempted to nest, in the same woodlots, sometimes very near together (Table 3 and Fig. 1). This proximity and the fact that the owl often used old nests of the hawk suggest that the two raptors are quite tolerant of one another in their nesting and territorial habits. However, Bent (1939) considered them to be complementary species. Tolerance is further indicated by the attempts of the two to occupy closely adjacent nest sites over the four-year period.

In 19 attempts to use a nest site separated from that of another raptor by not more than half a mile, there were 11 failures, four successes and four instances where the outcome was uncertain. The hawk was driven off in nine of the 11 failures and the owl was loser only twice. Two of the successful nestings were accomplished only after one pair, probably in both instances the hawks, moved to a greater distance. The other two successful close nestings, where the distances were only 700 and 350 yards, respectively, evidently represent maximum interspecific tolerance.

Intraspecific tolerance, as indicated by distances between nesting pairs, was somewhat less. Adjacent nests of Red-tails generally were separated by more than a mile, although two pairs successfully raised young only 0.7 miles apart. The minimum distance between two nesting pairs of owls was 1.25 miles. Distances between each nest or center of activity and next nearest for hawks and owls averaged 1.1 and 1.8 miles, respectively.

Other investigations have indicated that the Horned Owl has a smaller home range than my data indicate. Baumgartner (1939) substantiated the findings of Miller (1930), who showed that the feeding range seldom exceeded a quarter of a mile in any direction from the nest.

Fitch *et al.* (1946) found that the boundaries of Red-tailed Hawk territories were usually ill-defined; with a population apparently near saturation the birds centered their activities about an area of no more than half a square mile.

REPRODUCTION RATE

Of 18 active nests of the owl located during the four-year period, two were deserted. The number fledged in the 16 occupied nests ranged from one to three and averaged 1.7. There was no known infertility of eggs or mortality of young. Of 37 nests of the hawk, 15 apparently were deserted. The range of brood size was the same as for the owl and the average number of young per brood was 1.9. One young hawk apparently succumbed while in a weakened condition during a cold rain. It was subsequently eaten by the surviving nest mate. Two other instances of juvenal mortality were attributed to human disturbance. No infertile eggs were found.

There was a noticeable decline in number of young produced per pair in 1952 from that of 1951 for both species (Table 5). The lower reproductive rate in 1952 resulted from smaller average brood size rather than in the percentage of deserted nests. Average brood size for the Horned Owls was 2.2 in 1951 and 1.5 in 1952; for Red-tailed Hawks the averages were 2.7 and 1.4 young, respectively. Broods of hawks in 1952 may have suffered from heavy rains in May. Weather conditions may have influenced survival within owl broods but no accurate correlations were made. No attempt was made to gauge prey abundance or other possible determining factors.

NEST DESERTION

Horned Owls showed little tendency to desert, whereas the Red-tailed Hawks abandoned 40 per cent of their nests each season. The hawks that apparently deserted usually did so early in the season, often, I suspected, before eggs were even laid. They would build firm nests of sticks but further breeding activity was decidedly casual. These may have been pairs in which one or both birds were too young to perform the full breeding cycle.

TABLE 5

NESTING SUCCESS IN 1951 AND 1952

Horned Owl			Red-tailed Hawk		
Nests active at beginning of season	Young in nest	Average young per occupied nest	Nests active at beginning of season	Young in nest	Average young per occupied nest
1951					
1	3		4	3	
4	2		1	2	
1	deserted		1	?	
6	11	2.2	4	deserted	
			10	14+	3
1952					
1	3		5	2	
2	2		5	1	
5	1		1	?	
8	12	1.5	7	deserted	
			18	15+	1.5

SUMMARY

Observations on hawks and owls were made on a 52-square-mile area in southeastern Madison County, New York, from the fall of 1948 through the spring of 1952, with the exception of summers.

The common, large raptors were Red-tailed Hawks and Horned Owls, and my attention was given to them, nearly to the exclusion of other species.

Both species showed a strong tendency to use their respective woodlots in successive years. The owls appeared to be dependent upon the hawks for providing nests. The owls seemed restricted to larger woodlots with scattered hemlock to a greater extent than were the hawks. Beech was the preferred nest tree of the owls, whereas beech and sugar maple were equally important for the hawks.

An estimated 11 pairs of Horned Owls and 23 pairs of Red-tailed Hawks on the area in the spring of 1952 gave breeding population densities of one pair per 4.4 square miles and one pair per 2.2 square miles, respectively. The combined population would have allowed 1.4 square miles per pair.

Individual pairs of hawks and owls often occupied overlapping territories but attempts to use closely adjacent nest sites usually resulted in abandonment by the hawks.

The hawks fledged 1.9 young per pair, and the owls, 1.7, on an average. The average brood sizes in 1952 were about half those in 1951 for both species.

Nearly 40 per cent of the freshly constructed Red-tailed Hawk nests found in early spring had no young, probably because eggs were never laid in them.

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DEPARTMENT OF ZOOLOGY, UNIVERSITY OF CALIFORNIA, DAVIS, CALIFORNIA, APRIL 30, 1956

NOTES ON TAMAULIPAN BIRDS

BY DALE A. ZIMMERMAN

A few bird observations made by Marian Zimmerman and me in the Mexican state of Tamaulipas, April 7 to 12, 1955; April 7 and 8 and June 22, 1956, seem worthy of record. During these periods we enjoyed the hospitality of our friend, Mr. Everts Storms at Rancho Pano Ayuctle on the Río Sabinas, approximately five miles north-northwest of Gómez Farías, and some 45 airline miles (60 miles by road) south of Ciudad Victoria. Unless otherwise stated, the following observations were made at or near Pano Ayuctle.

Rather low temperatures and cloudy skies prevailed during our visit in 1955. No rain fell, however, and we understood that the previous months had been abnormally dry. Mr. Storms told us that he could not remember a more severe drought. Certainly everywhere but in the immediate vicinity of the river the countryside seemed parched, and we wondered if the aridity had resulted in a "late" season insofar as breeding birds were concerned. There were many birds about but none appeared to be nesting. We failed to find the Coppery-tailed Trogon (*Trogon elegans*) and the Crimson-collared Grosbeak (*Rhodothraupis celaeno*), species which were "seen daily" along the Sabinas in March and April, 1941, by Sutton and Pettingill (1942). *Rhodothraupis,* at least, nests at Pano Ayuctle (Sutton, Lea, and Edwards, 1950: 57–58), and is not considered migratory (Sutton, 1950:155). We did not encounter *Crotophaga sulcirostris* or *Vireo olivaceus flavoviridis,* which are known to be migratory. In 1941, Sutton and Pettingill (*op. cit.*) first recorded anis on April 7, and Yellow-green Vireos on April 9.

ACKNOWLEDGMENTS

I wish to express my appreciation to Mr. Byron E. Harrell and to Dr. George M. Sutton for reading portions of the manuscript and for their suggestions.

In the following list an asterisk indicates a species seen by us in the Gómez Farías region and which has not been previously recorded there by Sutton and Pettingill (1942), Eaton and Edwards (1948), Sutton, Lea, and Edwards (1950), or Robins and Heed (1951).

* *Podiceps dominicus.* Least Grebe.—One seen on a relatively quiet portion of the Río Sabinas on April 11, 1955.

* *Spizastur melanoleucus.* Black and White Hawk-eagle.—Although this species has not yet been collected in Tamaulipas there are three independent sight records—all from the vicinity of Pano Ayuctle: Amadon and Eckelberry (1955:70) reported one on April 17, 1952, and Byron Harrell (personal communication) and Paul S. Martin saw the species across the river from the Rancho on or about February 8, 1953. Mrs. Zimmerman and I observed one circling over a patch of forest across the river on April 10, 1955.

Our bird was not seen perched. When first sighted it was within 100 feet of the ground and near enough so that the red or orange-red cere was noticeable through 8 × binoculars. We could not tell if the iris was dark or light. The bird, seen against both the forested mountainside and the hazy, bluish sky in excellent light, was decidedly *Buteo*-like in proportions and manner of flight. It soared in wide circles, occasionally flapping, with its wings horizontal, its tail fanned. Its identity was not known immediately, for I had not pictured *Spizastur* as this type of bird. Furthermore, not once during the two or three minutes we watched did we see the black crest. The back and upper wing-surfaces were brownish black, but the bird did not bank fully enough to show us the top of the head. From our angle of observation it appeared white-headed (we could see the forehead, supra-orbital region and much of the nape), with immaculate white underparts and wing linings, reminding us somewhat of a White-tailed Kite (*Elanus leucurus*) in this respect. The black lores were conspicuous, and gave the bird a "masked" appearance. The tail from below appeared grayish white, with three sharply contrasting, narrow black bars, the terminal broadest. Sutton (1951:197) says of this species: "tail black, crossed by several gray bars," but the reverse is true in all adult specimens I have examined.

Unaware at that time of previous records of *Spizastur* from the area, and knowing that the Ornate Hawk-eagle (*Spizaëtus ornatus*) occurred there, I was careful to note that our bird definitely lacked all barring on flanks, thighs, and wing linings. There were *faint* bars on the outer primaries. The gray flight feathers were noticeably darker than the rest of the underparts. The Gray-headed Kite (*Leptodon cayanensis*) was briefly considered as a possibility, but that species is gray-faced, has dark wing linings and darkly barred flight feathers, and does not have a red or orange-red cere.

Although *Buteo*-like, the hawk-eagle seemed long-winged and was proportioned more like a Rough-legged (*Buteo lagopus*) or Swainson Hawk (*B. swainsoni*) than a Red-tail (*B. jamaicensis*). Its general appearance was not particularly aquiline, for the bill was rather small.

Since the above observation, I have had several excellent views of *Spizaëtus ornatus* in flight. It bears very little resemblance to *Spizastur melanoleucus*.

Circus cyaneus. Marsh Hawk.—Thirteen scattered birds were seen flying in a northerly direction between Ciudad Victoria and Matamoros on April 7, 1955. We saw no adult males.

Falco sparverius. Sparrow Hawk.—Forty-six were counted between Matamoros and Victoria, April 7, 1955; 14 were in sight at one time near San Fernando.

Columbigallina talpacoti. Ruddy Ground Dove.—One seen feeding along a trail at the foot of the mountain across the river from Pano Ayuctle, April 10. The only other record for the region is of one seen "at about 1,000 feet elevation," August 7, 1946, by Eaton (Eaton and Edwards, 1948:112).

Claravis pretiosa. Blue Ground Dove.—A pair seen April 8 along a road leading from the Rancho to the main highway. There are a few other sight records for the region but the species seems rare there.

Amazona autumnalis. Yellow-cheeked Parrot.—Sutton, Lea, and Edwards (1950:47) recorded this species near Pano Ayuctle in late May, 1947. We saw it there daily, April 8 to 12, 1955, and April 7 and 8, 1956, though it was far less common than the Red-crowned Parrot (*A. viridigenalis*). Ordinarily we saw *A. autumnalis* in pairs, and the Red-crowns in flocks of from 15 to 75 individuals. Not once did we identify both species in the same flock. The yellow cheek spot of *A. autumnalis* is a good field mark, and that bird's flight seemed slower and more labored than that of *A. viridigenalis*. The notes of the two species are noticeably different.

Campylopterus curvipennis. Wedge-tailed Sabre-wing.—Several times on April 9 and 10 we saw individuals feeding in dense vegetation along the Río Sabinas. They were easily approached, and we watched one singing and preening for several minutes at a distance of about six feet. Sutton and Pettingill (1942:17) found it "only in tangles of vines on mountainside . . . at from 1000 to 1500 feet."

* *Amazilia tzacatl.* Rufous-tailed Hummingbird.—The Mexican Check-List (Friedmann, Griscom and Moore, 1950:173) records this species from southern Tamaulipas but recent workers fail to mention it. One April 8, 9, and 11, I studied at close range several of these hummingbirds. They were definitely gray-bellied, and were darker, especially on the breast, than the common Buff-bellied Hummingbirds (*A. yucatanensis*) that sometimes fed with them. Their tails had a noticeable violet cast which was indistinct or lacking in *A. yucatanensis.* The latter species was abundant wherever we went. *A. tzacatl* seemed less common and more restricted to the immediate vicinity of the river. However, the two species were so similar that our attempts to determine relative numbers were futile; in the thickets along the river only a few Amazilias were seen well enough to be identified with certainty.

* *Sphyrapicus varius.* Yellow-bellied Sapsucker.—A male at Pano Ayuctle on April 9 spent most of its time on large trees near the river.

**Pachyramphus major.* Gray-collared or Black-capped Becard.—Several times on April 9 and 10 we saw a male in low trees near the banks of the Río Sabinas. A female was seen accompanying a male on April 10. Martin, Robins, and Heed (1954:48) noted the species in June in the Sierra de Tamaulipas (in pine-oak and oak-hickory woodlands).

Muscivora forficata. Scissor-tailed Flycatcher.—A total of 87 presumed migrants were counted along the highway between Matamoros and Ciudad Victoria, April 7, 1955. One flock contained 12 birds. We saw three Scissor-tails 25 miles south of Matamoros on June 22, 1956, and I saw them as far south as San Fernando on June 17 and August 13, 1949. Davis (1950) recorded this flycatcher in mid-July at Las Norias and at Tres Patos (= Tres Palos), points 19 and 24 miles, respectively, south of San Fernando.

Corvus imparatus. Mexican Crow.—Scattered flocks of from 10 to 250 birds were seen along the highway between Ciudad Victoria and San Fernando on April 7, 1955. The northernmost we noted in Tamaulipas were six, about 60 miles south of Matamoros. (We saw several at China, Nuevo Leon, about 48 miles from the Río Grande on April 7, 1956.) In cultivated portions of the arid land 20 to 30 miles north of Victoria the species is abundant. There we noted a flock estimated at 350 birds (adults and immatures) on June 22, 1956.

Hylocichla ustulata. Olive-backed Thrush.—One seen at close range near Pano Ayuctle on April 10, 1955.

Regulus calendula. Ruby-crowned Kinglet.—Several seen April 9, 1955. Sutton and Pettingill (1942:26) recorded this species no later than March 14 in 1941.

Cyclarhis gujanensis. Rufous-browed Pepper-shrike.—We saw two birds (probably not a pair) along the Río Sabinas on April 9 and 10, 1955. One was singing in a roadside thicket two miles south of El Limon on June 22, 1956. There seem to be very few records of *Cyclarhis* from Tamaulipas.

Dendroica magnolia. Magnolia Warbler.—Small numbers of both sexes seen daily, April 8 to 11, 1955, along the Río Sabinas. Sutton and Pettingill list but one record (April 2, 1941) from the area.

Dendroica coronata. Myrtle Warbler.—Two males seen on April 8 and 10, 1955.

Dendroica dominica. Yellow-throated Warbler.—Male seen at Pano Ayuctle on April 8, 1956. Sutton and Pettingill (1942: 28) list two sight records for March.

Euphagus cyanocephalus. Brewer Blackbird.—Sutton and Pettingill (1942:29) recorded this species on March 12 and 13, 1941, in El Mante. We saw several of both sexes feeding with House Sparrows (*Passer domesticus*) on the streets of that town and in El Limon on April 11, 1955, and near El Mante on April 8, 1956.

* *Dives dives.* Melodious Blackbird.—Two of these birds spent the morning of April 9, 1955, about the ranch buildings at Pano Ayuctle, feeding with Red-eyed Cowbirds (*Tangavius aeneus*). Examination of the cowbird flock the following morning revealed no *Dives*, and we did not see the species there again.

* *Icterus fuertesi.* Fuertes Oriole.—This species has been known to breed (or at least occur during spring and summer) along the Gulf coasts of southern Tamaulipas and Veracruz. The Grabers (1954:274–275) pointed out that it is concentrated in "the narrow belt of dune vegetation along the coast." They found "the population considerably less dense around Altamira (only six to eight miles inland) . . ." On June 22, 1956, I collected the male of a pair of Fuertes Orioles just west of the Pan-American Highway, two miles south of El Limon, at a point about 85 air-line miles west of the Gulf coast. This is considerably farther inland than any previous records known to me. (The westernmost specimens were the type series, taken 35 air-line miles northwest of Tampico.) It does not seem very likely that the species could have been present along the Pan-American Highway for many years without attracting the attention of some ornithologist, and its presence there may be further evidence of an inland spread as has been suggested by the Grabers (*loc. cit.*).

We found the orioles in a "hedge row" separating cultivated fields from a roadside canal and drainage ditch. The strip of woody vegetation was about 15 feet wide and was composed of large shrubs and trees 10 to 35 feet in height. Other birds living in the thicket included *Columba flavirostris, Crotophaga sulcirostris, Pitangus sulphuratus, Turdus grayi, Cyclarhis gujanensis, Icterus gularis,* and *Saltator coerulescens.* The orioles frequented the edge of the thicket, usually feeding between 15 and 25 feet above the ground. The female once perched quietly on a shaded branch near the top of a 30-foot tree for over five minutes, but otherwise both sexes were active—feeding, preening, and flying about. On one occasion they flew from the hedge row to an isolated sapling on "my" side of the canal. There the *male*, perched a few inches below the female, raised his bill and rapidly fluttered his wings before the female, in the manner of a fledgling begging for food. The performance was interrupted by an approaching farmer and I hastily collected the male before he could disappear across the canal after the female. The bird weighed 18.4 grams; the testes measured 7 x 10 and 7 x 9 mm.; the wing (arc), 74 mm.

Apparently this was not an isolated pair of birds, for 10 minutes after I collected the above bird we saw what we presumed was the same female perched close beside another adult male at the edge of the thicket.

The song, to quote from my notes, "definitely reminded me of that of *Icterus spurius*, but was very much softer and harsher—less musical and spirited." Chapman (1911:2) and the Grabers (1954:278) noted the same differences between the songs of *fuertesi* and *spurius*.

Icterus gularis. Black-throated or Alta Mira Oriole.—Common and in full song at Pano Ayuctle between April 7 and 12, 1955, but apparently not yet nesting. In 1956, we found several nearly completed nests on April 8.

Agelaius phoeniceus. Red-winged Blackbird.—Several northward-moving flocks, totalling 1,500 to 2,000 birds, seen south of Matamoros on April 7, 1955.

Thraupis abbas. Yellow-winged Tanager.—We saw flocks of six to eight Yellow-winged

Tanagers on April 9 and 10, 1955, in cypress trees along the Río Sabinas. Sutton, Lea, and Edwards (1950:56) found the species there in late May and early June, 1947.

Saltator coerulescens. Grayish Saltator.—The species was reported in May, 1947, by Sutton, Lea, and Edwards (1950:57), but apparently it is not common in the region. In 1955 we saw two in heavy brush near the Río Sabinas on April 10. In 1956 we noted one there and two near El Limon on June 22.

Melospiza lincolnii. Lincoln Sparrow.—In 1955, at Pano Ayuctle, we found Lincoln Sparrows familiar door-yard birds that were easily studied at close range as they fed on the lawn and about the buildings. Two individuals that frequented a much-used path leading from the house, seldom moved more than a few feet out of the way when people walked by. They were as fearless as House Sparrows of city parks. The contrast between this behavior and that of the species during migration, and particularly on its breeding grounds, was striking. Wetmore (1943:339) has also remarked on the confiding nature of wintering Lincoln Sparrows in southern Veracruz. We did not record the species in 1956.

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MUSEUM OF ZOOLOGY, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN, AUGUST 30, 1956

GENERAL NOTES

A technique for trapping cowbirds.—In April, 1955, an experiment with Brown-headed Cowbirds (*Molothrus ater*) at my country banding station proved interesting. An old Red-eyed Towhee (*Pipilo erythrophthalmus*) nest, containing three eggs of the English Sparrow (*Passer domesticus*), was placed inside one section of a two-compartment banding trap, which measured 24 × 12 × 9 inches. No grain or other bait was placed inside or near the trap. The drop-type entrance doors (6½ × 4½ inches) were at opposite ends of the trap, which was placed on the bank of a drainage ditch.

On April 12, between 8:00 a.m. and 9:00 a.m., a female Cowbird entered the section of the trap containing the nest. When the door dropped down behind her, her alarm notes immediately attracted her mate into the opposite section of the trap. On the mornings of April 13 and April 14, before 9:00 a.m., two other pairs entered the trap in the same manner, and a fourth pair was banded on April 20. On April 17, one male entered the trap at approximately 8:00 a.m., and another male an hour later. No females were observed nearby in either instance. One of the banded males was reported shot by a student in DeFuniak Springs, Florida, in December, 1955.—Bette J. Johnston, *191 North Rose Street, Mount Clemens, Michigan, February 8, 1957.*

Sparrow Hawks prey on newly hatched Killdeer.—While studying heron behavior during the spring of 1955 on Rulers Bar Hassock, an island in Jamaica Bay, western Long Island, New York, I had several opportunities to observe the feeding habits of a pair of Sparrow Hawks (*Falco sparverius*) which nested near one of the heron colonies. A pair of Killdeer (*Charadrius vociferus*) was observed incubating a clutch of four eggs during the last week in April, 1955. On the morning of May 3, 1955, it was noted that all of the eggs had hatched, and during the afternoon of the same day, I made the following observation: as I approached the Killdeer nest, a male Sparrow Hawk flew low over the sandy area where the Killdeer nest was located, swerved when it saw the two adult and four young Killdeer, landed near the young and seized one of them. The Sparrow Hawk pecked once at the young bird in its talons, and then flew to the top of a nearby telephone pole and proceeded to devour the young bird. On the morning of May 4, I saw a female Sparrow Hawk perched on the same pole. Both Killdeer adults were calling vigorously. The Sparrow Hawk swooped to the ground and attempted to seize one of the young birds; this bird ran under the raised end of a log. The Sparrow Hawk flew to the log, jumped to the ground, reached under the raised end of the log with one foot and seized the young Killdeer. The hawk flew to its former perch and ate the young bird. On the afternoon of the same day, the female Sparrow Hawk captured and ate a third young Killdeer from the same nest. The fate of the fourth young Killdeer at this nest was not determined. On May 11, four newly hatched Killdeer were noted at a nest about 200 yards south of the one just described. On the afternoon of May 11, a male Sparrow Hawk captured and ate one of the young from this nest. Of the eight young hatched from the two nests, four were positively taken by the two Sparrow Hawks. A very cursory review of the literature on the feeding habits of Sparrow Hawks revealed no mention of charadriids in their diet.

The two Killdeer nests discussed above were located in unfavorable sites; both nests were placed within 25 yards of a busy thoroughfare, Cross Bay Boulevard, and the adults at both nests were continually disturbed by passing pedestrians and motor vehicles. Both nests were placed on light-colored sand, and when the eggs hatched, the young were very conspicuous. The placement of the nests in unfavorable sites, and the continued disturbance of the adults contributed to the vulnerability of the young to predation by the Sparrow Hawks. Although my observations were very brief, I could find no evidence for predation by Sparrow Hawks on the young from three other Killdeer nests placed in much more favorable sites a few hundred yards further out in the marsh.—Andrew J. Meyerriecks, *Biological Laboratories, Harvard University, Cambridge 38, Massachusetts, October 2, 1956.*

Blue-winged Teal nest parasitized by Brown-headed Cowbird.—Near the village of Delta, on the Delta Marsh in south-central Manitoba, Blue-winged Teal (*Anas discors*) nest commonly at the marsh edge, in pastures, and occasionally in or at the edge of small patches of wooded land. The Brown-headed Cowbird (*Molothrus ater*) also occurs there through the spring and summer, frequenting wooded areas and the surrounding pasture and grassland up to several hundred yards from any woods. On June 2, 1956, at the grassy edge of a wooded, sandy ridge I flushed a female Blue-winged Teal at a nest scrape. The nest contained no eggs, lining or down. It was not revisited until June 8 when it was found to have been lined with grass and a small amount of down and contained the remains of three teal eggs, which had been destroyed by a skunk (*Mephitis mephitis*). Two cowbird eggs were also present. On June 11 another cowbird egg was found on the open ground in the adjacent woods about 30 yards from the destroyed teal nest.

Friedmann (1949. *Auk*, 66:154–163, and preceding literature there cited) reported no recorded instance of a Brown-headed Cowbird parasitizing any species of duck. He mentioned only two cases of cowbirds parasitizing precocial or semi-precocial species, the Killdeer (*Charadrius vociferus*) and the California Gull (*Larus californicus*), and one additional instance of Cowbird parasitism of a species laying a large egg, the Ferruginous Rough-legged Hawk (*Buteo regalis*).

Presumably, lack of discovery of a proper nest for parasitism may lead a female cowbird to drop her egg in a quite inappropriate place. The additional egg found on the ground lends support to the supposition that the female or females involved here were having difficulty locating suitable hosts at the time of this observation.—William J. Hamilton, III, *Museum of Vertebrate Zoology, University of California, Berkeley 4, California, December 12, 1956.*

Nocturnal predation on Summer Tanager nestling by kingsnake.—On June 6, 1942, I found a nest of the Summer Tanager (*Piranga rubra*), near Oreton, Raccoon State Forest, southeastern Vinton County, Ohio. The nest held three small young, and was 5 or 6 feet high in a small oak at the base of a fire tower. After dark in the early evening of June 7, I again visited the nest.

Because of the time lapse since the observation, I quote directly from my notes: "This evening I went out to look at the young tanagers in the nest near the fire tower. I flashed the light [flashlight] on the nest and was startled by a small Black Kingsnake, (*Lampropeltis getulus nigra*), coiled in the nest. The snake had just swallowed a young tanager. The tail and a foot of the young bird were protruding from its mouth." The snake was captured, and later released far from the nest. I left the area soon afterward, so I was unable to make further observations on the nest.—John J. Stophlet, *2612 Maplewood, Toledo, Ohio, January 16, 1957.*

Nesting of the Shoveller (*Spatula clypeata*) in central Ohio.—There are more than 40 small ponds scattered through the 7,000 acres which comprise the Delaware Reservoir Wildlife Experiment Station in Delaware and Marion counties, Ohio. The Station has been managed by the Ohio Division of Wildlife through the past several years for waterfowl production as well as for public hunting and fishing, but in 1956 most of the ponds were closed to public fishing because fishery research was in progress. Before 1956 the ponds were utilized by broods of Wood Ducks (*Aix sponsa*), Mallards (*Anas platyrhynchos*), Blue-winged Teal (*Anas discors*), and Black Ducks (*Anas rubripes*) and in that respective order of abundance. During the spring of 1956, a pair of Shovellers remained near several of the ponds in Delaware County beyond the usual spring departure date. On June 22, a female Shoveller with a brood of 10 young three to five weeks of age was observed on one of the ponds in Marion County about 75 yards from the Delaware-Marion County line. I returned to the pond the following day and collected two ducklings from this brood, and these specimens are now in the collection of the Ohio State Museum.

Apparently nesting of the Shoveller in Ohio has been previously observed only in the Lake Erie Marshes of Ottawa County. There Trautman (1935. *Auk*, 52:201) reported the observation of two pre-flight broods, one in 1925 or 1926 and one in 1932.—Paul A. Stewart, *Ohio Cooperative Wildlife Research Unit, Department of Zoology and Entomology, The Ohio State University, Columbus 10, Ohio, February 1, 1957.*

Anting performed by Scaled Quail.—The following incident was observed about mid-afternoon on November 30, 1956, some 7 miles east of Monahans, Ward County, Texas. The sun was shining brightly and the temperature was about 80° F. There was little breeze. A pair of Scaled Quail (*Callipepla squamata*) that had been feeding while moving along a dry streamcourse came to an ant bed. The female settled herself in the bed and remained motionless for a period of 20 or 30 seconds before she began to pick up ants from the bed. She appeared to hold the ant(s) in her bill and to stroke the undersides of her wings, the sides of the body and the tail area. The stroking action lasted only a few seconds, and was followed by a short period (10 to 12 seconds) in which the bird seemed dazed and suffering from what might be described as a momentary loss of balance. The stroking act was repeated three times. The ants did not appear to be placed in the feathers, but merely rubbed along their surfaces.

After the activity was completed, the quail remained motionless for about half a minute and then moved off the ant bed. I shot her immediately with a .410 shotgun loaded with dust shot. I examined her and could find no ants in the feathers. (Possibly any ants present could have been knocked off with the force of the charge.) I carefully removed all the feathers from the body and wings, but I could find no sign of a sting or other evidence of irritation to the skin. The digestive tract was examined and no ants were found there. The sex of the bird was determined by examination of the gonads.

The ants concerned were not collected. They were blackish-red in color and about ⅜ inch in length.

During the entire incident the other bird continued foraging, apparently ignoring the action of its companion.—Jack W. Thomas, *Department of Wildlife Management, Agricultural and Mechanical College of Texas, College Station, Texas, April 1, 1957.*

PROCEEDINGS OF THE THIRTY-EIGHTH ANNUAL MEETING

BY FRED T. HALL, SECRETARY

The Thirty-eighth Annual Meeting of the Wilson Ornithological Society was held at Duluth, Minnesota, from Thursday, June 13, to Sunday, June 16, 1957. It was sponsored by the Minnesota Ornithologists' Union, the University of Minnesota at Duluth, and the Duluth Bird Club.

There were four sessions devoted to papers and two business meetings at the Science Building on the University Campus. A first showing of Dr. Olin S. Pettingill, Jr.'s new movie, *Faraway Falklands*, opened the Thursday evening program, which was followed by an informal reception in the ballroom of the Kirby Student Center. The host group was the Duluth Bird Club. At the same time, the Executive Council met in the Kirby Student Center. The Annual Dinner was held in the Student Center on Saturday evening and President John T. Emlen, Jr. delivered the President's address. Entertainment provided by the Local Committee completed the program. The tables were attractively decorated with birds made by the Local Committee and several booklets of local information on natural history were at each place setting.

Even though the weather did not cooperate, early morning field trips were taken to Harbor Island and Minnesota Point, and to places along the West Boulevard. An evening trip visited the Fox Farm Road area. The Sunday field trip was to the famous Wilderness Canoe Country of northern Minnesota.

First Business Session

President Emlen called the meeting to order at 10:00 a.m. Friday, June 14. Dr. R. W. Darland, Provost of the University of Minnesota at Duluth, welcomed the Wilson Ornithological Society and President Emlen responded on behalf of the organization. The minutes of the 37th Annual Meeting were approved as published in *The Wilson Bulletin* for September, 1956.

Secretary's Report

The secretary, Fred T. Hall, summarized the principal actions taken at the previous evening's Executive Council meeting as follows:

1. The Council confirmed the 1958 meeting to be held at Oglebay Park, Wheeling, West Virginia, from April 24 to 27. The tentative plan to meet in Kentucky in 1959 was withdrawn and the future remains open to further invitation.
2. The Council unanimously reelected Keith L. Dixon editor of *The Wilson Bulletin.*
3. The Council voted to name the Society library, The Josselyn Van Tyne Memorial Library.

Treasurer's Report

The treasurer, Ralph M. Edeburn, submitted the following report on the finances of the Society:

Report of Treasurer for 1956

General Fund

Balance as shown by last report, dated December 31, 1955			$ 4,195.23

Receipts

Dues:			
Active	$ 3,819.00		
Sustaining	1,020.00	$ 4,839.00	
Subscriptions to *The Wilson Bulletin*		572.25	
Sale of back issues and reprints of *The Wilson Bulletin*		186.05	

Gifts:			
Color Plate Fund	$ 22.00		
Library Book Fund	28.00		
Miscellaneous	25.00	75.00	
Interest on Investments and Savings		419.62	
Miscellaneous Income		9.02	6,100.94
Total Receipts			$10,296.17

DISBURSEMENTS

The Wilson Bulletin—printing and engraving	$ 4,545.25	
The Wilson Bulletin—mailing and maintenance of mailing list	943.81	
Color Plates (2)	874.80	
Editor's Expense—Clerical	95.00	
Treasurer's Expense—printing, postage, etc.	268.57	
Secretary's Expense—stationery, printing, postage for annual meeting	276.60	
Committee Expense—printing and postage	16.48	
Purchase of books from Book Fund for Library	25.16	
Purchase of back issues and reprints	15.09	
Miscellaneous—other officers	15.38	
Total Disbursements		$ 7,076.14
Balance on hand in Twentieth Street Bank, Huntington, West Virginia, December 31, 1956		$ 3,220.03

ENDOWMENT FUND

Balance in Savings Account as shown by last report, dated December 31, 1956		$ 842.46
Receipts:		
Sale of U.S. Postal Savings Coupon Bonds (matured)	$ 1,012.50	
Life Membership Payments	700.00	1,712.50
3 Shares Mass. Invest. Trust at $32.62 (included below)		
Total Receipts		$ 2,554.96
Disbursements:		
S. Morris Pell Painting Grant	$ 25.00	
Louis Agassiz Fuertes Research Grants	200.00	
Purchase 20 Shares Firemans Fund Insurance	1,420.00	
Total Disbursements		$ 1,645.00
Balance in Savings Account, Twentieth Street Bank, Huntington, West Virginia, December 31, 1956		$ 909.96
*Securities Owned**		
U.S. Savings Bonds, Series "G," dated December 20, 1944 (maturity value, $1,500.00)	$ 1,518.75	
U.S. Savings Bonds, Series "G," dated June 1, 1945 (maturity value, $500.00)	593.00	
U.S. Savings Bonds, Series "G," dated July 1, 1945 (maturity value, $900.00)	887.40	
U.S. Savings Bonds, Series "G," dated Oct. 1, 1945 (maturity value, $1,400.00)	1,374.80	
U.S. Savings Bonds, Series "F," dated February 1, 1947 (maturity value, $2,000.00)	1,800.00	
U.S. Savings Bonds, Series "F," dated April 1, 1948 (maturity value, $2.000.00)	1,748.00	

U.S. Savings Bonds, Series "F," dated October 1, 1948 (maturity value, $1,450.00)	1,248.44	
U.S. Savings Bonds, Series "F," dated April 1, 1950 (maturity value, $1,000.00)	822.00	
Total Value of Government Bonds	$ 9,992.39	
Massachusetts Investors Trust (378 shares at $11.68)	4,415.04	
Firemans Fund Insurance (70 shares at $50.00)	3,500.00	
Total Securities Owned		$17,907.43
Total in Endowment Fund,** December 31, 1956		18,817.39

*Bonds carried at redeemable value December 31, 1956
Stocks carried at closing prices December 31, 1956.

***In Reserve*

Louis Agassiz Fuertes Research Fund (special gifts)	$ 125.00
S. Morris Pell Fund (special gift)	75.00

Respectfully submitted,
/s/Ralph M. Edeburn,
Treasurer.

Research Grant Committee

Kenneth C. Parkes, chairman, reported that three applications for the S. Morris Pell awards for the encouragement of bird art were received. The Committee awarded $25 each to Mrs. Carl (Colleen) Nelson, temporarily of Rome, Italy, and Mr. Albert Earl Gilbert of Chicago, Illinois, thus exhausting the S. Morris Pell Fund.

There were only four applicants for the Louis Agassiz Fuertes Research Grant and the Committee felt the projects were all of excellent quality. The Committee awarded the 1957 grant of $100 to Mrs. Robert (Millicent) Ficken of Ithaca, New York, for a "Comparative Study of the Behavior of the Canada Warbler (*Wilsonia canadensis*) and the Redstart (*Setophaga ruticilla*)." The Committee also reported that the Fuertes Grant funds were reduced to $25.00.

The Council regretted the termination of the S. Morris Pell award but hoped that similar funds might be forthcoming so that this project could be resumed. The Council appropriated funds to be used to continue the Louis Agassiz Fuertes Research Fund if no other funds were contributed for this purpose. It was hoped that someone might be interested in perpetuating this research grant.

Membership Committee

Howard F. Young, chairman, reported that 152 names of new members were posted for inspection by the members prior to the election at the final business meeting. On December 31, 1956, the Society had 112 life, 198 sustaining, and 1268 active members, a total of 1578. The addition of the new members and the loss of 180 old members leaves a balance of 1550. There are 183 institutional subscriptions to *The Wilson Bulletin.*

Library Committee

H. Lewis Batts, Jr., chairman, reported that during the past 12 months the Society has received gifts to the Library of 31 books, 381 reprints, 32 magazines, 25 bulletins, 18 pamphlets, 81 periodicals, and 25 disk recordings. Compared to last year, this listing represents fewer items received, except in the reprint and recording categories. In addition, 80 journals are exchanged for *The Wilson Bulletin,* and 22 others are received as gifts. The book fund has been increased by approximately $45.00.

Captain Karl Haller, in addition to again contributing generously to the book fund, donated the large collection of bird song recordings.

Special mention should be made of the list of serial holdings, published in *The Wilson*

Bulletin, as compiled by the late Josselyn Van Tyne, to whom The Wilson Society owes much gratitude for its excellent Library.

The University of Michigan continues to catalogue accessions, to bind completed serial volumes, and to aid W.O.S. members in their bibliographic and library loan requests. The University now separates the W.O.S. Library from that of the Bird Division and houses the two in separate rooms. This gives more shelf space to both libraries. The Library Committee has been expanded to four members; the additions are Robert W. Storer, William A. Lunk, and Haven H. Spencer.

Conservation Committee

Robert A. Pierce, chairman, reported by letter.

"Again, I wish to express my sincere appreciation for the excellent cooperation received from each member of the Committee, which was composed of P. F. English, Lee E. Yeager, Thomas G. Scott, and Frank Bellrose, Jr. I should also like to point out again, that the vigorous individual efforts of members of the Society in supporting good conservation legislation and practices on both the national and local levels are very important and effective.

"With this thought in mind, I feel that it is important for each of us to remember that there are presently many activities important to conservation which are being decided at State and local levels. Some of these activities are nationally important also, but while some of us can do much at the national level, all of us can do something locally.

"Tremendous quantities of insecticides, herbicides, fungicides, and rodenticides are being widely distributed annually over marshes, forests, farms and gardens, often with much damage to fish and wildlife. All of us can encourage more testing and research within our respective States on the effects of these poisons and can encourage legal controls for the use of these poisons where it is desirable. Often, too, foresters, farmers, entomologists, public health officials, and others need to be reminded that consideration must be given to all members of the fauna, not alone to the pests which they hope to eradicate.

"With increasing frequency we hear in game management circles that hunters are under-harvesting game and that bag limits and lengths of seasons may be relatively unimportant, since, when game becomes hard to find, hunters will cease hunting, leaving sufficient game to fill the habitat to its carrying capacity by the time the next hunting season arrives. While this philosophy has been developed quite vigorously in regard to pheasants, it is being extended to other species, and is not infrequently encountered in discussions of waterfowl and Mourning Doves. It is a theory which is sure to find much favor with many hunters, few of whom will care to distinguish between those situations where such practices may prove to be practical and those where the theory can be demonstrated to be invalid. As individuals we can remind those conservation leaders who do their leading behind the pack that certain fundamental precepts should be considered as well as license fees and pressure groups. On the national level we should demand some very sound experimental evidence before we accept the liberalization of hunting regulations for waterfowl and other migratory birds. Those who feel that theories without experimental evidence justify action might well read "Safety Testing of Poliomyelitis Vaccine" by Paul Meier (1957. *Science*, vol. 125, no. 3257, pp. 1067–71) and ponder the Cutter incident.

"Promiscuous introductions of exotic birds and mammals continue. Since most of this work is performed by State or local groups, it again falls to our lot as individuals interested in conservation to become informed about the merits of such activities and to lend our support to sound biological practices in our own communities.

"As a result of recent publicity, we are all aware of the fact that captive Whooping Cranes have hatched two eggs in New Orleans' Audubon Park Zoo. This serves to accent the fact that opinions differ as to whether or not wild birds should be taken captive to maintain a captive nucleus whose progeny could be added to the wild. David E. Davis represented the Society at a Whooping Crane Conference in Washington, D. C., called by Mr. John L. Farley on October 29. As a result of this conference, Dr. Davis suggested that perhaps an unbiased comprehensive plan of action could best be formulated by an advisory group appointed by some independent agency, such as the National Research Council or the Ecological Society of America. I feel that this suggestion has real merit, not only in respect to this problem, but also in other controversial conservation matters."

Endowment Committee

Olin S. Pettingill, Jr., chairman, gave no report but spoke briefly of the endowment needs of the Society.

Temporary Committees

The President appointed the following temporary committees:

Auditing Committee

N. Bayard Green, Chairman
Mary Lois Garrett
Kriston Macland

Resolutions Committee

Joseph J. Hickey
Betty Carnes
William A. Dyer

Nominating Committee

Walter J. Breckenridge
William W. F. Gunn
William F. Rapp, Jr.

Second Business Session

The final business session was called to order at 10:00 a.m. Saturday, June 15.

The applicants for membership, whose names were posted, were elected to membership.

Report of the Auditing Committee

The committee reported by letter that they had examined the books and accounts of the Treasurer and found them in good order.

Report of the Resolutions Committee

WHEREAS Dr. Josselyn Van Tyne was so largely responsible for the continued development of the Library of the Wilson Ornithological Society as a unique bibliographical instrument in the biological sciences; and

WHEREAS Dr. Van Tyne so successfully raised the standards of *The Wilson Bulletin* to world-wide eminence during the 10-year period of his editorship for the Society; and

WHEREAS Dr. Van Tyne served the Wilson Ornithological Society with such great distinction and sustained devotion as vice-president from 1931 to 1935; as president from 1935 to 1937; as councillor from 1931 to 1957; and as a member for thirty-five years;

BE IT RESOLVED that the Wilson Ornithological Society at its Thirty-eighth Annual Meeting herein assembled, record its great sorrow upon his passing away on January 30, 1957; and

BE IT FURTHER RESOLVED that the Society record on its minutes this small tribute to the great modesty, the life-long unselfishness, the tremendous labors, and the enduring vision with which Dr. Van Tyne contributed to the development not only of the Wilson Ornithological Society but of American ornithology in general; and

BE IT FURTHER RESOLVED that the Wilson Ornithological Society convey to his family the great sense of loss which they share in the passing of one of America's greatest ornithologists.

WHEREAS this Thirty-eighth Annual Meeting of the Wilson Ornithological Society has made for the continued interchange of facts, findings and new hypotheses in ornithological science; and

WHEREAS this meeting has been made possible by the great labors of the Society's hosts here in Duluth;

BE IT RESOLVED that the Wilson Ornithological Society extend its sincere thanks to the Minnesota Ornithologists' Union, the University of Minnesota at Duluth, and the Duluth Bird Club for their many efforts in making this Thirty-eighth Meeting of the Society a reality.

Election of Officers

The Nominating Committee proposed the following officers for the coming year: President, John T. Emlen, Jr.; First Vice-President, Lawrence H. Walkinshaw; Second Vice-President, Phillips B. Street; Secretary, Fred T. Hall; Treasurer, Ralph M. Edeburn; Elective members of the Executive Council, Leonard C. Brecher (term expires 1958), Andrew J. Berger (term expires 1959), and Pershing B. Hofslund (term expires 1960).

The report of the committee being accepted, and there being no nominations from the floor, the Secretary was instructed to cast a unanimous ballot for these nominees.

PAPERS SESSIONS

Friday, June 14

Rodney L. Bleifuss, Research Laboratory, Oliver Iron Mining Division, United States Steel Corporation, Duluth, Minnesota. *Introduction to the Geology of Minnesota,* slides.

O. A. Finseth, Duluth, Minnesota. *Ornithological History of Minnesota.*

Olga Lakela, University of Minnesota at Duluth. *Some Floral Elements in Northeastern Minnesota,* slides.

P. B. Hofslund, University of Minnesota at Duluth. *Some Aspects of Bird Migration in the Duluth Area,* slides.

Dwain W. Warner, University of Minnesota. *Some Comments on Mexican Overland and Trans-Gulf Migration.*

Robert W. Dickerman, University of Minnesota. *Preliminary Report on a Study of the Song Sparrows of the Mexican Plateau,* slides.

Dale A. Zimmerman, University of Michigan. *Distribution and Subspecific Identification of the Northern Waterthrush in Michigan,* slides.

Joyce Heckenlaible Le Febvre, University of Minnesota. *Responses of Four Species of Thrushes to Weather and Lumbering in a Mexican Cloud Forest,* slides.

Wendell Taber, Maine Audubon Society. *The Indigo Bunting, A Life History.*

Keith L. Dixon, Agricultural and Mechanical College of Texas. *Some Aspects of Social Organization in the Carolina Chickadee,* slides.

Saturday, June 15

Byron E. Harrell, University of Minnesota. *Temperate Forest Birds of Mexico and Eastern United States,* slides.

Kenneth C. Parkes, Carnegie Museum. *Feathers, Filipinos and Fevers,* slides.

Lawrence H. Walkinshaw, Battle Creek, Michigan. *Some Birds of Northern Michigan,* slides.

J. David West, Port Credit, Ontario. *1956-1957 Invasion of Three-Toed Woodpeckers.*

(Summarized by J. Murray Speirs, read by Doris Huestis Speirs, Dorion, Ontario).

Fred T. Hall, Buffalo Museum of Science. *An Arctic Three-Toed Woodpecker in Buffalo,* Kodachrome film.

Robert A. McCabe, University of Wisconsin. *Transplanting of Yellow-headed Blackbirds,* slides.

Frances Hamerstrom, Wisconsin Conservation Department, Plainfield, Wisconsin. *Myiasis in Hawks' Ears,* slides.

ATTENDANCE

Members and guests who registered totalled 143. Twenty-one states, the Territory of Alaska, The Provinces of Manitoba and Ontario, and Germany were represented.

From **Arizona**: 4—*Phoenix*, Mr. and Mrs. B. B. Hawkins; *Tucson*, Mr. and Mrs. Anders H. Anderson.

From **Florida**: 1—*Fort Walton Beach*, Gerald T. Rogers.

From **Illinois**: 4—*Blue Island*, Karl E. Bartel; *Evanston*, Monica Evans; *Peoria*, Ferd Luthy, Jr.; *Quincy*, T. E. Musselman.

From **Indiana**: 2—*Indianapolis*, Mrs. S. G. Campbell, Mildred Campbell.

From **Iowa**: 2—*Cedar Rapids*, Virginia Olson, Pauline Wershofen.

From **Kansas**: 3—*Lawrence*, John William Hardy, Robert M. Mengel, Harrison B. Tordoff.

From **Kentucky**: 3—*Louisville*, Leonard C. Brecher, Mr. and Mrs. F. W. Stovoner.

From **Maine**: 1—*Wayne*, O. S. Pettingill, Jr.

From **Massachusetts**: 2—*Cambridge*, Mr. and Mrs. Wendell Taber.

From **Michigan**: 13—*Alma*, Lester E. Eyer; *Ann Arbor*, Mr. and Mrs. Ralph Branch, Mrs. Reuben L. Kahn, Haven H. Spencer, Mr. and Mrs. Robert W. Storer; *Battle Creek*, Lawrence H. Walkinshaw; *Imlay City*, Dale A. Zimmerman; *Kalamazoo*, H. Lewis Batts, Jr.; *Marquette*, Mary Spear Ross; *Union City*, William A. Dyer; *Ypsilanti*, Maud Hukill.

From **Minnesota**: 55—*Albert Lea*, Charles Flugum; *Duluth*, J. K. Bronoel, Margaret Brown, Goldie Cohen, Flora Evans, James Glick, P. B. Hofslund, Catherine Lieske, Evelyn Palmer, Mr. and Mrs. Harvey Putnam, Mrs. Arthur Roberts, Helen Smith, Mrs. Lee Taylor; *Excelsior*, Arnold B. Erickson; *Fergus Falls*, Raymond Duenow; *Glenwood*, Mrs. E. R. Selnes; *Grand Rapids*, Bernie Bashingbauer; *Hibbing*, Clara Lilly, Mr. and Mrs. Ray Naddy; *Mankato*, William Luwe; *Minneapolis*, Mrs. Pearl Anderson, Mr. and Mrs. Walter J. Breckenridge, Amy Chambers, Robert W. Dickerman, Beth Doeringsfeld, Barbara J. Farrand, Edith Farrand. John Futcher, Harvey L. Gunderson, Bruce Hayward, Alfreda Johnson, Mr. and Mrs. Boyd Lien, Mary Lupient, Ethel Slider, Dana Struthers, John Testor, Mr. and Mrs. Dwain W. Warner. Mrs. John Watson; *Minnetonka Beach*, Mr. and Mrs. H. G. Mikkelson; *Northfield*, Arnold J. Petersen; *Owatonna*, Mrs. H. A. Northrop; *St. Paul*, Mrs. William F. Davidson, Byron E. Harrell. Mr. and Mrs. F. L. Jaques, Orwin Rustad; *Virginia*, Ruth Ambrose; *White Bear Lake*, Mrs. R. M. Berthel, Joyce W. Le Febure.

From **Nebraska**: 2—*Blue Springs*, Mrs. F. J. Patton; *Chadron*, Doris Gates.

From **New Jersey**: 3—*Spotswood*, Mr. and Mrs. Stanley S. Dickerson; *Tenafly*, Betty Carnes.

From **New York**: 3—*Buffalo*, Harold H. Axtell, Fred T. Hall; *Ithaca*, Lawrence I. Grinnell.

From **Ohio**: 6—*Cleveland*, Mary Stewart; *Delaware*, Mr. and Mrs. William D. Stull; *Painesville*, Mrs. Robert V. D. Booth; *Steubenville*, Earl Farmer; *Toledo*, John M. McCormick.

From **Pennsylvania**: 2—*Chester Springs,* Phillips B. Street; *Pittsburgh,* Kenneth C. Parkes.

From **South Dakota**: 3—*Sioux Falls,* Mr. and Mrs. J. S. Findley, Herbert Krause.

From **Tennessee**: 2—*Knoxville,* Mary Enloe; *Maryville,* Ralph Zaenglein.

From **Texas**: 1—*College Station,* Keith L. Dixon.

From **West Virginia**: 1—*Huntington,* Ralph M. Edeburn.

From **Wisconsin**: 20—*La Crosse,* Howard F. Young; *Madison,* Mr. and Mrs. John Emlen, Jr., Mr. and Mrs. Alfred E. Eynon, Mr. and Mrs. Joseph J. Hickey, Mr. and Mrs. Walter Scott; *Milwaukee,* Daniel D. Berger, Helmut C. Mueller; *Oshkosh,* Mr. and Mrs. John L. Kaspar; *Plainfield,* Mr. and Mrs. Frederick N. Hamerstrom, Jr.; *Ripon,* Paul Cors; *Superior,* Elizabeth Fisher, Juanita Walker; *Viroqua,* Margarette E. Morse; *West Bend,* Marvin Vore.

From **Alaska**: 1—*Anchorage,* Grace Schinske.

From **Bavaria, Germany**: 1—*Übersee,* Karl Beringer.

From **Manitoba, Canada**: 2—Mr. and Mrs. A. G. Lawrence.

From **Ontario, Canada**: 6—*Fort William,* Mr. and Mrs. A. E. Allin; *Pickering,* Mr. and Mrs. J. Murray Speirs; *Port Arthur,* Keith Dennis; *Toronto,* Frederick M. Helleiner.

In recognition of the need of our Hungarian colleagues, the American Ornithologists' Union has established a Committee for the Aid of Hungarian Ornithologists. The Chairman, Frederick Greeley, Illinois Natural History Survey, Urbana, Illinois, has a list of some 50 persons who are in urgent need of field clothes and/or woolens. Persons who are willing to send used clothing should inform Dr. Greeley of the sizes and kinds of garments, and he will provide the names and addresses of prospective recipients, and instructions for the mailing of packages to them. Whenever possible he will try to place donors in contact with recipients of similar ornithological interests. Also needed are issues of American journals prior to 1945 for the ornithological library at Budapest. Money for the purchase of these items may be sent to the Committee; checks should be made to "Frederick Greeley—Hungarian Relief." It is hoped that the response of our members will be prompt and generous.

This issue of *The Wilson Bulletin* was published on October 8, 1957.

SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (fourth edition) and supplements thereto insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. The Illustrations Committee will prepare drawings, following authors' directions, at a charge of $1 an hour, the money to go into the colorplate fund. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A WORD TO MEMBERS

The Wilson Bulletin is not as large as we want it to be. It will become larger as funds for publication increase. The Society loses money, and the size of the *Bulletin* is cut down accordingly, each time a member fails to pay dues and is put on the "suspended list." Postage is used in notifying the publisher of this suspension. More postage is used in notifying the member and urging him to pay his dues. When he does finally pay he must be reinstated on the mailing list and there is a publisher's charge for this service. The Bulletin will become larger if members will make a point of paying their dues promptly.

NOTICE OF CHANGE OF ADDRESS

If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia. He will notify the publisher and editor.

Plan Now to participate in

THE THIRTY-NINTH ANNUAL MEETING

to be held at

OGLEBAY PARK, WHEELING, WEST VIRGINIA

April 24–27, 1958

Sponsors:

The Brooks Bird Club

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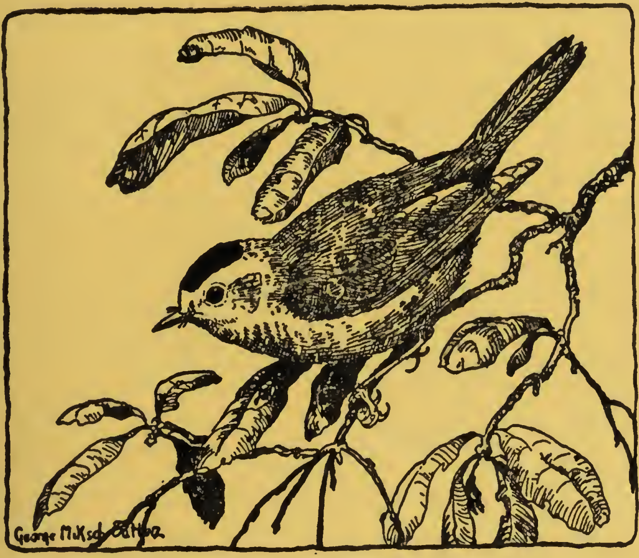

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THE WILSON ORNITHOLOGICAL SOCIETY

Founded December 3, 1888

Named after ALEXANDER WILSON, the first American ornithologist.

President—John T. Emlen, Jr., Dept. of Zoology, University of Wisconsin, Madison 6, Wisconsin.

First Vice-President — Lawrence H. Walkinshaw, 1703 Wolverine-Federal Tower, Battle Creek, Michigan.

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Secretary—Fred T. Hall, Buffalo Museum of Science, Buffalo 11, New York.

Membership dues per calendar year are: Sustaining, $5.00; Active, $3.00.

THE WILSON BULLETIN is sent to all members not in arrears for dues.

WILSON ORNITHOLOGICAL SOCIETY LIBRARY

The Wilson Ornithological Society Library, housed in the University of Michigan Museum of Zoology, was established in concurrence with the University of Michigan in 1930. Until 1947 the Library was maintained entirely by gifts and bequests of books, pamphlets, reprints, and ornithological magazines from members and friends of The Wilson Ornithological Society. Now two members have generously established a fund for the purchase of new books; members and friends are invited to maintain the fund by regular contributions, thus making available to all Society members the more important new books on ornithology and related subjects. The fund will be administered by the Library Committee, which will be happy to receive suggestions on the choice of new books to be added to the Library. H. Lewis Batts, Jr., Kalamazoo College, Kalamazoo, Michigan, is Chairman of the Committee. The Library currently receives 65 periodicals as gifts and in exchange for *The Wilson Bulletin.* With the usual exception of rare books, any item in the Library may be borrowed by members of the Society and will be sent prepaid (by the University of Michigan) to any address in the United States, its possessions, or Canada. Return postage is paid by the borrower. Inquiries and requests by borrowers, as well as gifts of books, pamphlets, reprints, and magazines, should be addressed to "The Wilson Ornithological Society Library, University of Michigan Museum of Zoology, Ann Arbor, Michigan." Contributions to the New Book Fund should be sent to the Treasurer, Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia (small sums in stamps are acceptable). A complete index of the Library's holdings was printed in the September 1952 issue of *The Wilson Bulletin* and each September number lists the book titles in the accessions of the current year. A brief report on recent gifts to the Library is published in every issue of the *Bulletin.*

THE WILSON BULLETIN

The official organ of The Wilson Ornithological Society, published quarterly, in March, June, September, and December, at Lawrence, Kansas. The subscription price, both in the United States and elsewhere, is $3.00 per year, effective in 1957. Single copies, 75 cents. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available (at 50 cents each for 1950 and earlier years, 75 cents each for 1951 and subsequent years) and may be ordered from the Treasurer.

All articles and communications for publication, books and publications for review should be addressed to the Editor. Exchanges should be addressed to The Wilson Ornithological Society Library, Museum of Zoology, Ann Arbor, Michigan.

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CONTENTS

GENERAL NOTES

Dillon Ripley

Mandarin Ducks at Litchfield

A SEROLOGICAL ANALYSIS OF SOME ANATID CLASSIFICATIONS

BY WILLIAM B. COTTER, JR.

THE recent classification of the ducks by Delacour and Mayr (1945) is in some respects in conflict with the older systems of Phillips (1922–1926) and of Peters (1931). Delacour and Mayr instituted, on the basis of ecological preferences, behavior, and the plumage of the downy young, a new tribe, Cairinini (the Perching Ducks), for the Spur-winged Goose (*Plectropterus gambiensis*), Muscovy (*Cairina moschata*), Wood (*Aix sponsa*) and Mandarin (*A. galericulata*) ducks, among others. The older classifications had associated the Wood and the Mandarin ducks with the river ducks of the genus *Anas*. The genus *Aix* had been relegated to that position in the revisions of Salvadori's subfamily Plectropterinae (1895) by Phillips and Peters. In addition, Peters removed the Muscovy Duck from the same subfamily and placed it within the Anatinae, diametrically opposed to the position of the Wood and Mandarin ducks. Between the genera *Cairina* and *Aix* in Peters' Checklist, 13 genera were interposed, including the type genus *Anas*.

The close relationship of *Cairina moschata* and *Aix sponsa*, as repostulated by Delacour and Mayr, was supported by Yamashina (1952), who compared the shape, number, and relative lengths of the anatid macrochromosomes in gametogenesis. *Cairina moschata* and *Aix sponsa* in all features resembled one another more closely than either resembled any other of the river ducks. However, because of similarity in shape and number of chromosomes, these two genera were retained in the supergenus *Anas* as a closely related group. A divergence in the number of macrochromosomes in the Mandarin Duck, with the associated changes in relative lengths and shape, caused Yamashina to isolate this duck in the monotypic supergenus *Dendronessa*. The supergenus is a taxonomic category roughly equivalent to the tribe. This action was contrary to the grouping of the Wood and the Mandarin ducks in the single genus *Aix* as done by Delacour and Mayr and other workers.

These conflicts concerning the validity of the Muscovy–Wood Duck complex, of the relationships *inter se* and also with the tribe Anatini have been resolved by the present study. A serological analysis was proposed to validate the most natural classification of the ducks, and incorporated in the methods were four major innovations in the field of systematic serology. As antigens, three separate protein systems (ovalbumin of the egg, serum albumin and serum gamma globulin of the blood) were analyzed to correct *inter se* for variation in any one system. Secondly, each protein used had been purified to provide a single chemically-defined antigen, instead of the usual moiety of antigens used in other investigations. Thirdly, the precipitated antigen–

antibody complexes were graded directly on the basis of the precipitated protein, and the per cent relatedness expressed as a fraction of the homologous cross-reaction's precipitate. Lastly, the usual method of cross-reaction estimation was supplemented by absorption titrations to determine the amounts of antigens shared in common by any two birds.

ACKNOWLEDGMENTS

This study was submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Graduate School of Yale University. I am particularly indebted to Dr. S. Dillon Ripley and Prof. G. E. Hutchinson for their generous advice and criticism throughout this work, and for their critical reading of this manuscript in preparation. My deep thanks go also to Dr. J. S. Nicholas as director of the Osborn Zoological Laboratory where this study was approved and supported.

I wish to thank also the trustees of the Frank M. Chapman Memorial Fund of the American Museum of Natural History for the research grant which served to support a summer segment of this project.

I am grateful to those people who aided in the procurement of whole eggs and blood samples used in this study: S. Bradford, Mrs. Edgar Cartmell, S. Downes, A. Fleischner, L. Glaser, Mrs. R. W. Hanson, J. Kirakoff, V. Loosanoff, and S. Dillon Ripley. Dr. Ellsworth Dougherty of the Duck Disease Laboratory at Eastport, New York, graciously donated five gallons of Pekin Duck blood which was used to perfect the methods of serum protein separation.

MATERIALS AND METHODS

The proteins that constituted the central material of this investigation were obtained from whole eggs and blood samples taken from six anatid representatives: *Anser anser* (Embden and Toulouse varieties of the Common Goose), *Anas platyrhynchos* (Mallard), *A. platyrhynchos* (domestic Pekin), *Aix sponsa* (Wood Duck), *A. galericulata* (Mandarin Duck), *Cairina moschata* (Muscovy).

The ovalbumin protein of the egg-white was prepared in crystalline form by the method of Kekwith and Cannan (1936); to reduce amounts of contaminating proteins, the ovalbumins were redissolved and recrystallized four times. Ovalbumins prepared by this method have been demonstrated by Heidelberger and Kendall (1935) to behave as single antigens in their reactions with rabbit antisera.

Crystalline serum albumin was prepared and recrystallized four times by the method of Adair and Robinson (1930), with the sole modification of substitution of sodium sulfate for ammonium sulfate as the salting agent. The serum gamma globulins were removed from the globulins first salted out from the serum, and then purified by Kendall's (1937) technique. This latter protein was not crystallized, but after proper purification was maintained in aqueous solution at 0°C. for two weeks, after which it was prepared anew from fresh serum. This precaution helped to reduce experimental error due to the use of auto-denatured proteins.

Standard 0.1 per cent protein solutions were prepared, checked with micro-Kjeldahl nitrogen determinations, used for antibody formation, and later for the titrations of those antisera in the cross-reactions and in the absorption tests. When inciting the production of antibodies, the rabbits were injected with these standardized solutions in the following manner:

First week	First day	5 cc. intravenous
	Second day	1 cc. subcutaneous
	Third day	1 cc. subcutaneous
Second week	First day	3 cc. intraperitoneal
	Second day	1 cc. subcutaneous
	Third day	1 cc. subcutaneous
Third week	First day	3 cc. intraperitoneal
	Second day	1 cc. subcutaneous
	Third day	1 cc. subcutaneous

The rabbits were then bled on the first day of the fourth week, and after separation of the serum from the clot, the antibody-containing antiserum was sterile-filtered and stored at 0°C. until used.

Relationships between these anatid species were determined first by the extent of cross-reactions of the anti-protein antisera in the presence of the homologous and the heterologous antigen solutions. This was effected by the addition of 0.1 cc. of the specific anti-protein antiserum to 0.5 cc. of that antigen solution, the latter in serial dilution from 1:1000 to 1:1024000. The reaction volume was adjusted then to 1.0 cc. with the addition of 0.4 cc. of 0.9 per cent saline; the test antigen–antibody solutions then were incubated at 4°C. for 24 hours, and at the end of that time, the precipitated antigen–antibody complexes were graded. The grading was performed visually, with six grades: 0, ±, +, ++, +++, ++++. These grades represent actual reaction levels, since they were checked frequently with micro-Kjeldahl nitrogen determinations on the precipitated antigen–antibody proteins after washing; the range values for these respective grades overlapped very little.

Grades	*Limits*	*Repetitions*	*Average*
±	0.002–0.030 mgm. N	69	0.016
+	0.030–0.070	77	0.049
++	0.066–0.116	91	0.092
+++	0.110–0.160	49	0.138
++++	0.156–0.304	37	0.236

The reaction values so determined were plotted with respect to antigen dilution. The areas under the heterologous reaction curves were expressed as a per cent relative to the area subtended by the homologous reaction curve. In the first three tables, the results of the cross-reactions of each antiserum with the heterologous and homologous antigens are given. In order, they represent the crystalline ovalbumin, the crystalline serum albumin and the serum gamma globulin systems.

To determine more precisely the common stocks of antigens, the specific anti-protein antisera were treated with the heterologous proteins individually to remove all antibodies reactant with the absorbing protein.

To 3.0 cc. of antiserum in a 15 cc. centrifuge tube was added 3.0 cc. of undiluted stock antigen solution (1:1000) and the mixture was incubated at 4°C. for 24 hours. After centrifugation, the supernatant serum was poured off into a sterile container, and the pellet of precipitated antigen–antibody complex was discarded. This volume of 1:1 diluted antiserum was sufficient to use for simultaneous experiments with the homologous and the five heterologous proteins.

The residual antibodies of the diluted antiserum could react then with the homologous protein when added; the extent of the reaction (total amount of precipitate formed) was taken as an inverse measure of antigenic similarity of the protein pair (the absorbing protein and the titrating protein) being examined. If the homologous titration after absorption were high, few antibodies had been removed and hence there was very little similarity in the antigenic groups of the two proteins. Conversely, if the homologous titration following absorption produced only a slight precipitate, there was a high degree of antigen similarity denoted.

Tables 4 to 7 present the results of the anti-ovalbumin antisera after absorption by four of the five heterologous proteins, the data from the Mallard ovalbumin absorption experiments being omitted because of the extreme similarity to the protein absorption results for the Pekin. In each of these series, the homologous ovalbumin absorption with titrations provided experimental controls, as well as controls to indicate the complete nature of the absorption by each heterologous antigen.

RESULTS AND DISCUSSION

In Table 1, the results are given from the reactions of the antisera prepared with the crystalline ovalbumins, when titrated with the homologous and the heterologous ovalbumin solutions. The precipitations by the anti-Embden Goose antisera gave similar results for the Pekin and the Mallard ducks (87 per cent, 81 per cent), and for the Wood and the Mandarin ducks (79 per cent, 79 per cent) also. Ovalbumins of the latter species pair reacted less strongly than the former species set, but each member of the set with an equivalent amount of antibodies. The position of the value for the Muscovy precipitation was intermediate, between those values for the *Anas* group, and for the Wood and the Mandarin ducks.

Antisera against the Pekin and the Mallard ovalbumins gave complementary values when titrated with the other's antigen; these results were utilized to determine the extent of variation within a single species, since the Pekin and the Mallard ducks are both members of the species *Anas platyrhynchos*.

TABLE 1
CROSS-REACTIONS OF CRYSTALLINE OVALBUMINS AND THE ANTI-OVALBUMIN ANTISERA

	Titrating Antigens					
Antisera	Embden	Pekin	Mallard	Wood	Mandarin	Muscovy
a-Embden	100	87	81	79	79	85
a-Pekin	80	100	89	67	66	69
a-Mallard	87	94	100	81	81	99
a-Wood	75	87	87	100	88	94
a-Mandarin	57	62	64	97	100	93
a-Muscovy	54	70	77	98	91	100

In the anti-Pekin and anti-Mallard antisera the values determined for the precipitation of the Wood and Mandarin ovalbumins were almost identical (67 per cent, 66 per cent; 81 per cent, 81 per cent). As with the anti-Embden Goose antisera, the Muscovy protein gave a value intermediate between the homologous and the Wood–Mandarin set of values.

Similarly, the reaction of the Muscovy ovalbumin with the antisera against the ovalbumins of the Wood and the Mandarin ducks showed an intermediate position between the Wood–Mandarin set of values and those of the Pekin–Mallard set. The complementary cross-reactions of the Wood and the Mandarin ducks demonstrated, as did the complementary titrations of the Pekin–Mallard set, an equal amount of serological divergence. When these antisera were titrated with the Pekin and Mallard ovalbumins, the reaction values were almost identical (87 per cent, 87 per cent; 62 per cent, 64 per cent) for these antigens, and greater in extent than those for the goose antigen (75 per cent, 57 per cent).

The antisera produced with the Muscovy ovalbumin yielded the greatest heterologous response with the Wood (98 per cent) and the Mandarin (91 per cent) ducks, appreciably less with the Pekin (70 per cent) and the Mallard (77 per cent), and least with the ovalbumin antigen of the goose (54 per cent).

On the basis of these data, it would be justified to represent the linear order of relationship as follows:

Embden Goose	Pekin–Mallard	Muscovy	Wood–Mandarin
(*Anser anser*)	(*Anas platyrhynchos*)	(*Cairina moschata*)	(*Aix sponsa–A. galericulata*)

In Table 2, the values are given for the cross-reactions of the serum albumin proteins with those antisera formed against the serum albumins of the Toulouse Goose, the Pekin, the Mallard and the Muscovy ducks. Here, the heterologous cross-reaction values for the anti-Toulouse antisera indicated a greater degree of divergence in the component parts of the serum albumin

Table 2

Cross-Reactions of the Crystalline Serum Albumins and the Anti-Serum Albumin Antisera

	Titrating Antigens					
Antisera	Toulouse	Pekin	Mallard	Wood	Mandarin	Muscovy
a-Toulouse	100	57	36	36	36	27
a-Pekin	48	100	81	53	55	57
a-Mallard	46	86	100	70	46	63
a-Muscovy	49	59	53	84	86	100

antigen complex than was indicated for the ovalbumin antigen in Table 1. This was true for all of the subsequent reactions in this table, the average heterologous reaction being smaller than that in the anti-ovalbumin system.

Use of the Toulouse Goose serum proteins, and the summation of those results with those from the Embden Goose ovalbumin can be defended by the data of these experiments. The goose, *Anser anser*, has been incorporated in this analysis as a reference point, far removed from the Cairinini and the Anatini. In addition, it has been determined that subspecific differences in heterologous cross-reactions tend to diminish or vanish as the taxonomic source of the inciting antigens for the testing antisera becomes more remote. Since in all non-goose antisera, the source of the inciting antigens was sufficiently distant, the author felt justified in the assumption of virtual identity in serum proteins for the two domestic strains of *Anser anser*. However, this holds only in those tests made with an antiserum developed against a bird of distant origin.

The serum albumins of the Pekin and the Mallard ducks still reacted as closely related sets of antigens with all antisera. The Wood and the Mandarin serum albumins behaved similarly. In addition, the Muscovy protein, in two reactions out of three with different types of heterologous antisera, gave an intermediate value between those of the Pekin–Mallard set and the Wood–Mandarin set. The data derived from these tests do support the postulated order of relatedness.

The cross-reaction values of the serum gamma globulins and the respective antisera are given in Table 3. These results showed a further confirmation for the high degree of similarity in protein structure of the two forms of *Anas platyrhynchos*. With the anti-Pekin antisera, the Mallard serum gamma globulin gave the greatest heterologous response; with the anti-Muscovy antisera, the values derived from the heterologous titrations by the Pekin and Mallard proteins were identical.

The amounts of precipitates yielded by the heterologous proteins of the Wood and the Mandarin ducks repeated, for the third time, the pattern of two distinct forms with an apparent underlying similarity in antigenic structure. The serum gamma globulin of the Muscovy duck gave evidence of closest association with the Wood–Mandarin set, both in the homologous and in the heterologous antisera tests. However, its position relative to the genera *Anas* and *Aix* was given by only one heterologous antiserum type; these results did corroborate the earlier findings of the anti-ovalbumin and the anti-serum albumin antisera.

The following set of tables (4–7) for the reactions of the anti-ovalbumin antisera allowed confirmation in part of the relationship order as postulated on the basis of the first three data sets. Each anti-ovalbumin antiserum was treated with a heterologous antigen to remove all antibodies common to the

TABLE 3

CROSS-REACTIONS OF PURIFIED SERUM GAMMA GLOBULINS AND THE ANTI-SERUM GAMMA GLOBULIN ANTISERA

	Titrating Antigens					
Antisera	Toulouse	Pekin	Mallard	Wood	Mandarin	Muscovy
a-Pekin	42	100	96	44	45	49
a-Muscovy	29	54	54	80	79	100

inciting and the absorbing antigens. The residual antibodies, detected by a homologous titration following this procedure, were used as an inverse measure of the degree of divergence that the protein-synthesizing systems had undergone.

In the Table 4, the titration with the homologous Pekin ovalbumin after absorption with each antigen showed that there was no reaction with the Pekin-absorbed antisera—a control, indicating complete removal of all antibodies. The minimal positive value (21 per cent) was given by those sera absorbed by the Mallard ovalbumin, which was able to remove most of the antibodies, but not all. The Wood and the Mandarin proteins were less efficient absorbers, and the Muscovy-absorbed antisera contained the greatest amount of residual antibodies.

Hence, the order of relationship is repostulated as:

Anser *Anas* *Aix* *Cairina*

following from this set of data. With all absorbing antigens, the Pekin and Mallard set of ovalbumins reacted in equal amounts. Similarly, it was true also for the reactions of the Wood and the Mandarin ducks, when their oval-

TABLE 4

ANTI-PEKIN DUCK OVALBUMIN ANTISERA ABSORBED WITH ALL OVALBUMIN ANTIGENS AND TITRATED WITH ALL ANTIGENS[1]

		Absorbing Antigens					
Antigens Titrating	Cross Reactions	Embden	Pekin	Mallard	Wood	Mandarin	Muscovy
Embden	80	0–1	0	12	16	36	41
Pekin	100	25	0	21	40	46	58
Mallard	89	23	0	0–1	35	44	53
Wood	67	10	0	6	0	9	29
Mandarin	66	7	0	6	8	0	28
Muscovy	69	8	0	5	6	8	0

[1] In this table, the antisera are those made against the Pekin ovalbumin. The values for the cross-reactions are given on the extreme left; each column to the right gives the reaction value for that antiserum after absorption by the antigen at the top of the column, with the titrating antigen on the left side.

TABLE 5
ANTI-WOOD DUCK OVALBUMIN ANTISERA ABSORBED WITH ALL OVALBUMIN ANTIGENS AND TITRATED WITH ALL ANTIGENS

Antigens Titrating	Cross Reactions	Absorbing Antigens Embden	Pekin	Mallard	Wood	Mandarin	Muscovy
Embden	75	0	1	1	0	0	0
Pekin	87	1	0	0	0	0	4
Mallard	87	7	1	0	0	0	7
Wood	100	34	34	39	0	9	23
Mandarin	88	26	21	26	0	0	15
Muscovy	94	15	9	17	0	0	0

bumins were used as the titrating antigens.

A further elaboration of the fundamental similarity of Wood and Mandarin ducks in their ovalbumin antigen complexes is found in Tables 5 and 6, where the reactions of the absorbed antisera for these ovalbumins are presented. When the complementary absorptions were made (that is, anti-Wood Duck antisera absorbed with Mandarin ovalbumin, and anti-Mandarin antisera absorbed with Wood Duck ovalbumin), the only antibodies remaining in solution were those specific for the inciting antigen, and in all other titrations no heterologous antigen reactions were observed. Similarly, after absorption by the other heterologous ovalbumins, the Wood Duck and Mandarin ovalbumin titrations followed identically with a slight increment for the homologous always found. This had been noted in the reactions of the Pekin–Mallard set of anti-ovalbumin antisera.

The position of the Muscovy ovalbumin as representative of the species showed that, in respect to the total sum of different antigens, this duck was the farthest from the *Anas* type. Its ovalbumin possessed the least share of common antigens with *Anas*, but formed a close-knit complex with the Wood

TABLE 6
ANTI-MANDARIN DUCK OVALBUMIN ANTISERA ABSORBED WITH ALL OVALBUMIN ANTIGENS AND TITRATED WITH ALL ANTIGENS

Antigens Titrating	Cross Reactions	Absorbing Antigens Embden	Pekin	Mallard	Wood	Mandarin	Muscovy
Embden	57	0	11	14	0	0	0–1
Pekin	62	14	0	0–1	0	0	4
Mallard	64	16	0–1	0	0	0	4
Wood	97	29	30	29	0	0	16
Mandarin	100	37	39	39	13	0	33
Muscovy	93	24	26	25	0	0	0

Table 7

Anti-Muscovy Duck Ovalbumin Antisera Absorbed with all Ovalbumin Antigens and Titrated with all Antigens

Antigens Titrating	Cross Reactions	**Absorbing Antigens** Embden	Pekin	Mallard	Wood	Mandarin	Muscovy
Embden	54	0	13	14	17	20	0
Pekin	70	34	0	3	18	31	0
Mallard	77	41	8	0	24	28	0
Wood	98	55	29	35	1	20	0
Mandarin	91	59	25	29	7	1	0
Muscovy	100	75	47	60	61	53	0

and the Mandarin ducks. This was not only true in its cross-reactions, but also in the step-wise reductions shown by each of the three species of Cairinini as the different absorbing antigens were used (*cf.* Tables 5 to 7). With the anti-serum albumin and the anti-serum gamma globulin antisera after absorption, the same order of relationship was found.

In the cross-reactions of all three protein types, the antigens of the Muscovy Duck appeared to be intermediate in reaction extent between those of *Anas* and *Aix.* However, the absorption titrations clearly demonstrated that the antigenic complex of *Cairina* was qualitatively more differentiated from that of the *Anas* group, than were the antigen complexes of *Aix* when compared to *Anas.* The findings of the absorption tests inferred that a greater number of bio-synthetic changes had occurred within the phyletic line of the Muscovy Duck, and that the usual cross-reaction techniques were not sufficiently sensitive to demonstrate these changes. In addition, the data revealed a relationship between *Aix* and *Cairina,* not so close as within the subspecific set of the Pekin and the Mallard ducks, or as within the species set of the Wood Duck and the Mandarin, but closer than that relationship of *Anas* and *Cairina* or *Anas* and *Aix.*

Hence, the validity of the original concept of the perching ducks as a natural taxonomic category, as presented by Salvadori and modified by Delacour and Mayr, has been strengthened by these findings from the application of serological techniques. Those revisions by Phillips, Peters, and Yamashina do not reflect the most natural placement of the ducks within the limits of the Cairinini. The latter classifications of the Anatidae showed, with particular reference to the perching ducks, the use of nonobjective criteria or undue reliance on a single taxonomic feature.

Summary

Analysis of recent classifications of the ducks by refined serological techniques has validated the conclusions of Delacour and Mayr, in their uniting

the genera *Cairina* and *Aix* in the single tribe Cairinini. To better the existing standard serological techniques, three separate protein systems were studied through the cross-reactions of the purified crystalline proteins with the testing antisera. Comparison of the final data derived from each set of experiments with those of the other sets served to reduce error possibly resulting from chance variations in single systems. As a check upon the cross-reaction as a true measure of species relatedness, absorption of the antisera by different heterologous antigens in the same protein species, followed by homologous titration, gave a measure of the common stocks of antigens shared. In certain cases, notably those of the Muscovy Duck proteins, the cross-reaction values indicated a much closer relationship than existed on the basis of common antigen stocks. Hence, the sole use of cross-reaction data requires that caution be exercised in their interpretation.

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FIELD NOTES ON SOME CUBAN BIRDS

BY CHARLES VAURIE

During the summer of 1956, Mrs. Vaurie and I passed the month of July in Cuba collecting insects, and I took this opportunity to observe birds as much as possible. The western part of the Province of Pinar del Rio was visited for about two weeks, including a stay of three days (July 3 to 5) on the Peninsula de Guanahacabibes at the extreme western tip of the Island. The rest of our time, except for about three days in Havana, was spent in the southern part of Las Villas Province.

The Peninsula is most inaccessible and seldom visited other than by lumbermen. Space may be taken to describe its features briefly as it represents one of the very few remaining regions of Cuba that are relatively undisturbed.

The Peninsula is a limestone table with a mean elevation of about 40 feet, and is connected to the rest of the island by a sandy savanna. The Peninsula itself is covered by a very dense hardwood forest, a brief survey of which is given by Smith (1954) in his paper on the forests of Cuba. Except for forests that have already been very much depleted in Pinar del Rio and Las Villas, no other major forest remains in Cuba until the eastern end of the Province of Oriente is reached, a distance of about 1300 kilometers. The Peninsula at its greatest length and width measures about 90 kilometers long by 35 wide, and halfway down its length is very deeply indented by the Ensenada de Corrientes dividing the Peninsula into two arms. The northern arm was not visited by us, the southern half of the Peninsula and the southern arm being the more interesting and rugged and the least disturbed. The ground is extremely rough, much of it covered by the sharp and jagged projections of the dogtooth limestone, or *seboruco* as it is called in Cuba, or the limestone is weathered into innumerable holes and pockets resembling a sponge. The south coast is an unbroken wall of high cliffs (Fig. 1) and, for some distance inland, the forest is separated from the sea by a wide zone covered by low xerophytic vegetation gradually replaced by a very dense, low scrub nearer the forest. No birds were observed in this zone, but it was the home of very large iguanas and bands of the Jutia Conga (*Capromys pilorides*) consisting of up to six individuals. This very large rodent is widely hunted for food, but on the Peninsula the fauna has been so little disturbed that the animals could be approached in the open to within a few feet.

The Peninsula de Guanahacabibes is threatened by ruthless exploitation. At present its only economic asset is the forest (Fig. 2), but on the northern arm, which is accessible from the sea, much of it has already been cut, according to Smith. On the southern arm the more valuable trees are rapidly disappearing, and a large saw mill has been erected. Worst of all, it is beginning to be invaded by charcoal burners who use the smaller remaining hardwood species. Figures 3 and 4 show the depredations already suffered. This type of forest grows very slowly and, once it is destroyed, it is not likely to be replaced. When it is gone the Peninsula will be transformed into a wilderness of scrub and rock, as it has little soil and cannot be used for agriculture or grazing. The Peninsula, or at least its southern half, could probably be saved and turned into a permanent asset by developing it as a National Park. Its possibilities are many: campsites in the forest could be provided, it has a very striking coastline and an extremely fine, tree-shaded sandy beach at the Ensenada. Such beaches are rare in Cuba and would readily attract visitors. The tip of the Peninsula is only about 100 miles distant from Yucatán and could be used as a convenient base for sport fishermen.

FIG. 1. Cliffs along the southern coast of the Peninsula de Guanahacabibes. Photograph by Fernando de Zayas.

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I would like to express my appreciation to our friends in Cuba for their cordial reception and their help. Chief of all to Ing. Fernando de Zayas, Jefe de la Defensa Agricultura, who helped us constantly and took us to the Peninsula. He is a keen entomologist and collector, knows the Peninsula well, and considers its insect fauna to be rich. Three of the photographs in this article were taken by him. Dr. Abelardo Moreno of the University of Havana received us in his home and I had the pleasure of discussing with him some of my observations on birds. He has also kindly read the manuscript and

made suggestions. Dr. and Mrs. I. D. Clement made our stay at the Atkins Garden and Research Laboratory at Soledad a very pleasant one and provided us with a vehicle which greatly facilitated our work. Help and hospitality were also given to us by Carlos Petersen of Casilda, Leonardo Sorsana of Ancón, and the officials of the agricultural experimental station at Topes de Collantes. Dr. Earl E. Smith kindly provided the photograph of the relatively undisturbed forest.

FIG. 2. View of the interior of the forest. Virtually all the larger trees have been removed, but those of medium size and the saplings have not been disturbed appreciably. The photograph was taken by Earl E. Smith near the south coast of the Peninsula, and the guide in the foreground is leaning on a block of eroded limestone. The tree that has been felled is a sabicú (*Lysiloma latisiliqua*).

SYSTEMATIC LIST

In the birds mentioned below, a complete list is given only in the case of the land birds observed on the Peninsula (this region is usually called only by the name of "el Cabo" and hereafter is called the Cape). These are the birds which could be seen readily, or, once heard, could be followed whenever possible. Because of lack of time, difficulty of the terrain, and other circumstances, an active search for other species was impossible. It will be noted, however, that on the Cape the birds of the open countryside or less densely wooded regions are conspicuous by their absence. The observations below are not necessarily restricted to those made on the Cape and species observed in other regions are mentioned. In the case of the latter, the name of the bird is placed in brackets. The order and the nomenclature follow Bond's check list (1956).

Cathartes aura. Turkey Vulture; Tiñosa.—Ubiquitous in Cuba but nevertheless not expected in the forest. A total of three was found, however, on the road near the beach. The term "road" on the Cape is a very free expression.

Buteo platypterus. Broad-winged Hawk; Gavilán.—One adult at the Cape.

[*Falco sparverius.* Sparrow Hawk; Cernicalo].—The Sparrow Hawk was not found on the Cape as it is a bird of the open and cultivated country. In Cuba, as is well known, the birds show two color phases, one in which the underparts are white or creamy white and the other in which they are strongly rufous, often a very deep brick red. On several trips to the valleys of the region of Viñales in Pinar del Rio I have always been under the impression that both phases are about evenly represented. Birds of the red phase, in which the whole cheek was black or virtually so, also were seen often. In the series of 54 specimens from the mainland of Cuba in the collection of the American Museum of Natural History, 16 specimens are of the red phase and 38 of the white one. The series, which was collected mostly in central and eastern Cuba, does not include specimens from Pinar del Rio. In a few of the pale phase, the breast is slightly tinged with rust, and in a few of the red phase the cheek is invaded with black to a varying extent but, with the exception of one, is not wholly black. In a series of eight from the Isle of Pines, one is red and seven are white.

[*Colinus virginianus.* Bobwhite; Codorniz].—The Bobwhite is a common bird of grassy fields and open hill sides and therefore was not present on the Cape. In the provinces of Pinar del Rio and Las Villas they seem to be abundant, judging by the calls heard everywhere. In Viñales Valley, coveys of very young birds were flushed in the last days of July. The mongoose (*Herpestes*) was seen also, and I wonder to what extent it preys on this species.

Columba leucocephala. White-crowned Pigeon; Paloma de Casco Blanco.—Zayas tells me it breeds in good numbers in the mangroves that fringe the northern coast. Only two, probably a pair, seen flying along the beach at the Ensenada.

Columba squamosa. Red-necked Pigeon; Paloma Morada.—Three sets of two individuals each, probably pairs, feeding or walking on the road where the forest was most dense.

Columba inornata. Plain Pigeon; Paloma Ceniza.—This species is said by Bond (1947) to frequent rather open country, but two couples and odd individuals were seen in the heart of the forest. At one of our camp sites shortly after the dawn two sat stolidly in a dead tree for a long while. Not seen on the ground.

Zenaida aurita. Zenaida Dove; Sanjuanera.—Common and very vocal.

Columbigallina passerina. Ground Dove; Tojosa.—Much less common than in the open country, but several pairs seen along the more open stretches of the road.

Amazona leucocephala. Cuban Parrot; Cotorra.—The first individuals seen were two, perhaps a pair, calmly feeding or investigating the terminal branches of a tall tree. They paid no attention to us or to the groans of the laboring Jeep. Later, bands of four and of eight birds were seen several times flying just above the tree tops. Usually very noisy in captivity (see remarks below on migrants and pets), but all those seen were silent.

Saurothera merlini. Cuban Lizard Cuckoo; Arriero.—Common or at least very vocal. Usually seen slinking through bushes or the lower levels, but one individual seen hopping along the bare branches at the top of a tall dead tree.

FIG. 3. View near the edge of the forest where it borders the savanna. To the left of the road, beyond the screen of palms, all trees have been removed, the larger ones for timber, and the small ones and undergrowth for charcoal. Photograph by Fernando de Zayas.

[*Crotophaga ani.* Smooth-billed Ani; Judío].—This Ani is a common bird in Cuba, where it inhabits savannas or open cultivated country with a few trees, and therefore was not present at the Cape. Its life history in Cuba has been studied by Davis (1940) at the Atkins Garden and Research Laboratory at Soledad near Cienfuegos in Las Villas. The feeding habits of the closely related Groove-billed Ani (*Crotophaga sulcirostris*) of Central America were studied by Rand (1953). Both species feed chiefly on moving animals, mostly insects, but, according to Davis, the Cuban one changes its food habits with the season. During the dry season it subsists largely on vegetable matter, whereas in *sulcirostris* no such change is noticeable, according to Rand, and vegetable matter seems to be eaten sparingly. Both species follow cattle and, according to Davis, the Cuban bird learns readily to follow closely the footsteps of a man, or even a gasoline-powered mowing machine, to glean the insects disturbed. In view of the fact that the anis and Mrs. Vaurie and I are fellow insect collectors, I tried to see how successful they were but, strangely enough, I never saw them catch an insect.

Insect collecting this year was extremely poor and even our repeated sweeps of the grass and weeds hardly produced anything. This year, and we were told also last year, the rains were very late and the rainfall very low. Many ponds and small streams that we knew from former years were dry, and during the entire month of July, when normally it rains virtually every day, we had but one hard rain and two or three light showers. This probably accounts for the great scarcity of the insect species that feed on grass and weeds. The bands of anis observed seldom numbered more than three or four, with one exception. In this case the band (or colony?) numbered 16 and was found along a road bordering a small field with drainage ditches filled with water emptying into a small stream. Very small frogs or toads and small lizards were numerous and probably were the chief source of food. Anis were seen not rarely in or near trees or bushes with small fruit.

Four days were spent at Soledad and I visited the sites of the colonies mentioned by Davis. There were no signs of breeding activity, as far as I could determine, anywhere in the Garden, July 20 to 24, and at the Bambusa Pond site, where the colonies numbered from 13 to 24 birds from June to August in 1937 and 1938, only two to three birds were seen. The grass was cut during our visit but the anis showed no particular interest in this activity. It probably was not worth the effort.

[*Tyto alba*. Barn Owl; Lechuza].—At least three individuals in the gardens of Soledad. They roost in the crowns of a very large exotic palm from Ceylon and India with huge fans about 10 feet or more across.

Caprimulgus cubanensis. Antillean Nightjar; Guabairo.—Several "singing" incessantly near our camp.

Chordeiles minor. Nighthawk; Querequeté.—Common. The nightjar and this bird probably breed along the south coast on the top of the bare cliffs or in the open zone near them. The Nighthawk is very common throughout Cuba, and not infrequently individuals can be seen hunting in broad daylight, even at noon when the sun is most intense.

The Cuban Nighthawk (*gundlachii*) has, as is well known, a totally different call than the Common Nighthawk (*minor*) of North America. Its call is polysyllabic, consisting of four rapidly spoken notes, rather than the single nasal or buzzing note of the nominate race. It seems also that, as a rule, the Cuban bird does not dive and boom, as is done by the males in North America during their courtship. These two birds are considered to be conspecific, but if, in addition to the very sharp difference in voice, the courtship performance is found to differ also to an important extent, our concept of their relationship may need to be altered.

I have never seen the Cuban bird dive and boom, but I have not been in Cuba during the mating season, which starts in March. Dr. Moreno writes me that he has seen the Cuban bird dive and boom, but "only twice." The possibility that it is a separate species has occurred to him, but he states that he has not reached a definite conclusion until he completes his studies of its courtship.

Chlorostilbon ricordii. Cuban Emerald Hummingbird; Zunzún.—Common. In the site selected for our first camp, an irregular clearing about 10 to 50 meters wide, many of these birds were seen quarreling violently and constantly with loud and exasperated shrill screams above a number of bushes covered with scarlet tubular flowers. On one occasion I counted 10 and probably others were out of sight. No sooner would an individual of either sex approach a flower than it would be pounced upon and driven off for a short distance, the two individuals indulging in all sorts of acrobatics during which the tail is spread open in a very wide deep "V." Elsewhere in the forest, as well as in the rest of Cuba where they are common also, it is rare to meet with more than one individual at a time, almost always at the same spot. Normally, they seem quiet for a hummingbird and often perch calmly for several minutes, usually in the shade, apparently resting or engaged in preening their feathers.

Mellisuga helenae. Bee Hummingbird; Zunzuncito.—This species apparently is rare, and on several trips to Cuba had been seen but once by me—in 1939 in a garden at Camagüey—although it was looked for on the other trips. Great was my delight, there-

Fig. 4. View of the interior of the forest. The road was built by loggers who removed all the large trees, but this part of the forest has not been invaded as yet by charcoal burners and the undergrowth is undisturbed. Photograph by Fernando de Zayas.

fore, when a male appeared at a smaller bush somewhat separated from those fought over by the Emeralds. It fed quietly for some seconds and was joined by a female of its species, and then by a male Emerald. The two species showed no signs of being aware of each other, moving about on the same bush about a foot or two apart. The contrast in the mutual behavior between the two species and the squabbling among the Emeralds a few feet away was very great. As Zayas wanted to take some pictures, the male *helenae* was captured easily in a sweep of the butterfly net and released a few minutes later unharmed. While held, it remained silent and at no time offered the slightest struggle. Its anxiety, if any, was expressed by one or two movements of the head and a few blinks. Zayas tells me that on several trips to the Cape he has seen but one male on each trip, always in the same vicinity. The Cubans that we talked to show much interest in this bird not only because they know that it is very beautiful but also because they have been told that the male is the smallest of all birds. Yet almost no one that we talked to had seen it. In the one that I held, the body, not counting the tail and bill, was barely over an inch long and the toes about the thickness of an insect pin of very small gauge.

Priotelus temnurus. Cuban Trogon; Tocoloro.—Common. Very stolid and quite indifferent to our presence. While we were trying to take a rest after lunch shortly after noon, an individual perched in full view about 20 feet away and over our heads and kept up his incessant song. We lost track of time but perhaps half an hour later the bird was still there, had not moved an inch, and was still singing. The song (or call) is slow, rolling, and sonorous, and can either carry for a long distance or be much muffled. The Cuba vernacular when written *To co-loro* is a faithful rendition of it. The *To* starts with a swelling of the feathers of the breast, takes nearly a second to travel up to the swelling throat where it becomes a *co*, and then, with a slow nod of the head, the *loro* is slurred out through the partly opened bills. Sometimes the final *o* is held. It is monotonous and is repeated at irregular intervals varying from about 30 seconds to two minutes, but heard from a distance, rolling and echoing along the great limestone cliffs of Viñales, it is to me one of the most pleasant sounds in Cuba. In Viñales, which we visited at the beginning and again at the end of July, the amount of song had much decreased by the end of the month.

Todus multicolor. Cuban Tody: Pedorrera.—Only one seen at the Cape, in dense underbrush, but several heard.

Centurus superciliaris. West Indian Red-bellied Woodpecker; Carpintero Jabado.—Very common and very noisy.

Xiphidiopicus percussus. Cuban Green Woodpecker; Tajá.—Common in the forest, as in the rest of Cuba, but always less so than the Red-bellied. On several occasions I have seen the two species in the same tree without signs of animosity.

[*Tyrannus dominicensis.* Gray Kingbird; Pitirre Abejero].—This species is one of settled open regions and therefore does not occur on the Cape. It is mentioned only because, although it is extremely aggressive, I have never seen it molest the Loggerhead Flycatcher and vice versa.

Tyrannus caudifasciatus. Loggerhead Flycatcher: Pitirre Cantor.—Common and usually very noisy but a cheerful bird to see.

Contopus caribaeus. Greater Antillean Pewee; Bobito.—Common at the Cape in clearings or other more open areas, such as roadsides and the screen of trees behind the beach.

Petrochelidon fulva. Antillean Cliff Swallow; Golondrina.—About a dozen of these birds were disturbed by us when we descended into an underground cave in search of bats. These were the only ones seen on the Cape. They are very common elsewhere in Cuba.

Corvus nasicus. Cuban Crow; Cao Montero.—The only way I can tell this bird in the field from the Palm Crow (*C. palmarum*) is through its croaking, guttural voice, that of the Palm Crow being very nasal and high pitched and rather similar to the voice of the Fish Crow (*C. ossifragus*) of North America. A band of five had apparently spent the night in a tree at our camp, were very vocal or noisy in the early dawn, and spent fully 15 minutes in loud conversation.

Mimocichla plumbea. Western Red-legged Thrush: Zorzal Real.—Common at the Cape as elsewhere in Cuba. Bond (1947) has found this species to be rather shy but, at least in Cuba, the reverse is usually true, for in many localities it seems drawn to man not unlike the American Robin (*Turdus migratorius*).[1] Two nests were found at the Cape, one at about six feet from the ground in a thick bush and the other built at about eight feet in some tangled saplings. The latter was at our resting place on the beach, and was watched on and off for about three hours. During this period, an individual singing from conspicuous perches varying between 30 and 50 feet from the nest was observed on three occasions to change places with the bird that was incubating. Exact

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[1] Ripley (1952:18) has merged the genus **Mimocichla** (of which the Cuban subspecies, **rubripes**, of **plumbea** is the type) with **Turdus.** I agree, however, with Bond (1956) that **Mimocichla** is sufficiently well characterized morphologically to be retained as a distinct genus. It differs from **Turdus** in having a very strongly rounded or graduated tail with large white tips, and, as shown in these notes, **M. plumbea** does not behave like a typical **Turdus.** Its song, also, is rather different. The song of **M. plumbea** is rather weak and consists chiefly of a jumble of notes, lacking the musical quality of a typical thrush song.

time was not kept but the intervals spent on the nest by both individuals seemed to vary between about 15 minutes, or perhaps a little less, to about 20. On one occasion the nest was left unattended for about 10 minutes.

The Zorzal was watched whenever possible. Its attitudes on the ground (see sketches in fig. 5) are somewhat similar at times to those of the American Robin and at other times similar to those of the Catbird (*Dumetella carolinensis*). When relaxed it holds itself not unlike a Robin, except that the tail is usually held horizontally or virtually so and the wing tip is never drooped so low. When more alert, the tail is cocked very high at a sharp angle, and it then looks and moves exactly like the Catbird, or, although more bulky, less slender, somewhat like the Northern Mockingbird (*Mimus polyglottos*). Generally speaking, when moving on the ground or through bushes and undergrowth, it more nearly resembles a large Catbird. It may be of some interest to note that the Cuban vernacular for the latter is Zorzal Gato. Its resemblance in behavior to that of the Catbird and Mockingbird is heightened during a phase of its courtship when it lifts its wing upwards and then "flashes" or waves them slightly.

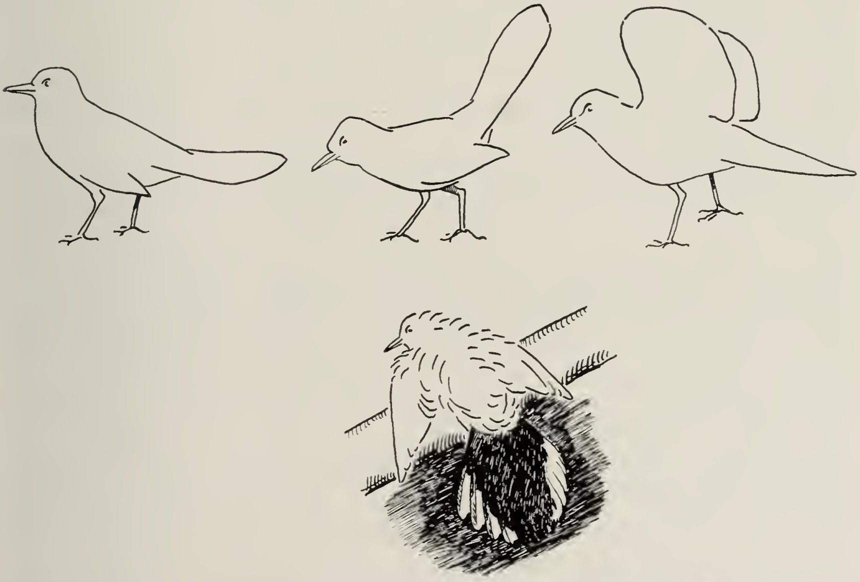

FIG. 5. Postures and display of the Western Red-legged Thrush (*Mimocichla plumbea*) from field sketches by the author.

This courtship performance, or what seems to have been almost certainly such a performance, was observed in the gardens of the agricultural experiment station at Topes de Collantes, Las Villas. In this garden were five Zorzals within a small open area. They seemed to pay no particular attention to one another with the exception of two individuals. These two were watched for about one hour, moving back and forth always to the same perches, namely the roof of a low shed, a fallen log about eight inches in diameter, a pile of crates and flower pots, and a small mound of earth about two feet high. One individual, no doubt the female, would move off to one of these perches, and was pursued closely and silently by the male. On alighting, the two would remain immobile for about two to three minutes. When she moved to the mound or log, the male would alight to within two or three feet but remain on the ground and would either remain immobile, as on the shed, or would raise and "flash" its wings as shown in the sketch, meanwhile taking a few steps toward her. This display was varied by the one shown at the bottom of Fig. 5, which took place only on the log. The male would mount on the log, arch his whole body and tail forward with all the feathers erected and the tail spread open to its fullest extent, thus displaying the white tips most conspicuously. He remained perfectly immobile but this display would be interrupted at once and pursuit resumed when the female flew off. The part played by the female through the various phases described consisted, apparently, only in flying back and forth to the various perches, and most of the time her back was turned. Both birds were silent throughout and the other individuals in the garden paid them no attention.

Wing "flashing" is usually believed to be a means through which insect food is secured, the movements making the insects reveal themselves by moving, but Sutton (1946) believes that in the case of the Mockingbird it is only more or less accidentally associated with the capture of food. In the case of the Zorzal, as also in the case of the Catbird in which I have witnessed the same behavior, I have seen it to take place only during courtship performance.

As stated, the other individuals in the garden seemed to pay no attention whatever to the pair. Most of the time they apparently were searching for food, but the only insects we could find that they seemed to be taking were tiny ants and small flies. They also took some fruit, namely they would greedily pluck off and swallow in rapid succession several small red peppers about two-thirds of an inch long. Only the brightest and reddest were taken. I collected specimens of the plant and its peppers which were identified by Dr. I. D. Clement as the wild small-fruited form of *Capsicum frutescens.* The digestive system of the Zorzal must be quite insensitive. Only one of these peppers is enough to burn off the lining of my mouth, or so it feels, and if swallowed is so hot that it makes me break out in profuse perspiration. The name of the pepper in Cuba is "aji guaguao."

Vireo gundlachii. Cuban Vireo, Juan Chiví.

Vireo altiloquus. Black-whiskered Vireo; Bien te veo.—This vireo and the preceding were very common at the Cape. The Black-whiskered is the larger of the two, and, as in the Bahamas where I had the occasion to observe it (1953), I found that it feeds, sings, and very probably (though I did not find any nests) nests higher in the trees than the smaller species. The situation in Cuba is the exact parallel of that in the Bahamas where the Cuban Vireo is replaced by the closely related Thick-billed Vireo (*V. crassirostris*).

Teretistris fernandinae. Yellow-headed Warbler; Bijirita de Vuelta-abajo.—Common at the Cape, seen singly and in small parties. One foraging party composed of five or six of these warblers and two Cuban Bullfinches (*Melopyrrha*) was observed. Birds in the tropics traveling in mixed hunting parties undoubtedly derive benefit from such associations, but it seemed unusual to find a warbler associated with the Bullfinch, and I followed the party for a while and found that the individuals of the two species keep together by means of short sibilant calls. I found later that this association was not unusual. In the mixed woods above Viñales I came across several such parties, but in their case the Bullfinches were more numerous than the warblers. One of these foraging parties included a third species, namely a pair of Cabreros (*Spindalis*).

Mr. William Partridge has since called my attention to a paper by Neunteufel (1953), in which Neunteufel reports that on many occasions he has observed mixed hunting parties of insectivorous and of fruit- or seed-eating birds in the forests of Argentina (Misiones) and Paraguay. In several instances Neunteufel was able to observe the formation of these parties, and reports that the insectivorous birds were first attracted to the trees by the disturbance caused to flying insects by the fruit- or seed-eating birds, and, once attracted, follow the latter from tree to tree.

Cyanerpes cyaneus. Blue Honey-creeper; Azulito.—One individual. Dr. Moreno told me that this species (which according to Bond is more numerous in eastern Cuba) seems to be extending its range westward.

Spindalis zena. Stripe-headed Tanager; Cabrero.—I saw only one pair at the Cape, but it is undoubtedly more common than this would indicate, and other individuals probably escaped my attention.

Melopyrrha nigra. Cuban Bullfinch, Negrito.—Very common.

Migrants, Cage Birds, and Bird-catchers

Zayas, who has visited the Cape during the spring migration, tells me that at this time the forest is alive with great numbers of birds, and that their numbers build up to recurring peaks, but he did not observe in what direction the birds take off. As the Cape is only 100 miles from Yucatán, it is possible they arrive from there and then, after resting, fly north across the Gulf or to Florida. It is also possible that the migrants may follow the Antilles and then fly north, or some perhaps cross to Yucatán. The Cape would seem to be an excellent location to study migration.

Cubans, like most people of Hispanic ancestry, are fond of pets and they usually care for them well. The Cuban Parrot is kept often in or out of a cage and makes a charming pet. This bird, however, is also still shot for food in some remote regions and, we were told, offered for sale as game at the price of a dollar a brace. Among native birds those most popular are first the Bullfinch, and then the two Grassquits or Tomeguines (*Tiaris olivacea* and *T. canora*), the latter the more popular of the two, as the male is the more striking. This summer, the asking price in the countryside for one Bullfinch, or a pair of either Grassquits, was one dollar, a small cage included. Other birds that I have seen in cages are the Cuban Trogon, the Red-legged Thrush, the Blue Honeycreeper, the Stripe-headed Tanager, and among migrants, the following warblers: Black-throated Blue (*Dendroica caerulescens*), Black-throated Green (*D. virens*), Yellow-throat (*Geothlypis trichas*), and the American Redstart (*Setophaga ruticilla*). The Painted Bunting (*Passerina ciris*) is especially popular. I have even seen caged House Sparrows, and among the non-passerines, and perfectly at liberty, the West Indian Tree Duck (*Dendrocygna arborea*) and the Sparrow Hawk. Around Viñales I have heard that in former years Sandhill Cranes (*Grus canadensis*) were kept as pets and in 1941 I saw one of these near Havana, tied by a small rope by the leg. The other leg had been broken and crudely splinted but the bird was able to limp on it. Though these were not pets, properly speaking, Limpkins (*Aramus guarauna*) frequented the kitchen steps at Soledad.

The most prized of all cage birds is, however, the Solitaire or Ruiseñor (*Myadestes elisabeth*). It is a very plain, unobtrusive species, but it is prized for its lovely, flutelike song; it does rather well in captivity. We were asked 10 dollars for one individual in Havana. My introduction to Cuban birds came through this bird when in 1939 I spent a month in Viñales and on the first day met the local bird catcher whom I then paid to take me on his rounds. He was interested primarily, if not exclusively, in the Ruiseñor, and the most that I have seen him capture in one day was seven. Usually he caught only two or three and sometimes none. His price, wholesale, was two dollars each and sometimes, when he would keep a bird and train it, five dollars. His manner of catching these birds is of interest. His equipment consisted of two or three bamboo poles of different thickness which could be fitted into one another for the desired length and a number of very thin slivers of bamboo, about one-eighth of an inch wide and a foot long. These were kept in a quiver made of a section of bamboo that dangled from his belt; they were immersed in a viscid substance obtained from the latex of a wild fig tree, and then thickened over a fire with the addition of wood ashes. When a bird was seen, one of these slivers would be placed very loosely at the top of his poles; the bird was then approached and the sliver dropped quickly on its back. The bird would take off in alarm, but was not able to shake off the sliver that would stick to its back as well as to the wings, and he would flutter down to be caught. With the fingers the sticky substance was then rubbed off just as easily and cleanly as rubber cement from paper. Tying two of these slivers in the form of a cross, he caught easily for me birds as large and as strong as the woodpeckers, the trogon, and the Zorzal. All birds caught for me were studied in the hand, sketched, and released the next day. Bird catchers do not seem to threaten the Ruiseñor population seriously. In the limestone country the bird lives on the high cliffs (*mogotes*), many parts of which are inaccessible. In 1956 they seemed to be about as common, judging by the amount of song, as they were in 1939 and the bird catcher has now become a sanitation inspector. His skill and methods probably are a lost art.

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THE CONTRIBUTIONS OF JOSSELYN VAN TYNE TO THE WILSON ORNITHOLOGICAL SOCIETY

BY A. W. SCHORGER

It will be left to future writers to describe the high rank earned among American ornithologists by Josselyn Van Tyne, who died in Ann Arbor, Michigan, on January 30, 1957. His formal publications may be easily assessed, but few people will realize fully his great contributions to the Wilson Ornithological Society.

He was born in Philadelphia on May 11, 1902. Following undergraduate work at Harvard, he received his doctorate in 1928 at the University of Michigan, with which institution he remained associated until his death. In 1931 he was made Curator of Birds and was instrumental in building the collections of the Museum of Zoology into one of the best among state institutions. Field expeditions to French Indo-China, British Honduras, Guatemala, Yucatán, Bahamas, Panamá, and Bylot Island, and regular attendance at the meetings of the International Ornithological Congress gave him a broad knowledge of the birds of the world.

He became a member of the Wilson Society in 1922 and up to the time of his death was present at all but four of its meetings. There was no interval during that time that he did not serve as a member of a committee or on the Council. From 1935 to 1937 he served as President. During his incumbency careful attention was paid to the business affairs of the Society, and to the programs of the meetings to give full satisfaction to the attendants. In his campaign to increase the endowment of the Society by securing life members, he was very successful.

It is as Editor of the Bulletin that his service was outstanding. During a period of ten years (1939–1948) as Editor, he paid particular attention to the quality and usefulness to the readers of the printed papers. Every issue involved a mass of correspondence, diplomatic handling of authors who consider their manuscripts sacrosanct, reading of proof, and endless minor details. Among the 175 papers published during his regime, there are some of particularly high quality, especially in taxonomy and behavior.

A request from members for comments and suggestions that would lead to a journal fulfilling the needs of the Society was among his first innovations. A bibliography of recent literature was added to the *Wilson Bulletin,* the articles being selected for usefulness to the members. A committee on illustrations was appointed to improve the latter. The December, 1941, issue inaugurated the use of attractive frontispieces, approximately one-third of which subsequently appeared in color. The 168 book reviews appeared under the signatures of persons best qualified to prepare them.

Aid to the younger ornithologists was unlimited. Contributors were re-

Josselyn Van Tyne

quested to avoid using trinomials indiscriminately and attention was called to the fact that binomials were still in good repute. His office acted as a clearing house for research projects, not only to acquaint investigators with the work in progress but to avoid duplication.

He was unstinting in the time devoted to editing although it involved curtailment of his personal research and social life, and sacrifice of holidays. Happening to be in Ann Arbor during this period and desiring to use the library, I inquired if the Museum would be open on Saturday. He replied: "It is not only open on Saturday, but Sunday and evenings."

The Society is unique among purely American ornithological organizations in the founding and maintenance of a library. The proposal to establish a library was made by Frank C. Pellet at the meeting in Ann Arbor in 1928, and two years later an agreement was signed with the University of Michigan whereby the Museum of Zoology became the custodian. Dr. Van Tyne announced in 1939 that the official book-plate of the Society would be a design by George Miksch Sutton, carrying a drawing of the Long-eared Owl —"an appropriate bird since it is named after Alexander Wilson." He was an enthusiastic bibliophile and in his efforts to enlarge the library he made frequent appeals for donations of books and separates. Members were requested to forward a complete list of their publications so that items lacking in the library might be filled. As a result the library now contains approximately 635 books and 8,825 pamphlets. In view of this great service to the Society, the Council at its meeting in Duluth in June, 1957, voted to name the library in his honor, the Josselyn Van Tyne Memorial Library.

It was Dr. Van Tyne's desire that his private collection of books be kept intact insofar as possible. Helen Van Tyne has recently announced her decision to present this valuable collection to the Wilson Ornithological Society, to be incorporated into its library.

I saw him for the last time during the Thanksgiving holiday in 1956. A glance showed that he was very, very ill and it was poignant to find him meticulously reading proof on the Check-List of the American Ornithologists' Union. It would be difficult to find an example of greater devotion to a profession.

Department of Forestry and Wildlife Management, University of Wisconsin, Madison, Wisconsin, September 4, 1957

POPULATION DENSITY OF ALDER FLYCATCHERS AND COMMON GOLDFINCHES IN *CRATAEGUS* HABITATS OF SOUTHEASTERN MICHIGAN

BY ANDREW J. BERGER

The dry upland nesting habitat of the Alder Flycatcher (*Empidonax traillii*) has been mentioned by several authors: Campbell, 1936:164; Wing, 1949:38; Berger and Parmelee, 1952:36; Meanley, 1952:111; King, 1955:149. Spiker (1937:48) said that the Alder Flycatcher in Iowa inhabited "dry, upland pastures, especially where there were rank growths of hazel bushes, wild crab, and hawthorn."

During the last two years in Washtenaw County, Michigan, I studied four additional areas, where hawthorns (*Crataegus* sp.) are the predominant shrubby vegetation. Each study area is sharply delineated on all sides by woods, cultivated fields, roads, or grassy pasture-land. Area *A* (Pittsfield Twp., Sect. 6) was used as a pasture through 1955, but not in 1956. Area *A* has a relatively uniform composition (*Crataegus* and various grasses and herbaceous plants), except that two ponds occupy an area of about one acre; the smaller pond dried up completely in 1956. This area is very much like that illustrated by Berger and Parmelee (1952:35). The other three areas (*B*, Pittsfield Twp., Sect. 5; *C*, Northfield Twp., Sect. 36; *D*, Superior Twp., Sect. 34) have not been grazed in recent years (10 years or longer), though all were pastured at one time, and have a lush undergrowth of herbaceous plants. These three areas also are characterized by having a few scattered trees (mostly *Acer*, *Populus*, and *Ulmus*) and some clumps and thickets of various shrubs (mostly *Cornus* and *Rubus*). Areas *B*, *C*, and *D* have some low pockets (occupying only a small part of each area), which hold standing water during the spring and early summer and which support a different flora (*Salix*, *Cephalanthus*, *Sambucus*, etc.). Of the 54 nests found in these four areas during 1956, however, all but one (in an elm sapling) were built in *Crataegus*. Table 1 presents certain information concerning Alder Flycatchers on the four areas in 1956. The population density was essentially the same in 1955, but I did not visit the areas that year until the middle of July, at which time the young had already left the nests built in early June. Because the adults were not banded, determination of the number of pairs was based primarily on the number of active nests at a given time. All population estimates, therefore, represent the minimum number of pairs in each area.

Little information is available on population density of the Alder Flycatcher. Wing (1949:40) reported an average of 9.2 breeding pairs per 100 acres of Palouse prairie in Washington; the flycatchers were "associated with the brush patches" on hillsides on a census area of 28.2 acres. King (1955) found 14 pairs per 100 acres of "alternately dense and open hawthorn thicket along a running stream" in southeastern Washington; over one-third of the nests found by King were built in *Rosa* sp. Meanley (1952) reported 17 pairs of Alder Flycatchers on an 18-acre tract of *Crataegus* and persimmon (*Diospyros virginiana*) in eastern Arkansas; 13 of 15 nests were located in *Crataegus.*

King (1955:154) reported the average height above ground of 42 nests as 32.4 inches (range of 16 to 66 inches) and that 83 per cent of 41 nests were between 20 and 40 inches above ground. If the one nest found 86 inches above ground (area D in Table 1) is excluded from the calculation, the average heights of ten nests in area D is 42.8 inches, thus indicating a very close average for the four areas; of the Michigan nests, 75.5 per cent were placed between 27 and 43 inches above ground. This seems to indicate, as King found in Washington, a "definite nest-height preference" by this species, but this seems to vary both geographically and ecologically. For example, Meanley reported the average height of 15 nests (13 in *Crataegus*) as 7.5 feet in Arkansas.

TABLE 1

POPULATION DENSITY AND NEST HEIGHT OF ALDER FLYCATCHERS IN *CRATAEGUS* HABITAT[1]

Area	Acres	Number of Pairs	Number of Pairs per 100 Acres	Nests Found	Nest Height Above Ground (inches)[2]		
					Minimum	Average	Maximum
A	30	18	60	16	29	42.6	66
B	20	11	55	13**	27	42.4	67
C	19	11	57.9	14	32	39.0	55
D	15	11	73.3	11	29	46.7	86
Totals	84	51	60.7	54			

[1] One nest 37 inches from ground in 4-foot elm; all other nests in **Crataegus.**
[2] To bottom of nest.

By way of comparison, it might be added that at Geddes Pond (Ann Arbor Twp., Sect. 27), a typical marshy habitat about one mile from Ann Arbor, from nine to 12 pairs (about 45 pairs per 100 acres) of Alder Flycatchers have nested every year from 1948 through 1956. The average height above ground of 45 nests in this habitat was 54.6 inches (minimum, 38; maximum, 89 inches). Of these nests, 22 were built in ninebark (*Physocarpus opulifolius*), 9 in red osier dogwood (*Cornus stolonifera*), 8 in panicled dogwood (*C. racemosa*), 5 in willow (probably *Salix niger*), and one in hawthorn. One other nest (not included in the calculation above) was placed 7 feet 10 inches above ground in a willow.

Further data are needed on clutch size of the Alder Flycatcher in order to determine more accurately the ratio of three-egg clutches to four-egg clutches. Farley (1901:347) stated that four eggs are more common in Massachusetts.

Berger and Hofslund (1950:9) found 14 (60.8 per cent) of 23 nests with four eggs in Michigan. Berger and Parmelee (1952:34) found 19 (40.4 per cent) of 47 nests with four eggs in nests visited only once. In Washington, King (1955:164) found 42.4 per cent of 33 nests with four eggs. In the present study, 51.8 per cent of 54 nests held four eggs. This percentage is probably lower than the actual ratio because some nests were destroyed before the clutch was complete and still other nests were not found until the eggs had hatched. In the latter instance, the presence of three young in a nest does not prove that the clutch consisted of three eggs, because one cannot know whether or not dead young may have been removed from the nest.

In the present study, 36 (76.6 per cent) of 47 nests were known to be successful in fledging one or more flycatchers. Of 129 eggs laid in successful nests, 115 (89.1 per cent) hatched and 114 (88.3 per cent) young left the nest. Only three (all in area B) of the 54 nests were parasitized by the Brown-headed Cowbird (*Molothrus ater*). One of the nests was destroyed; each of the other two nests fledged one Cowbird, but no flycatchers.

King (1955:164) commented that "it is evident that this species acquires some degree of proficiency in flying within a day after leaving the nest." This is certainly true, and, in fact, my experience suggests that if the young are not disturbed (e.g., by daily weighing or by banding after the young are 10 days of age or older), they are able to fly well when they leave the nest. Moreover, if the fledglings are not disturbed, they may remain in the nest tree for at least one day even after they have actually vacated the nest itself.

The breeding season of the Alder Flycatcher in southern Michigan extends from the first week of June into the third week of August. Berger and Parmelee (1952:37) commented that "it remains to be determined whether or not late spring or early fall migrants also appear on the breeding grounds during this period." Although proof is very difficult to obtain, I now feel confident that migrant birds do not appear in the *Crataegus* habitat during the period mentioned above. In 1956, Alder Flycatchers continued to sing through the first 10 days of August, when some nests still held young, but after August 16, I saw only one Alder Flycatcher (August 24) in any of the *Crataegus* nesting habitats, though I spent much time there during the following month. Furthermore, the total population on the areas rapidly decreased during the latter part of July. The number of flycatchers observed on the areas after the third week of July was directly correlated with the number of active nests and the number of nests from which young had recently fledged.

Although few people would attempt to identify the species of *Empidonax* flycatchers during migration, much could be learned about their general behavior if specimens were collected. Answers to the following questions are still needed: Do these species migrate together in loose flocks? Do they pass through deciduous woods or through shrubby vegetation along the margins of streams and marshes? What is the time-span of the migration period?

The Common Goldfinch

Nesting in the same habitats with the Alder Flycatcher is the Common Goldfinch (*Spinus tristis*), although the nesting season of the latter species usually begins four to six weeks later than that of the flycatchers (Berger, 1954:164). Table 2 presents information on Goldfinch nests in three of the same areas used in Table 1. All the nests included in Table 2 were built in *Crataegus*; density is based primarily on the number of simultaneously active nests, and, thus, indicates the minimum number of pairs on each area. Working with some color-banded birds, Stokes (1950:111, 116) believed that there was "a steady infiltration of birds and establishment of new territories" until the middle of August.

Table 2

Population Density and Nest Height of Goldfinches in *Crataegus* Habitat

Area	Year	Number of Pairs	Number of Pairs per 100 Acres	Nests Found		Nest Height Above Ground (inches)		
						Minimum	Average	Maximum
A	1955	16	53	19	34	34	50.7	98
	1956	—	—	15				
B	1955	18	90	20	44*	38	54.4	85
	1956	14	70	24				
C	1955	39	205	66	120	32	48.7	81
	1956	26	136	54				

Three additional nests were built in elm saplings, 39, 43, and 54 inches above ground.

On 24 acres of "park and marshland" at Madison, Wisconsin, Stokes (1950:114–115) found breeding densities of 150 (1944), 225 (1946), and 250 (1947) pairs of goldfinches per 100 acres, and during 1947, he found 38 pairs nesting on 6.4 acres of marsh.

There is a notable difference in the distribution throughout the nesting habitat between the Alder Flycatcher and the Common Goldfinch. The Alder Flycatcher tends to be evenly spaced throughout the areas. The Goldfinch, on the other hand, seems, in general, to be semi-colonial in that the nests are situated in groups. Plots of an acre or more may have no nests, whereas another area, equal in size, may have several nests, even though the vegetation appears identical in the two areas. This grouping of nests was especially evident in area C. The average distance between seven Goldfinch nests in such a group was 23 yards: the minimum distance between two nests was 6.7 yards. There are exceptions, of course, but isolated nests are not often found either in *Crataegus* or swampy habitats in southern Michigan. Nests along roadsides, in shade trees in towns, or along the edges of woods are more likely to be isolated from other Goldfinch nests.

The question of territorial behavior of the Goldfinch has been discussed by several authors. In his thorough study of the Goldfinch in Wisconsin, Stokes (1950:111–115) found that the "territory consists of the nest site and immediate area, but does not necessarily include food, water, or nesting material sufficient for the pair." This type of behavior is probably characteristic of the Common Goldfinch throughout most of its breeding range. Data presented by Batts (1948:52–54), as well as my own experience, suggest that the area defended may be a very small one, that immediately surrounding the nest; his data also suggest that individual Goldfinches differ considerably in their responses to the territorial instinct. Thus, I think that it has been pretty well shown by several authors that the Common Goldfinch defends its nest-site, but, at the same time, that this species tends to be semi-colonial during the nesting season. This social tendency has also been reported by Walkinshaw (1938:5), Nice (1939:123), and Nickell (1951:451).

Annual differences in nesting success are well illustrated by the data collected on Area C. In 1955, 60.6 per cent of 66 Goldfinch nests were successful in fledging one or more young. On the same area in 1956, only 33.3 per cent of 54 nests were successful; the outcome of three additional nests was in doubt. The low nesting success in 1956 is difficult to explain, because that same year at least 64.3 per cent (and possibly 71.4 per cent) of 14 Alder Flycatcher nests were successful. Stokes (1955:124–125) also found considerable annual difference in productivity during the three years of his study. One interesting fact is that, in the Ann Arbor region, 7.4 per cent of 121 nests observed in 1955 had six-egg clutches, whereas in 1956, 25 per cent of 80 nests has six-egg clutches. I found 29 six-egg clutches during 1955 and 1956. Some of these nests were destroyed or deserted and a few were visited only once, but all six eggs were known to hatch in 16 nests and 11 nests were successful in fledging six young.

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A STUDY OF SUMMER BIRD POPULATIONS NEAR TOKYO, JAPAN

BY H. ELLIOTT McCLURE

AS PART of a study of birds and their relationship to Japanese B encephalitis, an attempt was made to determine the population density of nesting birds, and seasonal changes in their abundance and age composition in a rural area bordering Tokyo. This great, sprawling city, encompassing rural as well as metropolitan areas, is the center of ornithological thought in Japan, and much has been written concerning the birds of the city and its environs. Austin and Kuroda (1953) described briefly the status of species which are found about Tokyo. Kabaya (1948, 1951) attempted accurate listing of species and their seasonal occurrence at Mt. Takao, a forested mountain about 600 meters high, located 25 miles west of Tokyo. But quantitative studies of birds in rural habitats in the Tokyo district do not appear to have been reported.

For the study of a breeding bird population reported here, a site that was roughly rectangular and included about 100 acres of upland farms was selected in Setagaya Ward on the southwest outskirts of Tokyo (Fig. 1). This acreage was part of a larger area which had been under observation since 1950. The site included most of the usual habitat segments characteristic of the district. Dominant trees of the 10 acres of wooded plots included several species of oaks (*Quercus stenophilla, Q. paucidentata, Q. myrsinaefolia*), chestnut (*Castanea puninervis*), beech (*Fagus japonica*), pine (*Pinus thunbergii*), *Zelkova japonica* (Ulmaceae), and *Cryptomeria japonica* (Taxodiaceae). Figure 2 shows a segment of the area dominated by *Zelkova* and chestnut. Bamboo thickets covering about four acres were mainly of the species *Phyllostachys reticulata* which forms such dense stands that no undergrowth can exist (Fig. 3). There were about two acres of farmyards, such as those shown in Fig. 4. A small stream crossing the study area was bordered with approximately two acres of dense shrubbery entangled with mats of vines and *Rosa multiflora*. There were about six acres of flower gardens and of nursery for young trees. As the area was also used for recreation there were about five acres of open lawn and pasture. The remainder included cultivated fields of barley, wheat, tomatoes, onions, radishes, and other truck crops which were rotated each year. The interspersion of these habitats and their approximate sizes are shown in Fig. 1.

During the period from March 11 through August 26, 1953, 24 weekly observations were made, and between April 17 and August 25, 1954, 20 weekly observations. The tallies were made along a route crossing the acreage 10 times in a north and south grid. Weather conditions during the mornings of observation were as follows; in 1953, four mornings were clear, seven partly cloudy and 13 cloudy; in 1954, three were clear, five partly cloudy and 12 cloudy. It rained on eight of the mornings in 1953, and on three in 1954. Wind was not a factor either year, for in early morning there was rarely more than a light breeze. The temperature range was not great, between 50° and 70° Fahrenheit.

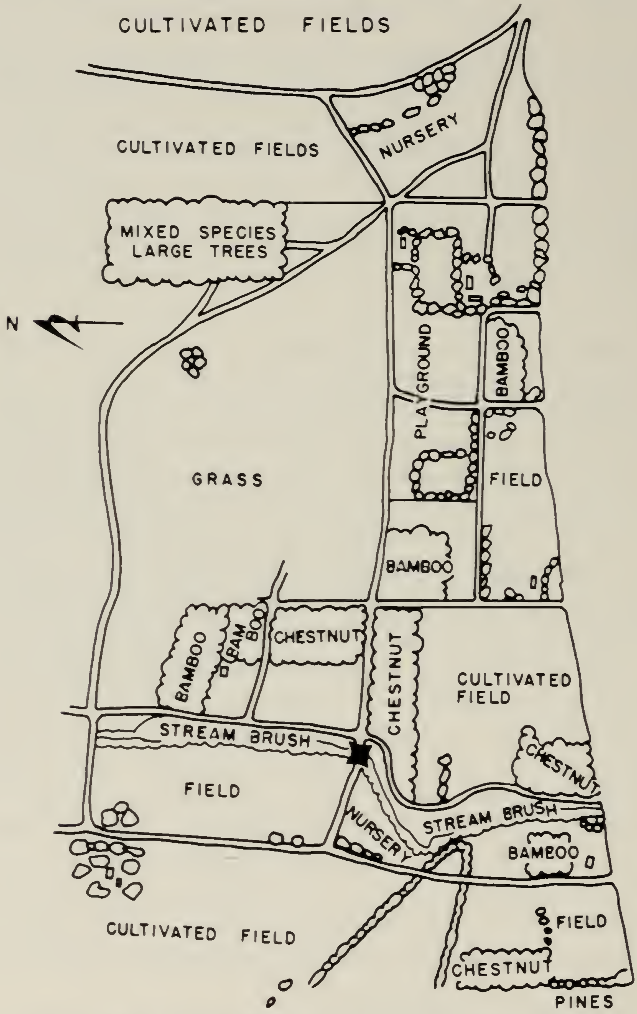


Fig. 1. Map of the Setagaya Breeding-bird Study Area.

A total of 6472 individuals, an average of 269 per trip, was tallied in 1953, and 5194 individuals, 259 per trip, were counted in 1954. There were 37 species recorded in 1953 and 30 in 1954, the difference being made up of winter residents present in 1953 which had left by the time the 1954 study was started. Only 11 permanent residents and one summer resident were

FIG. 2. A segment of the study area dominated by *Zelkova* and chestnut.

TABLE 1

THE AVERAGE NUMBER OF RESIDENT BIRDS NOTED WEEKLY PER 100 ACRES AT SETAGAYA, TOKYO-TO, JAPAN, DURING 1953 AND 1954

	April		May		June		July		August	
	1953	1954	1953	1954	1953	1954	1953	1954	1953	1954
Bamboo Pheasant	1.6	1.3	2.0	1.7	2.2	1.2	3.6	1.2	4.7	1.2
Turtle Dove	5.2	5.2	1.7	1.2	1.2	1.7	1.2	.2	0	.2
Skylark	8.0	6.2	9.3	6.7	5.5	5.5	5.0	6.0	4.0	3.2
House Swallow	.2	.5	1.0	4.0	4.0	4.0	8.0	6.5	8.0	2.5
Jungle Crow	1.8	.7	0	1.7	0	1.7	.6	.2	.2	.2
Carrion Crow	.6	1.8	2.0	1.2	2.7	1.7	3.6	3.2	1.7	5.0
Blue Magpie	3.6	3.0	1.0	.7	.5	1.0	.4	7.0	3.0	6.0
Bull-headed Shrike	1.0	2.5	1.3	2.2	1.5	2.7	2.0	1.2	1.7	1.0
Ashy Starling	7.8	9.5	13.0	6.7	32.0	13.7	42.2	49.5	109.7	125.2
Tree Sparrow	85.6	101.7	98.3	138.0	192.0	221.0	280.0	216.0	374.0	167.0
Greenfinch	2.6	2.8	1.0	.5	1.0	0	1.2	.7	2.5	0
Meadow Bunting	5.0	2.5	5.2	2.5	7.5	4.7	6.4	1.7	6.5	1.7
Misc. Species	62.0	31.5	8.2	14.4	.6	5.1	3.8	1.0	1.6	1.8
Totals	185.0	169.2	144.0	181.0	249.7	264.0	358.0	294.4	417.0	315.0

regularly seen each summer. These are listed in Table 1, and the average numbers tallied are compared by month and year.

The most striking facts shown by this table are the paucity of species and individuals in such a group of habitats, and the domination by Tree Sparrows. No similar habitat in America has been studied and reported in *Audubon Field Notes* in the past five years. However, an area in Missouri under observation by P. B. Dowling and his group was located in a deciduous forest region at about the same latitude. In Table 2 are presented Dowling's tally of breeding males per 100 acres of mixed farmland in 1954 as compared with the breeding males found on the Setagaya location. Dowling did not explain why the English Sparrow (*Passer domesticus*) was not evident on the

TABLE 2

A COMPARISON OF THE SUMMER BIRD POPULATIONS OF A FARMING AREA IN MISSOURI AND THAT AT A SIMILAR LATITUDE NEAR TOKYO, JAPAN

Habitat Group	Missouri[1]	Tokyo-to
Total Acres	86	100
Oak Woodland	18	10
Bamboo thicket		4
Farmyards	2 (abandoned)	2
Stream Border		2
Nursery and Garden		6
Lawn and Pasture		5
Cultivated Field	37	71
Fallow (Brushy)	16	
Open Parkland	12	
Pond	1	

Ecologic Counterparts — Estimated Males per 100 Acres

English Sparrow	0	Tree Sparrow	40
Field Sparrow	47	Meadow Bunting	4
Bob-White	10	Bamboo Pheasant	1
Meadowlark	9	Skylark	6
Common Starling	7	Ashy Starling	2
Barn Swallow	0	Barn Swallow	2
Eastern Kingbird	5	Bull-headed Shrike	2
Mourning Dove	4	Turtle Dove	1
American Goldfinch	4	Greenfinch	1
American Crow	1	Carrion Crow	1
Other Breeding Species	36		0
Total Species	44		10
Males per 100 acres	265		60
Times observed	15		20
Hours of observation	86		50

[1] Data from Dowling and others, 1954.

Missouri plot. Its counterpart, the Tree Sparrow (*Passer montanus*), was the most abundant form at Setagaya. Obviously the two areas compared do not have equivalent numbers of ecologic niches. The climate at Setagaya is much wetter than that in Missouri, and the foliage denser (where it is permitted to grow). The Setagaya area was mainly under cultivation, while much of the Missouri area was reverting to woodland. There were probably many more niches available in the Missouri area than there were at Setagaya. However, the paucity of species and numbers of birds would lead to the conclusion that many of the niches at Setagaya remain vacant in the breeding season. Probably the primary cause of the low level of this bird population is human pressure against the birds, since the human population density is 30 per acre or seven times that of the birds.

Seasonal changes in population levels of the Tree Sparrow and Ashy Starling (*Sturnus cineraceus*) in the Setagaya plot are illustrated in Table 3. As young were fledged, or birds from surrounding farms flew into the study plot to feed, the percentage of the population made up of Tree Sparrows increased each year from April until mid-summer. If the population as observed in

TABLE 3

POPULATION CHANGES NOTED IN THE BIRDS OF SETAGAYA, JAPAN, IN 1953 AND 1954

	Year	April	May	June	July	Aug.
Tree Sparrow, *Passer montanus*						
Per cent of the total population	1953	46.0	70.5	76.9	78.5	72.7
	1954	60.1	76.2	83.7	73.3	53.0
Ratio of average weekly population compared with that of April	1953	1.00	1.14	2.24	3.27	4.37
	1954	1.00	1.35	2.18	2.12	1.64
Rate of population change from month to month	1953	1.00	1.15	1.95	1.45	1.34
	1954	1.00	1.35	1.60	.98	.77
Ashy Starling, *Sturnus cineraceus*						
Per cent of the total population	1953	4.2	9.0	12.8	11.8	26.3
	1954	5.6	3.6	5.1	16.8	39.6
Ratio of average weekly population compared with that of April	1953	1.00	1.66	4.10	5.41	14.10
	1954	1.00	.70	1.44	5.21	13.10
Rate of population change from month to month	1953	1.00	1.66	2.46	1.31	2.45
	1954	1.00	.70	2.04	3.61	2.53
10 additional breeding species						
Ratio of average weekly population compared with that of April	1953	1.00	.83	.85	1.08	1.09
	1954	1.00	.82	.90	1.05	.79
Rate of population change from month to month	1953	1.00	.83	1.02	1.25	1.02
	1954	1.00	.82	.90	1.05	.75
Total population per acre per month	1953	1.85	1.44	2.49	3.58	4.17
	1954	1.69	1.81	2.64	2.94	3.15

April is given a value of 1 and the population of other months compared with that of April, it will be seen that the population increased steadily during the summer of 1953 until it was four times as great in August as it had been in April. In 1954 the population increase was not as great and the peak was reached in June. A reduction in grain crops in 1954 probably accounted for this reduction in sparrows. The rate of change in population each month can be determined by dividing the observed population of a given month by that of the preceding month. By this method June appeared to be the month of most rapid increase each year.

Fig. 3. One of the bamboo thickets in the Setagaya study area.

Not more than two pairs of Ashy Starlings nested in the study plot each year, the majority using tree holes in nearby residential districts. When the young have been fledged the families remain together and join other families to form flocks that roam the surrounding countryside. Movement of these flocks into Setagaya is reflected in the figures given in Table 3, showing the August population to be 13 or 14 times as great as that for April. The rate of population increase was greatest in July of 1954, but was of equal magnitude in June and August of 1953.

The population levels of the other 10 species breeding in Setagaya were so low that little can be said about them. When totaled they showed only slight increases in late summer over the April numbers. The period of most rapid population increases appeared to be in July.

TABLE 4

THE AVERAGE NUMBER OF BIRDS TALLIED PER CENSUS VISIT IN THE ENTIRE SETAGAYA 360-ACRE STUDY AREA OVER A FOUR-YEAR PERIOD, 1951 THROUGH 1954

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Black-crowned Night Heron	1.5	.7	1.7	4.7	1.0	.5	1.5	0	.8	0	1.0	.5
Bamboo Pheasant	.7	.2	.5	2.5	1.5	2.7	4.0	7.2	3.0	2.5	.2	1.0
Eastern Turtle Dove	11.0	12.5	6.2	9.0	2.7	4.2	3.5	2.5	2.2	4.2	6.0	11.2
Skylark	1.7	3.0	8.7	11.5	11.0	11.7	6.7	4.2	.8	2.5	.8	2.2
House Swallow				.2	7.2	7.5	17.0	29.5	13.3			
Jungle Crow	6.0	3.2	3.7	4.2	5.0	4.2	1.0	1.5	5.0	8.2	2.2	6.8
Carrion Crow	0	1.0	1.7	0	1.5	1.2	4.2	2.0	4.0	6.0	5.2	3.5
Blue Magpie	14.2	1.7	15.0	16.0	13.5	6.7	13.0	15.0	15.0	19.0	18.0	13.8
Bull-headed Shrike	5.0	4.7	3.5	1.5	2.5	3.0	2.5	1.5	5.0	13.8	8.2	6.0
Ashy Starling	18.0	13.7	10.5	8.2	15.2	64.7	57.0	194.2	79.0	10.5	9.0	6.8
Tree Sparrow	269.0	200.0	126.0	132.0	136.0	257.0	385.0	366.0	375.0	250.0	190.0	189.0
Greenfinch	8.0	6.2	33.0	6.5	1.7	6.5	1.7	3.2	.2	3.5	22.0	32.2
Meadow Bunting	24.2	23.7	16.7	11.2	5.5	8.0	9.5	6.5	3.0	4.8	19.0	12.0
Total, all species	440.0	350.0	337.0	272.0	220.0	386.0	516.0	649.0	525.0	468.0	366.0	389.0

The number of birds seen each month slowly increased in each year from April into summer. The total population reached approximately 4 birds per acre in August.

The 100-acre breeding bird census plot was a little less than one third of a greater area in Setagaya in which birds were tallied once a month during the four years from January, 1951, to January, 1955. Table 4 lists the 12 species commonly found during all months of the year, and includes the summer resident House Swallow as well. It will be noted, by comparison with Table 1, that there are no major differences in population pattern between the breeding-bird study area and the larger plot. Therefore it is believed that the study plot was representative of the farming district in Setagaya.

Following is a discussion of each of the common species observed.

Nycticorax nycticorax. Black-crowned Night Heron.—This common night heron, of circumpolar distribution, did not nest in the breeding bird census area. A small colony of four or five pairs nested in the tops of tall pine trees in a nearby grove. An abundant coastal species in central and southern Japan, it nests in great colonies in association with four species of egrets. Individuals or small groups may be found roosting in dense trees during the daytime throughout the year in coastal or low mountain woodlands.

Bambusicola thoracica. Bamboo Pheasant.—This species preferred woody cover in association with tree bamboo or sasa (low bamboo) and was found most commonly in the areas shown in Fig. 5. Pheasants nested in the dense thickets of the stream sides and rarely led their chicks from this cover. The cocks crowed each morning during the breeding season and occasionally at other seasons, and tallies were based upon the number heard crowing. Even though heavily hunted the population appeared to remain at a fairly uniform level.

Streptopelia orientalis. Eastern Turtle Dove.—Although this large dove is a permanent resident, it reached greatest abundance in the Tokyo area during the winter, when local populations were augmented by migrants from Hokkaido and northern Honshu. It is not a farmyard species as is the Mourning Dove of America, but prefers to nest in brush land or in second-growth timber. The breeding population in Setagaya was low, and tallies reflected the movement of winter concentrations from the area. Instead of showing a rise in numbers from the production of young, there was a steady decrease throughout the summer as the species moved into more desirable habitats. The nest is a typical dove's nest, loosely woven and usually placed in a low crotch.

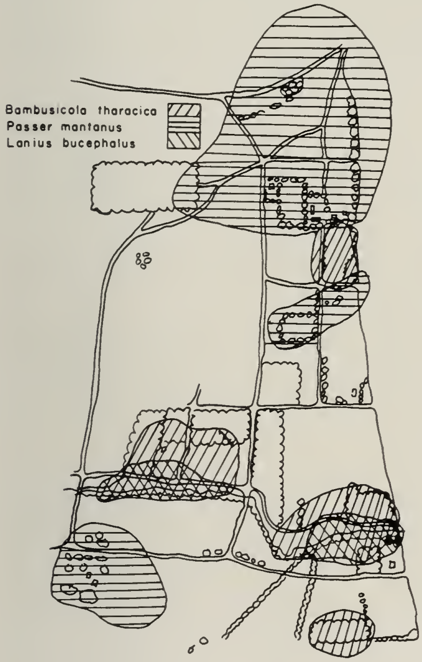
FIG. 4. A typical farmyard of the Setagaya area.

Alauda arvensis. Skylark.—The aerial performance of this palaearctic species was seen over all open, cultivated or noncultivated lowland habitats of Japan. It was a permanent resident of the farmlands reaching peak numbers in early summer. Since Skylarks nested early, the population was increased by juveniles during April, May and June. Population counts were based both upon calling males and flushed females or young; and the areas where Skylarks were commonly seen are shown in Fig. 6. The gradual reduction in numbers from month to month as shown in Table 1 reflected the gradual reduction in song performance rather than an actual decrease in numbers of birds. Because the nests are hidden at the bases of clumps of grass and are very difficult to find, none was discovered during the two years of early morning tallies.

Hirundo rustica. House Swallow.—The House or Barn Swallow was the only abundant summer resident in the area. It arrived from the south in April, reached peak numbers in August, and left in September. The species nested in or about farmhouses and foraged over open fields.

Corvus levaillantii, Jungle Crow, and *C. corone*, Carrion Crow.—These two species ranged over the entire study area. The Jungle Crow did not nest on the 100-acre plot, but ranged over it from nearby nesting territories. In 1954 a Carrion Crow nest was placed in a tall *Zelkova* tree near the southeast corner of the plot, and the daily range of this pair extended beyond the limits of the 100 acres. The family flock was present in July and August.

Cyanopica cyanus. Blue Magpie.—Also ranging over the breeding area, but not nesting in it, were Blue Magpies. Their jay-like nests were placed in pines and *Cryptomeria* one-half mile or more from the plot. As shown in Table 4 this species was present in small numbers throughout the year. In the breeding bird census area (Table 1) fewer were noted in May and June as nesting activity kept the parents closer to the nest. Usually five to seven young are fledged and they remain with the parents until late in the year.



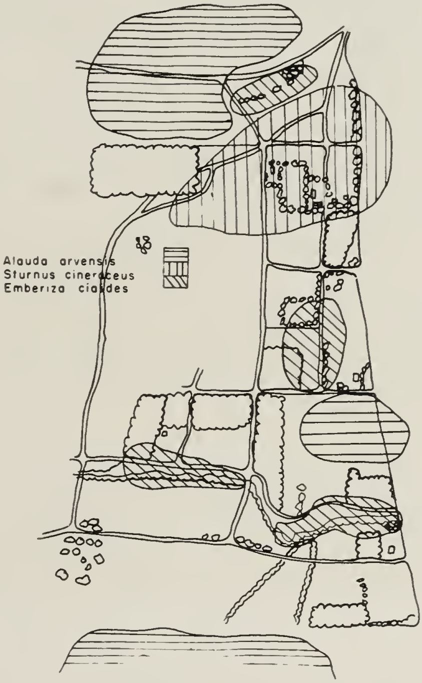


FIG. 5. (*left*) Distribution of *Bambusicola thoracica*, *Passer montanus* and *Lanius bucephalus* in the study area.

FIG. 6. (*right*) Distribution of *Alauda arvensis*, *Sturnus cineraceus* and *Emberiza cioides* in the study area.

Lanius bucephalus. Bull-headed Shrike.—This species was conspicuous, but not abundant. It nested very early each year and young were usually fledged by the end of March or middle of April. The observation of nestings late in May suggested that there may be two broods. After the young were fledged the family group remained in thickets along the creek (Fig. 5), where the shrikes were secretive during July and August. An influx of migrants and winter residents into the Kanto Plain from the north brought the population up to a peak in October (Table 4).

Sturnus cineraceus. Ashy Starling.—Figure 6 shows the habitats commonly used by this second most abundant species in the breeding area. Starlings nested in tree hollows or in thatched roofs of farm buildings. The daily range during nesting activities did not appear to extend much outside of that shown in Fig. 6, but after young were fledged the starlings gathered into flocks which included several families and roamed over the countryside. Foci of such wanderings appeared to be the original nesting or roosting place of the birds that had been there at the beginning of the nesting season.

Passer montanus. Tree Sparrow.—The sparrows' daily wanderings centered around farmyards (Fig. 5). They raised at least three broods, from April into August, preferring the interstices of tiled roofs of farm buildings as nesting places. After the young were fledged they joined adults and fed with them in the fields of ripening grain. These flocks returned each evening to the farm buildings where they roosted.

Chloris sinica. Greenfinch.—This was the most sporadic resident of the Setagaya breeding area. No nests were found, although a male had a singing perch on the top of a tall *Cryptomeria.* This was a common winter resident with peak numbers in March when migrants passed through on their way north. Breeding residents were most commonly found associated with large trees.

Emberiza cioides. Meadow Bunting.—A common, brush-loving species, the Meadow Bunting was found most often in the areas shown in Fig. 6. Males sang from the tops of the higher trees in their nesting territories. The song cycle was a long one, lasting from January until October. Two broods commonly were raised. The neatly woven cup-shaped nests were usually placed at a height of less than five feet in the crotches of shrubs in dense thickets. The population pattern, including singing males and flushed birds, is shown in Table 1.

SUMMARY

Bird populations were tallied in weekly observations made at sunrise during the periods from March 11 through August 26, 1953, and April 17 through August 25, 1954, on a 100-acre plot of upland farms and farmyards at Setagaya, near Tokyo, Japan. Twelve species, including one summer resident were regularly recorded. The two most abundant species were the Tree Sparrow (*Passer montanus*) and the Ashy Starling (*Sturnus cineraceus*). The total population recorded increased from fewer than two birds per acre in April to nearly four birds per acre in August. Population changes of the 12 species are discussed.

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NOTES ON REPRODUCTIVE ACTIVITIES OF ROBINS IN IOWA AND ILLINOIS

BY W. D. KLIMSTRA AND W. O. STIEGLITZ

FIELD observations made in Iowa from 1946 through 1948, and in Illinois during 1955 yielded data on nesting and reproduction of the American Robin (*Turdus migratorius*). In Iowa, the observations were made in Ames, Eldon, and a rural area 4 miles southeast of Eldon, representing, respectively, central and southeastern localities in the state. Ames is situated at 42° North Latitude, and Eldon at 40.5°. In Illinois, data were collected from within the city limits of Carbondale, which is about 200 and 275 air miles south of Eldon and Ames, respectively, and 37.4° N. The observations made in Iowa were restricted largely to nest site, clutch size and hatching success, whereas in Illinois they included general breeding activities. Records from 173 nests were available for study; 112 in Iowa and 61 in Illinois.

PHENOLOGY OF NESTING

The first nest in the Carbondale area was completed on April 1, three weeks after the peak of the Robin migration had passed through this area. The initial nest-building activities continued until April 23, with the peak of construction occurring from April 10 to April 15 when 70 per cent of all observed nest construction took place. In Iowa, first nests were recorded on March 15, 1946; April 6, 1947; and April 9, 1948, with the peak of initial nestings falling within the period from April 18 to April 28 in each of the three years. There was some indication that nesting around Eldon was five to 10 days earlier than at Ames. Data for 1947 and 1948 available from a study in Wisconsin (Young, 1955) showed the peak of activity to be 10 to 20 days later than in Iowa (125 air miles north of Ames, 43.5° N.). The unusually early nesting in Iowa in 1946 may have been a response to the abnormally high temperatures in late winter and early spring, especially those of March when the mean was 11.7° F. above normal. The slightly later peak of activities in Iowa and Wisconsin probably reflected the effects of the more northerly climatic conditions. Because studies in Carbondale were not conducted after early June, dates for later nests were not available. In Iowa the latest dates for nest establishment were August 3 (1946), August 9 (1947), and August 26 (1948). These dates are significantly later than those reported by Young (1955), for July 22 was the latest date recorded in Wisconsin.

NEST CONSTRUCTION AND LOCATION

Without exception, females established the nesting site only after several possible locations were investigated. Methodical inspection of the crotches of trees, such as reported by Meuli (1935), was not observed. Howell (1942) believed that both members of the pair took part in selection of nest sites, whereas Howe (1898) expressed the opinion that this activity was limited solely to the female.

As observed by others (Howe, 1898; Howell, 1942; Burns, 1924), nest construction was accomplished by the female. During nest building activities, the male was often perched nearby, but in no case did he give aid. Construction of the nests in the Carbondale area required from three to six days; the average for 18 nests was 3.5 days. The time utilized was dependent seemingly upon weather conditions and availability of nesting materials. Composition of three nests analyzed on a weight basis proved to be approximately 35 per cent mud, 35 per cent dried grass, 25 per cent weedy stems, and 5 per cent miscellaneous items (twigs, string, pieces of paper, cotton, and cloth). The approximate average dry weight of these nests was 205 grams.

A wide variety of structures are utilized as nesting substrates. Howe (1898) states that Robin nests were observed on buildings, old carriages, and woodpiles, in addition to those found in trees. Miller (1918) and Blincoe (1924) report nests on the ground. Stewart (1931) observed a pair of Robins nesting within a tree cavity. Of the nests under observation during this study (Table 1), 97.7 per cent were constructed in trees, 1.7 per cent on buildings, and 0.6 per cent in shrubs. Twenty-nine species of trees were utilized for nesting, but only eight (3.7 per cent) of the nests were located in coniferous species. Howell (1942) reported that 57.6 per cent of the early nests in a New York study were located in conifers and 25.4 per cent in deciduous species; later nestings, however, showed a reverse trend. It should be pointed out that conifers are much more abundant in New York than in most of the Midwest.

Of interest was the relative position of nests in trees characterized by a main trunk with prominent forked branches extending upward and outward, such as is characteristic of the elm (*Ulmus*) and maple (*Acer*) trees. Of the nest sites in these trees, 62.8 per cent were constructed in the first fork of the main trunk. Less than 25.6 per cent (11) of the nests were more than three feet from the main trunk. Such sites possibly offered greater stability, and were better protected from wind than those situated on limbs away from the trunk.

In Iowa, nest height above the ground varied from 5 to 45 feet, whereas those in Illinois ranged from 5 to 35 feet. Mean heights for the two areas were 10.7 feet and 15.4 feet, respectively. Young (1955) reported a mean height of 7.4 feet. In Ithaca, New York, 50 per cent of the nests were within 10 feet of the ground (Howell 1942).

CLUTCH SIZE

Sizes of 29 completed clutches (nest known to have been incubated) in the Carbondale area ranged from 1 to 5 eggs, showing a mean of 3.17. In Iowa 81 completed clutches numbered from 2 to 4 eggs with a mean of 3.44, which was almost identical to the value (3.4) reported by Young (1955). Possibly the slightly larger average clutches for Iowa and Wisconsin indicate a climatic relationship resulting in greater reproductive rate among species in the northern parts of their range. Abnormally large clutches (8 eggs), as reported by Keyser (1908) and Loveridge (1939) were not observed.

TABLE 1

NESTING SITES OF THE AMERICAN ROBIN IN ILLINOIS AND IOWA

	No. of nests	Per cent of total
Trees		
Deciduous species (95.3 per cent)		
American elm (*Ulmus americana*)	57	32.9
Box elder (*Acer negundo*)	28	16.1
Black maple (*Acer nigrum*)	10	5.8
Silver maple (*Acer saccharinum*)	8	4.5
Red maple (*Acer rubrum*)	6	3.5
Apple (*Malus pumila*)	6	3.5
Black willow (*Salix nigra*)	4	2.3
Green ash (*Fraxinus pennsylvanica*)	4	2.3
Norway maple (*Acer platanoides*)	3	1.8
Red mulberry (*Morus rubra*)	3	1.8
Wild plum (*Prunus hortulana*)	3	1.8
Sycamore (*Platanus occidentalis*)	3	1.8
Osage orange (*Maclura pomifera*)	3	1.8
White oak (*Quercus alba*)	3	1.8
Peach (*Prunus Persica*)	3	1.8
Sugar maple (*Acer saccharum*)	2	1.1
Catalpa (*Catalpa speciosa*)	2	1.1
Wild cherry (*Prunus serotina*)	2	1.1
Wild crabapple (*Malus ioensis*)	2	1.1
River birch (*Betula nigra*)	2	1.1
Persimmon (*Diospyros virginiana*)	2	1.1
Black walnut (*Juglans nigra*)	1	0.6
Post oak (*Quercus stellata*)	1	0.6
Shingle oak (*Quercus imbricaria*)	1	0.6
Dogwood (*Cornus florida*)	1	0.6
Pig nut hickory (*Carya glabra*)	1	0.6
Coniferous species (4.5 per cent)		
White pine (*Pinus strobus*)	2	1.1
Shortleaf pine (*Pinus echinata*)	1	0.6
Red cedar (*Juniperus virginiana*)	5	2.9
	169	97.7
Shrubs		
Coralberry (*Symphoricarpos orbiculatus*)	1	0.6
	1	0.6
Other Structures		
Houses	2	1.1
Corn granary	1	0.6
	3	1.7
TOTALS	173	100.0

INCUBATION

In all observed cases, the female accomplished incubation. The male was usually perched nearby, and on several occasions was noted to drive off other species which ventured near the nest. No instances of "incubation feeding" by the male, as reported by Brackbill (1944), were observed. During the early stages, the nest was vacated for fairly long periods for feeding, but as the time of hatching approached, the nest was left infrequently and then for very short periods. Only two cases of nest desertion were observed following the commencement of incubation.

HATCHING AND NESTING SUCCESS

In the Carbondale area the peak of hatching for spring nesting occurred from April 23 to May 1; 77 per cent of the nests hatched during this period. The earliest date on which a brood hatched was April 20. In Iowa 68 per cent of the nests were recorded hatching during the first 10 days of May. The earliest hatchings were on April 9 in 1946, April 20 in 1947, and April 26 in 1948. The peak of hatching reported for Wisconsin (Young, 1955) appears to occur about 20 to 30 days later than that in southern Illinois and 10 to 20 days after that observed in Iowa.

Of the 61 nests found at Carbondale, Illinois, only 31 could be considered for an evaluation of hatching success, since 30 nests contained no eggs during the period of study. One or more eggs hatched in 29 (93.5 per cent) of the 31 nests with eggs. Hatching success for nests observed in Iowa was found to be 48.6, 51.0, and 42.0 per cent for 1946, 1947, and 1948, respectively. Howell (1942) and Young (1955), reporting on success of nests which contained one or more eggs, showed 64.7 and 48.8 per cent hatches in New York and Wisconsin, respectively. An analysis of nest data by Kendeigh (1942) revealed a success of approximately 82 per cent for the American Robin, whereas an extreme of only 13 per cent was recorded by Thomsen (1944).

Ninety-four per cent of the eggs deposited in nests in the Carbondale area hatched, in comparison to 79.6 per cent in Iowa. Data presented by Howell (1942), Young (1955), and Kendeigh (1942) showed hatches of 60.6, 57.6 and 86.0 per cent, respectively.

The rural nesting sites assured greater safety to nesting birds than did those within urban areas in Iowa. Rural nests (49) showed 69.0 per cent success compared with 32.7 per cent for 63 urban nests. It was believed that the virtual absence of house cats (*Felis domesticus*) from the rural areas was a major factor contributing to the observed differential in rates of nesting success.

Data on the factors responsible for nesting losses were accumulated for 38 nests; wind, predators, miscellaneous factors and human interference were found responsible for 41, 29, 21 and 9 per cent of the losses, respectively.

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DISTRIBUTION OF THE PALM WARBLER AND ITS STATUS IN MICHIGAN

BY LAWRENCE H. WALKINSHAW AND MARK A. WOLF

Although the Palm Warbler (*Dendroica palmarum*) is known in most of the eastern United States as a migrant or winter visitant with a breeding range lying almost entirely in Canada, it has been known to breed in northern Minnesota, and evidence of its breeding in Michigan and Wisconsin has accumulated in recent years. This report is concerned principally with the western form, *D. p. palmarum*, most individuals of which are distinguishable in the field from the eastern race, *D. p. hypochrysea* (see Peterson, 1947: plate 49). The western form breeds from central Ontario westward in favorable wooded habitats through Manitoba, central and northern Saskatchewan and Alberta to northeastern British Columbia and into southern Mackenzie (Rand, 1944*b*).

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Spring Migration in Michigan

The western race of the Palm Warbler begins its migration northward by late March (Bent, 1953:447), and reaches Michigan during late April. At Ann Arbor, Washtenaw County, Michigan, the earliest records (Wood and Tinker, 1934:44) in the first half of a 50-year period ending in 1930 were April 26 (1886 and 1888). During the second 25 years the earliest date was April 21 (1919). In this latter period 17 dates fell between April 21 and April 30, and six in early May.

Near Battle Creek, Calhoun County, Michigan, Walkinshaw observed the species on 41 different days between April 24 (1948) and May 21 (1931 and 1944). Seven observations were in April, and 34 in May. The median date on which 100 birds were observed was May 8.

Autumn Migration

The western form of the Palm Warbler begins migration in the fall during the latter part of August (Bent, 1953:448; Soper, 1942:80; Godfrey, 1950:71). The main migration in the Canadian provinces occurs in late August and early September. Rand (1944*a*:123) observed two birds at Muskwa, Mile 152J, Alaskan Highway, British Columbia, September 16, 1943. At Junction Lake, Wood Buffalo Park, Alberta, Soper

(1942:80) observed small active bands in southerly migration on September 2, 1933, a few remaining until September 18. W. Ray Salt (1938:135) reported that between 75 and 100 Palm Warblers were observed, September 7 to 10, 1935, in the Rosebud District, Alberta. Godfrey (1950:71) observed the species at Flotten Lake, Saskatchewan, July 31 to September 6, 1948, but the main migration occurred between August 26 and September 6. At Moosonee, Ontario, Lewis (1939:51) noted a marked southward movement on September 18, 1938, and he and Peters (1941:114) gave the latest date as September 24, as did Hewitt (Manning, 1952:83). Along Lake Superior where the Agawa River enters Agawa Bay, Ontario, Fargo and Van Tyne (1927:8) noted the species regularly from late August to September 12 when 25 were observed. Thomas S. Roberts (1932:243–244) gave the earliest fall record in Minnesota as August 30 (1927, at Frontenac, Goodhue County) and the latest date, November 3 (1898, at Lanesboro, Fillmore County) but the average date fell in late September.

In southern Michigan, Walkinshaw has noted the species between September 5 (1955, in Muskegon County) and October 15 (1945, in Calhoun County). In Muskegon County he observed 61 Palm Warblers on 11 different dates in the fall, the median date being September 18. In Calhoun County, 86 birds were seen on 27 different dates, the median being September 25.

Wood and Tinker (1934:44) gave records for fall departure from Ann Arbor, Michigan, as September 3 (1912, earliest); and October 14 (1923, latest). Eight records fell in September; three in October.

Dendroica p. palmarum is a common migrant through central United States, rarely as far west as Montana (Saunders, 1921:148) and Nebraska, south to Louisiana where it occurs rarely in winter (Lowery, 1955:36). It is infrequent in New England in migration, but crosses the panhandle of West Virginia (Sutton, 1936:89; Haller, 1938:677).

WINTER

The eastern form of the Palm Warbler migrates from the northeastern United States and eastern Canada southwestward, wintering rarely in peninsular Florida but moderately in northwestern Florida (Howell, 1932:410) occasionally to the Keys, then westward along the Gulf States to Louisiana. Birds of the western subspecies cross this migration route enroute to and from peninsular Florida, the Bahamas and the West Indies. While on the Kissimmee Prairie from March 20 to 28, 1938, Walkinshaw observed from one to six Palm Warblers daily. Green *et al.* (1945:60) stated that the nominate race occurred commonly in southern Georgia in winter, and the *D. p. hypochrysea*, all over the state.

The western race of the Palm Warbler has been observed and collected in Bermuda (Griscom, 1937:543–544; Bent, 1953:449), at sea almost 200 miles in the North Atlantic (Scholander, 1955:228), regularly in the Bahamas (Bent; Vaurie, 1953:47; Mayr, 1953:500), in Cuba, "The commonest bird in Cuba . . ." (Barbour, 1943:115), south and east to the Virgin Islands, Puerto Rico and west to Providence Island, Honduras, and Yucatan (Bent). Northward it winters regularly to central Louisiana, Alabama, and South Carolina.

In March, 1945, Walkinshaw observed the species at the airport at Havana, Cuba, on arrival, and then commonly on the Isle of Pines, counting 98 birds (2 to 18 daily) March 13–23 (Walkinshaw and Baker, 1946:140–141).

Breeding Distribution

Although the Palm Warbler is of widespread occurrence in southern Canada, its breeding distribution in the northern United States is irregular (Fig. 1). Records for Minnesota were summarized by Roberts (1932:244–245), and W. J. Breckenridge stated (letter, 1956) that he knew of no additional ones. (Nests reported from Minnesota are listed in Table 1, and further discussion is presented under the topic, Nesting Habitats.)

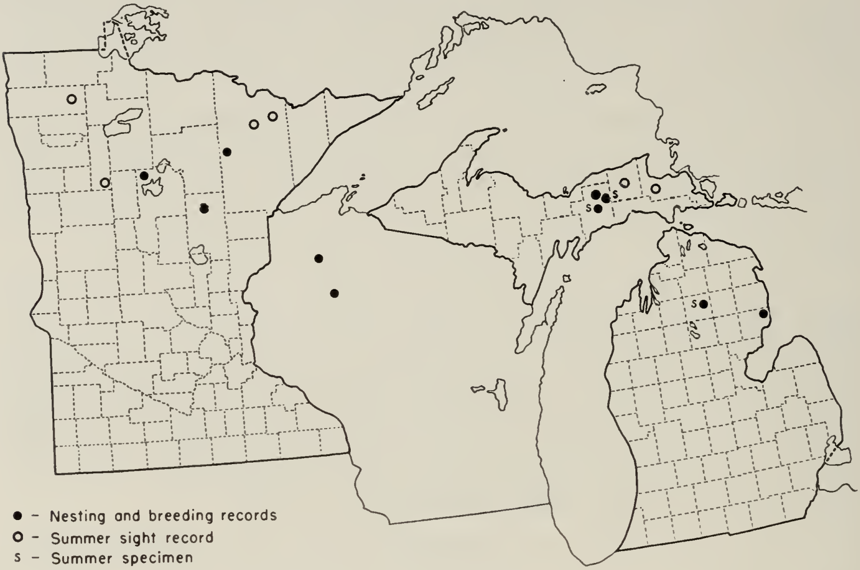

Fig. 1. Localities of record for *Dendroica p. palmarum* in the United States during the breeding season.

Kumlien and Hollister (1903) stated there was no evidence that this species was a summer resident in Wisconsin. Two decades later, Wallace B. Grange (1924:160) found it in northern Rusk County in June and July, 1923, and observed the birds carrying food on July 8, 1923. Francis Zirrer (Feeney, 1942:84; Bent, 1953:440) stated that the Palm Warbler bred at Hayward, Sawyer County, Wisconsin. Zirrer (letter, November 27, 1955) wrote that the species was a fairly common summer resident in northwestern Sawyer and Rusk counties and northeastern Washburn County.

The accounts that follow will outline our present knowledge of the status of the Palm Warbler as a breeding bird in Michigan.

Lower Peninsula of Michigan.—On June 16, 1931, Richard E. Olsen, Humphrey A. Olsen, Mr. and Mrs. N. T. Peterson and Walkinshaw went to Lovells, Crawford County, Michigan, hoping to photograph and study Kirtland's Warbler (*Dendroica kirtlandii*). They had found a newly completed nest there on May 31. Although this nest was deserted, two males were heard singing and a search for nests began immediately. During the afternoon, Mr. Peterson called that a Palm Warbler was scolding him. The Olsens and Walkinshaw rushed over and soon found the female with three stubby-tailed young that must have just left the nest. The nest was not found but the young were photographed (Olsen, Olsen and Walkinshaw, 1931:614). The male was heard singing that evening and the next morning from the top of a 35-foot jack pine (*Pinus banksiana*) which stood above the level of the smaller pines where the Kirtland's Warbler was found. Two Palm Warblers were observed on June 17, and one on June 18.

Independent of this group, Leonard Wing (1933:73–74) worked through this same area during June and early July, 1931, taking the first summer specimens of the Palm Warbler for Michigan. Norman A. Wood had taken an immature female (Univ. Mich. Mus. Zool., 61610) at Tobias Harbor, Isle Royal, August 9, 1929, which was probably a migrant. Wing took an adult male (UMMZ, 67489) on June 3; two males on June 15; one male and a juvenal male, July 4 and a female July 5 (all specimens in UMMZ). During the summer he observed 15 adults and six young.

With all of the work done on Kirtland's Warbler in the jack pine area since 1931, apparently no one found another Palm Warbler until 1955. This gap may represent a real absence of the species, although it may have been overlooked due to a similarity of its song to those of several other species, the Pine Warbler (*Dendroica pinus*), Slate-colored Junco (*Junco hyemalis*), and Chipping Sparrow (*Spizella passerina*) nesting nearby.

On June 18, 1955, while searching for Kirtland's Warblers two miles west of Oscoda, Iosco County, Michigan, and one-half to three-quarters of a mile south of the highway, Mark Wolf found a Palm Warbler's nest. This nest had four young about ready to leave and one infertile egg.

Upper Peninsula of Michigan.—Walkinshaw observed a male Palm Warbler which was definitely established on territory during May, 1943, in an extensive sphagnum moss–spruce swamp in Kinross Township, Chippewa County. On June 20, 1954, W. Powell and Betty Cottrille, William A. Dyer, Russell and Vivian Mumford and he observed three Palm Warblers in a small segment of this same area. On June 23 he again found one of these warblers here.

On June 17, 1953, a group of Wilson Ornithological Society members found a singing male Palm Warbler just west of Sleeper Lake (T48N,R10W,Section 33), Luce County. Pettingill (1951:285) reported the species here also.

On June 27, 1954, Walkinshaw found a singing male in another bog about seven miles northwest of Seney, Schoolcraft County.

On June 16, 1954, C. J. Henry, John Bunnell and Walkinshaw were searching for LeConte's Sparrow (*Passerherbulus caudacutus*) on the Seney

National Wildlife Refuge, Schoolcraft County. A little west of M-Pool, near the Driggs River, as they were hiking along a ridge they observed a Palm Warbler only a few feet away. The bird, which was carrying food, scolded and wagged its tail nervously. Separating, they sat down, and in only a short time the female went to the nest, which contained five young ready to leave. Hoping to obtain photographs, a rush trip was made for cameras, and in only a short time the Cottrilles, William Dyer, Eliot Porter and Walkinshaw returned to find the nest empty. After about two hours they caught four of the young and did get some photographs. One specimen was taken (UMMZ, 136638). The young were replaced in the nest and remained there into the night, but left again the next morning. Josselyn Van Tyne and Betty Cottrille collected the nest (UMMZ); it was made of plant culms, grasses, and some ferns, and lined with feathers, including one large feather of the American Bittern (*Botaurus lentiginosus*), and some fine grasses. Both male and female fed the young, usually at intervals of about three or four minutes. During the entire day, while they were there, with the young out of the nest, the male fed two only and the female fed the other two exclusively.

On June 22, 1956, Laurence C. Binford and Walkinshaw found a singing male in Section 35, T46N,R13W, about 2½ miles east of Seney. The next day there were two singing males here and one pair was carrying food. Binford, William A. Dyer and W. Powell Cottrille found a nest with five very alert young (Fig. 2). The nest was made of grasses, lined with fine dead grasses and small feathers. When collected it weighed 5.1 grams and measured 61.4 mm. across and 34 mm. in depth. Between 5:07 and 7:31 p.m. that evening Walkinshaw was photographing the birds at the nest. The female fed the young 14 times, the male six. They always fed the nestlings insects. The next morning all five young were out of the nest. Dyer captured and banded three of them. One was four inches from the nest; another six inches; a third, 40 feet away and three feet up in a black spruce (*Picea mariana*). The first two were hidden in the dead grass which surrounded the small spruce under which the nest was located.

On June 24, 1956, just one-half mile north of the town of Seney (Section 28,T46N,R13W), Schoolcraft County, Walkinshaw found another pair of Palm Warblers feeding four alert young in a nest. This nest was in the same bog in which the one was found the previous day. It was near a dry ridge but in the border of the bog area. The nest, which weighed 7.1 grams, was built of dead grass and lined with fine grasses and many feathers. It was placed in sphagnum on the ground in a tangle of dead grass at the base of an eight-foot jack pine.

Early in the morning of June 25 all four young Palm Warblers were out of the nest. One was 16 feet northwest; another 31 feet southwest; the third 156 feet west-southwest; the fourth, 39 feet west. Three were hidden

FIG. 2. Palm Warbler feeding nestlings 2 miles east of Seney, Michigan, June 23, 1956.

in leatherleaf (*Chamaedaphne*) and dead grass combination; the fourth was sitting on a jack pine branch one foot from the dry ground on the island of thick jack pine (Fig. 3). All the fledglings were captured and banded. The female fed the young regularly, but the male refused to do so while they were being photographed.

In this area Walkinshaw found two other singing males on June 24, 1956, and observed three on July 4, 1956, one of which was carrying food to young out of a nest. These males observed on the latter date were still singing. Two singing males were found here in late June and early July, 1957, and on June 13, 1957, Walkinshaw, William A. Dyer and Dale Zimmerman found a pair feeding at least three young just out of a nest. One of these could not fly and was easily captured.

Palm Warblers were not found in 'colonies' in any Michigan areas, but rather in scattered pairs. In some areas, probably more favorable, more pairs were located than in others where solitary singing males were observed. Thus, the discovery of one pair is no guarantee that others will be found in the vicinity.

Fig. 3. Female Palm Warbler with recently-banded fledgling, one-half mile north of Seney, Michigan, June 25, 1956.

Nesting Habitats

The eastern form of the Palm Warbler (Tyler, 1953:451) has been found nesting in two types of habitats. It frequents either the sphagnum bogs or the open barrens, building its nest on the ground or, more rarely, on low branches of the small spruce trees.

Very few nests of the western race have been found. It appears that, in addition to the brush-covered Arctic and sub-Arctic barrens, this form also nests in the same two types of habitats used by the eastern race (see Rand, 1944*b*). L. L. Snyder (1953:79) wrote that the western form used two types of habitats in western Ontario: dry forests of jack pine in park-like areas of mature trees or between thick stands of small trees; and the wet, black spruce bogs, usually of an open nature.

In Manitoba, August 1–31, 1936, P. A. Taverner, Ronald W. Smith, and T. E. Randall found *Dendroica palmarum* the commonest warbler at Thicket Portage, where several juveniles and adults were taken. That summer they recorded the species daily, July 18–30, at Ilford, and located a nest with five eggs at Bird in mid-July, but found only two individuals at Herchmer on June 22. Their field notes show that the species was fairly common in second-growth deciduous shrubbery (Godfrey, 1953:3, 39–40).

The Palm Warblers found in Crawford County, Michigan, in June, 1931 (no. 29, Table 1), were in completely dry area covered with Grayling sand, and grown to low-statured jack pines, with clearings and thick stands alternating. The ground cover was of grasses, bearberry (*Arctostaphylos uva-ursi*), blueberry (*Vaccinium*), wintergreen (*Gaultheria procumbens*), and sweet fern (*Myrica asplenifolia*). The area where Wolf found the nest (no. 31) in Iosco County, Michigan, was very similar to this Crawford County area. That nest was placed on the ground at the base of a jack pine.

The nest found on the Seney National Wildlife Refuge on June 16, 1955 (no. 25), was placed on a dry ridge completely surrounded by muskeg. The ridge was grown to a thin. wiry grass, some wintergreen and blueberry and a few dead bracken ferns (*Pteridium*). On the ridge were several jack pines ranging in height from 15 to 25 feet. Several yards to the south was an extensive sphagnum moss–leatherleaf bog similar to that just east of Seney. There were extensive areas of leatherleaf where no trees were located at all. Other portions of the bog were surrounded by black spruce in thick, dense stands. In a partial clearing of one of these stands of spruce, Binford, Dyer, and Cottrille found their 1956 nest (no. 26). It was situated at the base of a 4½-foot black spruce, sunken to the rim in sphagnum moss (Fig. 4). Dead grass, fine sedges, leatherleaf, Labrador tea (*Ledum groenlandicum*), swamp laurel (*Kalmia polifolia*), and rosemary (*Andromeda*) were found in the vicinity. On the dry ridges *Lycopodium*, trailing arbutus (*Epigaea repens*) and wintergreen were found. The second nest found in 1956 (no. 27) was situated in the sphagnum at the base of an eight-foot jack pine, surrounded by dead grass and sedges growing along the leatherleaf border. There were some tamaracks (*Larix laricina*) and orchids scattered through the bog also.

Francis Zirrer (W. S. Feeney, 1942:84; Bent, 1953:440) stated that in Wisconsin the Palm Warbler bred at Hayward, Sawyer County, in cedar (*Thuja occidentalis*)–tamarack–spruce bogs. Zirrer (letter, November 27, 1955) wrote: "This species is a fairly common summer resident in suitable bogs." He never found the species in thick bog forests or in treeless bog areas. It preferred situations where trees, such as tamarack, black spruce, white cedar and balsam (*Abies balsamea*), both large and small, in groups and singly, alternated with open sphagnum and bog shrubbery. The Palm Warbler rarely was found far from the rim of the bog. The nest (no. 24) Zirrer discovered on May 20, 1949, was sunken into sphagnum under the drooping boughs of a small black spruce, next to the bole of an uprooted tamarack of about 10 inches in diameter. It was made of dry swamp grass, and greenish-gray lichens from the tamarack bole, and was lined with feathers from a dead Barred Owl (*Strix varia*) found nearby.

In Minnesota, Dr. Roberts (1932:244) stated that the Palm Warbler was found in spruce–tamarack bogs, where the nests were sunken to the rim in sphagnum hummocks and surrounded by small, shrubby plants, but open from above. The nests in Minnesota (nos. 20–21) were made of coarse grass and roots, lined with fine grass and rootlets.

TABLE 1

NESTS OF THE WESTERN PALM WARBLER

No.	Locality	Date	Breeding Record[1]	Observer	Published Record or Specimen
1.	ONTARIO, Moosonee, Cochrane District, 51°N., 80.5°W.	July 11, 1939	Nest, 5 eggs	T. M. Shortt	(Royal Ontario Mus. Zool.)
2.	ONTARIO, Moosonee, Cochrane District	July 17, 1939	Nest, 4 young	T. M. Shortt	(ROMZ)
3.	ONTARIO, Cochrane District, McMillan Twp.	June 7, 1952	Nest, 5 eggs	Clifford Hope	(ROMZ)
4.	ONTARIO, Thunder Bay District, Port Arthur, 48.5°N., 89.5°W.	June 19, 1945	Nest, 4 eggs	L. S. Dear	(ROMZ)
5.	MANITOBA, Lake of the Woods, 95°+ W.	Summer, 1920	1 juv., 1 female taken	Wm. Rowan	(1922:232 and letter)
6.	MANITOBA, Bird, 56.5°N., 94°W.	July 3–17, 1936	Nest, 5 eggs	P. A. Taverner R. W. Smith T. E. Randall	(Godfrey, 1953: 3, 39, 40)
7.	MANITOBA, Vivian, 49.9°N., 96°W.	July 12, 1932	Nest, 4 young	T. M. Shortt	(ROMZ)
8.	SASKATCHEWAN, Jeanette Lake, 54.5°N., 108°W.	August 2, 1948	1 juv., 1 female taken	W. E. Godfrey	(1950:71)
9.	SASKATCHEWAN, Birch Lake near Roddick, 53°N. 106.25°W.	June 10, 1927	Nest, 5 eggs	H. H. Mitchell	(Saskatchewan Mus. Nat. Hist.)
10.	ALBERTA, Belvedere, 54°N., 114.7°W.	June 12, 1923	Nest, 5 eggs	R. C. Harlow	(Bent, 1953: 441)
11.	ALBERTA, Belvedere, 54°N., 114.7°W.	June 11, 1924	Nest, 5 eggs	Dick Rauch	(Bent, 1953: 441)
12.	ALBERTA, Belvedere, 54°N., 114.7°W.	June 16, 1924	Nest, 5 eggs	R. C. Harlow	(Bent, 1953: 441)
13.	ALBERTA, Grasslands, 54.9°N., 112.8°W.	May 23, 1933	Nest, 5 eggs	T. E. Randall	(Bent, 1953: 441)
14.	ALBERTA, Fawcett, 54°N., 112.8°W.	year ?	Nest, eggs	Wm. Rowan	(Letter, 1957)
15.	ALBERTA, Fawcett, 54°N., 112.8°W.	May 25, 1942	Nest, 5 eggs	L. H. Walkinshaw	(Baker and Walkinshaw, 1946:9)

16. ALBERTA, Chipewyan, 59°N., 111°W.	July 2, 1945	Nest, 4 eggs	T. M. Shortt	(letter)
17. BRITISH COLUMBIA, Trutch, 57.5°N., 123°W.	July 13, 1943	Adult feeding young	A. L. Rand	(1944*a*:123)
18. NORTHWEST TERRITORIES, Fort Resolution, Dist. of Mackenzie, 61°N., 113.5°W.	June 18, (year?)	Nest, 5 young	Kennicott	(Ridgway, 1889:155)
19. MINNESOTA, Marshall Co., Moose River, Mud Lake, 48°N., 96°W.	July 16–18, 1900	Three juveniles	Thomas S. Roberts	(1932:244)
20. MINNESOTA, Hibbing, 47.5°N., 93°W.	June 13, 1906	Nest, 4 young	H. F. Kendall	(Roberts, 1932:244)
21. MINNESOTA, Aitkin Co., 47°N., 93°W.	June 14, 1929	Nest, 1 egg, 3 young	N. L. Huff	(Roberts, 1932:244)
22. MINNESOTA, Cass Lake, 47.5°N., 94.5°W.	July, 1916	Adults, 2 young	L. L. Lofstrom Richardson	(Roberts, 1932:244)
23. WISCONSIN, Rusk Co., 46°N., 91°W.	July 8, 1923	Adults carrying food	Wallace Grange	(1924:160)
24. WISCONSIN, Sawyer Co., Hayward, 46°N., 91.5°W.	May 20, 1949	Nest, 3 eggs	Francis Zirrer	(letter)
25. MICHIGAN, Schoolcraft Co., Seney Natl. Wildlife Refuge, 46°N., 86°W.	June 16, 1955	Nest, 5 young	John Bunnell C. J. Henry L. H. Walkinshaw	(Nest, 1 juvenile UMMZ)
26. MICHIGAN, Schoolcraft Co., Seney, 2 mi. E.	June 23, 1956	Nest, 5 young	L. C. Binford W. P. Cottrille Wm. A. Dyer	(Nest UMMZ)
27. MICHIGAN, Schoolcraft Co., Seney, ½ mi. N.	June 24, 1956	Nest, 4 young	L. H. Walkinshaw	
28. MICHIGAN, Schoolcraft Co., Seney, ½ mi. N.	June 13, 1957	Three juveniles with parents	Wm. A. Dyer D. A. Zimmerman L. H. Walkinshaw	
29. MICHIGAN, Crawford Co., Lovells, 2½ mi. S. 44°N., 84°W.	June 16, 1931	Three juveniles with parents	H. A. Olsen R. E. Olsen N. T. Peterson L. H. Walkinshaw	(Olsen, Olsen, and Walkinshaw 1931:614)
30. MICHIGAN, Crawford Co., Lovells, 2½ mi. S.	July 4, 1931	Juvenile spec.	L. W. Wing	(1933:74) (UMMZ)
31. MICHIGAN, Iosco Co., Oscoda, 2 mi. W. 44°N., 83°W.	June 18, 1955	Nest, 4 young, 1 infertile egg	Mark Wolf	(personal communication)

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[1] Nestsites are referred to by number in section on Nesting Habitats.

One nest contained many feathers.

At Fawcett, Alberta, between the Pembina and Athabasca rivers, Walkinshaw found a nest with five eggs on May 25, 1942 (no. 15). This area was quite open, predominantly muskeg, surrounded by forests of black spruce and tamarack, with ridges covered with jack pine. In an area of drier muskeg, not far from a ridge, he flushed the female from her nest. It was an open location with a few small dwarf birch (*Betula*) growing in close proximity. The nest was beneath one of these little birches in dead grass on a sphagnum hummock. It was made of fine grass, lined with finer grasses, feathers, and fine rootlets. It measured 80 mm. across outside, 50 mm. across inside and 42 mm. deep.

Fig. 4. Nestsite of Palm Warbler at base of black spruce (*Picea mariana*), 2 miles east of Seney, Michigan, June 23, 1956.

The area near Belvedere, Alberta, worked by Richard C. Harlow, Dick Rauch and A. D. Henderson (Bent, 1953:441) was dry muskeg and the nests (nos. 10–12) were found in sphagnum moss among scattered spruces and tamaracks. One nest was concealed at the base of a spruce seedling under a clump of dry grass growing near the top of a large hummock of sphagnum. Another was constructed of plant fibers, fine dry grasses, and fine bark shreds, and was lined with feathers of the Ruffed Grouse (*Bonasa umbellus*).

W. Earl Godfrey (1950:71) found the Palm Warbler at Flotten Lake, Saskatchewan, where it was not uncommon in summer in the alder (*Alnus*) and willow (*Salix*) bogs, and at the water edges. At Fishing Lake, Saskatchewan, Walkinshaw found a singing male on June 11, 1947, in a clearing near the border of a black spruce swamp. Kennicott (Ridgway, 1889:155) found the Palm Warbler's nest (no. 18) at Fort Resolution, on the ground in a swamp, on a hummock, at the foot of a small spruce tree.

The nest (no. 7) found by T. M. Shortt at Vivian, Manitoba, was in a sphagnum moss hummock at the edge of a black spruce–tamarack swamp. The nest (no. 1) Shortt found at Moosonee, Ontario, July 11, 1939, was on the ground in sphagnum moss amid dwarf birch and Labrador tea in a treeless muskeg. The nest (no. 2) he found in the same area July 17, 1939, was also on a sphagnum hummock in open muskeg of dwarf birch, Labrador tea and a few scattered tamaracks. The nest (no. 16) he found at Chipewyan, Alberta, was in sphagnum at the edge of black spruce.

Thus, we see that the occurrence of *Dendroica p. palmarum* in the breeding season in Michigan and adjacent states is explicable on the basis of nesting habitats which are found consistent with those chosen by this warbler in the more northern portions of its range.

SUMMARY

The western race of the Palm Warbler nests in coniferous woodland areas of southern Canada and adjacent portions of Minnesota, Wisconsin, and Michigan, and it is known only as a migrant or winter visitant in most of the eastern United States. Details concerning the first reported nestings in Michigan are presented, and breeding habitats discussed.

Descriptive data for 31 nesting records of *Dendroica p. palmarum* are listed. Nesting areas used seem to be of two types. One is on dry plains grown to small jack pines, with clearings and a ground cover of low, spreading shrubs, such as bearberry, blueberry, wintergreen, trailing arbutus, and sweet fern. The Palm Warbler prefers such dry areas in the northern part of the lower peninsula of Michigan (the same habitat occupied by Kirtland's Warbler), and was found on similar dry ridges in spruce swamps in the northern peninsula. All nests were built in semi-open areas where the spruce and jack pine were neither too tall nor too dense, and where clearings were interspersed with patches of denser growth. The other type of nesting habitat was along the borders of spruce bogs, where clearings were grown sparingly to small black spruces, and the ground covered with sphagnum moss, leatherleaf, Labrador tea, *Andromeda*, and *Kalmia polifolia.* In northern Ontario and the treeless areas of the arctic slope of Canada, the species is found in second-growth deciduous shrubbery on the tundra. There, dwarf birch often is the predominant shrub.

With what meagre information is available, it appears that the Palm Warbler prefers to nest on the ground at the base of a small tree or shrub. Small spruces, jack pines or tamaracks are the favorite trees in Michigan; bracken fern was also used, whereas two nests from farther north were at the bases of small dwarf birches.

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1703 WOLVERINE–FEDERAL TOWER, BATTLE CREEK, MICHIGAN, AND 2609 JEFFERSON AVE., MIDLAND, MICHIGAN, JULY 1, 1957

FALL MIGRATION AND WEATHER, WITH SPECIAL REFERENCE TO HARRIS' SPARROW

BY O. A. STEVENS

Discussion of weather in relation to migration has usually pertained to the spring season. There are several reasons why fall migration should receive more attention. Systematic trapping and banding on a large scale have resulted in the accumulation of many new data. From 1926 to 1955 I banded approximately 7,000 Harris' Sparrows (*Zonotrichia querula*), about 80 per cent of them in the fall. This species has a narrow migration path, is easily trapped and seems well suited for such study. Harkins (1937) concluded that these birds do follow the same routes and stop at the same places, but he was working within the winter range where movements are limited. The only station return that I have had was a bird banded October 13, 1953, and recaptured October 1, 1955. No birds banded at other stations have been caught by me, but one banded here on September 16, 1937, was caught at Aberdeen, South Dakota, May 4, 1940.

In the spring, Harris' Sparrows reach Fargo, North Dakota, about May 7 (Stevens, 1950) and are present about two weeks. It seems evident that both their arrival and length of stay are delayed by cold weather, and that their departure is hastened by a warm wave. They are restless and there are few repeat records of individual birds. In the fall they appear about September 20 and are common for about four weeks. From 1927 to 1940 large numbers were trapped (Table 1). Fewer were taken from 1941 to 1951, but there were more again in 1952 when 52 of 210 individuals (25.2 per cent) registered repeat records.

Figure 1 shows the fall migration of Harris' and White-throated sparrows (*Zonotrichia albicollis*) based upon numbers of birds banded over a period of 14 years. For an individual year there are alternating highs and lows in numbers (Fig. 4) and, since these occur on different days in different years, an actual daily average would give a relatively flat curve.

Use of Trapping Data

The significance of the numbers caught in any one day may be questioned, but in the main I feel that the total captured corresponds to the numbers present. Large numbers trapped indicate influxes of birds and vice versa. In the spring an influx often represents a check in migration due to unfavorable weather. The often-observed "warbler waves," when correlated with high temperatures, suggest that an influx may also be a normal rest period. In the fall we might expect accumulations during favorable weather but it seems more likely that the peaks represent either minor local movement or normal rest periods. The frequent reappearance of individuals after an absence of several days is indicative of local population shifts.

I had noted (Stevens, 1930) that regular trapping operations contribute to general information because of the frequent visits to traps. Workers not engaged in trapping have questioned that numbers trapped are as reliable an index as those obtained from sight records. I feel that trapping records are useful for species that can be taken readily. They have seemed to me

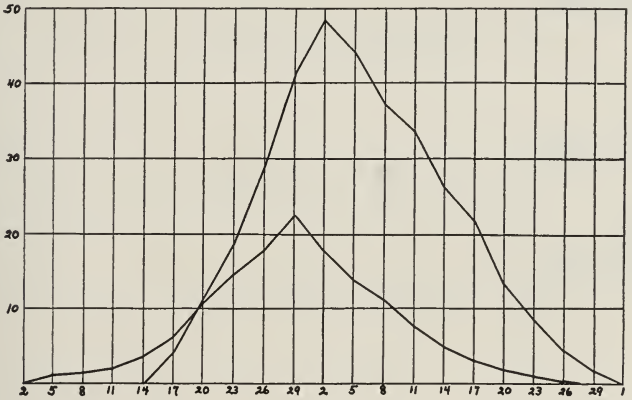

FIG. 1. Fall migration of Harris' (upper line) and White-throated sparrows at Fargo, North Dakota. The numbers are totals for three-day periods using a running average of five days for each day of the months of September and October from 1927 to 1940 inclusive.

TABLE 1

REPEAT RECORDS OF HARRIS' SPARROW AT FARGO, NORTH DAKOTA, IN RELATION TO OCTOBER TEMPERATURE

Year	Number banded	Per cent repeating	Avg. days stay	October Temperatures Mean, °F.	Departure from normal
1927	165	38.7	7.5	48	+3
1928	412	51.9	7.5	46	+1
1929	248	38.3	4.7	48	+3
1930	361	47.4	6.3	44	—1
1931	273	46.2	5.7	50	+5
1932	478	47.7	6.0	41	—4
1933	436	53.7	5.8	43	—2
1934	287	27.2	4.3	50	+5
1935	337	41.8	7.6	44	—1
1936	186	38.8	4.5	42	—3
1937	392	31.6	7.1	44	—1
1938	204	19.6	7.4	52	+7
1939	347	20.5	4.7	43	—2
1940	185	36.2	6.1	52	+7

more reliable with *Zonotrichia* than with *Junco*. Banded birds are definitely identified, but unbanded birds re-entering the area could not be distinguished by sight from new arrivals. Certainly trapping reveals some rare species

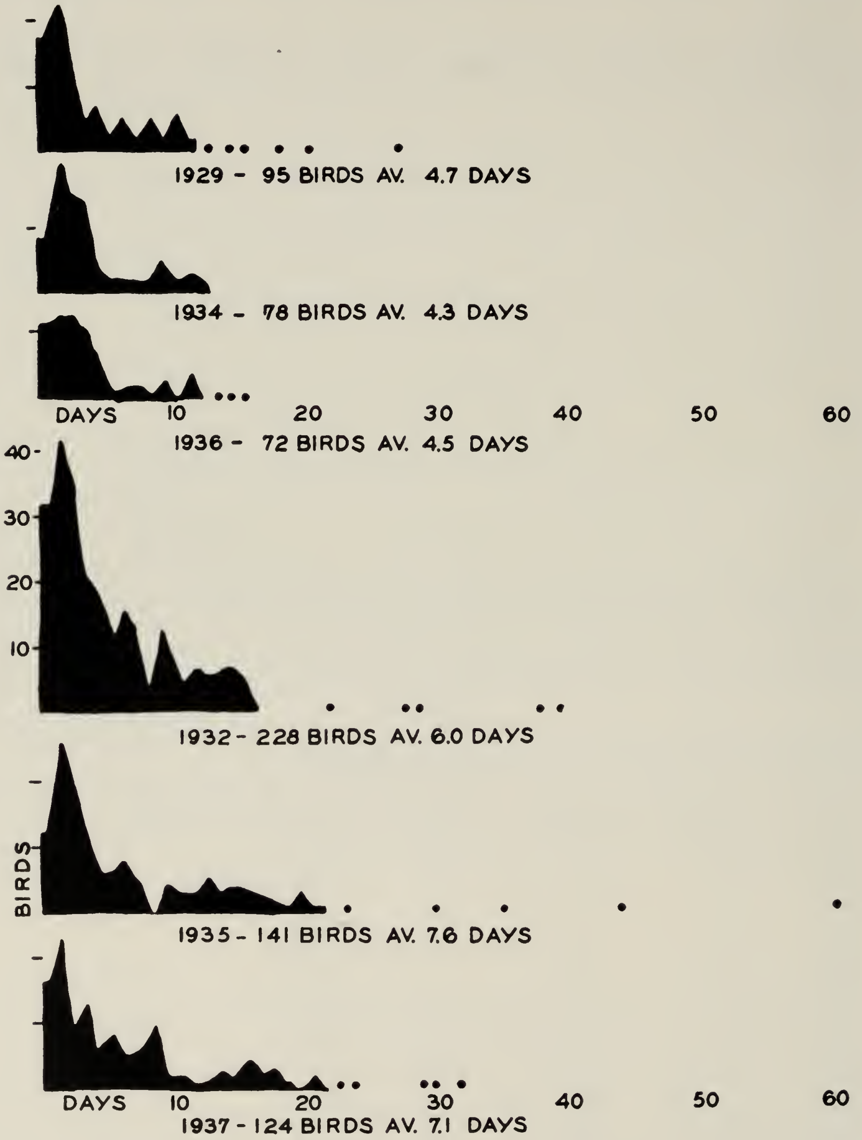

Fig. 2. Number of Harris' Sparrows repeating and length of their stay in autumn for different years. Black areas represent the total number of birds repeating and scattered dots, individual birds.

that would be unlikely to be seen on field trips. Usually only a small area is sampled by the traps and some species will be missed unless special efforts are made to secure them.

Weather Patterns and Numbers Trapped

Necessary absence of the operator and unfavorable weather at times interrupt trapping. In 1938 the weather was unusually warm and there were no interruptions. The number of birds taken (Fig. 3) shows a pronounced double peak unusually late in the season. More often there is a peak about September 25 to 30 and a second about October 15.

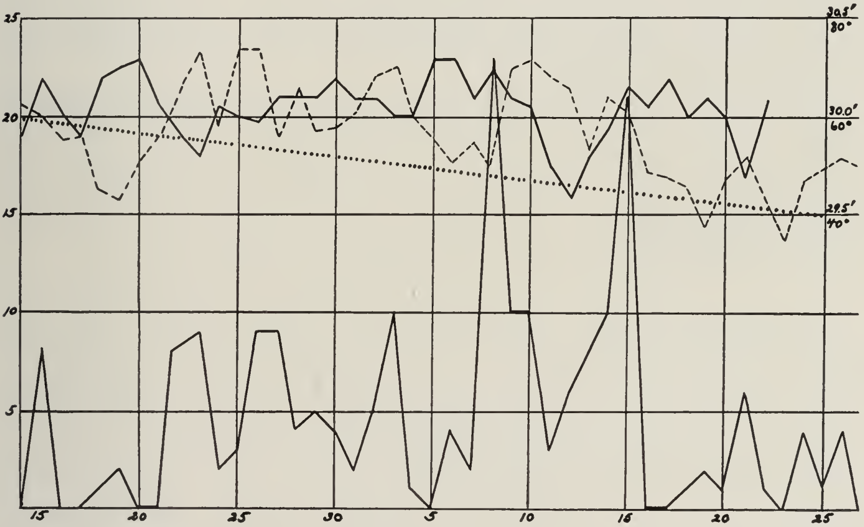

Fig. 3. Number of Harris' Sparrows banded in 1938 (lower line). Solid line above is barometric pressure at 7:00 a.m.; broken line, mean temperature in °F; dotted line, normal mean daily temperature.

It might be argued that the data for 1938 (Fig. 3) show the effects of warm weather in the late peak of birds. The weather of 1952 was similar to that of 1938 but the curve for birds banded was quite different. The largest numbers were taken on September 19 and 20. There were no well-marked fluctuations through October and very few Harris' Sparrows were taken after October 15.

The largest numbers were taken in 1952 on September 19 and 20. This was during a cool period. The temperature began falling from the 16th and remained below normal until the 23rd. There was a pronounced drop in birds on the 21st followed by a recovery for the next three days and then another drop for two days. A warm wave from September 25 to 30 showed little effect nor did another cool wave, October 1 to 7. The next cold wave on October 13 to 16 coincided with the end of the main migration.

It is often suggested that birds are detained longer by the feeding that accompanies banding operations but after many years of study I feel that very few individuals are so affected (see Fig. 2). For example, in October, 1952, very few repeats occurred, although the weather continued unusually mild. Other causes may be responsible for the persistent repeats. Occasionally a bird trapped frequently is found to be ill. Since 1932 I have used water traps almost entirely because they capture nearly all species. This method would eliminate the feeding factor, and dry, warm weather seems not to have an obvious effect on numbers taken by water traps. Unavoidable changes in cover and in natural feeding areas beyond the traps from year to year probably are more important.

In 1936, with about the same number of birds as in 1938, twice as many repeated. The distribution of the repeats was similar to that of 1938 but the average length of stay was much shorter. The banding pattern was fairly normal (Fig. 4), and not well related to temperature, which was average but with wide fluctuations.

SIGNIFICANCE OF REPEAT RECORDS AT TRAPS

For the present purpose repeat records are of much interest. I have reported (Swenk and Stevens, 1929) that, as judged from repeat records, the average stopover of Harris' Sparrows in this latitude is about a week. Later record indicate that it has varied appreciably from year to year. There seems a tendency toward a larger proportion of repeats when birds are more abundant (Table 1), but little relation between length of stay, or mean October temperature and number repeating. The length of time over which individual birds repeated is shown in Figure 2 for three each of the longer and shorter averages. In calculating repeats, birds that were recaptured only the same day as banded are counted as one day.

These conclusions are based upon general observations and the day-to-day log of birds caught. In 1952, eight birds were taken on September 15 and 16. All but one of these repeated one or more times over periods of from one to 10 days (extreme 24 days). Since these were the first of the species taken we could surmise they had traveled some distance and were due for a rest period. On September 17 and 18 eight more birds were banded but none of these repeated. Of 21 banded on September 19, only five repeated, four on September 27 and one October 12. Of 14 banded on September 20, three repeated once in the next day of two, but three others and eight of 11 banded on September 21 repeated several times until the end of the month. Of the next nine only two repeated, but again all but one of the last four on September 23 and the first five on the 24th repeated over several days. After

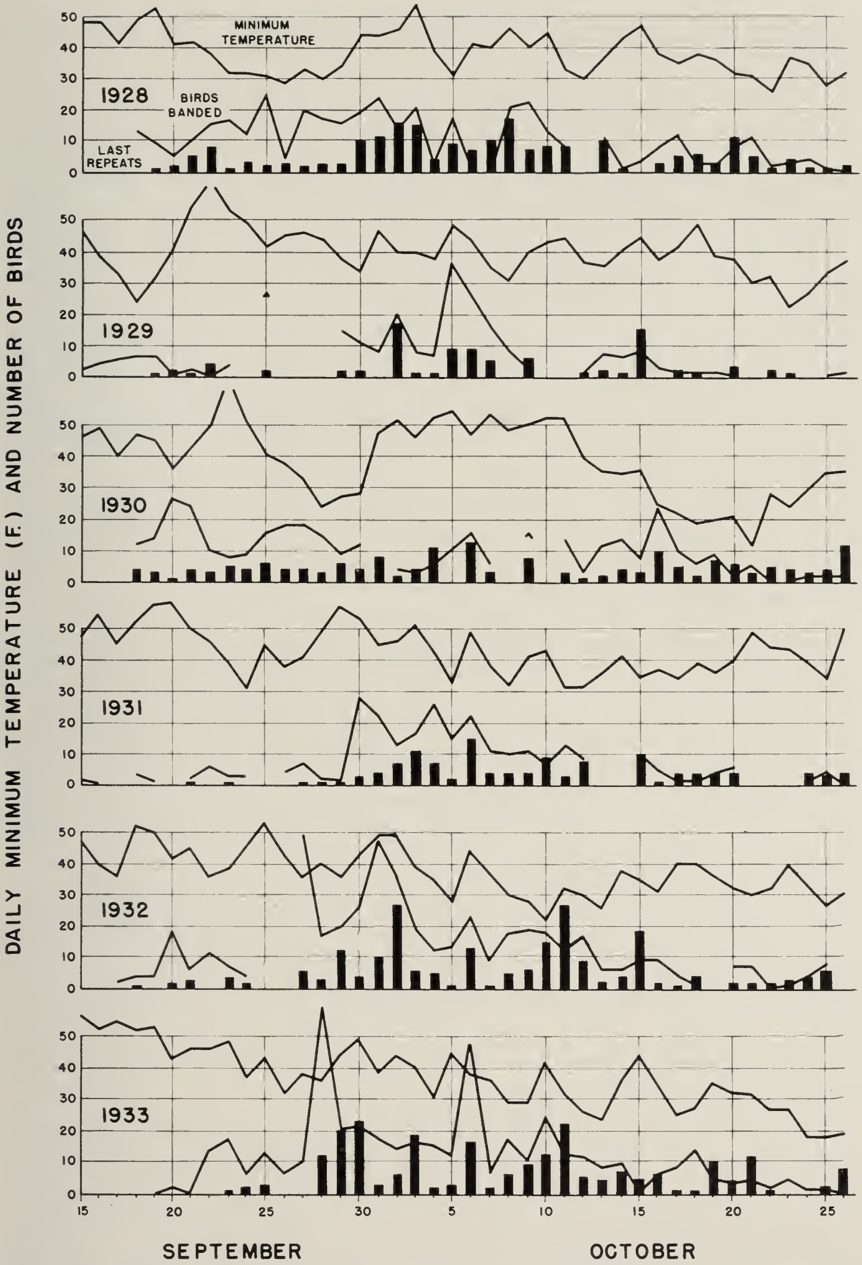

FIG. 4. Numbers of Harris' Sparrows banded and repeating for the last time; also minimum temperatures, 1928–33. Lower line, birds banded (trapping interrupted where broken); bars, birds repeating for the last time; upper line, minimum temperature in °F.

September 24 there were few repeats except for four of 10 birds banded October 4.

WEATHER PATTERNS AND AUTUMN DEPARTURES

The dates of departure from a given locality should show whether or not the weather is a major factor. When large numbers of birds have been banded and many have been retaken daily, we have good evidence of departure dates.

On the night of October 3, 1938, we saw a marked departure of all species. The wind shifted from southeast to northwest and a decided drop in maximum but not in minimum temperature followed. The largest number of Harris' Sparrows was taken October 15, when the wind was again from the *southeast.* They seemed to move on at once though the wind remained in the south and the temperature was relatively high. Notwithstanding the mild weather and lack of storms in 1938, the numbers of birds taken and numbers repeating were small but the length of stay was long.

An interesting point is the frequent observation that birds will be scarce the day the weather turns warmer, apparently having moved southward with the beginning of a south wind, rather than the day or two before during the cool period.

For the present study the departure of birds from the vicinity should indicate the time at which southward flights are begun. When the last dates on which individual Harris' Sparrows repeated in the fall of 1952 are plotted, they form as nearly a normal curve as one could expect from a limited number. The only well marked depressions are on September 25 and 28. A slight drop in temperature on September 25 was followed immediately by the greatest rise of temperature for the season. September 28 showed only a slight, temporary decrease in temperature.

Dates of pronounced arrivals and departures for the trapping periods from 1928 to 1940 were compared with weather changes. Marked increases and decreases of birds were associated about equally with either rising or falling temperatures and also with either rising or falling barometric pressures. Decided changes in numbers were most often associated with north winds, but nearly as frequently with winds from the south, less frequently with west and rarely with east winds.

Minimum temperatures might be expected to govern fall flights. In Figure 4 these are shown with numbers of birds banded and repeating for the last time on each day, 1928 to 1933. The data for October 3, 1928, seem to show heavy departure with a drop in temperature but departures on October 8 were on rising temperature. Similar cases appear on October 3 and 15, 1929, and October 2 and 11, 1932. Four departure dates in 1933 coincide with temperature drops.

SUMMARY

About 7,000 Harris' Sparrow were banded at Fargo, North Dakota, from 1926 to 1955, four-fifths of them during fall migration. They arrive at Fargo about September 15 and are abundant until October 14 to 20, reaching the peak about October 2. Only one return record has been secured during this period and no birds banded at other stations have been taken. Many individuals remain in the vicinity for several (usually five to seven) days, occasionally as much as a month. Birds banded on certain days frequently seem to remain in the area while those taken on other days do not repeat.

The number of birds taken each day was examined for peak records, as were the departure dates of individuals that were re-trapped. Southward flights seemed to follow the calendar and were not well correlated with weather fluctuations. Departures are commonly noted with the beginning of a rise in temperature and beginning of a south wind. Continued warm weather did not delay departures.

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NORTH DAKOTA AGRICULTURAL COLLEGE, FARGO, NORTH DAKOTA, AUGUST 20, 1957

GENERAL NOTES

Eastern Phoebe nesting in Louisiana.—In writing of the Eastern Phoebe (*Sayornis phoebe*) in Louisiana during the summer, Oberholser (1938. "The Bird Life of Louisiana," p. 394) states: "The only summer records for Louisiana are two birds seen northeast of Tallulah, between June 13 and July 13, 1924, by E. R. Kalmbach; and one seen at Logansport, by A. H. Howell, between August 25 and 27, 1906." No additional summer records in Louisiana since those cited by Oberholser have been reported. Alvin R. Cahn (1921. *Wilson Bull.*, 33:174) considered the Eastern Phoebe to be a "common breeding species about Marshall," Harrison County, Texas, in 1920. W. J. Baerg (1951. "The Birds of Arkansas," p. 97) states: "In the southern half of Arkansas it is a common resident species;" however, he gives no details. Ben B. Coffey, Jr. (1952. Personal communication) considers the Eastern Phoebe a rare summer resident at Memphis, Tennessee; he has found it nesting also in northern Mississippi (Newman, 1956. *Audubon Field Notes*, 10(5):389).

On April 18, 1954, James R. Stewart, Jr., and I observed an Eastern Phoebe in song near a small culvert at Metcalf, Caddo Parish, Louisiana. It disappeared shortly thereafter. Since we had been unable to locate a nest, the bird was considered to be a late migrant. The possibility that the species might occur as a breeding bird in the area was not entirely dismissed, however, for on the following weekend Stewart discovered a mud structure, which had the shape of a nest, beneath a bridge located 0.6 miles northeast of the point where we had observed the singing bird. Several visits to this bridge established that the nest, if such it was, was not in use, for no phoebes were seen or heard in the vicinity.

On May 28, 1955, I observed an Eastern Phoebe at a point about 7.5 miles north of Shreveport, Caddo Parish, Louisiana. I had been visiting this area regularly earlier in the month without having seen this species; I returned on May 29, but the phoebe could not be found. This individual was silent during my visit to the area on May 28; it had obscure brownish wingbars. The bird was believed to be a very late migrant, and was so recorded by Newman (1955. *Audubon Field Notes*, 9(4):337). The possibility is now presented that this may have been a wandering bird of the year. However, an extensive investigation of bridges and culverts in the northern half of Caddo Parish had been made on May 7; although the search was primarily for Barn Swallows, no phoebes were observed in that area.

On June 10, 1956, I observed two Eastern Phoebes perched together on a fence by a small bridge 1.1 miles west of Four Forks, in extreme southwestern Caddo Parish. Investigating, I found a nest on a beam on the underside of the bridge, over a small creek. After I had returned from underneath the bridge, I saw one of the phoebes fly under the bridge and not reappear. I went back and looked at the nest; the bird was settled on the nest but flew when it saw me. The site of these observations is only 2.5 miles east of the Texas state line; it is 14 miles southwest of Metcalf, and about 17 miles north of Logansport, DeSoto Parish. On June 23 this nest held three nestlings which were several days old. Both adults were watched as they carried food to the young. G. Dale Hamilton obtained color photographs of the adults with food at the nest. The adults were usually silent but would call when Hamilton or I was near the nest. The presumed male sang briefly on one occasion while holding food. Two other phoebes were seen on June 23, about 120 yards south of the nest site; at least one had brownish wingbars. Whether these individuals were another breeding pair or were young of an earlier nesting is unknown; there was no sign of an old nest under the bridge. I paid a brief visit to the area on July 2.

The nest was empty; an adult and a fledged juvenile were observed feeding about 25 yards north of the bridge. My next visit to the area was made on August 4 with Stewart; we were unable to locate any phoebes.

There were several other small bridges in the southwestern part of Caddo Parish, all within about six miles of this nest site, which were visited after the discovery of this breeding pair. No phoebes were observed at any of these bridges. A possible explanation is that the bridge which was used differed from the other bridges in that access to the underside was not partially obstructed by nearby grass or shrubbery.—Horace H. Jeter, *4534 Fairfield Avenue, Shreveport, Louisiana, December 27, 1956.*

Comments on wing-flashing and its occurrence in Mimidae with uniformly colored wings.—At least two species of mockingbirds without wing patches are known to flash their wings in the manner characteristic of the Common Mockingbird (*Mimus polyglottos*). Halle (1948. *Wilson Bull.*, 60: 243) noted the behavior in the Calandria Mockingbird (*M. saturninus*) in Argentina, and Haverschmidt (1953. *Wilson Bull.*, 65: 52) in the Graceful Mockingbird (*M. gilvus*) in Surinam.

My own observation on this last species on July 24, 1956, near San Cristobal de Las Casas, Chiapas, Mexico, where the resident race is *M. gilvus gracilis*, parallels Haverschmidt's. While studying birds with Mrs. Edna W. Miner along the Rio Amarillo in the vicinity of the Sumidero, I saw one of several Graceful Mockingbirds repeatedly flash its wings with the same jerky movements used by *polyglottos* in my yard in Oklahoma. This individual, foraging over an area of heavily grazed pasture grass, stopped now and then to flash its wings. It seemed to me that movements of its blackish wings against the light gray body were only a little less arresting than the flickering of white wing patches in the Common Mockingbird.

Halle suggested that the performance by mockingbirds with uniformly colored wings would seem to deal a blow to the theory of wing-patch display. The same might be said of wing-flashing in the Brown Thrasher (*Toxostoma rufum*).

Mrs. Amelia Laskey's brief comment on an adult Brown Thrasher "opening and closing its wings while investigating something in a dark spot at the base of a yucca plant where it had been feeding" has already been reported by Sutton (1946. *Wilson Bull.*, 58: 206–209). The fuller accounts for this species given by Ruth Thomas (1952. "Crip, Come Home." pp. 55, 140–141) also bear further mention.

Mrs. Thomas watched four young Brown Thrashers, about 30 days out of the nest, attack a mouse. One of them "pecked at it, at the same time lifting and spreading his wings." Of an adult female attacking a dead snake, Mrs. Thomas wrote: "First walking up and down beside its sprawled length, she raised and spread her wings, and every few steps jumped in for a quick peck. She grew bolder and for a few seconds stabbed in fury, then resumed the wary walk and the deliberate wing-lifting . . ." When another adult female "flew down and spread her wings at the snake," it was driven off by the first thrasher.

The inference is strong that all these Brown Thrashers were performing in the same way as Common Mockingbirds, although the observers have not expressly termed it wing-flashing. Tomkins (1950. *Wilson Bull.*, 62: 41–42), however, definitely ascribes wing-flashing to this species but without fully describing the action. The foregoing items, together with others in the *Wilson Bulletin* (Gander, 43, 1931: 146; Allen, 59, 1947: 71–73; Wampole, 61, 1949: 113; Brackbill, 63, 1951: 204–206), furnish considerable discussion of function, motivation and the age-sex factors in wing-flashing. Moreover, they also show that there is some confusion as to what constitutes wing-flashing, even in *M. polyglottos.*

Until we arrive at a clear understanding of, and a more definitive name for, this special wing display of certain mockingbirds, the term *wing-flashing* becomes ambiguous when used without descriptive details. Thus one wonders whether the Mockingbird that used wing-flashing many times during its half-hour attack on a blacksnake was performing the very same motions seen in the foraging bird (Hicks, 1955. *Auk*, 72: 296–297). If certain wing movements of the Least Bittern (*Ixobrychus exilis*) while stalking its prey, and Roadrunner (*Geococcyx californianus*) while hunting grasshoppers (Sutton, *op. cit.*) are to be equated with the Common Mockingbird's formalized and precisely repeated wing action as it works its way across a lawn, then it would seem that certain of the African herons while fishing (Austin L. Rand. 1955. "Stray Feathers from a Bird Man's Desk," pp. 131–132), the Jacana (*Jacana spinosa*) in sexual display (Rand, 1954. *Wilson Bull.*, 66: 131), and many another species might be said to wing-flash.

Dilger (1956. *Auk*, 73: 325), for instance, designates as "Wing Flashing" both the single wing and the double wing displays that certain thrushes (*Catharus* and *Hylocichla*) make toward an opponent bird. Such displays, he found, were typically preludes to fleeing action by the performer. What, then, of balancing and comforting movements of the wings or the pronounced wing-flicking in such birds as Ruby-crowned Kinglets (*Regulus calendula*) and the redstarts (*Setophaga ruticilla* and *S. picta*)? Where should we draw the line?

Skutch (1950. *Condor*, 52: 225) evidently did not consider that the reactions of a Blue Mockingbird (*Melanotis hypoleucus*), again a plain-winged species, to a handkerchief, placed over its nest and young as an experiment, involved wing-flashing. After pulling on the cloth and causing it to fall to the ground, the bird "hopped all around it, at times spreading his wings, jerking it and attempting to remove it farther from the nest . . ."

I do not think for one minute that the White-winged Dove (*Zenaida asiatica*) which I flushed from her nest and young was performing wing-flashing when she landed heavily near my feet and, back to me, began walking away with rapid, continued, upright stretching and folding of her wings, angel-fashion, though the performance suggested nothing so much as "setting-up" exercises. It was plain enough that these were intention movements motivated by attack and escape drives, neither of which drives has been shown clearly to function in wing-flashing of mockingbirds.

The distinguishing feature in wing-flashing of mockingbirds, as I see it, and one that was entirely absent in the case of the White-winged Dove, and apparently also in the above-mentioned thrushes, is the way the wings are extended by degrees and are held momentarily at several positions along the arc of movement. In *Mimus polyglottos*, *M. saturninus* and *M. gilvus*, at least, the wings "open by hitches," so to speak. Roy Bedichek (1947. "Adventures with a Texas Naturalist," p. 202) says of *polyglottos*: "I have counted as many as five notches before the extension was complete."

Very likely this special action also occurs in young birds of the three mockingbird species mentioned above. Certainly it often is seen in young Common Mockingbirds recently out of the nest and in later stages of development (Michener and Michener, 1935. *Condor*, 37: 106; Sutton; Allen; Brackbill; Tomkins). Peyre Gaillard of Atlanta, Georgia, who has given particular attention to this activity in the Common Mockingbird, informs me that he has seen young birds just before venturing out of the nest move their wings in this peculiar way (letter, January 15, 1955). I myself once saw a large, well-feathered young bird stand high in the nest and twice make three slow, incipient "hitches" of its wings while opening them only part way.

Possibly slow-motion pictures might reveal important differences in the wing-flashing of patterned and clear-winged Mimidae, or even in the Common Mockingbird when in feeding and in threat situations. I have not seen wing-flashing described for nestling Brown Thrashers. Any differences between their wing actions and those of nestling Common Mockingbirds might be especially significant.

An observation on *M. polyglottos* in Austin, Texas, in mid-November, 1946, seems worth including here, because of its unusual setting. A luxuriant growth of Moonflower (*Ipomoea Bona-nox*), trellised out a foot from the house and covering an entire wall and windows, was then untouched by frost. As I sat quietly near a window, my attention was caught by a Mockingbird wing-flashing inside the vines, about eight inches from the screen.

With its back squarely to me, the bird was opening and closing its wings with the usual jerky positionings, except that the vines seemed to hamper full extension at times and once almost threw the bird off balance. Apparently searching the foliage, the bird did not move about between flashings but instead turned its head from side to side with deliberation, sometimes peering up and down. Presently it jumped a few inches to a new footing in the vines and flashed the wings again.

This routine was repeated several times, though the bird did not progress over two yards. I noticed the wings were extended more fully as space permitted. Sometimes the movements were a mere "elbowing" in close quarters or extension was uneven when the wing toward the wall had freedom and the other was cramped by the vines. I saw no food taken, no other creature among the leaves. There was, I knew, a large Scaly Tree Lizard (probably *Sceloporus olivaceus*) that frequented the vines; but the bird did not center its attention on any particular spot and its general attitude suggested tranquillity. At no time did the bird seem to be aware of the observer.—LOVIE M. WHITAKER, *1204 W. Brooks Street, Norman, Oklahoma, January 26, 1957.*

Brood capture involving conflict between two female Mallards.—In April, 1953, a banded female Mallard (*Anas platyrhynchos*), returned to nest on a small artificial marsh near Norwich, Chenango County, New York, where she had been released the previous July. She was one of 10 game farm-reared, six-week old Mallards, equally divided as to sex, that were liberated on the marsh. Her mate wore an unidentified band, but may also have been from the same release.

From her clutch of 12 eggs she brought off only four ducklings on or about May 18. Sometime between late May and June 9, she lost one of the four, but the remaining three survived and were able to fly by the middle of July.

Also on the marsh, an unbanded female Mallard was rearing a brood of 10, hatched about July 1. The second female and her brood regularly remained on the opposite side of the marsh, away from the brood of three.

When the young of the banded female were able to fly she was in flightless condition. Apparently she still had an unusually strong "brood instinct," for she fought the unbanded female for possession of the brood of 10. Actual conflict, initiated by the banded bird, involving extended pursuits that resulted in scattering of the young, was observed on three occasions. By July 25, one week after she was last seen with her original three, the banded female had taken over the brood of 10, and the dispossessed female apparently had been driven from the marsh. Nine of the 10 were reared by the foster-mother. They were observed to fly on September 7, when the banded female was caught. At this late date the bird was still flightless with primary feathers just breaking their sheaths.

During the rearing of the original brood the banded female was accompanied by her mate whenever observed. He assisted in driving off other ducks that ventured too close to the young. When she possessed the new brood he deserted her, but remained with the three young even when they were flushed from the pond. He was comparatively slow in progressing into eclipse plumage but was flightless for only about two weeks. The female, on the other hand, was flightless for an abnormally long time, possibly as long as two months, for she was unable to fly on July 18 and her primaries still were sheathed on September 7.

With regard to brood capture, an interesting case was reported to me by Professor G. A. Swanson, who observed it on his farm near Ithaca, New York, during the summer of 1954. Two pairs of Mallards nested on the farm, the first bringing off a brood of six late in June, and the other a brood of three a few days later. Both were apparently renestings following unsuccessful first attempts. Several times during their first two weeks, the two broods of ducklings were observed on the same pond, and the size difference could readily be ascertained. Sometimes the two ducks fed near each other and the ducklings intermingled, and on a number of occasions when the broods were separated there were five ducklings with one and four with the other. The fourth one clearly had been transferred from its original parent to the second, since the size difference was still noticeable. Still later, the division was six and three again, but one brood consisting of three younger and three older ducklings, indicating that there had been still another transfer. At no time, however, was any fighting noticed between the two females.—Stuart S. Peters, *Department of Conservation, Cornell University, Ithaca, New York, March 1, 1957.*

Observations on Mexican birds.—Field trips made to various parts of Mexico over a period of years have disclosed information concerning various birds which it is thought may be of general interest.

Antiurus maculicaudatus. Pit-Sweet.—This bird, called "Spotted-tailed Nighthawk" by Cory (1918) in the "Catalogue of the Birds of the Americas," was listed under the genus *Caprimulgus* by Friedmann, Griscom and Moore (1950. *Pac. Coast Avif.* no. 29) and called "Spot-tailed Whip-poor-will." However, it has habits so different from typical members of *Caprimulgus* that it would seem to be best to retain the older classification. The use of a common name suggesting the call of the bird not only follows the usual custom for birds of the group but gives a shorter and simpler name. The Pit-Sweet is quite common on the savannahs of the coastal plain in the region of the Veracruz–Tabasco border, and has been heard calling over a wide area from the last week in March to the second week in May during visits in different years. On one visit to the region in June no birds were heard. (I have not been in the area in the fall.) During the day the birds hide in the dense woods. The plain between the mountains and the Gulf of Mexico in southern Veracruz, Tabasco, and Chiapas is marked with a multiplicity of low ridges over much of its area. Supposedly the great amount of rainfall has washed away most of the plant food on these ridges. At any rate they support a growth of low grasses, but only very scattered small shrubs and an occasional clump of dwarf palms. About half way down the slopes a dense growth of trees begins and the trees become larger and taller at the bottom, where there is frequently a small creek or swamp. The birds come out in the evening (about 7:00 p.m.), and fly back and forth over the grassy areas. They fly low over the grass (mostly from two to 10 feet above the ground) calling as they go. At times they alight on a small patch of bare gravel between clumps of grass and at times they perch for a short time on a twig of one of the small shrubs which are scattered over the grassland. They perch upright on these small branches and sometimes continue to call. A single call is given and, after a short pause, is repeated after the fashion of the "peent" call of the Booming Nighthawk (*Chordeiles minor*). The pitch of the call is even higher than that of the Nighthawk and reaches a maximum frequency of about 7000 cycles per second. The call may be represented as "Pit-Sweet"; it requires about one second of time and is repeated after a pause of slightly over a second. Occasionally there is a momentary speed-up and three calls are given in rapid succession. The quality is almost insect-like and the volume rather thin. At times the bird makes a "display" noise with the wings by beating them three or four times quickly and forcefully, causing a low-pitched "flut-flut-flut" sound as it pursues another of its kind low over the grass.

Caprimulgus ridgwayi. Whip-poor-will; Cookacheea.—Like other members of the genus this species calls for some moments from its hiding place in a thicket before it comes out for its evening flight. The song consists of a series of rapid notes of such quality and phrasing that it may be said to sound like a Katydid (*Pterophylla*). The phrasing varies somewhat in different parts of the country but the quality and effect is the same so that all are readily recognized. One song may be represented as "Cuk-cuk-cuk-cuk-acheeah-cheea"; this effort requires about one second of time and may be repeated 11 times in 25 seconds. A longer one may be given as "Cuk-cuk-cuk-cuk-cu-cu-cu-cu-cu-cu-cu-cu-cu-cu-cu-cu-cu-acheea." This whole song requires about two seconds and may be repeated at such a rate that four will be given in 15 seconds. The "cu" is pitched about the third A above middle C and the highest part of the "chee" is about four notes higher. This species was encountered from sea level up to over 4000 feet elevation, usually in rather open, semi-arid woods or in brushy "islands" in savannahs.

Sayornis saya. Say's Phoebe.—Although this species is frequently reported rather far south in the plateau region of Mexico in winter, it is seldom encountered in the summer months. On June 29, 1952, Richard Herbert and I found a pair of these birds feeding young in a nest on the wall of a very narrow, slit-like gorge on an arid hillside about 90 miles (via the Pan American Highway) northwest of the city of Oaxaca.

Empidonax mexicanus. Pileated Flycatcher.—Although this bird (usually listed as *Aechmolophus mexicanus*) has a longer and more pointed crest than other members of the genus *Empidonax* its appearance in the field suggests one of the browner members of that group, and field students always attempt to look it up in that genus when they first encounter it. (The crest is more often than not decumbant and seldom raised more than half way; hence they do not notice it.) Consequently, it would seem to be helpful to recognize the bird as belonging to that genus. The nest resembles that of the Acadian Flycatcher (*E. virescens*) and the song suggests the Buff-breasted Flycatcher's (*E. fulvifrons*) though better developed and stronger. The song starts with a chatter but quickly goes into a trill which becomes louder and faster, and then bursts into a sharply accented "ReeChoo." The "Ree" is pitched about the fourth A above middle C. The whole song may be represented as, "Ra re ee-e-e-e-e-ReeChoo"; it requires about one and a quarter seconds. Encountered most frequently in semi-arid woods at from 4000 to 5000 feet elevation, the bird seems to be most common from western Puebla to central Oaxaca.

Cissilopha beecheii. Beechey's Jay.—Although sometimes confused with the San Blas Jay (*C. san-blasiana*) this species is quite distinct in the field. It lacks the small frontal crest of the San Blas Jay, is larger, and has a conspicuous yellow iris (that of the San Blas Jay is pale yellow or brown); also the voices are quite different. The velvet-like feathers along the sides of the cap stand up somewhat so that the fore part of the crown appears sunken; this gives the bird a "raised eyebrows" look. The call is a rather soft "jaay," which is so nasal and burry that it is probably better represented as "Jerrr" or "Jurrr," according to the pitch, which varies with different individuals from about the first F above middle C up to the first A above it. The sound is almost like that of a fly buzzing under a piece of paper. A single call may be given, or a slow series, or as many as 10 may be given in a space of five seconds.

Cissilopha yucatanica. Yucatán Jay.—In the field this species appears like the Beechey's Jay except that it does not have the yellow iris. Instead of having a frontal crest as in the San Blas Jay, all the feathers of the head seem to be very slightly elongated. When the bird is excited it sometimes erects these feathers and the whole head appears to be somewhat fuzzy. This species makes a loud, harsh clatter or rattle that is suggestive of the call of a Great-tailed Grackle (*Cassidix mexicanus*). There is also a rather loud, sharp, "Pip"; and a series of clear, high-pitched, titmouse-like notes. This last mentioned song may be represented as, "Chea-chea-chea-chea-chea"; this requires one second of time and the "chea" note is pitched about the fourth G above middle C. (The last part slurs down about one tone but this is scarcely noticed since the call is so fast.) This song might be confused with the clear "che" song of the Petén Vireo (*Vireo semiflavus*) but it is given only at random whereas the vireo usually repeats his song a number of times. It might also be confused with the song of the Orange Oriole (*Icterus auratus*), but that bird places a short preliminary phrase ahead of its series of "che" notes. The loud "chea" song of the Yucatán Jay may be preceded by a fairly loud call, "Eyah," of a somewhat nasal quality. This requires from one fourth to a third of a second and is pitched about an octave lower than the "chea."

Vireo semiflavus. Petén Vireo.—While field studies do suggest that this bird is a member of the Mangrove Vireo complex (*pallens* "artenkreis"), it does not seem likely that any field student would take seriously the suggestion made by some taxonomists that it is a race of the White-eyed Vireo (*V. griseus*). In the field, the eyes of breeding adults seem to be quite dark, and have a beady appearance somewhat like those of the Hutton's Vireo (*V. huttoni*). The song consists of a series of identical notes. In one case there is a clear "che" repeated eight times in two seconds; the pitch is about the fourth G above middle C. Other songs are similar but of a somewhat nasal quality. There is a series of "weo" notes and a series of "chu" notes, both given at the rate of eight in two seconds. (The song may however continue for more than two seconds.) There is also a much faster song which is just a rattle of some 20 "chu" notes in two seconds. (The bird vibrates his tail as he does the rattle). The call used as a warning or alarm note is a slightly nasal, vibratory, "Queeee," which lasts about one second. In the Yucatan Peninsula this species is common in rather open areas of second growth woods, and in the region of low scrub both inland and along the coast. This is quite different from the habitat selected by the Mangrove Vireo (*V. ochraceous*), which seems to be confined entirely to the mangrove swamps along the Pacific Coast. The Mangrove Vireo, however, shows close relationship in the form of his song, which is also a series of "che" notes. Aside from the indistinct wing bars and the incomplete yellow eye ring, the Petén Vireo looks very much like the Golden Vireo (*V. hypochryseus*) in the field, and it happens that the song of the Golden Vireo is also a series of "che" notes.

Icterus spurius. Orchard Oriole.—Except for a small colony on the banks of the Rio Grande in extreme northeastern Tamaulipas, this species (in Mexico) is confined during the breeding season to high tableland from Coahuila southward. The colonies are small and isolated and usually situated in irrigated areas. The adult males are quite dark. Orchard Orioles nest during June and seem to return to the same area each year. Two adult males were observed feeding young in different nests located about 20 miles south of Zamora, Michoacan, on June 19, 1953. The species was first observed in the area in June, 1941, and the colony was still present in the summer of 1956. The song of the Mexican birds is of the same quality and style as that of Texan population. The form of the song of this species is so variable from individual to individual that it is not possible to make fine points of distinction on the phrasing. The form of the song of Fuertes' Oriole (*I. fuertesi*) varies in the same way and this makes it extremely difficult to compare the songs of the two species. It may be noted that Fuertes' Oriole is a bird of the eastern lowlands (during the breeding season) where the nearest individuals are 200 miles or more away from any known breeding Orchard Orioles; and, as has been pointed out by the Grabers (1954. *Condor*, 56:274–281), the lightest Orchard Oriole male is darker than the darkest of the Fuertes Orioles (there are no intergrades). The Fuertes Oriole seems to be quite common locally at the extreme northern limit of its range, in southern Tamaulipas. Nesting begins in Tamaulipas about the middle of May; a pair was observed with young out of nest in southern Veracruz (La Piedra) on June 29, 1952, which would seem to indicate that they nest no earlier in the south.—L. Irby Davis, *Box 988, Harlingen, Texas, January 10, 1957.*

Notes on the Red Crossbill in Minnesota.—The country-wide invasion of Red Crossbills (*Loxia curvirostra*) in the fall, winter and spring of 1950–51 (Tordoff, 1952. *Condor*, 54:200, and others) was but poorly recorded in Minnesota. Two sight records were published (Oman, 1951. *Audubon Field Notes*, 5:139, and Flaherty, 1952. *Flicker*, 24:25), and four specimens were preserved. The identification of these specimens and the re-identification of the 23 other Minnesota specimens of the Red Crossbill in the University of Minnesota Museum of Natural History collection reveal the need for several changes in the taxonomic appraisal of this species as presented by Roberts (1936. "The Birds of Minnesota"). An additional 11 Minnesota specimens from the collection of H. F. Kendall of Virginia, Minnesota, were examined. Sheridan S. Flaherty (*loc. cit.*), of Morris, Minnesota, kindly loaned photographs of the Red Crossbills that visited his feeding station between March 23 and May 31, 1951. One or more birds were seen daily during that period, with nine seen on the latter date. They were believed to be preparing to nest, although this seems improbable since Morris is situated in the prairie region of central western Minnesota. The subspecific identity of the birds could not be determined.

The material studied confirms Griscom's statements (1937. *Proc. Boston Soc. Nat. Hist.*, 41:5) that the races *minor* and *sitkensis* (of the American Ornithologists' Union Check-list, 1931) occur in Minnesota, and allows us to add the race *benti* to the state checklist. Apparently Griscom did not include in his monographic revision the Minnesota specimens recorded in this study.

These specimens are identified as follows:

Loxia curvirostra sitkensis.—Five females measure: wing, 77:3–82.0 mm.; culmen, 13.3–14.3; two males measure: wing, 83.0 and 83.5; culmen, 14.2 and 14.7. Also the culmen (rhinotheca *in situ*) of one male skeleton measures *ca.* 14.8 mm. Dates represented are July and August, 1922 (five specimens); May, 1923 (one); and January, 1951 (two).

Griscom (*op. cit.*:124) lists specimens of this form from Illinois taken in April and June, 1923, but apparently he did not recognize these as indicative of an extensive flight year. There are four specimens of *sitkensis* in the Louis Agassiz Fuertes Collection at Cornell University taken at Ithaca, New York, in January, 1923.

Loxia curvirostra minor.—Four females measure: wing, 83.2–88.3 mm.; culmen, 15.0–17.0; 12 males, wing, 86.8–93.0; culmen, 15.1–17.4. Ten of these were breeding birds taken by T. S. Roberts at Grand Marais, Cook Co., northeastern Minnesota, August, 1879. The only post-1900 specimen in the University of Minnesota Museum of Natural History collection is a male found dead near Minneapolis on February 22, 1956. There are apparently no valid records of *minor* outside the boreal regions during the 1950–51 flight (Tordoff, *loc. cit.*) of the western populations.

Roberts (*loc. cit.*) cites several sight records of juvenal Red Crossbills, but to date no specimens from the state have been reported. The collection of H. F. Kendall contained 11 Red Crossbills taken between August 12 and October 4, 1931; all in various stages of post-juvenal molt. However, the progress of this molt does not correlate with the date on which a given specimen was collected. A male taken August 20 has nearly completed the molt, whereas two males and a female, taken August 30 and September 1, have but a few new feathers on the back, throat and breast. Males taken on August 12 and 20 have more than half completed this molt, while a male taken October 4 has replaced fewer than half his juvenal feathers. The males are acquiring the mottled plumage ascribed to first winter birds of the eastern race, with red and green feathers interspersed. Most of these specimens show evidence of having been rather fat when collected. The two females measure: wing, 90 and 91 mm.; culmen, 17.0; males, wing, 89.7–93.4; culmen, 16.1–17.6. Gratitude is expressed to Mr. Kendall for his loan of these birds.

Loxia curvirostra benti.—Two crossbills of this race flew into a window during a snowstorm on November 15, 1950, in a suburb of Minneapolis. These were an adult male and a first-year male; they measure, respectively: wing, 98 and 90 mm., culmen, 20.5 and 18.7.

Appreciation is expressed to Harrison B. Tordoff who examined certain specimens, and confirmed identification of those representing the race *benti.*—ROBERT W. DICKERMAN, *University of Minnesota Museum of Natural History, Minneapolis, Minnesota, April 30, 1957.*

The look-out perch as a factor in predation by Crows.—On the grounds of the Preston Laboratories at Butler, Pennsylvania, we normally have a couple of dozen Mallards (*Anas platyrhynchos*) of which about 10 are females. They are fully flighted, and nest over a wide area inside the fence (100 acres) and sometimes outside it. We also have a pair of Common Crows (*Corvus brachyrhynchos*) which destroy all the early nests and most of the later ones, and also (apparently) catch the ducklings. This predation is successful to the point of holding the numbers of ducks to about two dozen, the number of ducklings raised per annum being three or four at this population density. It is probable that other predators help, perhaps raccoons (*Procyon lotor*) and opossums (*Didelphis marsupialis*) more particularly, but since eggs disappear from nests in the middle of the day and the other predators are essentially nocturnal, and since we observe the crows watching and searching, we believe that the crows are the effective agents. Each female duck probably makes at least three attempts to nest, and probably lays in excess of 20 eggs, since there are often 15 or more eggs in the first nest, though only half a dozen or so in late ones. Out of some 200 eggs, probably 20 hatch, 15 ducklings reach the water, and 3 or 4 are raised. This is an efficiency of about 2 per cent, and is much lower than Lack (1954. "The Natural Regulation of Animal Numbers," p. 79) gives in his tabulation.

The crows also discover and destroy the nests of Ring-necked Pheasants, (*Phasianus *colchicus*) and even peafowl (*Pavo cristatus*). When eggs or ducklings are not available, they will condescend to eat the grain we set out for the ducks. There is no evidence that these particular crows or their offspring search for dead rabbits along the neighboring roads, and I am not sure that they eat dead fish stranded by the lake or brought ashore by raccoons. They probably have sources of food other than those here mentioned, though it would not be necessary.

The crows sit in the treetops, and watch for the duck to go to her nest. At the time of first nesting the herbage is low, and, although the nest itself may be well hidden under a low evergreen, the duck must necessarily betray it.

On the later nestings, the nest is equally well hidden, usually among tall weeds and grasses, but the duck now has the advantage that she can sneak through such cover for many yards, and sometimes the crows do not find the nest. If the nest is well away from the water, the raccoons do not find it either. All goes well till the ducklings hatch, and then the mother must quack to call the ducklings to follow her to the lake. The crows appear to know what that means as well as do the ducklings. They fly to the tree nearest the sound, and each crow apparently captures its duckling. Thus, on June 25, 1955, in one nest in which nine of 11 eggs hatched, three crows settled in the oak tree nearest the nest, and six ducklings reached the water, where I saw them on June 26. It seems fairly clear what happened to the others. Then the crows moved down to trees by the lake, sometimes at one end thereof, sometimes at the other, depending, apparently, on where the mother and her brood were. By noon of June 28, the family was reduced to three, and by 7:00 p.m. the same day was down to one. The ducklings were safe on the water, but in danger when they came ashore and they disappeared one after the other till not one was left.

The Wood Ducks (*Aix sponsa*) which nest with us seem to be much more successful. To begin with, they nest in holes, or in the boxes we put up for them, and perhaps the crows do not like to venture into boxes. Some nests no doubt are destroyed, but most likely by other predators. None the less some of the early clutches hatch out, and by just about 100 per cent. The young are kept "out at sea" among the lily pads to a much greater extent than young Mallards, and there they are safe from both crows and hawks. When they do go ashore, the mother seems able to protect them and is very alert to place herself between the danger and the ducklings. In two or three years' observation, involving some scores of young, we have observed that very few were lost once they were hatched. In some way the Wood Duck is adapted to the presence of crows and able to outwit them, while the Mallard is extremely vulnerable.

This brings me to the main point, or question, of this memorandum. Logan J. Bennett (1938. "The Blue-winged Teal") several times comments on the incompatibility of trees and teal. He ascribes this to the fact that herbage does not grow well under trees to provide good nesting cover for the ducks, and also to the fact that trees provide nesting sites for Crows and Horned Owls (*Bubo virginianus*). These are valid reasons, but I here raise the question whether the bad influence of trees may not be more direct. The trees are lookout perches from which a crow may survey a meadow or prairie and locate duck nests by the movements of the mother. In the absence of the perches, the crow is relatively helpless, even if he has a good nesting site within commuting distance. He cannot hover, and if he cruises about overhead, he will use up a lot of energy, and even then may not be well-placed to survey the situation. I find that our crows use dead trees, trees not yet in leaf, and power poles to watch what goes on, and I suspect that if I could remove all elevated perches of this kind for a quarter mile around the lakes, Mallard hatching success would be much greater, and probably raising success also. I offer this as a suggestion, without proof, since I am not in a position to make the experiment.

The behavior of the crow is similar to that of Brown-headed Cowbirds (*Molothrus ater*). They also sit in the treetops, watching for small birds to carry nesting material to their nests, so that the cowbird knows where the nest is before the first egg is laid. Sometimes she lays the first egg herself (Norris, 1947. *Wilson Bull.*, 59:92).

The effectiveness of this elevated look-out perch is clear from the behavior of the Eastern Bluebird, *Sialia sialis*, (Preston, 1948. *Wilson Bull.*, 60: 120) of the Loggerhead Shrike (*Lanius ludovicianus*) and other species.

We have seen that the crows are ineffective against the Wood Duck. They are also ineffective against our Canada Geese (*Branta canadensis*) or our Egyptian Geese (*Alopochen aegyptiacus*). This is probably because both parents keep a tight control over their young, and are very bellicose in their defense. The young come ashore freely, but the crows get few or none. It would probably be a very rash crow that attempted it.

In England as a boy I often found Mallard nests in hollow trees, and hence in wooded areas, but the game keepers had cleared out the Carrion Crow (*Corvus corone*) in those sections.

It would seem possible that one reason the great nesting grounds of many species of our North American ducks are in the prairies is because originally the prairie was treeless, thereby putting the crow at a disadvantage. Potholes, kettles, ponds and lakes exist in forested regions, and in partly wooded regions, and probably food is plentiful there, but the nesting ducks in such places are few, and largely those that nest in hollow trees.

Perhaps the predators' look-out perch is the clue to the situation, and the prairies could be depopulated of ducks by a modest amount of tree planting supplemented with lines of telephone poles. At any rate the crow has increased in the prairies with the coming of settlement, and is now an important factor in waterfowl predation there.

Perhaps as a sort of appendix I may be permitted to add an account of the behavior of the Carrion Crow as a predator on the Red Grouse (*Lagopus scoticus*) on the Scottish moors. This is secondhand information given to me by a gamekeeper in northern Scotland in 1949, when I spent some time with him after the main nesting season.

"When the hen grouse is incubating, the cock frequently sits conspicuously upon a rock or other perch at a little distance. The crow, observing him, alights on another neighboring rock and waits to see if he is attacked. If he isn't, he moves to another perch and repeats this till he *is* attacked. He then knows the hidden female is near, and looks around till he finds her. He then fights with the female. In the melee the eggs are scattered, which is the crow's objective. He can then gather them at his leisure, while the grouse must abandon the site. This goes on as long as the crow has young in the nest, and so effective are the tactics that no grouse can hatch its eggs in the crow's territory. However, when the young crows have left the nest, the crows seem much less interested in eggs. The grouse then renest and may have a fair measure of success." This complete suppression of the early nestings of the grouse and the incomplete suppression of the late renestings agrees exactly with what we observe with the Mallards on our Laboratory grounds.—F. W. PRESTON, *Box 149, Butler, Pennsylvania, June 13, 1957.*

Broad-winged Hawk in Coahuila.—On July 6, 1955, I obtained a Broad-winged Hawk (*Buteo platypterus platypterus*) 13 miles east of San Antonio de las Alazanas, Coahuila, in a Douglas fir-pine-aspen association. The specimen (KU 32628), an adult male, lacked the right foot and distal one-third of the tarsus. Despite this abnormality the animal was not emaciated. Pertinent measurements, in millimeters, were: right testis, 6 × 3; left testis, 7 × 2; wing, 274; culmen from cere, 18.1; middle toe without claw, 26.5. Because of the migratory habit of this species, its occurrence in Coahuila and other northern states of Mexico would be expected. Previously, however, the Broad-winged Hawk has been recorded in the Republic of Mexico only from the more southern states of Sinaloa, Jalisco, Colima, Oaxaca, Chiapas, and Veracruz (Friedmann, Griscom, and Moore, 1950, *Pacific Coast Avifauna* no. 29: 56). This species is known to breed as far south as Texas, the Gulf States and Florida. The condition of the testes of the Coahuilan bird suggests that it was not in breeding condition. This hawk, if a migrant, may have been retarded from moving northward by the loss of its foot.—ROBERT L. PACKARD, *University of Kansas, Museum of Natural History, Lawrence, Kansas, May 17, 1957.*

A pallid-eyed individual of *Dumetella carolinensis*.—From April 25 thru May 31, 1957, I banded 55 Catbirds (*Dumetella carolinensis*) at my station in Addison Township, Oakland County, Michigan. On May 13, I caught and banded (55-147402) one which, instead of the normal dark purplish-brown, had extremely light-colored eyes. The outer margins of both irises were very pale gray, even lighter than platinum gray. Every detail of plumage was normal. I regret to report that the bird escaped while I was carrying it to the house where I intended to photograph it.—ALICE D. MILLER, *1150 Brewer Road, Leonard, Michigan, July 21, 1957.*

WILSON ORNITHOLOGICAL SOCIETY NEWS

THE JOSSELYN VAN TYNE MEMORIAL LIBRARY

In recognition of the leadership and service of the late Josselyn Van Tyne to the Wilson Ornithological Society, the Executive Council, at its meeting in June, 1957, voted to rename the Society's library the Josselyn Van Tyne Memorial Library. Subsequently Mrs. Van Tyne announced her plan to present the bulk of Dr. Van Tyne's personal library to the Wilson Ornithological Society. Included in this gift are a number of virtually unobtainable items, among them Stresemann's "Aves," the complete set of the Aves section of the *Zoological Record*, and the reprints on birds from the publications of the Museum of Comparative Zoology. The Wilson Ornithological Society is deeply indebted to Mrs. Van Tyne for her generosity, and we hope that this development will be followed by the increased growth and use of the Josselyn Van Tyne Memorial Library.

THIRTY-NINTH ANNUAL MEETING

The Annual Meeting for 1958 will be convened at Oglebay Park, Wheeling, West Virginia, April 24 to 27. Sponsors for this meeting are the Brooks Bird Club and the Oglebay Institute. A call for contributions to the program will be mailed to members soon.

LOUIS AGASSIZ FUERTES RESEARCH GRANT

Application forms for the 1958 Louis Agassiz Fuertes Research Grant may be obtained from the chairman of the Research Grant Committee, Dr. Kenneth C. Parkes, Carnegie Museum, Pittsburgh 13, Pennsylvania. A grant of $100 is awarded annually by the Wilson Ornithological Society as an aid to the completion of the research project which, in the judgment of the Committee, seems most likely to make an important contribution to ornithology. Affiliation with a university is not required, and applications from non-student amateurs are invited. Prospective applicants will find a detailed account of the history of the Fuertes Research Grant in the December, 1955, issue of *The Wilson Bulletin.*

The deadline for applications for the 1958 Grant will be April 1. The decision of the Committee will be announced at the annual meeting in Wheeling on April 25, and published in the September issue of *The Wilson Bulletin.*

The National Science Foundation will award grants to defray partial travel expenses for a limited number of American scientists who wish to participate in the XIIth International Ornithological Congress, scheduled to meet in Helsinki, Finland, June 5 to 12, 1958.

Application forms may be obtained from the National Science Foundation, Washington 25, D.C., and must be returned by January 20, 1958.

Ornithologists who plan to submit applications for grants from the Frank M. Chapman Memorial Fund should do so before March 15. Awards from this fund are made annually to assist younger scientists conducting research in any branch of ornithology. Further information may be obtained from the Chairman, Chapman Memorial Fund Committee, The American Museum of Natural History, New York 24, N. Y.

The American Ornithologists' Union will meet in New York, October 14 to 19, 1958, on the occasion of the Union's 75th Anniversary. This meeting is sponsored jointly by the Linnaean Society of New York, The National Audubon Society, the New York Zoological Society, and the American Museum of Natural History.

ORNITHOLOGICAL LITERATURE

Birds of Pine-oak Woodland in Southern Arizona and Adjacent Mexico. By Joe T. Marshall, Jr. Cooper Ornithologial Society, Berkeley, California; Pacific Coast Avifauna Number 32, 1957: 7 × 10½ in., 125 pp., frontispiece, 26 figs., 1 color plate. Illustrated by Don R. Eckelberry. Price: $4.00 (paper covers), $5.00 (bound with buckram).

It is gratifying to note, among the increasing deluge of published material on the Mexican avifauna, some recent progress beyond the faunal list and geographical distribution stage of investigation. Marshall's study is an interpretation of the abundance and ecological distribution of the breeding birds of the pine-oak woodland of southeastern Arizona and the neighboring Mexican states of Sonora and Chihuahua. The report is based on censuses and observations of behavior made during the summers of 1951, 1952, and 1953. It may rightfully serve as a model for similar analytical work on other equally interesting biotic communities of Mexico.

Approximately one-quarter of the book is devoted to the floristic composition and general vegetational features of the study area, including descriptions of the various camps and dates of visitation. Another quarter deals with census methods and general aspects of the avifauna, among which are habitat selection, competition, history, and factors limiting distribution. The remaining half of the book consists of accounts of 170 species, 93 of which are considered to nest regularly and/or feed in pine–oak woods. These accounts consist largely of observations of local behavior, habitat perferences, and interspecific relationships. Binomials are used throughout, since the distinction of subspecies is not an expressed purpose of the study. There is a four page bibliography but no index.

Seventeen photographs help the reader to envisage the physiognomy of this ecotone community. There are nine tables and six maps. A pair of Spotted Screech Owls painted by Don Eckelberry makes an appropriate and attractive frontispiece. Black and white drawings by Eckelberry depict three more pine-oak species: Olivaceous Flycatcher, Bushtit, and Hutton Vireo. The single color plate of a pair of Olive Warblers, also by Eckelberry's talented hand, will be familiar to readers of the *Condor* (vol. 58, no. 2). Its inclusion in the present Cooper Society publication presumably was regarded as a financial *coup de maitre*, but unfortunately may give the erroneous impression that this is another indicator species of pine-oak woods.

Pine-oak woodland was apparently selected not as an entity but rather as a convenient division of an over-all continuum of vegetation that might be used to study the ecological needs of birds and their consequent abundance and distribution. This is a healthy and refreshing attitude in view of the tendency of some contemporary workers to emphasize the discreteness of natural communities. "Species and their populations are the realities to be seen; their sortings and mixtures can be classified less objectively . . . . Only after we realize these facts can we permit ourselves the luxury of speaking of vegetation types, associations, or communities as may be necessary for discussing the distribution of birds" (p. 39).

Marshall's style of writing is anecdotal, descriptive, and chatty. Those who prefer their scientific reading concise and telegraphic will regard many of the author's comments as trivial and inconsequential. Such is the plight of most writers who abhor the thought of omitting any detail on the grounds that it may be useful or significant to someone, sometime.

In general, care has been exercised by both author and printer for there appear to be few errors or omissions. Exceptions are apparently inevitable, as evidenced by the misspelling of "Olivaceous" on figure 24 and the incomplete labeling of figure 3 (*Pinus durangensis*) and of figure 21 (Rusty Sparrow). The author had some difficulty with his herpetological material: *ochrorhyncha* (misspelled on p. 76) has been replaced generally by *torquata*; *Coleonyx* is misspelled on page 76.

One might question the efficacy or even purpose of certain tables and figures in this work. The complexity and variability of bird behavior make its presentation in tabular form difficult and too frequently misleading. Feeding behavior, for example, may be presented in a far too typological vein (table 5). Data on the geographical limits of pine-oak birds do not merit repetition in three forms of editorial expression: map (fig. 21), table (table 9), and text (pp. 45 and 67). The use of scientific names in table 2 and common names in table 3 presumably enables the reader to interpret the former, if necessary; but table 3 contains more species, hence the entries are not comparable.

The author demonstrates a good grasp of the vegetation of the study area, which could only have been developed by carefully observing and collecting over a period of years. This knowledge has been used to best advantage in interpreting the ecological needs of the birds in his study area. His analysis of a number of prominent biological topics is critical and erudite. The views on "ecologic" races and competition (pp. 53–60), for example, will be of interest to many readers.

Anyone who has had field experience within Marshall's study area will be appreciative of the obstacles that he must have overcome in compiling the amount of data presented in this publication. The inaccessibility of most of the isolated mountain ranges, coupled with the limited time available to university faculty for field work have unquestionably discouraged many less determined workers. We can only hope that Marshall will give us a repeat performance with other segments of the Mexican avifauna.—WESLEY E. LANYON, *American Museum of Natural History, New York 24, New York.*

Ornithologists are indebted once more to Col. W. P. C. Tenison for his compilation of the Aves section of the *Zoological Record*, listing and indexing the world literature of ornithology for 1956. This volume may be purchased from the Zoological Society of London for 10 shillings.

INDEX TO VOLUME 69, 1957

This index includes, in addition to names of species and authors, references to the following topics: behavior, conservation, embryology, food habits, hybrids, geographic localities, growth, measurements, migration, molts and plumages, nesting, parasitism, physiology, populations, predation, taxonomy, voice, and weights. References of biological significance to mammals and reptiles are grouped under those headings. Names of new forms described in this volume are printed in **boldface** type.

This issue of *The Wilson Bulletin* was published on January 7, 1958.

EDITOR OF THE WILSON BULLETIN
KEITH L. DIXON
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Agricultural and Mechanical College of Texas
College Station, Texas

SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (fourth edition) and supplements thereto insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. The Illustrations Committee will prepare drawings, following authors' directions, at a charge of $1 an hour, the money to go into the colorplate fund. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A WORD TO MEMBERS

The Wilson Bulletin is not as large as we want it to be. It will become larger as funds for publication increase. The Society loses money, and the size of the *Bulletin* is cut down accordingly, each time a member fails to pay dues and is put on the "suspended list." Postage is used in notifying the publisher of this suspension. More postage is used in notifying the member and urging him to pay his dues. When he does finally pay he must be reinstated on the mailing list and there is a publisher's charge for this service. The *Bulletin* will become larger if members will make a point of paying their dues promptly.

NOTICE OF CHANGE OF ADDRESS

If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia. He will notify the publisher and editor.

Plan Now to participate in

THE THIRTY-NINTH ANNUAL MEETING

to be held at

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